DAVID L. HAMBLEN • A. HAMISH R.W. SIMPSON

ADAMS'S Outline of Orthopaedics

FOURTEENTH EDITION



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Fourteenth Edition



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Preface

This new 14th edition of *Outline of Orthopaedics* is the first without the direct input of John Craw ford A dam s. It appears just over 50 years from the publication of his first edition of this book and its companion volume *Outline of Fractures*. To mark this remarkable achievement it was decided to add his name to both titles, which still contain evidence of his lucid writing style and clear illustrative line drawings. H is original aim of providing a broader coverage of orthopaedic diseases and their diagnosis and treatment than that required for undergraduate examinations has been preserved. We make no apology for this, since musculoskeletal disorders now make up at least 20% of the clinical material presenting to primary care. This book should provide a valuable reference tool for general practitioners, physiotherapists, orthopaedic nurses, and basic surgical trainees, as well as instructing the undergraduate medical student.

The broad arrangement of material into three parts; clinical methods, a general survey of orthopaedic disorders, and regional orthopaedics, has been retained in the new edition. All the text has now been put into the same standard font size which should ease the task of the reader. To make space for this change without enlarging the book to a cum bersom e size, we decided to elim inate the literature references previously included. It was felt that these are now more readily available in an up-to-date digital form at using com puter technology. We have also elim inated some of the duplication of material in the regional chapters where this has already been covered in the general survey of Part 2.

Professor Hamish Simpson, the co-author for the latest edition of Outline of Fractures, has now joined the editorial team for this revision of Outline of Orthopaedics. His input has provided valuable material on the fast-changing nature of today's orthopaedic practice. We also welcome the collaboration of Dr Nigel Raby, who has contributed a new expanded chapter on the role of im aging in orthopaedic diagnosis and treatment. This development probably represents the most important change to orthopaedic practice in the past ten years and has revolutionised clinical care. The danger is that these sophisticated investigations may also be used as a substitute for the clinical skills of history taking and physical examination of the patient. Without this, other co-morbid conditions may be missed and the opportunity to make a provisional diagnosis allowing more focused investigation may be lost. With the assistance of Dr Raby and other clinical collaborators we have been able to include a large num ber of new illustrations to replace and enhance som e of the older redundant im ages. We hope that the new edition, while retaining the strength of its predecessors, will provide today's trainees, whether undergraduate or postgraduate, with a broad overview of the constantly expanding field of orthopaedic surgery.

> David L H am blen Ham ish Sim pson 2010

Acknowledgements

The authors must first pay tribute to the original author, John Craw ford Adams, whose inspiration and enthusiasm produced the original volume and steered it through twelve further editions. The success the book has enjoyed for over 50 years is a tribute to his writing skills which have provided us with a sound base on which to develop this new edition.

A major contribution to the latest revision has come from Dr Nigel Raby, Radiologistatthe W estern Infirm ary, G lasgow, who has written the new chapter on 'Im aging in Orthopaedics' and co-edited the material on bone and soft tissue tum ours. In addition he has supplied a large number of new and replacement radiographs and scans in many of the other chapters to reflect the advances in this field of investigation. Because of the increasing specialisation within orthopaedics we have had to seek help from other clinical colleagues to fill gaps in the illustrative material. For this we thank Dr Robin Reid, Dr Martin Sam brook, Mr Nick Geary, Mr Thanos Tsirikos, and Mr Graham Lawson. Thanks also go to Dr Helen Frost for editing and updating the material on the role of physiotherapy in treatment. We acknow ledge the assistance of Morag Macleod and the staff at the National Centre for Prosthetics and Orthotics, University of Strathclyde, for supplying the pictures of patient appliances and prostheses.

Particular thanks are due to Helen Leng, our Development Editor, who has shown great patience and understanding in accommodating our frequent and confusing alterations to the text and figures. We are also grateful to all the staff at Elsevier for all their help and encouragement in the production of this new edition.

Our respective secretaries Catherine Davidson and Linda Digance have played a key role in the typing of the manuscript and their efforts are very much appreciated.

Finally we record our appreciation for the support and forbearance of our wives and families during the time devoted to the writing of the book, which might otherwise have been spent in their company.

> David L Hamblen Hamish Simpson

Note by John Crawford Adams

Outline of Orthopaedics evolved from bedside teaching of medical students over many years. Despite inevitable flaws and omissions in the original version, the book proved popular and revised editions were called for every few years. Indeed, so many changes have been made in successive editions that the present one is hardly recognisable as the same book.

In the half century that has elapsed since the book was first published there has been spectacular progress in the practice of orthopaedic surgery - more so than in most other branches of surgery. One field in which developments have been particularly striking is that concerned with diagnostic procedures. Notable among the sophisticated refinements that now make diagnosis easier, more accurate, and substantially less traumatic for the patient include image intensification; computerised tomographic scanning; magnetic resonance imaging, contrast radiography; ultrasound scanning; radio-isotope scanning; and interventional radiology using intra-arterial cannulas. These diagnostic methods, together with techniques of direct inspection of the inside of joints or other cavities (arthroscopy, endoscopy) have nearly all been introduced or greatly refined since this book was first published.

In the field of operative surgery the development of total replacement arthroplasty - at first confined mainly to the hip - was the most spectacular landmark. For several decades surgeons had striven to create a mobile artificial hip joint, but success generally eluded them and forced them to rely mainly upon arthrodesis for relief of arthritic pain. Only when a two-part (ball and socket) prosthesis of special metal, or metal and plastic, was developed was successful arthroplasty achieved. The technique was refined very quickly and was soon extended to the knee and other joints. Today many thousands of replacement arthroplasties are undertaken every year in Britain alone.

A nother major surgical landmark in the last half century was the refinement of arthroscopic examination of major joints - at first mainly the knee - which led naturally to the development of arthroscopic surgery. This proved so successful - at first in the knee - that open operations for damaged semilunar cartilages and ligaments of the knee were soon almost wholly superseded. At the same time minimal access surgery was extended to other sites - notably the spine - as well as to the separate fields of abdominal and gynaecological surgery. These major developments are still relatively new : hardly mentioned in the earliest editions of this book half a century ago.

One of the consequences of these developments has been a trend for surgeons to concentrate on a particular field of surgery - for instance hip surgery, knee surgery, spine surgery or hand surgery - w hile largely abandoning other fields to their colleagues. W hile this trend tow ards "super-specialisation" m ay be generally applauded, care m ust be taken to ensure that it does not go too far, to the point w here a surgeon, initially trained in general orthopaedic techniques, becom es incapable of undertaking routine w ork.

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The stage has already been reached at which it is no longer practicable for a single author to undertake the production of a book covering the whole range of orthopaedic surgery. Som e degree of collaboration is clearly desirable, and it is with much pleasure that I now hand over this work to the capable hands of Professor Davíd H am blen, my long-term co-author, and Professor H am ish Sim pson, his new collaborator.

John Crawford Adams

Note on terminology

The anatom ical nom enclature used in this book conforms to that recommended by the International A natom ical N om enclature C ommittee and approved at the Eighth International C ongress of A natom ists at W iesbaden in 1965. This nom enclature, which differs only in minor respects from the earlier B irm ingham revision of the Basle nom enclature, has been adopted at most schools of anatom y and it is to be hoped that it will become the standard term inology acceptable to anatom ists and surgeons alike.

The recommended method of recording and expressing joint movement conforms to that laid down by the American Academy of Orthopaedic Surgeons in the booklet *Joint Motion* published by the Academy in 1965 (reprinted 1966), and approved by most of the Orthopaedic Associations of the English-speaking world. (See also McRae, R. (2003): *Clinical Orthopaedic Examination*, 5th edn. Edinburgh: Churchill Livingstone.) The guiding principle of the method is that for any joint the extended 'anatom ical position' is regarded as zero degrees (0°), and movement at the joint is measured from this starting position. For example, in the knee the straight position is described as 0° and the fully flexed position is expressed as (say) 145 degrees (145°) of flexion; likew ise at the elbow. A t the ankle the anatom ical position, with the foot at a right angle to the leg, is the zero position, from which plantarflexion and dorsiflexion (extension) are measured.

The A cadem y booklet also gives figures for the norm al range of m ovem ent at each joint. In som e instances these do not accord with authors' experience and they have not alw ays been follow ed in this text. Individual variations are com m on, so that any statem ent of the norm al m ust necessarily be im precise. This page intentionally left blank

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Introduction

HISTORICAL NOTE

The orthopaedic surgeon today is concerned with diseases and injuries of the trunk and lim bs. H is field is not confined to the bones and joints; it includes in addition the muscles, tendons, ligam ents, bursae, nerves, and blood vessels. H e is not concerned with injuries of the skull, which fall within the province of the neurosurgeon; or with injuries of the jaws, which are the responsibility of the facio-maxillary or dental surgeon.

The term orthopaedic is derived from the Greek words o $\rho\theta \circ \zeta$ (straight) and $\pi \alpha \zeta$ (child). It was originally applied to the art of correcting deform ities by Nicolas Andry, a French physician, who in 1741 published a book entitled Orthopaedia: Or the Art of Correcting and Preventing Deformities in Children: By such M eans, as may easily be put in Practice by Parents them selves, and all such as are Employed in Educating Children.

In Andry's time orthopaedic surgery in the form known today did not exist. Surgery was still primitive. Indeed, except for sporadic attempts by ingenious individuals, it is probable that little real progress had been made since the days of H ippocrates, who lived in about 400 sc.

That is not to say that surgeons were unintelligent or that they lacked a capacity for careful study and research. Early writings prove that many of them were shrew dobservers, and from the time of John Hunter (1728–1793) onwards this was increasingly true. Take, for exam ple, the words of Sir Astley Cooper (1768–1841) in his *Treatise on D islocations and Fractures of the Joints*: 'N othing is known in our profession by guess; and I do not believe, that from the first daw n of medical science to the present moment, a single correct idea has ever emanated from conjecture. It is right, therefore, that those who are studying their profession should be aw are that there is no shortroad to know ledge; that observations on the diseased living, exam inations of the dead, and experiments upon living anim als are the only sources of true know ledge; and that inductions from these are the sole basis of legitim ate theory.'

The enthusiasm and the capacity for study were there. The real obstacle to progress was the lack of the essential facilities that we now take so much for granted – anaesthesia, asepsis, powerful microscopes, and X-rays. Any surgical operation that could not be completed within a few minutes was out of the question when the patient's consciousness could be clouded only by intoxication or exsanguination. And when every major operation was inevitably followed by suppuration which often proved fatal, it is small wonder that operations were seldom advised except in an attempt to save life.

Thus orthopaedic surgery, until relatively recent times, was confined largely to the correction of deformities by rather crude pieces of apparatus, to the reduction of fractures and dislocations by powerful traction, and to amputation of limbs (Fig. 1).

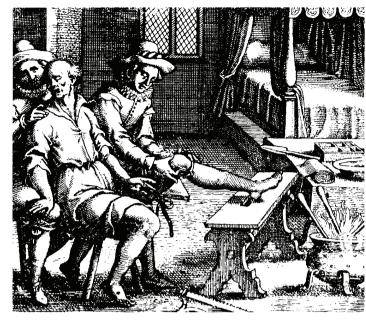


Fig.1 A seventeenth century amputation scene. (From Fabricus: Opera, 1646.)

LANDMARKS OF SURGERY IN THE NINETEENTH CENTURY

Fundamental advances in surgery were in fact dependent upon the development of other branches of science and of industry which provided, for instance, the high-powered microscope and the X-ray tube. It is therefore not surprising that, after centuries of stagnation, the facilities that were lacking were all made available within the span of a single life-time, at the period of the Industrial Revolution.

The first epoch-making advance was the introduction of anaesthesia. The credit for this should be given jointly to Craw ford Long, of Athens, Georgia, who was the first to use ether in 1842 but delayed publication of his observations for seven years; and to W.T.G. Morton, of Boston, Massachusetts, whose use of ether anaesthesia was reported in 1846.

A few years later Louis Pasteur (1822-1895), working in Paris and equipped at last with an adequate microscope, was carrying out his fundamental research on bacteria as a cause of disease. Then in 1867 Joseph Lister (1827-1912), working in Glasgow, Scotland, on the basis of Pasteur's work introduced his antiseptic surgical technique which allowed the surgeon, for the first time in history, to look for primary healing of his operation wounds. Finally, in 1896, came Roentgen's report from Würzburg in Germany of his discovery of X-rays, which within a short time were put to practical use in surgical diagnosis.

THE EMERGENCE OF ORTHOPAEDICS AS A DISTINCT SPECIALITY

Thus at the dawn of the 20th century the stage was set for the phenom enally rapid evolution of surgery that has been witnessed by many still alive today. W ith the consequent widening of the scope of surgical practice orthopaedic surgery, at first encom passed by the general surgeon, began to branch off as a distinct science and art; but it was not until after the First W orld W ar that it cam e to be widely recognised as a separate speciality.

In Great Britain many of the fundamental principles of orthopaedics had been propounded, just before the 20th century began, by Hugh Owen Thomas¹ (1834-1891) of Liverpool. Thom as was not primarily concerned with operative surgery but rather with manipulative surgery and with conservative methods such as rest and splintage, and it was left to his nephew, Sir Robert Jones (1857-1933) to set orthopaedic surgery upon the sound foundation that it now enjoys. During and after the First W orld W ar Robert Jones trained many of the surgeons, British and American, who were among the first to devote their professional lives entirely to the practice of orthopaedics.

THE PRESENT

The second half of the 20th century saw major technological advances in biomaterials, instrumentation, and diagnostic techniques. These have had a major impact on the practice of orthopaedic surgery, particularly in the development of reliable methods for joint replacement in the treatment of arthritis. The results have been spectacular for the major joints of the hip and knee, where success rates are better than 90% after 10 years, even in the younger patient. This success has brought its own problems, with an increasing demand for complex and expensive revision surgery in the few patients who develop late failure with implant loosening and bone destruction.

A nother significant advance has been the development of microsurgical techniques, allowing the anastom osis or repair of very small blood vessels and nerves, and thus facilitating the transfer of living tissue – whether skin or bone or nerve – from one site to another, and even the replacement of severed parts. Major advances have been made in the field of arthroscopy and arthroscopic surgery, allowing patients the benefits of minimally invasive surgery on most of the major joints in both upper and low er limbs. This has dramatically reduced the time patients spend in a hospital bed, and in many cases allows operations to be carried out as day case procedures with reduced morbidity and a more rapid return to normal function.

A t the sam e tim e, orthopaedic surgeons - particularly in W estern countries have seen the virtual elim ination of m any diseases that w ere form erly prevalent, notably tuberculosis, poliom yelitis, tertiary syphilis, and rickets. The reduction in infective disease ow es m uch to the advent of m ore pow erful antibiotics, but their w idespread use - particularly for prophylaxis in surgical operations - has resulted in an alarm ing increase in the em ergence of resistant strains of bacteria. If this trend continues the risk of severe infection as a feared post-operative com plication m ay again becom e a factor in lim iting surgical treatment.

¹Thomas's name is remembered in the widely used Thomas's knee splint and in Thomas's test for fixed flexion at the hip.

THE FUTURE

The limits to the developm ent of improved technology and biomaterials for orthopaedic surgery may now have been reached. A sa result there has been an increasing interest in methods for restoring normal tissues, as an alternative to replacing them. This will require new developments in the field of tissue engineering to allow composites of cultured autogenous or donor stem cells to be combined with a synthetic biodegradable matrix to repair bone and articular cartilage. Surgical skill will still be required to provide access to bones and joints for their repair, but this will need to be com bined with an increased know ledge in the new disciplines of m olecular biology and cellgenetics. At the same time the completion of the project to map the entire hum an genom e has enabled scientists to identify the genetic basis for m any of the diseases w hich affect the m usculoskeletal system . This new know ledge of the DNA make up of genes can be combined with the techniques of m olecular biology to produce 'designer drugs', such as the recom binant bone m orphogenetic proteins (BMPs) now being used to stim ulate bone healing in difficult clinical situations. O ther monoclonal antibodies are now widely available and used to enhance diagnostic and im aging techniques in orthopaedics.

The aim must be to consolidate the new knowledge gained and to develop an even more sound clinical judgement, so that in devising treatment for our patients we do the right thing at the right time. 'G et it right first time' should be the slogan. This is still quite a challenge; the challenge that adds to the fascination of orthopaedic surgery.

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Part 1

PRINCIPLES OF DIAGNOSIS AND TREATMENT

In this part guidance is given on the correct line of approach to an orthopaedic problem, with particular reference to diagnosis and treatment.

As in all branches of medicine and surgery, proficiency in diagnosis can be acquired only from long experience. There is no short cut to a familiarity with physical signs or to skill in radiographic interpretation. Nevertheless the inexperienced surgeon who tackles the problem methodically step by step will often achieve a better result than a more experienced colleague who makes a 'snap' diagnosis after no more than a cursory investigation.

The essential clinical skills to obtain an adequate differential diagnosis remain the ability to take a careful history and perform an appropriate physical examination. The dramatic improvements in imaging techniques and other sophisticated investigations, though valuable, should not be allowed to replace these vital preliminary steps. Instead they should be used in a more efficient and cost-effective manner to complement and refine the clinical diagnostic skills. To reflect the increased importance of imaging, a new chapter has been added describing the range of methods available and their role in diagnosing and facilitating the treatment of orthopaedic disease. It is also worth noting the expansion of arthroscopy as a diagnostic tool for viewing the internal structure of most of the larger joints of the limbs, in addition to its use in treatment.

In the choice of treatment, whether conservative or surgical, the development of a sound judgement is also largely a matter of experience. Yet more than that is needed. Other essential qualities are common sense and a sympathetic appreciation of human problems. There are surgeons who never acquire a sound judgement, however long their apprenticeship. Others seem to have a natural aptitude that quickly matures under proper guidance and training.

Clinical methods of history taking and examination

As in other fields of medicine and surgery, diagnosis of orthopaedic disorders depends first upon an accurate determ ination of all the abnorm al features from :

- 1. the history
- 2. clinical examination
- 3. radiographic examination and other methods of imaging
- 4. special investigations.

Secondly, it depends upon a correct interpretation of the findings.

HISTORY TAKING

In the diagnosis of orthopaedic conditions the history is often of first im portance. In cases of torn meniscus in the knee, for instance, the clinical diagnosis sometimes depends upon the history alone. Except in the most obvious conditions, a detailed history is always required.

First the exact nature of the patient's complaint is determined. Then the development of the symptoms is traced step by step from their earliest beginning up to the time of the consultation. The patient's own views on the cause of the symptoms are always worth recording: often they prove to be correct. Enquiry is made into activities that have been found to improve the symptoms or to make them worse, and into the effect of any previous treatment. Facts that often have an important bearing on the condition are the age and present occupation of the patient, previous occupations, hobbies and recreational activities, and previous injuries.

When a full history of the local symptoms has been obtained, do not om it to enquire whether there have been symptoms in other parts of the body, and whether the general health is affected. Ask also about previous illnesses.

Finally, in cases that seem trivial, a tactful enquiry as to why the patient decided to seek advice, and to what extent he is worried by his disability, will often give a valuable clue to the underlying problem. It should be remembered that very often patients seek advice not because they are handicapped by a disability (which is often insignificant) but because they fear the development of some serious disease such as cancer, paralysis, or progressive crippling deformity.

CLINICAL EXAMINATION

The part complained of is exam ined according to a rigid routine which should become habitual. If this is done, familiarity with the routine will ensure that no step in the examination is forgotten. A ccuracy of observation is essential: it can be acquired only by much practice and by diligent attention to detail. The exam ination of the part complained of does not complete the clinical exam ination. It som etim es happens that symptoms felt in one part have their origin in another. For exam ple, pain in the leg is often caused by a lesion in the spine, and pain in the kneem ay have its origin in the hip. The possibility of a distant lesionm ust therefore be considered and an examinationm ade of any regionunder suspicion.

Finally, localised symptoms may be the first or only manifestation of a generalised or widespread disorder. A brief examination is therefore made of the rest of the body with this possibility in mind.

Thus the clinical exam ination may be considered under three headings:

- 1. examination of the part complained of
- 2. investigation of possible sources of referred symptoms
- 3. general examination of the body as a whole.

1. EXAMINATION OF THE PART COMPLAINED OF

The following description of the steps in the clinical examination is intended only as a guide. The technique of exam ination will naturally be varied according to individual preference. Nevertheless, it is useful to stick to a particular routine, for a familiarity with it will ensure that no step in the examination is forgotten.

Exposure for examination

It is essential that the part to be exam ined should be adequately exposed and in a good light. Many mistakes are made simply because the student or practitioner does not insist upon the removal of enough clothes to allow proper exam ination. When a limb is being exam ined the sound limb should always be exposed for comparison.

Inspection

In spection should be carried out system atically, with attention to the following four points:

- The bones Observe the general alignment and position of the parts to detect any deformity, shortening, or unusual posture.
- 2. The soft tissues O bserve the soft-tissue contours, com paring the two sides. Note any visible evidence of general or local swelling, or of muscle wasting.
- 3. Colour and texture of the skin Look for redness, cyanosis, pigm entation, shininess, loss of hair, adventitious tufts of hair or other changes.
- 4. Scars or sinuses If a scar is present, determ ine from its appearance whether it was caused by operation (linear scar with suture marks), injury (irregular scar), or suppuration (broad, adherent, puckered scar).

Palpation

A gain there are four points to consider:

1. Skin tem perature By careful com parison of the two sides judge whether there is an area of increased warm thor of unusual coldness. An increase of local tem perature denotes increased vascularity. The usual cause is an in flam matory reaction; but it should be remembered that a rapidly growing tumour may also bring about marked local hyperaemia, with increase in skin warmth.

- 2. The bones The general shape and outline of the bones are investigated. Feel in particular for thickening, abnorm al prominence, or disturbed relationship of the norm al landmarks.
- 3. The soft tissues D irect particular attention to the muscles (are they in spasm, or wasted?), to the joint tissues (is the synovial mem brane thickened, or the joint distended with fluid?), and to the detection of any local swelling (?cyst; ?tumour) or general swelling of the part.
- 4. Local tenderness The exact site of any local tenderness should be mapped out and an attempt made to relate it to a particular anatom ical structure.

Determ ining the cause of a diffuse joint swelling. The question often arises: what is the cause of a diffuse swelling of a joint? The answer can be supplied after careful palpation. For practical purposes a *diffuse* swelling of the joint as a whole can have only three causes:

- 1. thickening of the bone end
- 2. fluid within the joint
- 3. thickening of the synovial membrane.

In some cases two or all three causes may be combined, but they can always be differentiated by palpation. *Bony thickening* is detected by deep palpation through the soft tissues, the bone outlines being compared on the two sides. A *fluid effusion* generally gives a clear sense of fluctuation between the two palpating hands. *Synovial thickening* gives a characteristic boggy sensation – rather as if a layer of soft sponge-rubber had been placed between the skin and the bone. It is nearly always accompanied by a well-marked increase of local warm th, for the synovium is a very vascular mem brane.

Measurements

M easurement of lim b length is often necessary, especially in the low er lim bs, where discrepancy between the two sides is important. M easurement of the circumference of a lim b segment on the two sides is also important if any asymmetry is suspected. It provides an index of muscle wasting, soft-tissue swelling or bony thickening. Details will be given in the chapters on individual regions.

Estimation of fixed deformity

Fixed deform ity exists when a joint cannot be placed in the neutral (anatom ical) position. Its causes are described on page 56. The degree of fixed deform ity at a joint is determ ined by bringing the joint as near as it will come to the neutral position and then measuring the angle by which it falls short.

V algus and varus. Explanation is needed of the commonly used terms valgus and varus, which are often confusing to students. In valgus deform ity the distal part of a member is deviated laterally (outwards) in relation to the proxim al part. Thus, for example, in hallux valgus the toe is deviated outwards in relation to the foot; and in genu valgum the lower leg is deviated outwards in relation to the thigh. Varus deform ity is the opposite: the distal part of a member is deviated medially (inwards) in relation to the proximal part (examples - cubitus varus and genu varum).

Movements

In the examination of joint movements information must be obtained on the following points:

- 1. What is the range of active movement?
- 2. Is passive movement greater than active movement?
- 3. Is movement painful?
- 4. Is movement accompanied by crepitation?
- 5. Is there any spasticity (stiff resistance to free movement)?

In measuring the range of movement it is important to know what is the normal. The range is recorded as an angle usually measured from the straight position of the joint as neutral. Measurement can be facilitated by the use of a jointed protractor with long arms, termed a goniometer. With some joints the normal varies considerably from patient to patient; as, for instance, at the metacarpo-phalangeal joint of the thum b: so it is wise always to use the unaffected limb for comparison. Restriction of movement in all directions suggests some form of arthritis, whereas selective limitation of movement in some directions, with free movement in others, is more suggestive of a mechanical derangement.

Except in two sets of circum stances passive movement will usually be found equal to the active range. The passive range will exceed the active only in the following circum stances:

1. when the muscles responsible for the movement are paralysed

2. when the muscles or their tendons are torn, severed, or unduly slack.

Stability

The stability of a joint depends partly upon the integrity of its articulating surfaces, partly upon intact ligaments, and to some extent upon healthy muscles. When a joint is unstable there is abnormal mobility – for instance, lateral mobility in a hinge joint. It is important, when testing for abnormal mobility, to ensure that the muscles controlling the joint are relaxed; for a muscle in strong contraction can often conceal ligamentous instability.

Power

The power of the muscles responsible for each movement of a joint is determined by instructing the patient to move the joint against the resistance of the examiner. With careful comparison of the two sides it is possible to detect gross impairment of power. By general convention, the strength of a muscle is recorded according to the Medical Research Council grading, as follows:

- 0 = no contraction;
- 1 = a flicker of contraction;
- 2 = slight power, sufficient to move the joint only with gravity eliminated;
- 3 = power sufficient to move the joint against gravity;
- 4 = power to move the joint against gravity plus added resistance;
- 5 = normal power.

Sensation

Patients often complain of 'numbness' or tingling, and it is important to test sensibility both to light touch and to pin prick throughout the whole of the affected area. In unilateral affections the opposite side should be similarly tested for comparison. The precise area of any blunting or loss of sensibility should be carefully mapped out, and from a knowledge of the sensory dermatomes and the cutaneous distribution of the peripheral nerves the particular nerve or nerves affected may be identified and the root value established.

Reflexes

As part of the neurological examination the appropriate deep and superficial reflexes must be tested. Details will be given in the sections on individual regions of the body.

Peripheral circulation

Symptoms in a limb may be associated with impairment of the arterial circulation. Time should therefore be spent in assessing the state of the circulation by examination of the colour and temperature of the skin, the texture of the skin and nails, and the arterial pulses; and by such special investigations as may be necessary. This examination is particularly important in the case of the lower limb. Further details are given on page 420.

Tests of function

It is necessary next to test the function of the part under exam ination. How much does the disorder affect the part in its fulfilm ent of everyday activities? Methods of determ ining this vary according to the part affected. To take the low er lim b as an exam ple, the best test of function is to observe the patient standing, walking, running and jum ping, or clim bing and descending stairs. Special tests are required to investigate certain functions – for exam ple, the Trendelenburg test for abductor efficiency at the hip (p. 340).

2. INVESTIGATION OF POSSIBLE SOURCES OF REFERRED SYMPTOMS

When the source of the symptoms is still in doubt after careful examination of the part complained of, attention must be directed to possible extrinsic disorders with referred symptoms. This will entail examination of such other regions of the body as might be responsible. For instance, in a case of pain in the shoulder it might be necessary to examine the neck for evidence of a lesion interfering with the brachial plexus, and the thorax and abdomen for evidence of diaphragmatic irritation, because either of these conditions may be a cause of shoulder pain. A gain, in a case of pain in the thigh the examination will often have to include a study of the spine, abdomen, pelvis, and genito-urinary system as well as a local examination of the hip and thigh.

10

3. GENERAL EXAMINATION OF THE BODY AS A WHOLE

The mistake is sometimes made of confining the attention to the patient's immediate symptoms and failing to assess the patient as a whole. It should be made a rule in every case, how ever trivial it may seem, to form an opinion not only of the patient's general physical condition but also of his psychological outlook. In simple and straightforw ard cases this general survey may legitimately be brief and rapid, but it should never be omitted.

DIAGNOSTIC IMAGING

Until recent years radiography was the only method by which bone and other relatively dense tissues could be shown as a visual im age contrasting with adjacent less-dense tissues. This is no longer the case, for technical developments have led to alternative methods of im aging. These include:

- 1. ultrasound scanning
- 2. radioisotope scanning
- 3. X-ray computerised tomography (CT scanning)
- 4. magnetic resonance imaging (MRI).

A more detailed consideration of these methods and their applications to the diagnosis of orthopaedic disorders will be dealt with in Chapter 2.

Imaging for orthopaedics

Nigel Raby

Im aging has now assumed a greater role in the management of patients with orthopaedic disease than ever before. For many years imaging was limited to the use of plain radiographic films which really only gave useful inform ation on bony structures. Over the past 25 years orthopaedics has benefited greatly from newer imaging modalities which are able to give much greater information, not only on the bony structures, but also of the surrounding soft tissues. While plain films remain the mainstay of imaging in trauma, in other orthopaedic conditions they are now less important. Cross-sectional imaging, in particular the use of magnetic resonance imaging (M R I), has now become the most important imaging modality for many orthopaedic conditions. M R I allows detailed identification of the soft-tissue structures in and around joints and for this reason has assumed a very prominent position in imaging of orthopaedic patients.

PLAIN RADIOGRAPHIC FILMS AND DIGITAL RADIOGRAPHY

In a modern medical imaging department the plain radiograph taken on X-ray film is now almost obsolete. Plain radiographic images are mostly obtained with digital equipment using a much smaller X-ray dose compared to conventional film. The resulting im age is displayed on a computer screen where it can be manipulated to alter the image brightness and contrast, magnify areas of interest, and measure the size of abnorm alities. Whether obtained with a digital system or on 'hard copy' X-ray film, plain radiographs continue to be the com monest im aging modality used in orthopaedics. They are usually the only diagnostic im ages required for most cases of traum a and the great majority of degenerative disorders. Fracture diagnosis and management is satisfactorily guided by plain films, as is planning joint replacement surgery for arthritic disease in the hip and knee. The use of plain films has diminished in other areas of orthopaedic practice, where for many years they were the standard im aging investigation. An exam ple would be patients with back pain, where it is now recognised that the plain film has little to offer in evaluation and MRI is the investigation of choice.

COMPUTERISED TOMOGRAPHY (CT)

CT is a technique that utilises X-rays, but acquires multiple thin slices axially through the area of interest. With the advances in digital technology modern CT scanners can now acquire this data very rapidly. Current models in use can obtain 16 slices simultaneously, while new machines will be able to acquire







Fig. 2.1 Reconstructed CT images acquired in axial plane but reformatted in the coronal and sagittal planes. With current scanners the quality and detail of the images is as good as on the original axial scans. (A A sagittal reconstruction of the cervical spine. (B) A coronal reconstruction of a hip.

64 and even 256 slices at a time. The result is a stack of very thin radiographic im ages, in thickness. These can be manipulated by the usually about 1 m m nerate im ages in any plane with excellent detail. Typically СТ reform atted into coronal and sagittal planes so that im ages are sim ilar to looking at AP and lateral radiographs (Fig. 2.1). These im ages be acquired in only a few seconds and the reconstructions are also availcan within a similar short time. Modern scanners can also rapidly reconstruct ree-dimensional model of the scanned area (Fig. 2.2). The commonest role of CT in orthopaedics is assisting in the management of trauma patients with plex fractures. While the fracture is usually easily visualised on plain radioc 0 m graphs, the exact position, num ber and size of the fracture fragm ents may be more difficult to identify correctly. This is where CT and its multiplanar capahility of most use in orthopaedic patient management. Typical areas where is СТ of most value are in the assessment of fractures in complex anatomical i e such as the spine, pelvis, tibial plateau and calcaneus. Fracture treatm ent planning is greatly aided by the multiple views that can be obtained of these com plex injuries and in selected cases three-dim ensional reconstructions can also add useful inform ation.

Non-traum atic conditions where CT can be useful are the evaluation of bone- and cartilage-based tumours. Although MRI is the principal method used for the anatom ical staging of these tumours, CT may add further useful inform ation regarding the extent of the ossifying or calcified portions of these tumours which an MR scan can underestimate (Fig. 2.3). Another example is osteoid osteoma, where a CT scan provides the diagnostic finding of a very

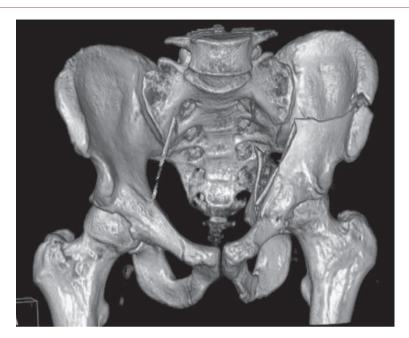


Fig. 2.2 CT scan which has been reconstructed to give a three-dimensional image. On computer screen this can be rotated on real time to allow full evaluation of the bony structures in detail.

sm all central sclerotic nidus (Fig. 2.4). A CT scan is also valuable for the full staging of bone and soft-tissue sarcom as, where it is used routinely to detect the presence of lung metastases (Fig. 2.5).

MAGNETIC RESONANCE IMAGING (MRI)

MRI is a new technology now commonly used in the evaluation of orthopaedic patients without the use of ionising radiation and with no known harmful effects. MR scanning can produce images in any plane and the tissue contrast can be altered to highlight particular anatom ical structures and areas of pathology.

When a patient is placed into the core of a very powerful magnet the protons (hydrogen atoms) of the body align them selves to the magnetic field. If a radiofrequency pulse is then applied the protons will be tipped slightly from the line of the field and for a short time will oscillate (or resonate - hence the name). These resonating protons emit low -power radio waves which can be detected by magnetic coils within the scanner and can then be used to form a three-dimensional image. By altering how the resonance is performed and how the radio waves are captured, it is possible to form ulate the images into slices in any plane. It is also possible to alter the characteristics of the imaging are called T1 and T2 weighted images. Images where signal from fat is suppressed, term ed fat saturation, are also useful.

Imaging for orthopaedics



Fig. 2.3 (A) MRI scan of a very large mass arising from the pelvis and occupying a large part of the abdomen. (B) A coronal reformatted CT of the same lesion. This shows the bony origin and the bone content of the tumour which is not well seen on the MRI scan.

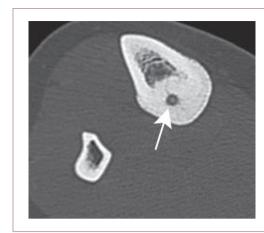


Fig. 2.4 An axial CT through an osteoid osteoma. The central sclerotic nidus is identified (arrow) and is best seen on CT.

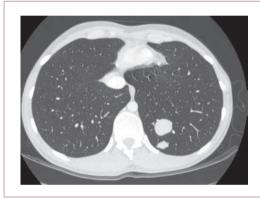


Fig. 2.5 CT of lungs in a patient with an osteosarcoma of the femur demonstrating pulmonary metastases.

The T1 im ages show fat as white, bone and tendons as black, with muscle and water appearing grey (Fig. 2.6A). A T2 im age of the same structure is most easily recognised because water is seen as white (Fig. 2.6B). This is useful in the detection of fluid structures such as cerebrospinal fluid in the spinal canal and cystic masses in the soft tissues. If the same im age then has fat saturation, the fat becomes black leaving even small amounts of fluid as the only white areas on the im age. This means that subtle oedema in muscle or bone can be easily identified.

Further inform ation can be obtained by using M R contrast agents. These substances are injected intravenously and are most commonly compounds derived from gadolinium, a heavy metal which alters the signal characteristics of various structures, particularly those with a large blood supply. Further scans obtained after injection of this contrast medium may give helpful additional information in selected cases. Typically this is used for the assessment of tum ours, infection and post operative patients follow ing spinal surgery (Fig. 2.7).

M R I is particularly helpful where the abnormality is confined to soft-tissue structures and is most commonly used for evaluation of disease and injury in the spine and knee. In the spine, M R I can identify the intervertebral discs and individual nerve roots, making it the investigation of choice for patients with suspected disc herniation causing nerve root compression (Fig. 2.8). It can also be used to identify spinal stenosis, disc space infection and spinal tum ours.

Imaging for orthopaedics

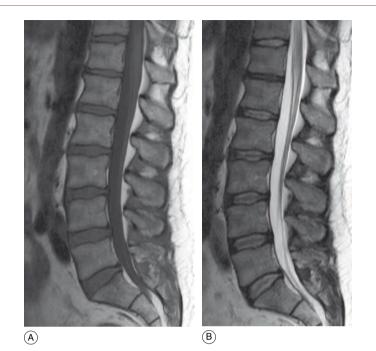


Fig. 2.6 (A) A sagittal T1 weighted image of the lumbar spine. Note that the CSF in the spinal canal is dark grey. (B) Sagittal T2 weighted image of same patient. Here the CSF is now white. Fluid appears white on T2 weighted images. The intervertebral discs are healthy as they can be seen to contain high signal fluid within the nucleus pulposus.

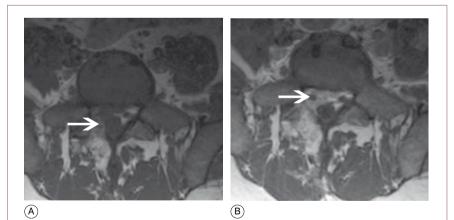


Fig. 2.7 (A) Axial T1 weighted scan. This is a patient who had a microdiscectomy at L5/ S1 on the right and now has recurrent symptoms. There is a mass of abnormal tissue (arrow) along the right side of the thecal sac. It is not possible to see the right S1 nerve root. A recurrent disc herniation could be the cause of this. (B) Following administration of intravenous gadolinium there is enhancement of all the abnormal tissue indicating that this is post-operative granulation tissue and not disc material which would not enhance. The S1 root is now clearly visible (arrow) surrounded by the granulation tissue.

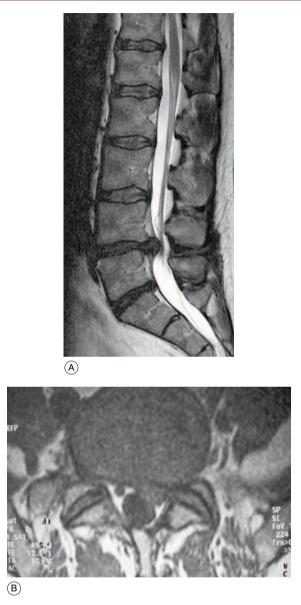


Fig. 2.8 (A) Sagittal T2 weighted image of lumbar spine. There is a large herniation of the L4/5 disc. (B) Axial scan through the disc space showing disc material has herniated into the left side of the spinal canal and compressed the left L5 nerve (compare with normal nerve on the right). By convention axial images are viewed as if looking from the patient's feet. Thus, the patient's right is on the left of the image and vice versa.

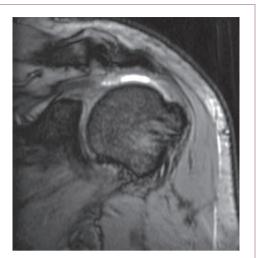


Fig. 2.9 Coronal MRI scan of shoulder. There is fluid seen as an area of bright signal within the supraspinatus tendon indicating a tear of the rotator cuff.

In patients with knee pain, MRI is highly accurate in diagnosing patients with meniscal tears and can distinguish between degenerate oblique tears and the less common bucket handle tears. It is also valuable in detecting injuries of the cruciate and collateral ligaments following trauma to the knee joint.

In the shoulder MR scans are increasingly used to identify degenerative tendinopathy of the rotator cuff muscles and tears of the individual tendons (Fig. 2.9). A round the ankle it has proved useful in the diagnosis of tears and degeneration of the Achilles tendon, as well as for osteochondral fractures of the talar dome, and injuries to the collateral ligaments of the ankle and subtalar joints.

M R I is particularly sensitive for imaging the bone marrow because of its high fat content, so that any disease associated with abnorm al bone marrow will be identified. These include malignant primary bone tumours, as well as metastases and myeloma, all of which are marrow-based disorders (Fig. 2.10). Infection of bone, avascular necrosis and stress fractures, only cause changes visible on plain radiographs late in the disease process, but M R scans will identify all of these conditions at an early stage.

ULTRASOUND

U ltrasound has a useful role in orthopaedic imaging. U ltrasound machines are readily available in alm ost every hospital. The scan only takes a short time, but its value and reliability is very operator dependent. Like M R I, there are no known dangerous side effects associated with the use of ultrasound. W hile little or no information is obtained from bony structures, ultrasound can visualise the soft tissues in many areas. Particular structures which are well seen on ultrasound are tendon and muscles. Thus suspected abnormalities of the patellar tendon, A chilles tendon and rotator cuff of the shoulder can all be diagnosed by this technique (Fig. 2.11). Muscle tears are easily identified as are their associated haem atom as. In skilled hands evaluation of tendon lesions around the hand and wrist can be assessed and some operators are also able to identify ligamentous

ADAMS'S OUTLINE OF ORTHOPAEDICS

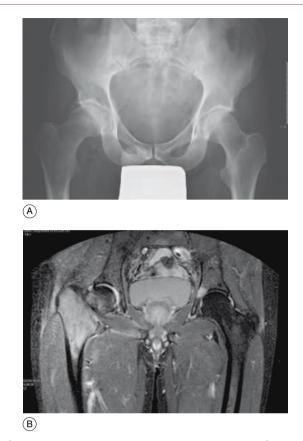


Fig. 2.10 A Plain film of pelvis does not show any abnormality. B MRI shows extensive abnormal signal in right proximal femur. This is due to marrow replacement by tumour. Patient subsequently shown to have metastatic disease.

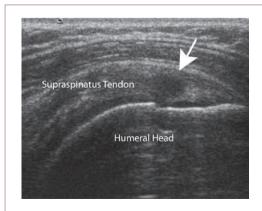


Fig. 2.11 Ultrasound of shoulder. The humeral head and overlying supraspinatus muscle and tendon are labelled. The arrow points to an area of altered reflectivity within the tendon. This indicates a tear at this site.

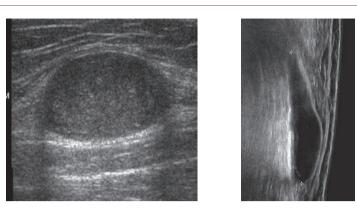


Fig. 2.12 (left) Ultrasound of a small soft-tissue lump in the mid thigh. It contains multiple echoes seen as white speckles. This indicated a solid mass rather than a fluid lesion and is clearly delineated from surrounding muscle. The appearances suggest a nerve sheath tumour and a schwannoma was confirmed at surgery.

Fig. 2.13 (right) Ultrasound of a clinical mass in the popliteal fossa. On this occasion there is an oblong structure which does not have any echoes within it. This indicated the presence of fluid (compare with Fig. 2.12) and is a popliteal or Baker's cyst.

injuries around the elbow and ankle. U ltrasound is also of use in the evaluation of soft-tissue m asses (Fig. 2.12), and fluid-filled structures such as Baker's cyst of the knee (Fig. 2.13), w hich can be diagnosed reliably by this technique alone.

Because of the lack of ossification in the fem oral head at birth, ultrasound has been advocated as a method for screening the neonatal hip joint for developmental dysplasia (D D H). Its value has not been proven for universal population screening, though it is used extensively in many European countries. How ever, in Britain and N orth A merica, the technique is only used for selective screening in babies show ing clinical evidence of hip instability or dislocation.

ISOTOPE SCANNING

bone scanning requires the intravenous injection of a radioactive usually technetium (^{99m} Tc), linked to a molecule such as disphosphowhich will become incorporated into areas of high bone turnover where in creased osteoblastic and osteoclastic The bone-seeking i s activity. radioisotope is injected intravenously and the emitted rays are charted with camera. A fter injection of the isotope there is an immediate diffumma of isotope into the bone matrix from the blood: thus an increased uptake of isotope locally in the skeleton denotes hyperaem ia of the bone. This is seen a scan obtained a few minutes after injection (early phase). It will only be seen in conditions with markedly increased blood flow to the area, typically in acute infection. Within 2-4 hours (late phase) the isotope is taken up by active bone-form ing cells, increased uptake thus denoting increased osteogenic activity. How ever, this is non specific as osteoclastic activity is increased by many

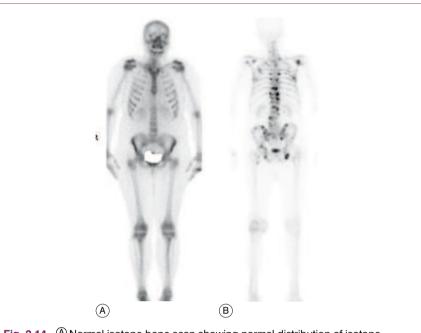


Fig. 2.14 (A) Normal isotope bone scan showing normal distribution of isotope through the bony skeleton. (B) Isotope scan showing multiple areas of increased isotope uptake. This pattern is seen in patients with multiple bone metastases.

d isease processes, including the site of healing fractures as well as tum ours and bone infection. Nevertheless, taken in conjunction with the history and clinical findings, areas of increased up take can be identified and the likeliest cause suggested. The commonest use for isotope scanning is in identifying the site of bony metastases (Fig. 2.14). Bone scanning will provide images of the complete bony skeleton and this is its major advantage. It is often necessary to supplement the scan with plain radiographs of the areas showing abnormal increased isotope up take. An exam ple where this is required is when the plain films may be able to identify benign causes of increased isotope up take and distinguish these from tum our (Fig. 2.15). Isotope bone scanning may also have a role in the diagnosis of infections of bone or joint, primary bone tum ours, osteoid osteoma, and stress fractures.

A less common application of radioisotope imaging is for the detection of focal bone or joint infection where this is not demonstrable clinically. The technique takes 24-48 hours, uses the patient's own white cells, which are labelled with indium-111 and then reinjected intravenously to localise in areas of focal inflammation.

POSITRON EMISSION TOMOGRAPHY (PET CT)

Positron em ission tom ography is the newest addition to imaging, now usually combined with a CT scan. In essence it is an isotope imaging technique, but one which uses a more complex isotope which emits positrons. The isotope can be linked to various molecules but the one most commonly used is

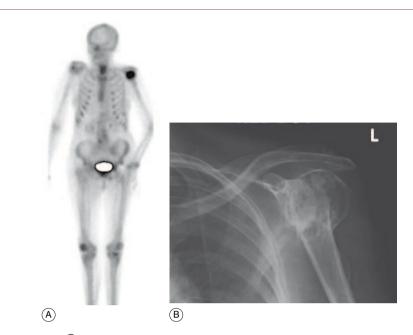


Fig. 2.15 (a) Isotope scan in a patient with known breast carcinoma and left shoulder pain. There is marked increased uptake in the region of the left humeral head. In view of the history a metastatic deposit was thought likely. (b) Plain radiograph of the shoulder shows that there is an old humeral neck fracture which accounts for the isotope uptake.

fluorodeoxyglucose (FDG), which ассц m u la t lucose The localisation ofthe t h th e 0 b СТ i m age with th а scan acq u ire d com plication is in th e id en tification o f activ ø h its role m 0 an d althou i n rth opaed ics is currently limited, it may in th evaluation а n t n role soft-tissue tum ours. The technique a n d m a v also be useful in the evaluinfection around joint replacements but as yet this is not well defined. technology for PET CT is currently lim ited to a few specialist centres and is not generally available.

ARTHROGRAPHY

Arthrography is a technique where an X-ray contrast is injected directly into a to enable visualisatio n of the joint \$ 11 d the joint o u l d otherw ise not be v is ib le o n a n bein much X - ra This i s М RΙ d visuali n t h 11 l t can n o 0 without the need for any contrast. Where it is still in tere st it is u su a llv in conjunction with MRI and occasionally C.T. The resultant м give even greater detail about intra-articular structures arth rog ram са n MRI. The commonest indications are; in the than plain shoulder to demonstrate disruption of the glenoid labrum in patients with recurrent dislocation or instability (Fig. 2.16), and in the hip when looking for evidence of impingement and labral tears

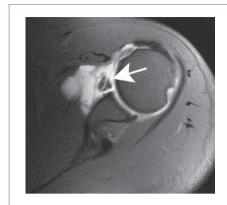


Fig. 2.16 MR arthrogram of the shoulder of a patient with recurrent dislocation. The scan demonstrates that the anterior cartilaginous glenoid labrum (arrow) is detached from the underlying bony rim. This is the so-called Bankart lesion.



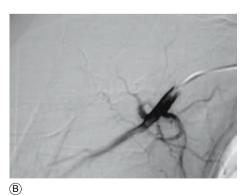


Fig. 2.17 ^(A) Angiogram showing a large tumour blush with vessels feeding a metastasis from renal carcinoma. ^(B) Following embolisation the blood flow to the lesion has been occluded allowing surgery to take place with much less blood loss and an easier operative field.

ANGIOGRAPHY (ARTERIOGRAPHY)

This is a specialised technique which is now used only infrequently in orthopaedics. The two major indications are trauma and tumour. Following trauma with a severely displaced bone fracture, angiography may be indicated to evaluate associated vascular injury, such as may occur in the pelvis and humerus. Note that angiography can now be carried out using CT and MRI, as well as by conventional intra-arterial catheterisation. In the evaluation of tumours, arteriography may be useful to delineate the extent of the vascular supply, or the relationship of vascular structures to the tum our, to enable safe surgical planning. In both circum stances the use of conventional catheterisation for angiography has the advantage of being able to carry out therapeutic procedures. In life-threatening haem orrhage, em bolisation or stenting can be undertaken at the site of vascular dam age. In cases of highly vascular tum ours, preoperative em bolisation of the tum ourm ay reduce intraoperative haem orrhage. This is m ost com m only used in patients with m etastasic renal tum our as these are generally highly vascular and prone to bleed profusely at surgery without prior em bolisation (Fig. 2.17).

3 Other investigation techniques

OTHER INVESTIGATIONS

M ore often than not the diagnosis can be established from the clinical assessm ent and im aging studies without the aid of other special investigations. In any case the possibilities should be narrow ed down to as few as possible before such investigations are ordered. If doubt then exists, appropriate tests are ordered to support or weaken each possible diagnosis.

Tests commonly employed in orthopaedic diagnosis include haematological studies; biochemical tests upon urine, faeces, plasma, and cerebrospinal fluid; serological and bacteriological tests; electrical tests; arthroscopy; and histological examination of specimens excised at biopsy or at definitive operation.

BLOOD TESTS

Haematology

Full blood count. A ssessm ent of the haem oglobin is of great value after traum a and post-operatively, as it gives an indication as to how much blood has been lost. The white cell count is usually, but not alw ays, raised when an infection is present. The ESR (erythrocyte sedim entation rate) and CRP (C -reactive protein) are more sensitive tests for revealing system ic inflam mation. The CRP is particularly useful, as it rises rapidly when there is an infective process. The ESR and CRP are also helpful in distinguishing septic and aseptic loosening of total joint replacements. If these tests are norm al on two occasions, it is unlikely that the loosening is as a result of an infection.

Biochemistry

If there are concerns about organ dysfunction, liver function tests and renal function tests are of value and part of the pre-operative work-up. Sim ilarly, routine electrolytes can also be of value, particularly if the patient is on drugs such as diuretics.

The biochemical tests that are of particular value for assessing bone function are the plasma levels of calcium, phosphate and alkaline phosphatase. Derangements in the calcium and phosphate balance can confirm the diagnosis of rickets and osteomalacia.

MICROBIOLOGICAL TESTS

The diagnosis of musculoskeletal infection is often challenging for a number of reasons.

- 1. Bacteria such as the norm al skin flora are grown as contam inants from specim ens such as sputum. How ever, in orthopaedics these same organisms can be pathogens and the cause of musculoskeletal infections. To distinguish between a grow thof, for example, Staphylococcus epidermidis, which is a contaminant as opposed to one which is a pathogen, it is vital to obtain multiple samples. A toperation of a patient with suspected musculoskeletal infection, at least five samples should be obtained under sterile conditions. If two or more of these multiple specimens grow the same bacteria, it is likely that this is a true pathogen rather than a contaminant.
- 2. The sw abs from sinus tracts are often m isleading and do not accurately reflect the true deep organisms that are causing the infection. How ever, aspiration of fluid from the depth of a sinus is worthwhile and often will give a more accurate picture of the true range of causative organisms.
- 3. In 10-20% of cases with established musculoskeletal infection, despite optimum culture techniques, it may not be possible to grow an organism. Thus, it is vital to obtain material for histological analysis as well as for microbiological culture where infection is suspected (see below).

ELECTRICAL TESTS (ELECTRODIAGNOSIS)

The two most common electrodiagnostic techniques used in orthopaedic practice are nerve conduction studies and electromyography.

Nerve conduction studies are used to determ ine whether or not a nerve is able to transm it an electrical impulse. The principle is to apply a stimulating electrode over a point on the nerve trunk distal to the lesion, and to observe whether or not the muscles supplied by the nerve will contract in response to the stimulus. The nerves in the sound limb are examined first, to determ ine the threshold of current required to cause a muscle contraction. If in the affected limb a current at least twice as great as the threshold fails to produce a muscle contraction, nerve conduction is absent. A nerve conduction test provides a simple method of determining whether or not a clinical paralysis is due to a complete lesion of the nerve, which has resulted in degeneration of its myelin sheath. If nerve conduction is present the lesion cannot be complete and myelin degeneration has not occurred.

Nerve conduction tests may also be used to measure motor conduction velocity in the peripheral nerve, and the principle can also be applied to afferent sensory testing. A slowing in the velocity of conduction may indicate the site of an incomplete lesion in the nerve trunk, such as may occur in compression neuropathy. Using stimulating electrodes, applied both proximal and distal to the suspected lesion, the latent period before the appearance of the muscle action potentials is measured. The difference in conduction time and the distance between the electrodes provides a measurement of velocity, which can be compared with the normal side, or with normal values (40–70 m/s).

The measurement of sensory nerve conduction is technically more difficult, but has a useful clinical application in spinal cord monitoring. Surface electrodes are used to provide repetitive peripheral stimulations during spinal surgery, so that recordings of central cortical responses can be used to detect any interference with spinal cord function.

Electrom yography. In this technique the electrical changes occurring in a muscle are picked up by a needle or surface electrode, suitably amplified and studied in the form of sound through a loudspeaker, or as a tracing on an oscillograph. Norm al muscle is electrically 'silent' at rest, but on voluntary contraction shows increasing electrical discharges in the form of triphasic action potentials, as more motor units are recruited into activity. Partly denervated or totally denervated muscle shows only spontaneous contractions of individual fibres (fibrillation potentials). Repeated testing at intervals can be used to detect evidence of re-innervation, as small polyphasic motor unit action potentials reappear and spontaneous fibrillation disappears. The motor unit action potentials gradually increase in duration and amplitude, but do not return to a norm al pattern until rem yelination of the nerve is complete. Electrom yography may show diagnostic changes in some types of myopathy, as well as in anterior horn cell disease such as poliom yelitis and motor neurone disease.

GAIT ANALYSIS

G ait analysis is the study of locomotion. In its most rudim entary form, it can be the observation of a patient during walking. Sim ple measures of walking speed and step length can be obtained with a stopwatch and a walkway of known length covered in powder. How ever, modern gait laboratories use multiple video cameras, which record simultaneously, and floor load transducers (force plates), which measure the ground reaction force in magnitude and direction. In addition, passive reflective marker balls are placed along the length of the limbs to aid in imaging the movement, and surface electrodes are placed over major muscle groups such as the quadriceps, so that electrom yograms can be recorded simultaneously. Gait analysis can be used in sports medicine, Parkinson's disease and other neuromuscular diseases. In orthopaedics, it has been used to help plan surgery in children with cerebral palsy.

ARTHROGRAMS

A rthrogram s consist of injecting contrast m edium into a joint and then obtaining serial plain X-rays, CT/MR images. Arthrograms are commonly used with plain X-rays, for assessing children's dysplastic hip joints, and in adults for determining whether the components of an artificial joint replacement are loose. In this latter situation, the arthrogram is often combined with an aspiration of the joint (under sterile conditions), which allows fluid to be sent for microbiological assessment. CT and MRI arthrograms are frequently used in the assessment of rotator cuff injuries of the shoulder.

ARTHROSCOPY

In recent years the technique of direct in spection of the interior of a joint through a fine telescope introduced through a cannula has become highly developed. In deed it is relied upon alm ostroutinely in the diagnosis of mechanical derangements within the knee, and also in the study of many non-traum atic affections of doubtful nature. The use of arthroscopy has now been extended to joints other than the knee, and is increasingly used for the diagnosis and treatment of intra-articular disorders of the shoulder, hip, wrist, and ankle.

BIOPSY

Biopsy is the operation of taking a specimen of living tissue for histological, electron-microscopic or other examination in order to elucidate the nature of a disease. Very often it is done as a final step in the diagnosis and staging of a tum our. Tw o techniques of biopsy are available:

- needle biopsy, in which a core of tissue is extracted by a special hollow needle
- 2. open biopsy.

Except in certain situations open biopsy is usually to be preferred despite a theoretically greater risk of tum our dissem ination, because it is more likely to yield a representative specim en. Nevertheless needle biopsy has an important place, and with improvements in technique its application has been widened, though diagnostic accuracy may not be as good as with open biopsy, except in very specialised centres.

The main essentials in a biopsy operation are:

- 1. that an adequate and representative piece of tissue be obtained
- 2. that the incision be so placed that it does not prejudice the success of a subsequent operation for total eradication of the tum our - especially in m alignant disease.

The scarm ust be so placed that it is conveniently included in the block of tissue to be excised at the time of definitive surgical excision.

INTERPRETATION OF THE FINDINGS

W hen the study of the patient is complete the abnormal findings elicited from the history, clinical exam ination, diagnostic imaging, and appropriate special investigations should be assembled together to form a composite clinical picture. This can then be matched against the recognised disorders of the region under consideration. It is comforting to remember that the number of disorders that commonly affect a particular region is limited. Often the number is not large. Theoretically, therefore, if all the possibilities are listed and thereafter confirmed or eliminated one by one the correct diagnosis must always be revealed.

This is, of course, an over-sim plification. In practice diagnosis is not as simple as that. But it is nevertheless true that if the problem is tackled logically, step by step, in the manner described, a correct conclusion can be formed in the great majority of cases. The only essentials are a capacity for painstaking enquiry, with strict attention to detail, accurate observation, and a working know ledge of the salient features of the common disorders.

PSYCHOGENIC OR STRESS DISORDERS

This heading is included to issue a word of warning. When the cause of a patient's symptoms remains obscure despite a thorough investigation there is a prevalent tendency to discount the genuineness of the symptoms and to ascribe them to 'functional' or 'psychogenic' factors, or simply to stress. This must be deplored as a dangerous policy that has led on many occasions to the overlooking of a serious organic disease.

Just because we fail to discover the cause of a particular symptom it by no means follows that the symptom is imaginary or psychogenic; it usually means only that we are not sufficiently skilled in diagnosis. A dmittedly, true hysterical

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disorders are encountered from time to time in orthopaedic practice, but they are few and far between. Much more often a long-continued organic pain leads to a distracted state of mind that is wrongly interpreted as a hysterical manifestation. It is widely accepted that physical symptoms may be prolonged or may seem to be worse if there is an associated psychological disorder. Such aggravation is often term ed 'psychological overlay' or 'illness behaviour', especially in legal practice. It is far safer to err on the side of disregarding possible psychogenic factors than to overlook an organic lesion on the supposition that the symptoms are imaginary.

4 Treatment of orthopaedic disorders

Orthopaedic treatm ent falls into three categories:

- 1. no treatment simply reassurance or advice
- 2. non-operative treatment
- 3. operative treatment.

In every case these three possibilities of treatment should be considered one by one in the order given. At least half of the patients attending orthopaedic out-patient clinics (excluding cases of fracture) do not require treatment: all that they need is reassurance and advice. In many cases the sole reason for the patient's attendance is a fear that there may be cancer, tuberculosis, im pending paralysis, crippling arthritis, or other serious disease. If reassurance can be given that there is no evidence of serious disease the patient goes away satisfied, and the symptoms immediately become less disturbing.

If active treatment seems to be required it is a good general principle that whenever practicable a trial should be given first to non-operative measures; though obviously there are occasions when early or indeed immediate operation must be advised. Most orthopaedic operations fall into the category of 'luxury' rather than life-saving procedures. Consequently the patient should seldom be persuaded to submit to operation: rather the surgeon should have to be persuaded to undertake it. When one is undecided whether to advise conservative treatment or operation it is wise always to err on the side of nonintervention.

METHODS OF NON-OPERATIVE TREATMENT

REST

Since the days of H.O.Thom as (p.3), who, more than a century ago, emphasised its value in diseases of the spine and limbs, rest has been one of the mainstays of orthopaedic treatment. Complete rest demands recumbency in bedwhich, for the most part, is deprecated today - or immobilisation of the diseased part in plaster. But by 'rest' the modern orthopaedic surgeon does not usually mean complete inactivity or immobility. Often he means no more than 'relative rest', implying simply a reduction of accustom ed activity and avoidance of strain. Indeed complete rest is enjoined much less often now than it was in the past, because diseases for which rest was previously important, such as poliom yelitis or tuberculosis, can now be prevented or are more readily amenable to specific remedies such as antibacterial agents. Complete rest after operations, form erly favoured, has given place in most cases to the earliest possible resumption of activity.

SUPPORT

Rest and support often go together; but there are occasions when support is needed but not rest - for exam ple, to stabilise a joint rendered insecure by muscle paralysis, or to prevent the development of deformity. When support is to be temporary it can be provided by a cast or splint made from plaster of Paris or from one of the new er splinting materials. When it is to be prolonged or permanent an individually made surgical appliance, or orthosis, is required. Exam ples in common use are spinal braces, cervical collars, wrist supports, walking calipers, knee and ankle orthoses, and devices to control drop foot (Figs 11.3-11.5, pp. 177-8).

PHYSIOTHERAPY

Physiotherapy in its various form s occupies an important place in the nonoperative and post-operative treatments of orthopaedic disabilities. Emphasis on evidence-based practice has helped to produce an awareness among physiotherapists of the hazards as well as the merits of treatment. This has led to a correctemphasis being placed upon the value in many conditions of active rather than of passive treatment: in other words, of helping the patient to help him / herself. This approach is particularly rewarding in the rehabilitation of patients after injury or after operations, and in diseases such as poliom yelitis, cerebral palsy, hem iplegia, peripheral nerve palsies and mechanical low back pain. When it is used, physiotherapy should be pursued thoroughly. A number of different physiotherapy interventions have evolved over the years. These may be active, passive or a combination of the two. Passive approaches involve a range of different techniques carried out on the patient by the therapist. Active approaches require active involvement by the patient, either by exercising or changing behaviour.

Active intervention

Physiotherapists use the term physical activity, exercise and physical fitness to describe active interventions, but they are often used loosely and interchangeably. The term 'exercise' is used to include a range of methods from isometric stabilising exercise through to intensive aerobic fitness programmes. Exercise programmes aim to (1) strengthen specific muscles, (2) stretch soft tissues, (3) mobilise joints and (4) im prove coordination of muscles. Exercise to im prove coordination is of particular importance in cerebral palsy, multiple sclerosis, ankle and knee injuries.

Physical fitness is a multi-dimensional concept that has been defined as a set of attributes that people possess or achieve that relates to the ability to perform physical activity, and is comprised of skill-related, health-related and physiological components. Physical fitness programmes vary in intensity, design and delivery and are generally supervised in a group, but can be offered to patients on an individual basis. They usually include aerobic exercise with an aim to improve overall cardiovascular fitness, as well as specific exercises.

Hydrotherapy

Hydrotherapy is a valuable way of allowing active pain-free movements of all joints in warm water. The warmth and buoyancy of the water relieve the

muscle spasm and can help to reduce pain and increase the range of movement. Hydrotherapy is often particularly useful in the treatment of rheumatoid arthritis.

Passive interventions

These techniques are carried out by the therapist and do not require any active participation by the patient. The chief use of passive movements, or 'mobilisation' is to preserve full mobility when the patient is unable to move the joint actively - i.e. when the muscles are paralysed or severed. They are important after nerve injuries, especially to preserve mobility in the hand, and in poliomyelitis in countries where it still occurs. Recently, the use of machines to provide continuous passive motion of joints after operation or injury has become popular to minimise complications and encourage healing of articular cartilage.

Manual therapy

M anual therapy includes a wide range of joint mobilisation and manipulation techniques used by osteopaths and chiropractors, as well as physiotherapists. It also includes mobilisation of soft tissue. The manipulation can be high-velocity thrust applied at the end of joint range (such as to spinal joints) or a more gentle passive low-velocity mobilisation applied in various parts of the available joint range.

Soft-tissue techniques

Soft-tissue techniques include interventions that aim to mobilise soft tissue, either by massage or passive stretching techniques. Massage techniques range from Swedish massage to deep connective tissue massage and stretching of neural tissue.

Traction

Traction for the spine is carried out both m anually or using a motorised traction couch. The duration and magnitude of force can be varied, and if motorised traction is applied it can be carried out continuously or intermittently. The rationale for the use of traction therapy is based on the mechanical effects of traction on the spine, mainly stretching structures. These mechanisms are thought to cause separation of the vertebrae, widening of the intervertebral foram ina, movement of the facet joints and stretching of spinal muscles and ligaments. The proposed mechanisms are not supported by research findings.

Electrotherapy

The theoretical basis for the use of these modalities is weak and they are not recom mended in national or international guidelines. How ever, they continue to be used in clinical practice. Transcutaneous electrical nerve stim ulation (TENS) and interferential therapy, short wave diathermy, laser therapy are all used by physiotherapists with the aim of providing pain relief. The interference effect uses two different medium -frequency alternating currents applied sim ultaneously through two electrodes to induce a current at the site of their interaction in the deep tissues. Transcutaneous nerve stim ulation uses direct current pulses of adjustable frequency to stim ulate the larger sensory nerve fibres selectively, and thereby to set up a gate control mechanism blocking the activity of the small fibres which conduct pain signals.

Ultrasound

Ultrasound waves at approximately 10⁶ Hz can be projected as a beam from a transducer to induce a heating effect in deep tissues. They may also produce benefit from their mechanical and chemical effects on collagen and proteogly cans. Ultrasound is frequently used to reduce post-traumatic haematoma, oedema and adhesions of joints and their associated soft tissues.

ALTERNATIVE THERAPIES

There has been an increasing trend for patients to seek alternative therapy (i.e. chiropractic therapy, osteopathy, acupuncture, massage and homeopathy) to relieve musculoskeletal symptoms. However, no strong evidence has emerged over the last decade that suggests that alternative therapy is any more beneficial than physiotherapy.

LOCAL INJECTIONS

The indications for local injections fall into two groups:

- 1. osteoarthritis or rheum atoid arthritis, in which the substance (usually hydrocortisone with or without a local anaesthetic solution) is injected directly into the affected joint with rigid aseptic precautions
- 2. extra-articular lesions of the type often ascribed (for want of more precise know ledge) to chronic strain, as exem plified by tennis elbow, tendonitis about the shoulder, and certain types of back pain.

The response depends upon the nature of the basic lesion: perm anent relief is often gained in extra-articular lesions such as tennis elbow, but in arthritis the benefit is often no more than tem porary, and repeated injections are seldom to be recommended.

DRUGS

Drugs have rather a small place in orthopaedic practice. Those used may be placed in eight categories:

- 1. antibacterial agents and antibiotics
- 2. analgesics
- 3. sedatives
- 4. anti-inflam matory drugs
- 5. horm on e-like drugs
- 6. anti-osteoporosis drugs
- 7. specific drugs
- 8. cytotoxic drugs.

Antibacterial agents are of immense importance in infective lesions, especially in acute osteomyelitis and acute pyogenic arthritis. To be successful treatment must be begun very early. These drugs are also of definite value in certain chronic infections, notably in tuberculosis.

A nalgesics should be used as little as possible. M any orthopaedic disorders are prolonged formany weeks ormonths, and it is undesirable to prescribe any but the mildest analgesics continuously over long periods, except for incurable malignant disease. *Sedatives* may be given if needed to promote sleep, but as with analgesics the rule should be to prescribe no more than is really necessary.

Anti-inflamm atory drugs are those that damp down the excessive inflamm atory response that m ay occur especially in rheum atoid arthritis and related disorders, by inhibiting the cyclo-oxygenase enzymes responsible for prostaglandin formation. Non-steroidal anti-inflammatory drugs are generally to be preferred - especially in the first instance - and they are a mainstay in the treatment of rheumatoid arthritis. Many of these drugs also have an analgesic action. The powerful steroids cortisone, prednisolone, and their analogues should be used with extreme caution and indeed should be avoided altogether whenever possible, because through their side effects they may sometimes do more harm than good. Nevertheless there are times when their use may be justified - as for instance in acute exacerbations of rheumatoid arthritis, and especially in polymyalgia rheumatica and giant-cell arteritis (see p. 166).

Hormone-like drugs include the corticosteroids noted above, and sex horm ones or analogues used for the prevention of osteoporosis in post-menopausal women and for the control of certain metastatic tumours such as hormone-dependent breast and prostatic tumours. These are being increasingly replaced by the bisphosphonates, a family of drugs which block the resorption of bonemineral.

Anti-osteoporosis drugs. Hormone replacement therapy and the SERMS (selective oestrogen receptor modulators) have largely been replaced by the bisphosphonates which block bone resorption and by anabolic agents such as parathyroid hormone and strontium.

Specific drugs work well in certain special diseases. Exam ples are vitam in C for scurvy, vitam in D for rickets and salicylates for the arthritis of rheum atic fever.

Cytotoxic drugs form the basis of chemotherapy for malignant tumours. These anti-cancer drugs include cyclophosphamide, melphalan, vincristine, doxorubicin, and methotrexate. They have serious side effects and are used only under expert supervision.

MANIPULATION

Treatment by manipulation is practised widely by orthopaedic surgeons and by others in allied professions. Strictly, the term might legitim ately be used to include the passive movements, or 'mobilisations', that form part of the daily activities of a physiotherapy department and which have already been referred to above: but it is used here in a more restricted sense, to describe passive movements of joints, bones, or soft tissues carried out by the surgeon - with or without an anaesthetic, and often forcefully - as a deliberate step in treatment.

The subject will be considered under three general headings:

- 1. manipulation for correction of deformity
- 2. manipulation to improve the range of movements at a stiff joint
- m anipulation for relief of chronic pain in or about a joint, especially in the neck or spine.

Manipulation for correction of deformity

In this category manipulation has its most obvious application in the reduction of fractures and dislocations. It is also used to overcome deform ity from contracted or short soft tissues - as, for example, in congenital club foot. Yet another simple example is the forcible subcutaneous rupture and dispersal of a ganglion over the dorsum of the wrist.

Technique. An anaesthetic may or may not be required, according to the nature of the condition that is being treated. In many instances – as in manipulation for a fracture or dislocation – the aim is to secure full reduction at the one sitting; but in resistant deform ities such as club foot repeated manipulation may be required at intervals of a week or so, a little further im provem ent being gained each time.

Subsequent m anagem ent. A fter m anipulation for a deform ity that is liable to recur - as in m ost cases of displaced fracture and in chronic deform ities of joints - the lim b is usually im m obilised on a splint or in plaster to m aintain the correction. In cases of resistant deform ity gradual yielding of the soft tissue allows re-application of the splint in a more favourable position each time it is changed.

Manipulation for joint stiffness

The type of case mainly concerned with here is that in which a joint shows serious limitation of movement after an acute injury – usually a fracture of a lim b bone. 'Frozen' shoulder (periarthritis) in its non-active stage may also be included in this category. In such cases the stiffness is caused by adhesions either within the joint itself or, more often, in the soft tissues about or near the joint. Forcible manipulation by the surgeon is not required very often for stiffness of this type, because it will usually respond gradually to treatment by active exercises under the care of a physiotherapist, com bined with increasing use of the limb.

The joint that is most amenable to manipulation is the knee. The shoulder and the joints of the foot may also respond. Manipulation of the elbow and of the joints of the hand may increase the stiffness and should not be attempted.

Technique. Muscular relaxation should be secured by anaesthesia, supplemented if necessary by a relaxant drug. Great force should not be used: it is better to gain slight improvement by moderate force and then to repeat the manipulation after an interval. Excessive force may fracture a bone; or it may cause fresh bleeding within the joint, thereby aggravating the stiffness.

Subsequent management. Manipulation for joint stiffness should always be followed by intensive active exercises designed to retain the increased range of movement.

Manipulation for relief of chronic pain

In this third category of case treatment by manipulation is somewhat empirical, because in many instances it is impossible to determine precisely the nature of the underlying pathology, and consequently the way in which manipulation acts is a matter of conjecture and - it must be said - of misconception.¹ Manipulation is used in such cases simply because previous experience has proved that it is often successful.

¹Non-medical practitioners – especially chiropracters and osteopaths – often postulate 'displacements' (for instance, of vertebrae) which clearly do not exist.

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The painful conditions that respond best to manipulation are chronic strains, especially of the tarsal joints, the joints of the spinal column, and the sacro-iliac joints. A chronic strain may be the consequence of an acute injury that has not been followed by complete resolution, or it may be caused by long-continued mechanical overstrain. It is generally surmised that adhesions are present that prevent the extremes of joint movement (even though a restriction of movement may not be obvious clinically), that these adhesions are painful when stretched, and that the effect of manipulation is to rupture them. A nalternative explanation that is advanced in certain cases is that there is a minor displacement of the joint surfaces or of an intra-articular structure (even though this can seldom be demonstrated radiologically), and that the effect of manipulation is to restore norm al apposition.

Technique. Manipulation for relief of pain from chronic strain consists in putting the affected joint or joints forcibly through a full range of movement, usually while the patient is fully relaxed under an anaesthetic but som etimes without an anaesthetic. Steady longitudinal distraction of the joint is often a useful prelim inary to the forcing of the extrem e range.

Subsequent m an agem ent. The m an ipulation should usually be follow ed by physiotherapy to m aintain the function of the joint. It m ay be repeated after an interval if initial im provem ent does not progress to com plete cure.

D angers and safeguards in treatm ent by manipulation. Manipulation may do harm if it is undertaken for the stiffness of inflam matory arthritis in an active stage, or if a tum our or other destructive disease exists close to the joint. It is also inadvisable in cases of acute back pain due to prolapsed intervertebral disc, because it may cause further extrusion of disc material. This emphasises the importance of careful clinical and radiological exam ination - supplemented when necessary by other investigations such as determination of the erythrocyte sedimentation rate, radioisotope scanning, radiculography or magnetic resonance imaging - before treatment is begun. It must be emphasised again that manipulation is of no value for stiffness of the metacarpo-phalangeal joints and interphalangeal joints of the hand.

During the manipulation itself care must be taken to avoid disasters such as the fracture of a bone or massive displacement of an intervertebral disc. It is well known that a fracture - especially of the patella or humerus, or even of the femur - may be caused easily by injudicious manipulations. This risk is greatly increased if the bone is already weak from the osteoporosis of disuse or from other rarefying disease.

RADIOTHERAPY

Radiotherapy - by X -rays or by the gam ma rays of radio-active substances - may be used for certain benign conditions or for malignant disease. Because of its possible ill effects - particularly the risk of inducing malignant change - it should be advised only with caution for benign lesions, but its use may rarely be justified in the treatment of some cases of giant-cell tum our of bone that are unsuitable for local excision because of their anatom ical site. In malignant disease radiotherapy is occasionally curative but more often palliative. In conditions such as malignant bone tum ours, for which a tum our dose in the range of 5000-6000 centig ray may be required, only the penetrating rays produced by a super-voltage linear accelerator or by a radio-active cobalt unit should be used. W ith such apparatus a high dose can be delivered to the tum our with the least possible dam age to the skin.

OPERATIVE TREATMENT

The chief essential of any operation is that it should not make the patient worse. This is so obvious that the statement may sound almost absurd. Yet it is unfortunately true that a disturbing number of operations carried out for orthop aedic conditions do in fact cause more harm than good for one reason or another. Hence the selection of cases for operation, the choice of the most appropriate operation in given circumstances, the technical performance of the operation, and the post-operative management are matters of the highest importance, and they call for a high degree of judgement and skill. Herein lies much of the fascination of orthopaedic surgery.

A detailed account of operative techniques is unnecessary here. All that is required is a brief mention of the more important operations.

SYNOVECTOMY

Synovectom y is the operation for rem oval of the inflam ed lining of a joint, while leaving the capsule intact. It may be of value in some types of chronic infective arthritis as well as occasionally in early rheum atoid arthritis. Because of the difficulty in gaining anatom ical access, it is necessarily a subtotal procedure; but it may nevertheless afford worthwhile relief by reducing local pain and swelling. There is no clear evidence that it protects the articular cartilage from further dam age; but the rem oval of a large part of this invasive granulation tissue or pannus may be of benefit by reducing the production of proteolytic enzymes.

OSTEOTOMY

O steotomy is the operation of cutting a bone or creating a surgical fracture. Indications. The general indications for osteotomy are as follows:

- 1. to correct excessive angulation, bow ing or rotation of a long bone
- 2. to permit angulation of a bone in order to compensate for mal-alignment at a joint
- 3. to perm it elongation or shortening of a bone in the low er lim b in order to correct a discrepancy of length betw een the two sides.

In addition, there are certain special indications for osteotom y at the upper end of the fem ur, as follow s:

- 4. to improve stability at the hip by altering the line of weight transmission (abduction osteotomy)
- 5. to improve containment in transient avascular necrosis of the epiphysis of a long bone
- 6. to relieve the pain of an osteoarthritic hip (displacement osteotomy, Fig. 17.28A, p. 363).

Technique. If the bone is relatively soft (as in children) it may be divided sim ply with an osteotom e or, in the case of a thin bone, by bone-cutting forceps. The strong cortex of the major long bones in an adult is not easily divided in that way because it tends to splinter; so most surgeons weaken the bone by making multiple drill holes before applying the osteotom e, or, alternatively, they use a powered saw or a high-speed dental burr. When the bone has been divided and the necessary correction made it is often convenient to fix the fragments with

CHAPTER 4

a plate, nail-plate, or medullary nail: this may allowexternal splintage to be dispensed with. If internal fixation is not used the fragments may be immobilised by an external fixator; or they may be held in position by a suitable splint or plaster until union has occurred.

ARTHRODESIS

The operation of arthrodesis, or joint fusion, is used less commonly since the advent of reliable techniques of joint reconstruction, or arthroplasty, for the major limb joints. It has the advantage of providing a painless stable joint and the disability from a single stiff joint is usually slight, and patients readily adapt them selves to it. Even when two or three joints are fused function may be surprisingly good, depending upon the particular joints affected. This gives arthrodesis its most common application for treatment of arthritis in the small joints of the hands and feet but it is now rarely used for the hip, knee, or shoulder except as a salvage procedure.

Indications. A rthrodesis is indicated mainly in the following conditions:

- advanced osteoarthritis or rheum atoid arthritis with disabling pain, especially when confined to a single joint
- quiescent tuberculous arthritis with destruction of the joint surfaces, to elim inate risk of recrudescence and to prevent deform ity
- 3. instability from muscle paralysis, as after poliomyelitis
- 4. for permanent correction of deform ity, as in ham mer toe.

M ethods of arthrodesis. A rthrodesis may be intra-articular or extra-articular, or the two may be combined. In *intra-articular* arthrodesis the joint is opened and the bone ends are displayed. The articular cartilage (or what remains of it) is removed so that raw bone is exposed. The joint is placed in the desired position and immobilised, usually by metallic internal fixation as well as by a plaster-of-Paris splint, until clinical tests and radiographs show sound bony fusion. In some cases an external fixation device can be used with the addition of compression across the opposed bone surfaces which seems to speed union.

In extra-articular arthrodesis the joint itself is left undisturbed (though it may be im mobilised by a nail or screw), but it is 'by-passed' by securing bone-tobone fusion outside the joint, usually through the medium of a bone graft. The method is applicable mainly to the spine, shoulder, and hip. It has a theoretical advantage in cases of infective joint disease, because any risk of reactivating or disseminating the infection by opening the joint is avoided.

Examples of methods for arthrodesing the spine and a metatarso-phalangeal joint of the toe are illustrated in Fig. 4.1.

Position for arthrodesis. The best position for arthrodesis should not be regarded as rigidly established for each joint: variations may be appropriate and desirable in individual cases – for instance, to conform to the requirements of the patient's work. The following is only a general guide. Shoulder: 30° of abduction and flexion, with 40° of medial rotation. Elbow: If only one elbow is affected, 75° of flexion from the fully extended position (or according to the requirements of the patient's work). If both elbows are affected, one should be in flexion 10° above the right angle and the other about 20° below the right angle. If forearm rotation is lost the most useful position of the forearm is in 10° of pronation. Wrist: Extended 20°. Metacarpo-phalangeal joints: Flexed 35°. Interphalangeal joints: Sem iflexed. H ip: A bout 15° of flexion; no abduction or

Treatment of orthopaedic disorders

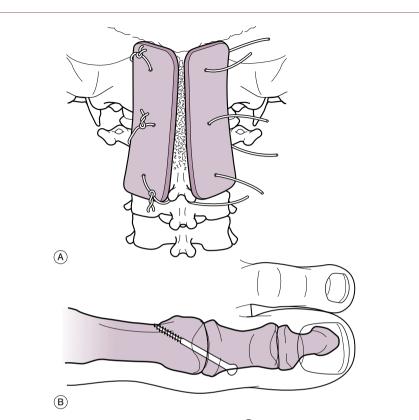


Fig 4.1 Two methods of arthrodesis (joint fusion). (A) Extra-articular arthrodesis of the cervical spine using a posterior cortico-cancellous bone graft with wire fixation, proximal and distal to the intervertebral joint to be fused. (B) Intra-articular arthrodesis of the metatarso-phalangeal joint of the great toe using internal fixation with a single screw to fix the raw cancellous bone surfaces in the desired position.

uction. Knee: About 20° of flexion. Ankle: In men, a d d righ t ang le: i n o m en. of plantarflexion, according to accustom ed 1.5 height of heel etatarso-М phalangeal joint of big toe: Slight extension, depending upon the accustom ed height of shoe heel.

ARTHROPLASTY

Arthroplasty is the op e ratio n fo r construction o f 0 a b l e io in t. Its m i n t h 1 a 3.0 h 11 1+ d fro m t h ion of t o t o d t h pla h o f th e hip ha 0.111 d e n t r t h r e tio n i n at joint and its use has now been extended to the knee, as well t h elbow, certain joints in the hand, and the first 1e. th e shoulder, the tarso-phalangeal joint in the foot.

Indications. The indications for arthroplasty vary with the particular joint affected and the degree of disability. Broadly, it has a use in the following conditions:

- advanced osteoarthritis or rheum atoid arthritis with disabling pain, especially in the hip, knee, ankle, shoulder, elbow, hand and metatarso-
- 2. quiescent destructive tuberculous arthritis especially of the elbow or hip
- 3. for the correction of certain types of deform ity (especially hallux valgus)
- 4. certain ununited fractures of the neck of the fem ur.

It will be realised that in several of these conditions arthroplasty is an alternative to arthrodesis. By far the commonest applications for arthroplasty are disabling osteoarthritis of the hip and the knee.

Methods of arthroplasty

Three methods are available:

1. excision arthroplasty

phalangeal joints

- 2. hem iarthrop lasty or half-joint replacement
- 3. total replacement arthroplasty.

Each method has its merits, disadvantages and special applications.

Excision arthroplasty. In this method one or both of the articular ends of the bones are sim ply excised, so that a gap is created between them (Fig. 4.2) effectively creating a false joint or pseudarthrosis. The gap fills with fibrous tissue, or a pad of muscle or other soft tissue may be sew n in between the bones. By virtue of its flexibility the interposed tissue allows a reasonable range of movement, but the joint often lacks stability making it less suitable for the large weight-bearing joints of the low er lim b. Excision arthroplasty is used most commonly at the metatarso-phalangeal joint of the big toe, in the treatment of hallux valgus and hallux rigidus (Keller's operation). It is also occasionally used at the hip, usually as a salvage operation after failed replacement arthroplasty. It is used occasionally at the elbow, the shoulder, and certain of the small joints of the elbow.

Hemi-arthroplasty (half-joint replacement arthroplasty). In a hemiarthroplasty only one of the articulating surfaces is removed and replaced by a prosthesis of similar shape (Fig. 4.3A). The prosthesis is usually made from

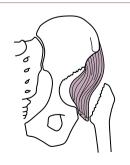


Fig. 4.2 Excision arthroplasty (pseudarthrosis) of the hip. Note the interposed soft tissue between the bony surfaces.



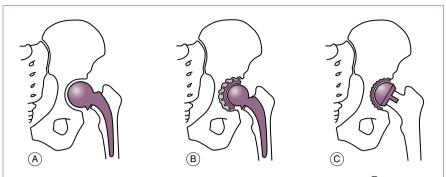


Fig. 4.3 Three methods of arthroplasty (joint replacement) used at the hip. A Half-joint replacement arthroplasty: the femoral head is replaced by a metal prosthesis. Total replacement arthroplasty. The femoral head is replaced by a metal prosthesis and the acetabulum by a plastic socket. Both components may be held in place by acrylic filling compound or 'cement'. Resurfacing (double cup) arthroplasty. Matching metal shells are used to resurface the femoral head and acetabular socket with cemented or cementless fixation.

m etal. W hen appropriate, it may be fixed into the recipient bone with a crvlic com pound or 'bone cem ent'. The opposing, norm al articulating su rface undisturbed. The technique has its main application at the is le hip, replacement of the head and neck of the femur is commonly sth e tic pracfem oral neck fracture in the elderly. The disadvantage i s eneration in the unreplaced articular surface will accelerate with recurrence and loss of movement making it unsuitable for younger patients. It has rather a limited use elsew here, exam ples being the replacem ent of the head of th e radius after certain types of fracture, and replacem ent of the lunate bone in Kienböck's disease

Total replacement arthroplasty. In this technique both of the opposed articulating surfaces are excised and replaced by prosthetic components (Fig. 4.3B). In the larger joints one of the components is usually of metal and the other of high-density polyethylene, and it is usual for both components to be held in place by acrylic 'bone cement'. In small joints such as the metacarpo-phalangeal joints a flexible one-piece prosthesis made from silicone rubber may be used.

Total replacement arthroplasty has proved very successful at the hip, and at the knee. It has been extended, so far with only moderate success, to many other joints including the shoulder, elbow, ankle, metacarpo-phalangeal joints, and metatarso-phalangeal joints. A disadvantage - which applies also to halfjoint replacement arthroplasty - is that there is a tendency for the prosthesis to work loose after 10-15 years. This results from bone resorption around the implant due to an aseptic inflammatory reaction triggered by the production of microscopic wear particles from the artificial materials used for the articulating surfaces. In turn this has led to a search for harder materials and improved prosthetic designs to minimise the production of wear particles.

A nother approach to preserve bone in younger patients, who might require later revision surgery, is to resurface rather than replace the joint. A ttem pts have been made to achieve this biologically with autogenous chondrocytes in the knee, or with artificial materials as in the double cup arthroplasty of

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the hip (Fig. 4.3C). The longer-term results from these new techniques remain uncertain and it should be noted that a conventional well-fitted replacement jointmay give good service for as long as 15-20 years, especially in the case of the hip or knee.

BONE GRAFTING OPERATIONS

Bone grafts are usually obtained from another part of the patient's body (autogenous grafts or autografts). If it is im practicable or undesirable to take bone from the patient's own body, grafts from another human subjectmay be used (allografts, hom ogenous grafts or hom ografts). These must be stored frozen under aseptic conditions until they have been proved to be free from transmissible infection, including HIV and other dangerous viral infections. For bone from living donors (mainly femoral heads removed during hip replacem ent operations) this necessitates retesting after 9 m onths to ensure that the donor was not incubating infectious disease at the time of removal of the bone. Cadaveric bone sterilised by irradiation is som etim es used and is increasingly available from large tissue banks. Grafts obtained from animals (xenografts, heterogenous grafts or heterografts) may be applicable if they are specially treated to reduce their antigenic properties. At som e centres limited use is still m ade of such bone (chiefly bovine) prepared com mercially in sterile packs, but it has been shown to be far inferior to the patient's own bone and cannot be relied upon to become incorporated with the host bone.

Bone transferred as a free autograft from one site to another does not survive wholly in a living state. For the most part the bone cells die, although a proportion may possibly survive, especially in cancellous bone. The purpose of the graft - as of allografts and heterografts - is mainly to serve as a scaffolding or temporary bridge upon which new bone is laid down. It also provides an osteogenic stim ulus to the host cells from the bone morphogenic proteins released from the non-cellular bone matrix. Thus the whole of a graft is eventually replaced by new living bone. This process of replacement is dependent upon adequate revascularisation of the graft; so a graft that lies in a highly vascular bed is more likely to succeed than one that is surrounded by relatively ischaemic tissue.

W ith refinements in the technique of microvascular surgery it is now possible to transfer bone with its soft-tissue coverings on a vascular pedicle to a distant recipient site, with im mediate anastom osis of its nutrient vessels to those in the new bed. Such living grafts are found to become incorporated rapidly. Vascularised grafts are especially valuable in major reconstructive procedures after extensive loss of bone and soft tissue.

Indications. Bone grafts are used mainly in three types of case:

- 1. in cases of ununited fracture, to promote union
- in arthrodesis of joints, either to supplement an intra-articular arthrodesis or to promote extra-articular fusion (see p. 39)
- 3. to fill a defect or cavity in a bone.

Technique. A utogenous bone for grafting may be obtained as a solid slab, or it may be used in the form of multiple slivers or strips, or of small chips.

Strut grafts. A strut graft is usually obtained from strong cortical bone: the subcutaneous part of the tibia is a common site. The graft is fixed to the recipient bone either by internal fixation or by inlaying. Such a graft serves as an internal splint as well as providing a framew ork for the grow th of new bone (Fig. 4.4A).

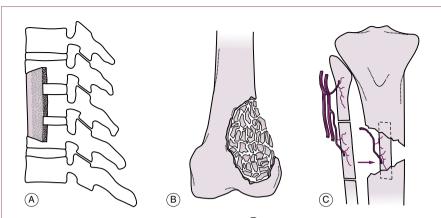


Fig. 4.4 Examples of bone grafting techniques. A Strut graft of cortico-cancellous bone used to provide inlay fixation for anterior cervical spine fusion. B Cancellous grafts used to fill a cavity in a bone. C Vascularised fibula bone graft.

Strip grafts. Sliver or strip grafts are generally obtained from spongy cancellous bone - especially from the crest of the ilium. They are used commonly for ununited fractures. They are laid about the fracture, deep to the periosteum, and are held in place by suture of the soft tissues over them.

Chip grafts. These also are preferably obtained from cancellous bone. They serve the same purposes as sliver grafts but are smaller pieces of bone. The chips are packed firm ly into, or around, the recipient bone and are held in place simply by suture of the soft tissues over them (Fig. 4.4B).

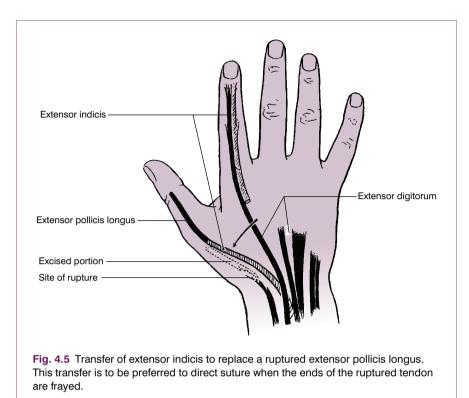
Vascularised grafts. These require a suitable donor site, such as the fibula, rib, or iliac crest, together with a meticulous microscopic technique to secure the necessary re-anastom osis of the nutrient vessels at the new site (Fig. 4.4C). The method is only suitable for use in specialised centres with the necessary equipment and expertise.

TENDON TRANSFER OPERATIONS

In the operation of tendon transfer, or tendon transplant, the insertion of a healthy functioning muscle is moved to a new site, so that the muscle henceforth has a different action. In this way the lost function of a paralysed or severed muscle can be taken over by one that is intact. In properly selected cases there need be no noticeable loss of pow er in the form er sphere of action of the transferred muscle, because there is often considerable duplication or overlap in the function of individual muscles. Thus a tendon of flexor digitorum superficia-lis may be transferred to a new site without appreciably impairing the power of finger flexion, which can be adequately controlled by the flexor profundus. Similarly the extensor indicis can be spared for a new function without seriously interfering with the power of extension of the index finger (Fig. 4.5).

Indications. Tendon transfers have their main application in three groups of conditions:

 in cases of muscle paralysis, to restore or improve active control of a joint by re-routing a healthy muscle to act in place of a paralysed one



- in cases of deform ity from muscle im balance, to maintain correction by switching healthy muscles to restore proper balance
- 3. in cases of ruptured or cut tendon, when direct suture of the ends is im practicable.

Technique. The tendon to be transferred is divided at an appropriate point, re-routed in the direction of its new action, and secured to its new insertion. If it is to be inserted into bone it is passed through a drill hole and held by suturing back on itself or by suturing to the periosteum or soft tissues on the deep aspect of the bone. If it is to be united to a tendon stump the junction may be secured by end-to-end suture or, preferably, by interlacing the tendons one through the other and transfixing them with mattress sutures.

ples. 1. In a case of paralysis of the radial nerve, with loss Еха of the wrist, fingers, and thum b, function may b e b v follow ing tendon transfers: pronator teres is transferred to extensor carpiradialis brevis; flexor carpi ulnaris is transferred to extensor digitorum and extensor pollicis longus; and palm aris longus is transferred to abductor pollicis longus. 2. In a case of congenital talipes equino-varus (p. 434) transfer of the tendon of tibialis anterior or tibialis posterior to the outer side of the foot will help prevent recurrence of the deformity. 3. In a case of rupture of the t o sor pollicis longus, with extensive fraying of the tendon, direct repair may be im practicable. Function may be restored by transfer of the extensor indicis to the extensor pollicis longus (Fig. 4.5).

Treatment of orthopaedic disorders

TENDON GRAFTING OPERATIONS

In tend on grafting a length of free tend on is used to bridge a gap between the severed ends of the recipient tend on.

Indications. The chiefuse of free tend on grafts is in the reconstruction of flexor tend ons severed and adherent in the fibrous digital sheaths of the hand (p. 324).

Technique. The free tendon graft is usually obtained from the palmaris longus or from one of the toe extensors at the dorsum of the foot. The original, adherent tendon is removed. Proximally, the graft is joined to the recipient tendon by sutures of stainless steel wire. Distally, it may be secured to the distal stum p of the recipient tendon or it may be attached directly to bone through a drill hole.

EQUALISATION OF LEG LENGTH

If a patient's legs are of marked ly unequal length, as in certain cases of congenital anom aly, previous poliom yelitis, or dam age to a grow the piphysis, the discrepancy may be reduced or eliminated by operation. The methods available are:

- 1. leg lengthening
- 2. leg shortening
- 3. arrest of epiphysial grow th.

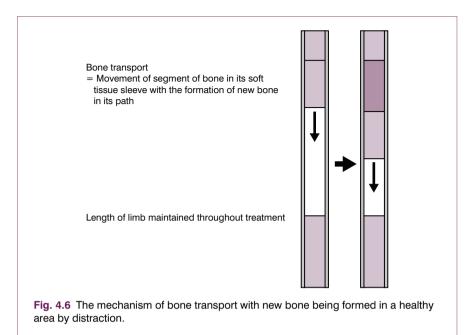
Leg lengthening is suitable mainly for children. It is achieved by dividing the appropriate bone (usually the tibia, som etim es the fem ur) and then gradually elongating the lim b in a special screw -distraction apparatus at the rate of about 2 m m a day. A maxim um of about 5 cm may be gained. The procedure is tim e-consum ing and trying for the patient, and should be reserved for carefully selected cases in which the discrepancy in length is marked. A more recent innovation is the technique of *bone transport*, in which a length of the diaphysis is moved slow ly dow nw ards to fill a gap, while new bone forms to fill in the space created by its advancement (Fig. 4.6). These techniques have been facilitated by the introduction of the ring fram e distraction apparatus of Ilizarov¹, which allow s correction of angulation as well as lengthening (Fig. 4.7).

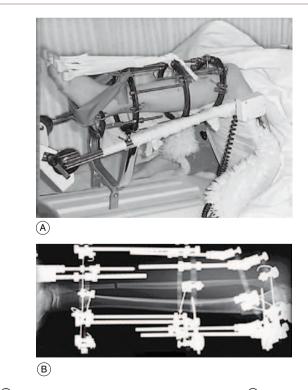
Leg shortening, by removing an appropriate length from the shaft of the longer femur or tibia, is less hazardous but not to be undertaken lightly because it disturbs a limb that was previously normal. In a patient who is fairly tall, and especially in adults, it is often preferable to leg lengthening.

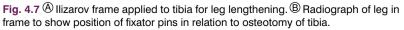
A rrest of epiphysial grow th (on the longer side) is applicable only to children with considerable grow th still to com e. It entails either destruction, or bridging by bone grafts or by metal staples, of the low er fem oral epiphysis or of the upper tibial epiphysis, or both. The correction to be expected depends upon the amount of grow th still to com e from the corresponding epiphysis of the opposite (shorter) leg, which depends in turn upon the patient's age at the time of operation, and upon the nature of the abnorm ality that is responsible for the shortening.

¹Gauril Abramovich Ilizarov (1921–1992) Russian surgeon with little formal research training who developed practical application of tension stress to tissues. Became Professor at Kurgen Institute in Siberia and was elected to the Soviet Academy of Medicine.

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Tissue distraction techniques

Relatively recently, the principle of tissue distraction was described by Ilizarov. This states that if a tissue is very gradually pulled apart it responds by creating new tissue. The principle was initially described for bone, where it was shown that if a bone was divided and following a delay period of 3-10 days, was pulled apart at approximately 1 m m / day, the body responded by creating a column of callus, which eventually would consolidate into healthy new bone.

This process is now used extensively in limb lengthening, bone transport and the correction of deform ity. In the latter case, the bone is gradually straightened and rotated to the desired position. In bone transport, the same process is used to fill a bone defect (which may have arisen as a result of trauma or from the treatment of bone infection or tumours), the bone is divided through a healthy area and a segment of bone is pulled through the defect in order to create a column of new bone which fills the defect (Fig. 4.6).

The same principle can be used to create soft tissues such as muscle, nerve, tendon and skin during the gradual correction of contractures of joints.

BONE FIXATION TECHNIQUES

The same modalities of bone stabilisation that are used during fracture treatment are used for reconstructive surgery. Osteotomies are often stabilised with casts in children, but in adults are more commonly stabilised with plates, intramedullary nails, or external fixation. During the arthrodesis of joints, both internal and external fixation methods are used. Limb lengthening is usually carried out with specific external fixators, but more recently internal lengthening nails have been developed which are applicable for some patients.

External fixation fram es consist of a fram e that lies external to the skin, which is connected to the bone via 'half pins' or fine wires that pass from the fram e through the skin and into the bone. The half pins are relatively broad (4-6 m m) and pass from the external fram e through the soft tissues on one side of the lim b and finally through both cortices of the bone. Fine wires (1.5-2 m m) are used with circular external fixators and com pletely transfix the lim b, going through both cortices of the bone and the soft tissues on each side of the lim b. The fine wires are placed under tension and then clam ped to the circular external fram e. D uring lengthening and the correction of deform ity, fine adjustments are m ade to the connecting struts on the external fram e which bring about the desired am ount of lengthening or deform ity correction.

AMPUTATION

A m putation can be a useful treatment option. It may be necessary for malignant tum ours for which it is not possible to perform a lim b salvage procedure. In certain patients with congenital conditions, such as pseudarthrosis, a belowknee am putation may be the best treatment. Most commonly, am putations are carried out for peripheral vascular disease, infection or trauma.

W ith improvements in the design and manufacture of modern prosthetic limbs, the function after below-knee amputation is usually extremely good



Treatment of orthopaedic disorders

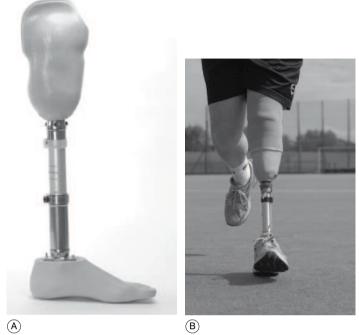


Fig. 4.8 (A) Otto Bock below knee prosthesis with patellar tendon bearing socket and a SACH foot. (B) Amputee wearing the below knee prosthesis, without its cosmetic covering, to demonstrate the level of functional activity that can be achieved.

(Fig. 4.8). Howev utation, walking is more difficult and ove-knee am p nner r e a i m i r d m 0 t h a n n o m a 1. F 11 nctio n a f lim ould be a m n d lim b 11 'phantom аv i d e d 80% o f mav experience i f m a n a s n a tien ts lim feel a lim b that is no longer there b n that is the v an d t h m а m p а n ie d b n rsisten t i n

Com are through the m id -foot (Chopart, Lisfranc), p d istal i a (Srogroff), proxim al tibia (below -knee am putation), distal m amputation). The aim is to provide a soundly healed end f e m good muscle control and this should not be compromised bea in g stu m i t h in order to maintain length

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Part 2

GENERAL SURVEY OF ORTHOPAEDIC DISORDERS

This part, comprising seven chapters, is devoted to a broad preliminary review of the field of orthopaedics. The main groups of disorders will be described without a detailed consideration of their local manifestations. Against this general background the features of the common disorders as they affect each particular region will be discussed in the subsequent chapters.

Recent injuries of the limbs and spine form a subject of separate study, and are dealt with in the companion volume to this work, *Outline of Fractures*.

CLASSIFICATION OF ORTHOPAEDIC DISORDERS

Most orthopaedic disorders fall within the following groups:

Deformities Congenital deformities Acquired deformities	Soft tissue tumours and other diseases Tumours of soft tissue Inflammatory lesions of soft tissue
General affections of the skeleton Bone dysplasias Inborn errors of metabolism Metabolic bone disease Endocrine disorders	Arthritis and other joint disorders Arthritis Dislocation and subluxation Internal derangements
Infections of bone and joints Infections of bone Joint infections	Neurological disorders Cerebral palsy Spina bifida Poliomyelitis Peripheral nerve lesions
Bone tumours and other local conditions Tumours of bone Osteochondritis Cystic change	

5 Deformities and congenital disorders

D eform ities m ay be congenital or acquired, and they m ay reflect an underlying abnorm ality of bone, joint, or soft tissue.

CONGENITAL DEFORMITIES

Congenital deformities or malformations, by definition, are attributable to faulty development and are present at birth, though they may not be recognised until later. They vary from severe malformations that are incompatible with life and may be found in still-born infants, to minor abnormalities of structure that have no practical significance. Incidence varies in different countries and among different races: in Britain probably 2 or 3% of infants are born with som e significant developmental abnormality, but only about half of these affect the musculo-skeletal system. Some of the better-known anomalies are summarised in Table 5.1 (p. 53).

Causes

An abnormality of development may be caused by:

- 1. genetic abnorm ality
- 2. environm ental abnorm ality
- 3. com bined genetic and environm ental abnorm alities.

Studies of families and twins have helped geneticists to determine the influence of genetic and environmental factors, alone or combined, in the causation of many of the recognised malformations.

Genetic causes include mutation of a whole chromosome, as in Down's syndrome (mongolism), and mutation of a small part of a chromosome or of a single gene, as in achondroplasia. The defect is not necessarily always inherited from an affected parent: it may arise from a fresh mutation in the germ cell.

Environmental causes are not well understood. Experiments in animals have shown that many different types of environmental influence - dietetic, horm onal, chemical, physical, or infective - may cause abnormalities of development, and the system of the body that is mainly affected depends upon the timing of the environmental 'insult'. But except for a few specific agents acting early in pregnancy there is no conclusive evidence that similar influences are important causes of malformations in man. The specific agents whose influence in man is well attested include radiation, the virus of rubella, and certain drugs (notably aminopterin and thalidomide).

Combined genetic and environmental factors seem to be the usual cause of the more common congenital malformations in man, on the evidence of twin and family studies. It is thought probable that developing embryos react **Table 5.1** Some of the better-known congenital deformities or anomalies of orthopaedic interest, with their salient clinical features. (When a fuller description appears elsewhere in this book the relevant page number is given. Conditions not thus designated are either so rare or of such little importance to the student that further description is unnecessary.)

Name of deformity or anomaly	Clinical or pathological features
Generalised Osteogenesis imperfecta (fragilitas ossium) (p. 62)	Fragile soft bones, easily broken or deformed. Often blue sclerotics. Joint laxity. Otosclerosis
Diaphysial aclasis (multiple exostoses) (p. 63)	Cartilage-capped bony outgrowths from metaphyses. Deficient remodelling. Stunted growth
Dyschondroplasia (multiple chondromatosis; Ollier's disease) (p. 65)	Masses of cartilage in metaphyses of long bones. Impaired growth. Deformity. Often unilateral
Achondroplasia (chondro-dystrophy) (p. 61)	Short-limb dwarfing from defective growth of long bones. Trident hand. Large head
Osteopetrosis (Albers-Schönberg disease; 'marble bones')	Hard dense bones, but with increased liability to fracture. Anaemia from obliteration of medulla
Gargoylism (Hurler's syndrome)	Dwarfing. Kyphosis from deformed vertebrae. Corneal opacity. Large liver and spleen. Mental deficiency
Cranio-cleido dysostosis (p. 71)	Impaired ossification of skull. Deficient clavicles. Often deficient symphysis pubis
Arthrogryposis multiplex congenita (amyoplasia congenita)	Stiff deformed limb joints from defective development of muscles, usually secondary to nerve cell deficiency though a type due to primary dysplasia of muscle is also recognised. Hips often dislocated. Club feet
Pseudohypertrophic muscular dystrophy	Genetic transmission to boys through female carriers. Progressive muscle weakness evident at age 3–6 years. Raised urinary creatine phosphokinase: carriers may thus be identified. The defect may be diagnosed in early pregnancy, when abortion may be advised
Fibrodysplasia ossificans progressiva (p. 71)	Ectopic ossification, often beginning in trunk but extending to limbs. Short great toe
Familial hypophosphataemia (p. 76)	Rachitic bone changes corrected only by massive doses of vitamin D. Hypophosphataemia not responsive to vitamin D
Cystinosis (renal tubular rickets) (p. 78)	Rachitic rarefied bones with consequent deformity. Hypophosphataemia. Glycosuria; amino-aciduria
Neurofibromatosis (von Recklinghausen's disease) (p. 70)	<i>Café au lait</i> areas or spots. Cutaneous fibromata. Neurofibromata on cranial or peripheral nerves. Often scoliosis. Occasionally, overgrowth of bone
Haemophilia (p. 145)	Prolonged blood clotting time from deficiency of Factor VIII. Bleeding into joints or soft tissue
Gaucher's disease (p. 72)	Deposition of kerasin in reticulum cells, causing cyst-like appearance in bones, and large liver and spleen
Down's syndrome (mongolism)	Mental and physical impairment from trisomy of chromosome 21, giving 47 instead of 46 chromosomes

Continued

Table 5.1 Cont'd.

Table 5.1 Cont d.	
Name of deformity or anomaly	Clinical or pathological features
Trunk and spine	
Congenital short neck (Klippel–Feil syndrome) (p. 188)	Short stiff neck with low hair-line. Fused or deformed cervical vertebrae
Congenital high scapula (Sprengel's shoulder) (p. 189)	Scapula tethered high up, usually only on one side. Scapular movement impaired
Cervical rib (p. 202)	Often symptomless. Vascular symptoms (partial ischaemia) or nerve symptoms (paraesthesiae, lower trunk paresis)
Hemivertebra (congenital scoliosis) (pp. 213, 218)	Defective development of vertebra (and often of adjacent structures) on one side. Scoliosis
Spina bifida (spinal dysraphism) (p. 171)	Spina bifida occulta, meningocele or myelocele. Often leg deformities from paralysis or muscle imbalance. Often incontinence. Often associated hydrocephalus. Diagnosable in early pregnancy from excess of alpha-fetoprotein in urine and amniotic fluid
Limbs	
Congenital arterio-venous fistula	Hypertrophy and lengthening of limb. Bruit
Congenital amputation	Part or whole of one or more limbs absent
Phocomelia	Aplasia of proximal part of limb, the distal part being present ('seal-limb'). Diagnosable in pregnancy by ultrasonography
Constriction rings	Limb or digit constricted as if by a tight string. May be associated with syndactyly
Absence of radius (radial club hand)	Hand deviated laterally from lack of normal support by radius. Thumb often absent
Absence of thumb	Thumb alone may be absent, but other deformities may co-exist
Absence of proximal arm muscles	Trapezius, deltoid, sternomastoid, or pectoralis major absent
Radio-ulnar synostosis	Forearm bones fused at proximal ends, preventing rotation
Madelung's deformity (dyschondrosteosis) (p. 303)	Head of ulna dislocated dorsally from lower end of radius. Radius bowed
Syndactyly	Webbing of two or more digits
Polydactyly	More than five digits
Ectrodactyly	Lobster-claw appearance of hand, with pincer grip
Congenital dislocation of hip (p. 343)	Neonatal: diagnostic click obtainable. Later infancy: shortening; limited abduction. Radiographs diagnostic
Congenital coxa vara (p. 376)	Defective ossification of femoral neck, with reduced neck-shaft angle
Congenital short femur	Proximal end of femur deficient or rudimentary. Thigh short
Congenital tibial pseudarthrosis	Resembles ununited fracture in tibial shaft. Aetiology unknown, may be neurofibromatosis

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Table 5.1 Cont'd.

Name of deformity or anomaly	Clinical or pathological features
Absence of fibula	Leg under-developed on outer side. Foot small and everted; lateral two or three digital rays may be absent
Congenital club foot (p. 434)	Foot inverted and plantarflexed (equino-varus), or everted and dorsiflexed (calcaneo-valgus)
Congenital curled toe (p. 458)	Lateral angulation of one or more toes. Toe may lie over or under adjacent toe

d ifferently to environm ental in fluences: som e have a natural resistance w hereas others are susceptible. A m alform ation is therefore likely to arise w hen an environm ental 'insult' is inflicted upon cells that have a genetically determ ined lack of resistance to it.

CONGENITAL PSEUDARTHROSIS

Pseudarthrosis (false joint) occurs when a fractured bone fails to unite and remains mobile. Congenital pseudarthrosis can be present at birth, or the bone can bend (resulting in anterolateral bowing), and then fracture in the first few years of life. Congenital pseudarthrosis is a rare condition. It occurs most often in the tibia (1 in 200000) births, but also is seen in other long bones such as the fibula, fem ur, radius, and ulna.

The aetiology of congenital pseudarthrosis is unknown, but the periosteum for several centimetres either side of the pseudarthrosis is abnormally thickened.

Approximately 50% of cases of congenital pseudarthrosis of the tibia have neurofibromatosis type I (but only 3% of neurofibromatosis patients have pseudarthrosis). Congenital pseudarthrosis is also associated with fibrous dysplasia and amniotic constriction bands.

The affected limb usually grows more slowly, and shortening of the limb ensues. Treatment options include bone grafting, Ilizarov procedures, intramedullary nailing, and below-knee amputation.

Practical significance

M any of the recognised congenital abnormalities of the musculo-skeletal system have little practical importance, either because they are very rare or because there is little that can be done for them : these will not all be considered further in this book. There are others, how ever, that present m ajor problem s to the orthopaedic surgeon and m ay dem and energetic treatment. These include developmental or congenital dislocation of the hip (p. 343), congenital club foot (p. 434), spina bifida (p. 171), congenital scoliosis (p. 218), osteogenesis imperfecta (p. 62), and cervical rib (p. 202).

Inborn predisposition to disease in adults

It is well recognised that, quite apart from the overt congenital anom alies discussed above, there exists in some patients a genetically determined predisposition to abnorm alities developing in later life. Exam ples of orthopaedic 56

conditions to which a susceptibility may exist include certain types of osteoarthritis (especially of the hips), ankylosing spondylitis, gouty arthritis, rheumatic fever, idiopathic scoliosis, osteochondritis dissecans, and Dupuytren's contracture.

ACQUIRED DEFORMITIES

A cquired deform ities may be classified in two groups: those in which deform ity arises at a joint, and those in which it arises in a bone.

DEFORMITY ARISING AT A JOINT

Deformity may be said to exist at a joint when the joint cannot be placed voluntarily in the neutral anatom ical position.

Causes

The causes of deform ity arising at a joint may be sum marised under the follow ing headings (Fig. 5.1):

- 1. dislocation or subluxation
- 2. m uscle im balance
- 3. tethering or contracture of muscles or tendons
- 4. contracture of soft tissues
- 5. arthritis
- 6. prolonged abnorm al posture
- 7. unknown causes.

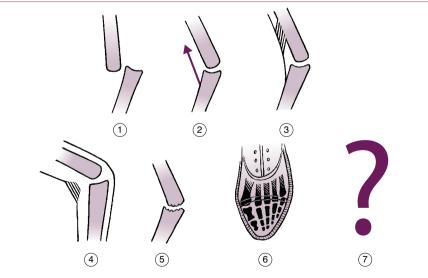


Fig. 5.1 Seven causes of deformity arising at a joint. 1. Dislocation. 2. Muscle imbalance. 3. Tethering of muscle or tendon. 4. Soft-tissue contracture. 5. Arthritis. 6. Posture 7. Idiopathic (cause unknown).

Dislocation or subluxation

This is usually caused by injury, but it may occur as a congenital deformity, or it may follow disease of the joint (pathological dislocation).

Muscle imbalance

Unbalanced action of muscles upon a joint may hold it continuously in a particular arc of its range. In time, secondary contractures occur in the dominant muscles or in the soft tissues, preventing the joint from returning to the neutral position (Fig. 5.1 (2)). The two fundamental causes of muscle imbalance are:

- 1. weakness or paralysis of muscles
- 2. spasticity of muscles.

Thus equinus deform ity at the ankle may follow paralysis of the dorsiflexor muscles (for instance, from damage to the lateral popliteal nerve) because the action of the plantarflexors and of gravity is unopposed. Or a similar deform ity may be caused by spasticity of the calf muscles, which overpower their antagonists. This occurs commonly in cerebral palsy (p. 168).

Tethering or contracture of muscles or tendons

If som ething happens to muscles or tendons that prevents their norm al to-andfrogliding, or their elongation and retraction, the joint may be held in a position of deform ity. Thus a muscle or tendon may be tethered to the surrounding tissues in consequence of local infection or injury (Fig. 5.1 (3)). An example is the anchoring of a flexor tendon of a finger within its fibrous sheath as a result of suppurative tenosynovitis, with consequent flexion deform ity at the interphalangeal joints. Or a muscle may lose its elasticity and contractile power from im pairm ent of its blood supply. An important example is Volkmann's ischaemic contracture of the forearm flexor muscles (p. 299) from occlusion of the brachial artery or from increased intra-com partmental pressure, with consequent flexion deform ity of the wrist and fingers.

Contracture of soft tissues

A part from any disturbance of the muscles, contracture of other soft tissues alone can account for joint deform ity. An exam ple is the common condition of Dupuytren's contracture (p. 321), in which the thickened and contracted palmar aponeurosis pulls the metacarpophalangeal and proximal interphalangeal joints of one or more fingers into flexion. Similarly, a flexion deform ity of the knee or elbow, or indeed of any joint, may occur from contracture of the scarred skin after burns of the flexor surface of the limb (Fig. 5.1 (4)).

Arthritis

The various types of arthritis will be discussed in a later chapter. Any type of arthritis may lead to joint deform ity. In some cases the joint is firm ly fixed in a deform ed position by bony or fibrous ankylosis. In other instances the joint retains some movement but is prevented from reaching the neutral position. Thus flexion and adduction deform ity is common in osteoarthritis of the hip, flexion deform ity is common in arthritis of the knee, and the deform ity of ulnar deviation of the fingers (Fig. 16.11A, p. 305) is a well-known feature of rheum atoid arthritis of the metacarpo-phalangeal joints.

Posture

The habitual adoption of a deform ed position of a joint often leads in time to perm anent deform ity. A common example is the lateral deviation of the great toe at the metatarso-phalangeal joint - hallux valgus - so common in women who cramp their feet into narrow pointed shoes (Fig. 5.1 (6)). A nother postural deform ity that is still seen occasionally - though it should never be allow ed to occur - is fixed flexion of the knees in a patient confined to bed for a long time with the knees bent over a pillow.

Unknown causes

In some cases deform ity occurs at a joint for no apparent reason. Thus many children develop knock-knee deform ity between the ages of 3 and 5 years without demonstrable cause. It is usually unimportant because it tends to correct itself spontaneously. A nother common and more serious example is the inversion deform ity of the foot known as talipes equino-varus or congenital club foot. A more sinister deform ity that is equally ill explained is the idiopathic scoliosis of adolescents (p. 215).

DEFORMITY ARISING IN A BONE

Deform ity exists in a bone when it is out of its norm al anatom ical alignment.

Causes

There are three causes of deform ity arising in bone:

- 1. fracture
- 2. bending
- 3. uneven epiphysial grow th (Fig. 5.2).

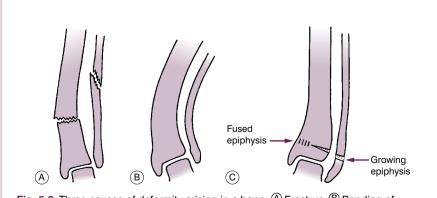


Fig. 5.2 Three causes of deformity arising in a bone. Fracture. Bending of softened bone. Uneven epiphysial growth.

Fracture

This is by far the most common cause. Unless a fracture is reduced so that the fragments are perfectly aligned, deformity will result. Examples are the genu valgum (knock knee) that is often the consequence of compression fractures of the lateral condyle of the tibia, the cubitus valgus that may follow displaced fractures of the lateral condyle of the humerus, and the common 'dinner-fork' deformity of an unreduced fracture of the low er end of the radius.

Congenital tibial pseudarthrosis may mimic an ununited fracture, but is often present at birth and may be linked to neurofibrom atosis (see p.70).

Bending of softened bone

M any unrelated conditions can cause softening of bone, with liability to bending and consequent deform ity. They are mostly generalised disorders in which several or all of the bones are affected. The following are exam ples. *M etabolic disorders*: rickets, osteom alacia. *Endocrine disturbances*: parathyroid osteodystrophy, Cushing's syndrom e. *A ffections of unknown cause*: Paget's disease (osteitis deformans), fibrous dysplasia of bone, idiopathic osteoporosis. The main features of these disorders will be described in a later chapter.

Uneven growth of bone

In children any disturbance of the growing epiphysial cartilage (grow th plate) m ay lead to uneven grow th and consequent deform ity. The usual effect of interference with a growing epiphysial cartilage is that its grow th is retarded; occasionally it is accelerated. D eform ity will follow only if the growing cartilage is affected more in one part than another, or if the interference with grow th affects only one bone of a pair, as in the forearm or leg (Fig. 5.2C). The most frequent causes of retarded epiphysial grow th are:

- 1. crushing fracture involving the epiphysial grow th plate
- in fection of the cartilage, usually from adjacent osteom yelitis or joint infection
- enchondrom a (a benign tum our) adjacent to the cartilage, as in O llier's disease (multiple enchondrom atosis (p. 65)).

In the relatively uncommon cases in which epiphysial grow this accelerated the usual cause is local hyperaemia induced by an adjacent focus of infection or by a vascular tumour such as a haem angioma.

TREATMENT OF DEFORMITIES

Each deform ity must be considered as an individual problem. Many do not require treatment, or are not amenable to it. In other cases an attempt may be made to correct or improve the deformity. One or more of the following methods may be used in appropriate cases:

- m an ipulative correction and retention in a plaster or splint (exam ple for displaced fracture)
- gradual correction by prolonged traction (exam ple for deform ity in certain types of arthritis)

ADAMS'S OUTLINE OF ORTHOPAEDICS

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- A lternatively, the gradual exertion force may be applied by an external frame such as the llizarov external fixator.
- 4. division or excision of contracted or tethered soft tissues (exam ples for Dupuytren's contracture or scarring from burns)
- osteotom y or osteoclasis (exam ples for deform ity from rickets or m alunited fracture)
- 6. arthrodesis (exam ple for scoliosis)
- 7. selective retardation of epiphysial grow th (in children) (exam ple for deform ity from uneven epiphysial grow th).

6 General affections of the skeleton

A large num ber of general affections of the skeleton have been described. Even an incom plete description could occupy a large volum e. Fortunately many of these affections are so rare that it is unnecessary for the student to concern him self with them. Most of the others require only brief consideration. Clearly, many of the affections to be described have a congenital basis and many of them cause deform ity; so there is inevitably some overlap between this chapter and Chapter 5.

CLASSIFICATION

The following classification is based on that of Wynne-Davies and Fairbank (1976).

Bone dysplasias and malformations

Achondroplasia

Osteogenesis imperfecta Hereditary multiple exostosis (diaphysial aclasis) Dyschondroplasia (Ollier's disease) Paget's disease (osteitis deformans) Polyostotic fibrous dysplasia Neurofibromatosis Fibrodysplasia ossificans progressiva (myositis ossificans) Cranio-cleido dysostosis Inborn errors of metabolism

Gaucher's disease Histiocytosis X

Metabolic bone disease

Hyperparathyroidism Nutritional rickets Other forms of rickets Nutritional osteomalacia Other forms of osteomalacia Vitamin C deficiency

Endocrine disorders

Osteoporosis Hypopituitarism Gigantism Acromegaly Hypothyroidism Glucocorticoid excess

BONE DYSPLASIAS

ACHONDROPLASIA

A chondroplasia is a congenital affection in which there is marked shortness of the limbs, with consequent dwarfing. It is of autosomal dominant inheritance but many cases arise from a fresh gene mutation.

Pathology. There is a failure of norm allossification in the long bones, which may be only half their norm allength. Grow thof the trunk is only slightly impaired.



Fig. 6.1 Achondroplasia, showing the typical features in a child. The dwarfing is due to shortness of the limbs, especially in their proximal segments; development of the trunk is but little impaired. Note the 'trident' hands.

Clinical features. A chondroplasia is apparent at birth, the child being strikingly dw arfed, with very short lim bs that are out of proportion to the trunk: shortness is especially marked in the proximal segments of the lim bs (Fig. 6.1). A dult achondroplasts are seldom more than 130 cm (4 feet 3 inches) in height. The hands are short and broad, the central three digits being divergent and of alm ost equal length ('trident' hand). The head is slightly larger than norm al, with a bulging forehead and depressed nasal bridge. There is marked lum barlordosis, often with thoracic kyphosis, which may occasionally lead to com pression of the spinal cord. There is no mental im pairm ent and life expectancy is usually norm al.

R ad iographic features. A part from striking shortness of the lim bs, there are characteristic changes in the pelvis, the inlet being widened from side to side but narrowed in the antero-posterior diameter, with notably small greater sciatic notches. The spinal canal is also narrowed in the antero-posterior diameter, which predisposes to spinal stenosis. The calvarium of the skull is large, but the base short.

Treatment. With improved techniques of leg lengthening, there may be increasing scope in the future for worthwhile gain in stature.

OSTEOGENESIS IMPERFECTA (Fragilitas ossium)

Osteogenesis imperfecta is a congenital and inheritable disorder - or more probably a heterogeneous group of disorders - in which the bones are abnormally soft and brittle, on account of defective collagen formation. In addition to the bones, other collagen-containing tissues such as teeth, skin, tendons, and



Fig. 6.2 Recent and old fractures of the bones of the upper limbs in an infant with osteogenesis imperfecta (fragilitas ossium).

ligam ents may be abnormal. It is usually transmitted as an autosomal dominant, but in a severe variant of the disease the parents are normal and a fresh gene mutation or autosomal recessive inheritance is postulated.

C linical features. In the worst cases, which occur sporadically rather than from inheritance and probably represent a distinct entity, the child is born with multiple fractures and does not survive. In the less severe exam ples fractures occur after birth, often from trivial violence. A smany as fifty or more may be sustained in the first few years of life. The fractures unite readily, but in the more severe cases marked deformity often develops, either from malunion or from bending of the soft bones (Fig. 6.2), and such patients may be badly crippled. In the milder cases there is a tendency for fractures to occur less frequently in later life.

A dditional features, not alw ays present, are a deep blue colouration of the sclerotics of the eyes, deafness from otosclerosis (which becomes worse in later life), and ligamentous laxity.

Treatm ent. Fractures are generally treated in the ordinary way, but in a severe case intram edullary nailing of affected long bones should be considered as a means of preventing crippling deform ity and permitting earlier resum p-tion of activity. New er techniques have been developed with telescoping rods, to obviate the need form ultiple operations. Protective appliances, such as walk-ing calipers, may be required in older children and adults.

MULTIPLE HEREDITARY EXOSTOSES (Diaphyseal aclasis)

This is a congenital affection characterised by the form ation of multiple exostoses (osteochondromata) at the metaphysial regions of the long bones. It is transmitted by an autosomal dominant mutant gene without any gender predisposition.

Pathology. The fault is in the epiphysial cartilage plate. Nests of cartilage cells become displaced and give rise to bony outgrow ths, which are capped by

proliferating cartilage. Grow th of the exostoses m ay cease at skeletal m aturity. These exostoses, or osteoch ond rom ata, constitute one type of benign bone tum our (p.109). The num ber of outgrow ths varies; often there are betw een ten and twenty, of varying size. In severe cases the process of rem odelling by which a bone attains its norm al adult shape is im paired, and there m ay be m arked deform ity, with reduction of longitudinal grow th and consequent shortness of stature. M alignant change in the cartilaginous cap of one of the tum ours can lead to the developm ent of a chondrosarcom a (the lifetim e risk is approxim ately 5%).

Clinical features. U sually the only symptoms and signs are those caused by the local swellings, or by their pressure effects. The patient is often of short stature, and there may be marked deformity of the limbs. Malignant change – often lethal – is suggested by rapid enlargement of one of the swellings in a patient, often at the age of skeletal maturity.

Radiographs show the bony outgrow ths. In severe cases the bones are broad and ill modelled (Fig. 6.3).

Treatment. A noutgrow th that is causing symptoms should be excised at its base and sent for routine histological examination to exclude any malignant change. Some deformities, particularly when they interfere with function, may require corrective osteotomies. Leg length discrepencies may also require correction, by either epiphyseal arrest or lengthening procedures.

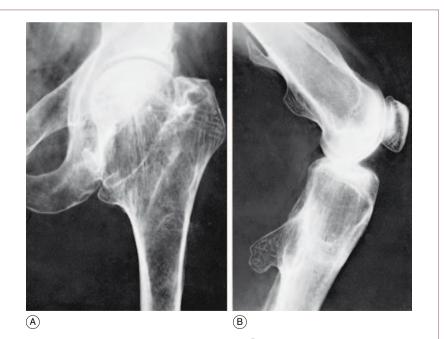


Fig. 6.3 Diaphysial aclasis (multiple exostoses). (A) shows stunting of the upper end of the femur due to failure of the remodelling process that accompanies normal growth. Defective remodelling is a characteristic feature of the disease in its more severe forms. (B) shows typical exostoses (osteochondromata) projecting from femur and tibia. Such outgrowths are always directed away from the end of the bone.

MULTIPLE ENCHONDROMATOSIS (Dyschondroplasia; Ollier's disease¹)

In dyschondroplasia masses of unossified cartilage persist within the metaphyses of certain long bones, and the grow th of the bone is retarded. The condition becomes evident in childhood, but the cause is unknown. In contrast with multiple hereditary exostoses, just described, heredity plays no part.

Pathology. The fault is in the epiphysial cartilage plate. In this respect dyschondroplas bles multiple exostoses, but this is the only hlance s e m resem them i n other respects they are entirely distinct. Nests of cartilage displaced from the epiphysial plate into the metaphysis, where they nersist enchondrom ata

bone formed cartilage may be affected. The more rapidly growing Anv in ends femurand tibia (that is, the ends near the knee) and the sm all long o f th e the hands and particularly common sites. There is a tendency body predom in an tly, disorder to a ffe one side of the o r exclubone is affected in t at the w а maior long erference w grow th the lesion h v s i a l cartilag e adiacent to mav lead to serious s h orten in g a n d (Fig. 6.4 A). When skeletal grow th ceases bone ossify. Rarely one of the tum ours undergoes malignant change, cartilage may to become a chondrosarcom a (p. 117).



Fig. 6.4 Multiple enchondromatosis (Ollier's disease). (A) Masses of proliferating cartilage occupy the metaphyses of one tibia. Growth is retarded and uneven. The normal tibia is shown for comparison. (B) Multiple enchondromata in the metacarpals and phalanges.

¹Louis Ollier (1830–1900) French surgeon who was senior surgeon at Lyons and described the clinical and radiological features of the condition in 1899. He was also an army surgeon and was decorated by the French President for his service.

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Clinical and radiographic features. A lim b affected by dyschondroplasia is usually short and m ay be m arkedly deform ed. The hands m ay be grotesquely enlarged by multiple cartilaginous swellings or outgrow ths. *Radiographs* show multiple areas of transradiance in the affected bones (Fig. 6.4).

Treatment. Osteotomy may be required to correct deformities resulting from uneven growth of bone. If there is marked discrepancy in the length of the lower limbs a leg equalisation procedure (p. 46) may be advisable. Lesions in the hand may be curetted and packed with bone chips.

PAGET'S DISEASE¹ (Osteitis deformans)

Paget's disease of bone is a slow ly progressive disorder of one or several bones. A ffected bones are thickened and spongy, and show a tendency to bend. The disease is one of the commonest general affections of the skeleton. The cause is unknow n. It has been suggested that infection with a slow virus of the paramyxovirus family may be responsible, on the evidence of inclusion bodies that have been found consistently in the osteoclasts of affected bones.

Pathology. The basic abnormality is thought to be defective function of osteoclasts, with consequent irregular bone resorption and increase of bone turnover. The bones most commonly affected are the pelvis, vertebrae, femur, tibia, and skull. The disease may be confined to a single bone at first, but it often spreads to involve other bones later. The cortex of the bone loses its normal compact density and becomes spongy. At the same time the cortex is widened by the formation of new bone on both its outer and inner surfaces. The whole bone is thus thickened, but the usual sharp distinction between cortex and medulla is blurred. The marrow spaces are filled with fibrous tissue. Whereas the bone is soft and vascular at first, in the later stages there is a tendency for it to become denser and very hard.

In the spongy state the softened bones are liable to bend. Pathological fracture m ay occur. In rare instances osteosarcom a develops in the diseased bone.

Clinical features. The affection seldom begins before the age of 40, but a childhood form is recognised. Often there are no symptoms, the condition being discovered incidentally during routine radiographic examination. When long bones are affected pain is sometimes complained of, but it is by no means an invariable feature. Bending of the softened long bones leads to deform ity, usually in the form of anterior and lateral bow ing of the fem ur or tibia (Fig. 6.5). Thickening may be obvious clinically, especially in the case of the tibia or the skull. Thus if the patient wears a hat he may notice that he requires progressively larger sizes. More importantly, bone thickening may also cause constriction of foram ina in the skull, with risk of damage to a nerve - for instance the optic nerve or the auditory nerve.

Im aging. The main *radiographic* features (Figs 6.6 and 6.7) are:

- 1. thickening of the bone, mainly from widening of the cortex
- diminished density of the cortex, which loses its compact appearance and assumes a spongy or honeycombed texture
- 3. marked coarsening of the bone trabeculae
- 4. in the later stages a general increase of density of the affected bones.

¹Sir James Paget (1814–1899) English surgeon who worked at St Bartholomew's Hospital, London and described the disease in great detail in 1877.

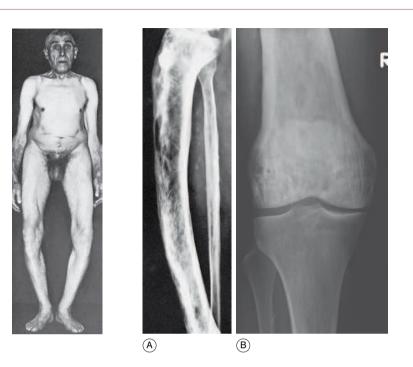


Fig. 6.5 (left) The typical appearance of a patient with widespread Paget's disease. Note the bowing of the legs and shortening of the trunk from collapse of softened vertebrae. The head was also enlarged.

Fig. 6.6 (right) Paget's disease. (A) Tibia, showing bending, coarsening of trabeculae, and thickened cortex which, however, is not sharply demarcated from the medulla. (B) Femur, showing broadening of the bone with loss of the normal demarcation of cortex and medulla.

The long bones are often shown to be bowed, the pelvis may be deformed, the vertebrae may be compressed and the vault of the skull thickened. *Radioisotope scan*ning with ^{**m} technetium shows markedly increased up take in the affected bones.

Investigations. The alkaline phosphatase content of the plasm a is increased, often to a high level if several bones are affected. Urinary hydroxyproline is increased, reflecting the increased resorption of bone matrix.

Complications. The important complications are pathological fracture, compression of cranial nerves, and occasionally - but most importantly - osteosarcoma.

Treatment. Very often treatment is not required because the disability is negligible. Treatment is needed mainly for bone pain and for complications. Two drugs are known to affect the outcome – calcitonin and bisphosphonates.

Both drugs inhibit bone resorption. They reduce bone turnover, with low ering of plasm a alkaline phosphatase, and both are effective in relieving bone pain in a high proportion of cases. Treatm ent must, how ever, be prolonged. Unlike calcitonin, which must be injected (though nasal spray and suppository form s are being tried), a bisphosphonate com pound may be taken by mouth. Moreover its benefit General affections of the skeleton

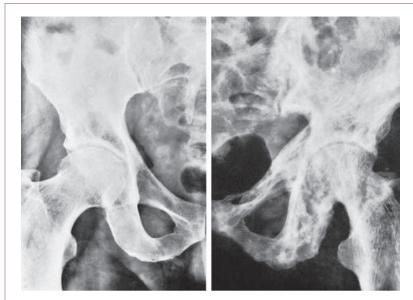


Fig. 6.7 Paget's disease. Half pelvis, side by side with a normal one shown for comparison. Note the coarse trabeculae and slight distortion of the softened pelvic ring, with deepening of the acetabulum.

often persists for up to six months after the drug has been discontinued; so it is the preferred drug in the first instance, on the basis of cost and ease of administration.

POLYOSTOTIC FIBROUS DYSPLASIA

Replacement of bone by fibrous tissue forms a conspicuous part of several unrelated bone diseases. In two conditions in particular, fibrous replacement is the predominant change. In one of these – parathyroid osteodystrophy – the changes are associated with hyperparathyroid ism (p. 73). In the other, now to be described, there is fibrous replacement without any evidence of excessive parathyroid secretion.

Polyostotic fibrous dysplasia, then, is a condition in which parts of several bones are replaced by masses of fibrous tissue, but in which there is no evidence of hyperparathyroidism. The condition is rare and the cause is unknown. There is no evidence to suggest a genetic basis.

Pathology. The num ber of bones involved varies from two or three to twelve or more. The major long bones are those mainly affected – especially the femur. The skull and mandible are also commonly involved. A ffected bones are liable to bend or break.

Clinical features. The onset is in childhood but the condition is often not recognised until adult life. The main features are deform ity, from bending or local enlargement of bone, and pathological fracture. The disease progresses for years and may eventually lead to severe crippling.

Radiographs of the affected bones show well-defined transradiant areas which often have a characteristic hom ogeneous or 'ground-glass' appearance: these changes may be localised and patchy rather than uniform. The lesions

t h a n t h ip h v W h e n t h ion is d htd t h i n a n d t h h h h oducin deform c h th e А xiø 'e h m a 1 fem ur (Fig. 6.8). Som etim es the lesion has a honeycom bed appearance.



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Fig. 6.8 Polyostotic fibrous dysplasia affecting the radius (a) and the tibia (b). Parts of the skeleton are replaced by fibrous tissue, giving in places a 'ground-glass' appearance. Unlike hyperparathyroidism, this disorder is not associated with any known endocrine dysfunction. (c) Extensive fibrous dysplasia affecting the proximal femur with softening of the bone resulting in a typical 'shepherd's crook' deformity.

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Investigations. There is no consistent biochemical abnormality of the blood. In a few cases the plasma alkaline phosphatase has been raised.

Albright's syndrome

The bone lesions of polyostotic fibrous dysplasia som etim es occur in association with patchy pigm entation of the skin and, in fem ales, sexual precocity. This com bination of clinical features is known as Albright's syndrom e.

NEUROFIBROMATOSIS (von Recklinghausen's disease¹)

This is a congenital inheritable affection characterised by pigmented areas on the skin, cutaneous fibromata, and multiple neurofibromata in the course of the cranial or peripheral nerves. It is ascribed to an autosomal dominant mutant gene.

Pathology. The neurofibrom at a consist of connective tissue arranged in whorls, with a few nerve fibres.

Clinical features. Skin lesions are seld om present at birth but often develop in early child hood. They consist of multiple 'café au lait' areas, axillary or perineal freckling and of small fibromata which may be flat or raised. Neurofibromata may occur on any of the cranial or peripheral nerves, and important pressure effects may occur, including compression of the spinal cord.

The orthopaedic significance of neurofibrom atosis lies mainly in the liability to scoliosis and to neurological disturbances in the limbs. There may also be pathological fracture – usually of the tibia in infants, due to fibrous infiltration of the bone (congenital pseudarthrosis).

Scoliosis. Why scoliosis should occur is unknown: but it is a common complication and it sometimes progresses to an angulation so severe that the function of the spinal cord is impaired.

Neurological disturbances. There m ay be impairment of function of cranial or peripheral nerves in consequence of neurofibromata lying in the course of nerve trunks. Various manifestations are observed, depending upon the site of the tum our. For instance, a tum our of a nerve root within the spinal canal may compress the spinal cord and give the typical picture of a spinal cord tum our. Or it may compress the cauda equina or an individual nerve trunk, with consequent radiating pain and impairment of function of the involved nerve. Thus neurofibromatosis enters into the differential diagnosis of brachial pain and sciatica.

Im aging. Plain radiographs may show erosion of a bone where a neurofibrom a lies in contact with it. CT or MR scanning may be helpful in outlining the extent of a bulky neurofibrom a.

Diagnosis. The pigmented spots or areas, and cutaneous fibromata, afford important clues to the diagnosis. A positive family history is important corroborative evidence.

¹Frederich von Recklinghausen (1833–1910) Distinguished German pathologist working in Strasbourg who described this and several other diseases that bear his name.

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Complications. Occasionally a neurofibroma may undergo malignant change, to become a neurofibrosarcoma.

Treatment. A neurofibrom a that is causing symptoms should be excised.

MYOSITIS OSSIFICANS PROGRESSIVA (Fibrodysplasia ossificans)

M yositis ossificans progressiva is a congenital affection characterised by the form ation of m asses of bone in the soft tissues, with consequent progressive im pairm ent of m ovem ent of the underlying joint or joints. It is often associated with shortness of the great toe or of other digits (m icrodactyly). M ost cases are sporadic. It is caused by a defect in a gene for the receptor of the BM P fam ily of proteins.

Pathology.¹ The ectopic bone is formed by metaplasia of connective-tissue cells, not from displaced osteoblasts.

Clinical features. Changes usually appear first in early childhood. Sw ellings develop in the region of the neck and trunk. At first soft and perhaps transient, they later give place to hard plates of bone which lie in the course of muscles, ligaments and fasciae. Movements of the spine and ribs, and later of the lim b joints, are reduced progressively until in the worst cases there may be total immobility. In most cases the great toe is congenitally short; the thum bs or other digits may also be short.

Radiographs show the plates of bone in the soft tissues.

Progress. A fter m any years increasing rigidity renders the patients bedridden. No curative treatm ent is know n. System ic treatm ent by bisphosphonates after excision of bony bars m ay retard their regeneration, but the eventual fatal outcom e seem s unlikely to be influenced significantly.

CRANIO-CLEIDO DYSOSTOSIS

In this dysplasia the most striking features are enlargement of the frontal and parietal regions of the head with delayed ossification and delayed fusion of the skull bones, and absence or partial absence of the clavicles. O ther bones may also show less striking anomalies. The disorder is of autosomal dominant inheritance. It is caused by a mutation in the gene for osteoblast specific transcription factor 2 (osf 2) also known as (bfa-1) on chromosome 6.

Clinical features. The disorder usually becomes apparent in early childhood. The head is somew hat larger than norm al, with bulging frontal and parietal regions. The clavicles are either absent or rudimentary, in consequence of which the two shoulders can be approximated anteriorly - a characteristic feature. Life expectancy is norm al.

Radiographs in childhood show delayed fusion of the skull bones, with Worm ian bones in the suture lines; absence of the clavicles either in whole or in the lateral parts; and delayed ossification of the pelvic bones with wide symphysis pubis.

¹This disease, formerly known as myositis ossificans progressiva, must not be confused with posttraumatic myositis ossificans. The two conditions are entirely distinct. Post-traumatic 'myositis ossificans' is misnamed: it is nothing more than ossification within a subperiosteal haematoma.

INBORN ERRORS OF METABOLISM

GAUCHER'S DISEASE

G aucher's disease is one of the group of lysosom al storage diseases included under the generic title *mucopolysaccharidoses* or *sphingolipidoses*. It is a rare lipoid storage disease of autosom al recessive inheritance, in which the enzyme beta-glucosidase is deficient and gluco-cerebroside accumulates in reticulo-endothelial cells of the spleen, liver, bone marrow, and other tissues.

Clinical features. Symptoms usually appear first in adult life. There is enlargement of the spleen and liver. There may be a feeling of weakness due to anaemia, but often the general health is good. Skeletal involvement, which takes the form of infiltration and replacement of bone by masses of lipoid-laden reticulo-endothelial cells (Gaucher cells) brings a risk of pathological fracture. Bone pain or joint pain is a common feature.

R adiographs show irregular cyst-like spaces in some of the bones, sometim es with expansion of the cortex, especially of the fem ur, the low er end of which m ay appear flask-shaped. O steonecrosis (avascular necrosis) of the head of the fem ur or the head of the hum erus, with consequent disorganisation of the corresponding joint, is also com m on.

Investigations. Bone marrow biopsy usually yields typical Gaucher cells.

Treatm ent. Replacement therapy with the enzyme (glucocerebrosidase) is effective but very expensive. Splenectomy relieves local discomfort and may help the anaemia but it does not influence the chronic course of the disease.

HISTIOCYTOSIS X (Skeletal granulomatosis)

The title histicytosis X comprises a group of diseases characterised by proliferation of histicytes and storage within them of cholesterol. The three clinical entities to be briefly described are:

- 1. eosin ophilic gran u loma
- 2. Hand-Schüller-Christian disease
- 3. Letterer-Siwedisease

A ll occur m ostly in children or young adults.

Eosinophilic granuloma

In eosinophilic granulom a the bone lesion is usually solitary. It consists of brownish granulation tissue containing abundant histiocytes and eosinophils, with leucocytes and giant cells. Often there are no symptoms, but there may be local pain, or occasionally a pathological fracture.

Radiologically the lesion is seen as a clear-cut hole in the bone – usually a rib, skull bone, vertebra, pelvic bone, fem ur, or hum erus. An affected vertebral body may collapse, becom ing com pressed into a thin wafer (see Calvé's vertebral com pression, p. 235). Exam ination of the blood usually fails to show any abnorm ality. Eosinophilic granulom a may sim ulate a bone cyst, a primary or metastatic bone tum our, or tuberculosis. If multiple, it resembles Hand-Schüller-Christian disease.

Treatm ent. The lesion often heals spontaneously. Surgical curettage may accelerate healing. Radiotherapy has som etim es been given but it is now widely regarded as unnecessary.

Hand–Schüller–Christian disease

In this condition there is proliferation of reticulo-endothelial cells to form multiple lesions, often in the skull but also in other bones. The yellow ish deposits consist of granulation tissue with abundant histiocytes, many of which contain cholesterolesters and from their vacuolated appearance are known as foam cells.

Radiologically the lesions appear as punched-out areas, without any surrounding reaction. The areas of destruction are often large. The occasional occurrence of diabetes insipidus and exophthalm os is explained by the presence of lesions in the base of the skull, involving the hypophysis and orbits. There m ay be other m anifestations of pituitary dysfunction, such as retarded grow th. The disease progresses very slow ly but is often fatal eventually.

Treatm ent. Radiotherapy m ay cause the lesions to regress, but the long-term prognosis is poor.

Letterer–Siwe disease

This is the most serious form of non-lipoid granulom atosis or histiocy tosis X. It begins in early childhood and progresses rapidly, usually with fatal outcome. Granulom atous deposits occur not only in bone but also in lymph glands, spleen, and liver, which may show enlargement clinically. Radiologically the skeletal lesions resemble those of H and - Schüller - Christian disease.

METABOLIC BONE DISEASE

The majority of these disorders are associated with diffuse rarefaction of the skeleton and their causes are listed in Table 6.1.

HYPERPARATHYROIDISM (Parathyroid osteodystrophy; generalised osteitis fibrosa cystica; von Recklinghausen's disease)

The characteristic features of hyperparathyroidism are lassitude, dyspepsia, generalised osteoporosis, and cystic changes in some of the bones.

Cause. It is caused by excessive parathyroid secretion, usually from an adenom a of one of the parathyroid glands.

Pathology. The excessive secretion of parathormone causes generalised absorption of bone, the calcium from which is liberated into the blood, whence it is excreted in excessive quantities in the urine. The bone becomes spongy and the cortices are increasingly thin. Cystic changes often develop in one or more of the long bones: from their macroscopic appearance these are commonly referred to as brown cysts. A consequence of the increased excretion of calcium is that the kidneys frequently contain calculi. 73

Cause	Diagnostic features				
Osteoporosis					
Prolonged recumbency	History of confinement to bed for months or years				
Idiopathic	Post-menopausal. Spine predominantly affected. No biochemical change in blood				
Hyperparathyroidism	Diagnostic biochemical changes in blood: plasma calcium increased; plasma phosphate decreased				
Glucocorticoid excess (Cushing's syndrome)	Characteristic clinical features: obesity, hypertrichosis, hypertension, amenorrhoea in women				
Osteomalacia					
Rickets (all types)	Rachitic changes at growing epiphyses. Biochemical changes depend on type of rickets (Table 6.2, p. 77)				
Nutritional osteomalacia	Dietary deficiency apparent. Characteristic biochemical changes in blood: plasma calcium normal (or decreased); plasma phosphate decreased (Table 6.2, p. 77)				
Idiopathic steatorrhoea	Excess of fat in faeces. Blood changes: plasma calcium decreased; plasma phosphate normal (Table 6.2, p. 77)				
Tumour					
Multiple myeloma	Usually multiple circumscribed lesions, but may be diffuse. Bence Jones proteose often present in urine. Marrow biopsy shows excess of plasma cells				
Diffuse carcinomatosis Leukaemia	Primary tumour demonstrable Blood examination and marrow biopsy show excess of immature white cells				

Table 6.1	Ten causes of diffuse rarefaction of bone

Clinical features. The patient is adult. There are pains in the bones, indigestion, and weakness. There may also be deformity from bending of softened bone, or a pathological fracture.

R adiographic features. Radiographs show rarefaction of the whole skeleton. The loss of density m ay be m arked, and the cortices very thin. An early sign is irregular subperiosteal cortical erosion in the phalanges of the fingers. Scattered cystic changes m ay be present in the long bones (Fig. 6.9A, B). The skull show s a uniform fine granular mottling, som etimes with small translucent cyst-like areas (Fig. 6.9C). Radiographs of the renal tracts often show nephrolithiasis.

Investigations. The plasma calcium is increased but the plasma inorganic phosphate is diminished. Excretion of calcium and phosphate in the urine is increased.

Diagnosis. This is from other causes of diffuse or generalised rarefaction of bone. These are sum marised in Table 6.1.

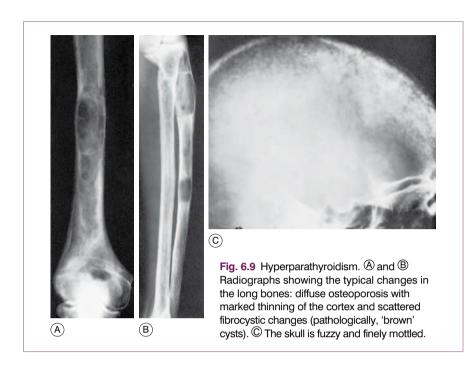
Treatment. The causative parathyroid tum our should be located and rem oved.

NUTRITIONAL RICKETS

In rickets there is defective calcification of growing bone¹ in consequence of a disturbed calcium – phosphate metabolism. With the general improvement in economic conditions infantile rickets has become rare in Western countries.

¹When similar influences act on mature adult bone the condition is known as osteomalacia.

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There is, how ever, a relatively higher incidence among immigrants from the West Indies and from Asia.

Cause. Nutritional rickets is caused by a deficiency of vitam in D in the diet and by inadequate exposure to sunlight, which promotes the synthesis of vitam in D in the body.

Pathology. Vitam in D promotes the absorption of calcium and phosphorus from the intestine. Its deficiency therefore leads to inadequate absorption of calcium and phosphorus. The level of calcium in the blood can then be maintained only at the expense of the skeletal calcium. Proliferating osteoid tissue in the grow ing epiphyses remains uncalcified, and there is a general softening of the bones already form ed (Fig. 6.10).

Clinical features. The ordinary nutritional rickets usually occurs in children about one year old. The general health is im paired. The predom inant signs are a large head, retarded skeletal grow th, enlarged epiphyses, curvature of long bones, and deform ity of the chest, which may show a transverse sulcus. In a typical case these signs produce an easily recognised clinical picture.

R adiographic features. There is a general loss of density of the skeleton with thinning of the cortices. The most striking changes, how ever, are in the growing epiphyses. The vertical depth of the epiphysial lines is increased, the epiphyses are widened laterally, and the ends of the shafts are hollowed out or 'cupped' (Fig. 6.10). Bending of the bones may be obvious.

Investigations. The plasm a phosphate level is usually decreased. The plasm a calcium is normal. The alkaline phosphatase is increased, often markedly: its level gives some indication of the severity of the disease and of the response to treatment. Measurement of the serum levels of 25-hydroxyvitam in D is a useful guide to diagnosis and treatment.

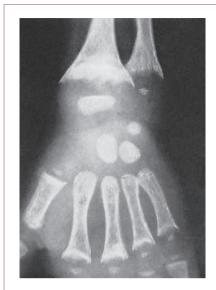


Fig. 6.10 Rickets. Note the typical widening and 'cupping' of the metaphyses of the radius and ulna. The depth of the epiphysial cartilage is increased, and the general density of the bones is reduced.

Diagnosis. If rickets is suspected an antero-posterior radiograph of a wrist should be obtained. The radiographic features are diagnostic of rickets, but biochem ical exam inations are required to indicate its type (Table 6.2, p. 77).

Treatm ent. Nutritional rickets responds well to vitam in D in ordinary doses. Severe bony deform ity persisting after vitam in therapy should be corrected by osteotom y or osteoclasis.

OTHER FORMS OF RICKETS

The characteristic epiphysial changes seen in nutritional rickets occur in a number of other diseases, the primary factor responsible for the disordered calcium-phosphate metabolism being different in each type. Four types will be described: familial hypophosphataemia, cystinosis, uraemic osteodystrophy, and coeliac (gluten-induced) rickets.

Familial hypophosphataemia (chronic phosphate diabetes; vitamin-resistant rickets)

Familial hypophosphataem ia is a hereditary disorder transmitted by an X-linked dom inant gene. The nature of the primary defect is uncertain: it may be a failure of normal reabsorption of phosphate by the renal tubules, or it may be a fault in the absorption of calcium from the intestine. Bone changes, which are like those of nutritional rickets, may become manifest soon after the first year of life. The characteristic biochem ical features are: norm al plasma calcium, low plasma phosphate level *not corrected by vitamin D*, increased alkaline phosphatase, and excess of phosphate in the urine (Table 6.2, p. 77). Relatives who are clinically unaffected may nevertheless show hypophosphataem ia.

		Plasma	Plasma inorganic		
	Primary fault and mechanism	calcium	phosphate	Urine	Stools
Nutritional rickets (children); nutritional osteomalacia (adults)	Deficiency of vitamin D in diet \rightarrow impaired absorption of calcium and phosphorus	Normal	Low	Normal	Normal
Familial hypophosphataemia	Inherited fault: impaired reabsorption of phosphates by renal tubules \rightarrow excessive excretion of phosphates in urine	Normal	Low	Excess of phosphate	Normal
Cystinosis (Fanconi syndrome)	Impaired reabsorption of phosphates, glucose, and some amino acids by renal tubules→ excessive excretion of phosphates, etc. in urine	Normal	Low	Glucose, amino acids, excess of phosphate	Normal
Uraemic osteodystrophy	Mechanism uncertain. Possibly impaired glomerular function \rightarrow retention of phosphorus \rightarrow excretion in bowl \rightarrow combination with calcium preventing its normal absorption	Low	High	Albumin	Normal
Coeliac rickets (children); idiopathic steatorrhoea (adults)	Digestive deficiency \rightarrow impaired absorption of vitamin D and calcium	Low	Normal	Normal	Excess of fat

Table 6.2 Summary of the biochemical changes in the various forms of rickets and osteomalacia

Note: The plasma alkaline phosphatase is increased in all types of rickets in the active stage. It is an index of activity rather than of type.

Treatment. Vitamin D in high doses should be combined with the administration of phosphates. Treatment on these lines corrects the bone changes but does not restore the plasma phosphate to a normal level. Improved results have been achieved by the use of a synthetic vitamin D analogue, 1 Ω -hydroxyvitam in D 3. Surgical correction of residual deformities may be required.

Cystinosis (Fanconi syndrome; renal tubular rickets with glycosuria and amino-aciduria)

In cystinosis (Fanconi syndrom e) rachitic changes in the bones are associated with renal glycosuria and am ino-aciduria. The primary defect, a congenital fault transmitted by a recessive mutant gene, is a failure of the proximal renal tubules to reabsorb phosphate, glucose, and certain am ino acids in the norm al way. The excessive loss of phosphates in the urine leads to depletion of the bone phosphate. Onset may be later in childhood than that of nutritional rickets, but the bone changes are the same. The characteristic biochem ical features are: norm al plasm a calcium ; low plasm a phosphate; increased alkaline phosphatase; and excess of phosphate in the urine, which also contains glucose and certain am ino acids (Table 6.2, p. 77).

Treatment. The intake of calcium, phosphate, and vitamin D should be increased. Alkalis (sodium citrate) should be given to combat the associated acidosis.

Related disorders

A num ber of similar disorders from renal tubular defects are recognised. In all of them there is deficient reabsorption of phosphate, but they differ in the extent to which other functions of the tubules are impaired.

Uraemic osteodystrophy (renal osteodystrophy; renal (glomerular) rickets; renal dwarfism)

In uraem ic osteodystrophy generalskeletalchanges are associated with chronic renal im pairment. The skeletal changes often become manifest between the ages of 5 and 10 years.

Pathology. The renal impairment may be due to congenital cystic changes, to ureteric obstruction with hydronephrosis, or to chronic nephritis. The mechanism by which the renal deficiency leads to rachitic changes in the skeleton is uncertain, and probably complex. One factor may be that impaired excretion of phosphorus by the kidneys leads to retention of phosphorus in the blood, and its excretion in the intestine. There it forms an insoluble compound with calcium, which in consequence is not absorbed in proper amounts.

The skeletal changes consist in deficient epiphysial grow th and multiple deformities from bone softening. The parathyroid glands are hypertrophied, probably as a secondary effect.

Clinical features. The child is dwarfed and deformed. There are symptoms of renal impairment, such as excessive thirst and sallow complexion. The commonskeletal deformities are coxa vara, genu valgum, and severe valgus deformity of the feet. **Fig. 6.11** Rachitic changes in the epiphyses of a renal dwarf aged 14 years. There was diffuse rarefaction of the skeleton, with multiple deformities from bending of softened bones.

R adiographs show epiphysial changes that are generally similar to those of nutritional rickets (Fig. 6.11).

Investigations. The biochemical changes are characteristic (Table 6.2). The plasm a phosphate is markedly increased. The plasm a calcium is low. The blood urea is raised, often to a high figure. A lbum in is usually present in the urine.

Prognosis. Unless the renal lesion is remediable gradual progression is likely, with poor prognosis.

Treatment. This should be directed primarily against the underlying renal condition. The diet should be supplemented with calcium and vitamin D.

Coeliac (gluten-induced) rickets

Coeliac disease (gluten-induced enteropathy) is a digestive disorder characterised by m alabsorption and consequently by an excess of fat in the stools. Before a knowledge was gained of how to control the disease it was often complicated by rachitic changes in the bones. Such changes will now be seen only in neglected cases.

The primary fault is a susceptibility of the villi of the small intestine to atrophy under the influence of gluten, the protein fraction of flour. This villous atrophy leads to deficient absorption of fats and of fat-soluble vitam in D.

The disease begins in infancy or early childhood. The general features are w asting, impaired growth, failure to gain weight, muscular hypotonia, distended abdomen, and loose offensive stools containing 40–80% fat after drying (normal = 25%). The skeletal changes, which do not develop for several years, are like those of nutritional rickets.

Investigations. The biochemical changes in the blood differ from those of nutritional rickets. The plasma calcium is low. The plasma phosphate is normal or low (Table 6.2, p. 77). Diagnosis should be confirmed by jejunal biopsy effected by a swallowed capsule with a special cutting device. **Treatment**. There is steady improvement in the calcification of the skeleton as the primary disorder is brought under control. The diet should be free from gluten and should contain an abundant supply of calcium and vitam in D.

NUTRITIONAL OSTEOMALACIA

Nutritional osteomalacia is the adult counterpart of infantile (nutritional) rickets. It is regarded as rare except in certain Asiatic countries. Nevertheless it may be more common than is generally realised, especially in elderly women.

Cause and pathology. As in infantile rickets, there is a deficiency of vitam in D (and often of calcium) in the diet. In consequence the intestinal absorption of calcium and phosphorus is inadequate, and calcium is with drawn from the bones to maintain a reasonable level in the blood. The bone trabeculae are not abnorm ally thin, but they are largely composed of poorly calcified osteoid tissue. There is an abundance of fibrous tissue in the marrow.

Clinical features. The main features are pain in the bones, and deformity. Because of the porosity of the bones fractures are common.

R adiographic features. There is rarefaction of the whole skeleton. The bone cortices are abnorm ally thin. The long bones may be curved and the pelvis triradiate. M ultiple spontaneous fractures (Looser's zones), seem ingly ununited though possibly bridged by unmineralised osteoid tissue, may be shown in ribs, pelvic ram i, or elsew here. These are characteristic of osteom alacia and are not seen in osteoporosis.

Investigations. The plasma calcium is normal or low. Plasma phosphate is low. A lkaline phosphatase is increased. The calcium balance is negative (Table 6.2, p. 77). Serum levels of 25-hydroxyvitam in D are low.

Diagnosis. Nutritional osteomalacia must be distinguished from other causes of diffuse rarefaction of bone (Table 6.1, p.74). In the elderly it may be mistaken for idiopathic osteoporosis.

Treatm ent. Recalcification of the skeleton is induced by adequate diet and adm inistration of vitam in D and calcium. Osteotom y m ay be required to correct deform ity.

OTHER FORMS OF OSTEOMALACIA

Just as in children rachitic changes in the bones may occur from a number of different metabolic faults, so in adults osteomalacia may arise from causes other than purely nutritional. Such causes include advanced renal disease, and malabsorption syndromes such as chronic obstruction of the bile ducts, chronic pancreatic disease, and adult coeliac disease.

VITAMIN C DEFICIENCY (Infantile scurvy)

Scurvy is a haem orrhagic disease caused by a deficiency of vitam in C (ascorbic acid) in the diet. It is rare in W estern countries, especially in adults.

Pathology. The most striking changes are in the long bones. There is a lack of osteoblastic activity in the epiphysial grow th cartilage (grow th plate). Haemorrhage, beginning at the epiphysial cartilage, extends beneath the periosteum, which may be raised from the bone throughout its whole length.

Fig. 6.12 Infantile scurvy. (A) Early active stage. Note the clear zone in the metaphysis, indicating arrest of osteoblastic activity, and the dense zone adjacent to the epiphysial cartilage. (B) Later stage, showing well-marked ossification in the subperiosteal haematoma.



H aem orrhages also occur from other sites, especially from the gums or within the orbit.

Clinical features. Scurvy affects infants during the second six months of life if the diet is deficient in fresh milk or other sources of vitam in C. The onset is rapid, with loss of use of a lim b or lim bs because of pain (pseudoparalysis). An affected lim b is swollen and exquisitely tender over the affected bone or bones. The gum s are often spongy and bleed, and there may be a 'black' eye.

Radiographic features. Plain radiographs show a dense line at the junction between metaphysis and epiphysial cartilage, with a clear band of rarefaction on the diaphysial side (Fig. 6.12A). Later there is ossification in the subperiosteal haematoma, as a result of which the bone is often markedly thickened (Fig. 6.12B).

Investigations. A scorbic acid is deficient in the plasma.

D iagnosis. The skeletal features of scurvy in infants resem ble those of syphilitic m etaphysitis, w hich, how ever, occurs at an earlier age - nam ely during the first 6 m onths of life. O ther distinctive features are the positive W asserm ann reaction in syphilis and bleeding from the gums in scurvy. Scurvy m ay also be confused clinically with acute osteom yelitis. D eficiency of plasm a ascorbic acid is diagnostic.

Treatment. The disease responds readily to the administration of vitamin C.

ENDOCRINE DISORDERS

OSTEOPOROSIS (Idiopathic osteoporosis; post-menopausal osteoporosis)

This condition is characterised by diffuse osteoporosis of unknown cause. It affects the elderly, especially post-menopausal women, but it may be seen also in patients of middle age. It may possibly have an endocrine basis.

Pathology. The whole skeleton is affected, but the changes in the spine are more obvious than those elsew here. The cortices of the vertebrae are thinner than normal, and the bone is rarefied throughout from thinning of the individual trabeculae and widening of the vascular canals. In other words there is a reduction of total bone mass. Compression fracture of one or more of the vertebral bodies is liable to occur from only trivial violence. Even without fracture the thoracic vertebrae tend gradually to become wedge-shaped so that the spine bends forward to produce a rounded kyphosis. The long bones – particularly the upper end of the femurand the low er end of the radius – are also prone to fracture easily.

Clinical features. The patient is often a woman of over 60. The osteoporosis may be symptom less and may be found only by chance. In other cases there is pain in the back. The pain occurs in two forms - a mild generalised ache, and a sharper pain of sudden onset, denoting a compression fracture. Examination reveals a rounded kyphosis in the thoracic region. If a vertebral body has collapsed there may be a more angular kyphosis with prominence of a spinous process in the thoracic or thoraco-lum bar region. The trunk is shortened, with consequent loss of height, and there is a transverse furrow across the abdom en (Fig. 6.13A).

Radiographic features. The striking feature is the reduced density of the vertebral bodies, which become concave at their upper and lower surfaces from pressure of the intervertebral discs. Often there is wedging of one or more of the vertebral bodies from compression fracture (Fig. 6.13B). Other parts of the skeleton are also rarefied, but less obviously.

Investigations. The biochem istry of the blood is norm al. Metabolic balance studies may show a negative calcium balance. Bone density is best measured by dual X-ray absorptiometry.

Diagnosis. O steoporosis may be confused with other forms of diffuse rarefaction of bone, especially that caused by parathyroid osteodystrophy, glucocorticoid excess (Cushing's syndrome), osteomalacia of various types, carcinomatosis, myelomatosis, or leukaemia (Table 6.1, p. 74). Diagnosis rests largely on the exclusion of these specific disorders.

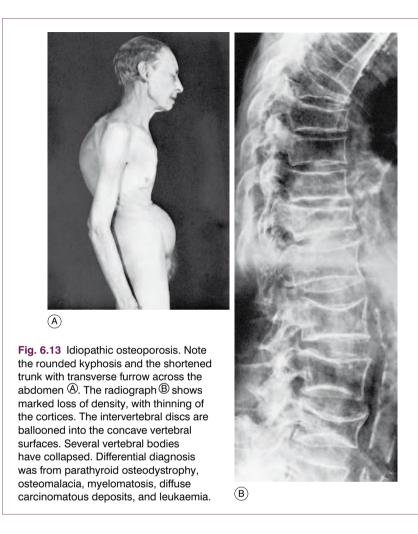
Prevention. Horm one replacement therapy (HRT) with oestrogens, supplemented by progesterone for 10 days of the month unless the patient has had a hysterectomy, is an important option in post-menopausal women.

Treatm ent. Once osteoporosis is established, treatm ent is rather unsatisfactory. It may be possible to restore the patient to positive calcium balance by high-dosage calcium supplements to the diet, combined with calcitriol if malabsorption is present; but the gain is slow because of the slow turnover rate of bone tissue. Thus a dramatic improvement in the radiographic appearance cannot be expected.

A num ber of drugs have been used in trials to treat established osteoporosis in the older patient, particularly after vertebral or fem oral neck fractures. These are selected for their ability to decrease osteoclastic bone resorption or to stim ulate the form ation of new bone by osteoblasts. The most widely used inhibitors of bone resorption are bisphosphonates, while strontium and the peptide of parathyroid horm one may promote new bone form ation.

HYPOPITUITARISM

Deficient secretion of the anterior lobe of the pituitary gland leads to various types of disturbance of skeletal grow th, often with im pairm ent of sexual developm ent and som etim es with learning disabilities. The patient may be dwarfed, or on the other hand there may be good stature with marked obesity. The orthopaedic im portance of this latter condition is that it may predispose to slipping



of the upper femoral epiphyses in adolescents (p. 371) – as indeed may obesity from any cause.

GIGANTISM

In gigantism (one form of hyperpituitarism) skeletal overgrowth is caused by an excess of anterior pituitary hormone occurring before the growth epiphyses have fused.

Pathology. There is an eosinophilic adenom a of the anterior lobe of the pituitary. Excessive grow th occurs at the epiphysial cartilages. Despite this overactivity, epiphysial fusion occurs at about the norm al time.

C lin ical features The patient, usually a boy, may grow to a height of 7 feet being in the lim bs. Sexual developm ent or more, the main inc often im paired and the mav be subnorm al. Signs of acromegaly o fte n m e n ta litv ost of the giants, whose skeletons are preserved in medical develop later. M ore than 9 feet tall, are exam ples of this condition. s o m m

Diagnosis and treatment are as for acromegaly (see below).

ACROMEGALY

The primary fault is the same as in gigantism – namely, an excessive secretion of pituitary grow th horm one – but it occurs after the epiphyses have fused. It is characterised by enlargement of the bones, especially of the hands, feet, skull, and mandible.

Pathology. As in gigantism, there is usually an eosinophilic adenom a of the anterior lobe of the pituitary. The enlargem ent of the bones is caused by deposition of new bone upon the surface of the original cortex.

Clinical features. The disease often begins in early adult life. The physical features become coarse and heavy, the skin is thickened, and the hands and feet slow ly enlarge. At first strong, the patient often becomes weak and sluggish later. *Radiographs* show marked enlargement of the bones of the hands and feet, and especially of the mandible. The vertebral bodies are also enlarged, especially in the antero-posterior diam eter. The sella turcica of the skull may be expanded and eroded.

Diagnosis. This is made from the clinical appearance and by demonstration of excessive grow th horm one excretion by radio-immunoassay.

Treatment. Early treatment – often by removal of the pituitary adenoma or sometimes by irradiation or by drug therapy – is important in preventing deterioration.

INFANTILE HYPOTHYROIDISM (Cretinism)

In fantile hypothyroid ism (cretinism) is characterised by dwarfism, with sexual and mental retardation. It is caused by congenital deficiency of thyroid secretion. From the orthopaed ic view point the important features are retarded grow th of the lim b bones, kyphosis, and distortion of the joint surfaces. Early diagnosis is important because marked improvement follows treatment with thyroxine.

GLUCOCORTICOID EXCESS (Cushing's syndrome)

This endocrine disorder is characterised by obesity, hypertrichosis, hypertension and, in w om en, am enorrhoea. It is induced by excessive secretion of adrenocortical horm ones, caused either by a tum our of the adrenal cortex or by hyperplasia of the gland w hich m ay be secondary to a basophil adenom a of the pituitary. A sim ilar condition m ay also be caused by prolonged adm inistration of cortisone, prednisone, or related steroid drugs.

The orthopaedic significance of Cushing's syndrom e lies in the fact that it is accompanied by generalised rarefaction of the skeleton, with liability to pathological fracture of porotic bone (Table 6.1, p. 74).

7 Infections of bone and joints

INFECTIONS OF BONE

Infection of bone by pyogenic organisms is termed osteomyelitis.¹ It occurs in acute and chronic forms. The only other infections of bone with which the student in Western countries need concern him self are tuberculous infections, although syphilitic infections and fungal infections may still occur occasionally in other parts of the world.

ACUTE OSTEOMYELITIS (Acute pyogenic infection of bone; acute osteitis)

Two distinct types of acute osteom yelitism ust be considered:

- haem atogenous osteom yelitis, a disease mainly of childhood in which organisms reach the bone through the blood stream
- osteom y elitis com plicating open fracture or surgical operation, in w hich organism s gain entry directly through the wound.

The two types are sufficiently distinct to require separate descriptions.

ACUTE HAEMATOGENOUS OSTEOMYELITIS

A cute haem atogenous osteom yelitis is one of the important diseases of childhood. Only about 5% of cases occur in adults. Early diagnosis is especially important because a satisfactory outcome depends upon prompt and efficient treatment.

Cause. It is caused by infection of the bone with pyogenic organisms - usually Staphylococcus aureus, though a variety of other organisms are occasionally responsible, including Salmonella. A minor injury to a bone may render it vulnerable to infection by organisms circulating in the blood.

Pathology. Organism s reach the bone through the blood stream from a septic focus elsewhere in the body – for instance from a boil in the skin. In a rare atypical form in adults infection reaches the vertebral column through the spinal venous plexus from an infected intrapelvic lesion.

In the usual childhood manifestation, the infection begins in the metaphysis of a long bone, which must be presumed to form a productive medium for bacterial grow th (Fig. 7.1A); thence it may spread to involve a large part of the bone. The organisms induce an acute inflam matory reaction, but the marshalling

¹There is nothing to be gained by distinguishing between *osteitis* (inflammation of bone) and *osteomyelitis* (inflammation of bone and bone marrow). For practical purposes the two terms may be regarded as synonymous.

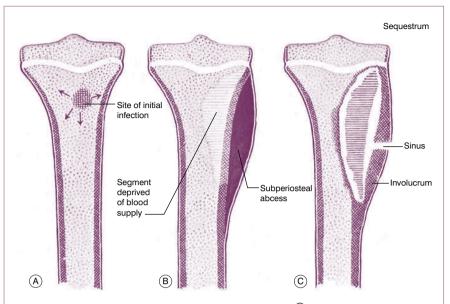


Fig. 7.1 The natural evolution of a focus of osteomyelitis. (A) Initial lesion in the metaphysis. (B) Pus has escaped to the surface of the bone and formed a subperiosteal abscess. Part of the bone has lost its blood supply from septic thrombosis of vessels. (C) The devitalised area eventually separates as a sequestrum. Meanwhile new bone (involucrum) is formed beneath the stripped-up periosteum; it is perforated by sinuses through which pus escapes. This is the stage of chronic osteomyelitis. With prompt treatment the disease can often be arrested at the stage shown in (A).

of the body's defensive forces is greatly handicapped in bone because its rigid structure does not allow swelling. Pus is form ed and soon finds its way to the surface of the bone where it forms a subperiosteal abscess (Fig. 7.1B); later the abscess may burst into the soft tissues and may eventually reach the surface to form a sinus.

Often the blood supply to a part of the bone is cut off by septic throm bosis of the vessels (Fig. 7.1B). The ischaem ic bone dies and eventually separates from the surrounding living bone as a sequestrum (Fig. 7.1C). Meanwhile new bone is laid down beneath the stripped-up periosteum, form ing an investing layer known as the involucrum (Fig. 7.1C).

The epiphysial cartilage plate is a barrier to the spread of infection, but if the affected m etaphysis lies partly within a joint cavity the joint is liable to become infected (acute pyogenic arthritis). M etaphyses that lie wholly or partly within a joint cavity include the upper m etaphysis of the hum erus, all the m etaphyses at the elbow, and the upper and low er m etaphyses of the fem ur (Fig. 7.2). Even when the joint is not infected it may swell from an effusion of clear fluid (sym pathetic effusion).

W ith efficient treatment, the infection may be aborted in its earliest phase. But when it has progressed to the stage of septic throm bosis and death of bone it alm ost inevitably passes into a state of chronic osteom yelitis.

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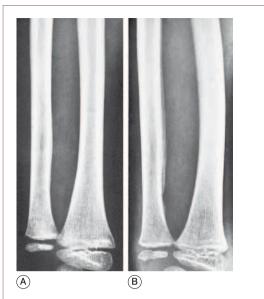
Fig. 7.2 The metaphyses shown in black are wholly or partly intracapsular. Infection at one of these sites is liable to involve the adjacent joint, with consequent pyogenic arthritis.

Clinical features. Except for rare exceptions acute haem atoge nou osteoconfined to children, especially boys. The bones i s m ost com m o n l v ia, the fem ur and the hum erus. The onset is rapid. The child are the tib of feeling ill, and of severe pain over the affected bone. There may be a histor of recent boils or of a m inor injury.

ination there is obvious constitutional illness with pvrexia. Locally quisite tenderness over the affected bone h e circum scribed; it is usually near the e n d of the bone phyi n t h gion. The overlying skin is warmer than normal, and often are indurated ; later a fluctuant abscess m ay be present. The neighbouring joint is sometimes distended with clear fluid, but a good range of movement unless the infection has spread to the joint (septic arthritis): in that is retained vementwould be greatly restricted.

Im aging. Radiographic examination in the early stage does not show alteration from the normal (Fig. 7.3A). Only after two o r d o visible changes appear, and they may never do so if efficient treatm ent is started very The important changes are diffuse rarefaction of the metaphysial area early. and new bone outlining the raised periosteum (Figs 7.3B and 7.4).

Radioisotopescanning with ^{99m} technetium is reserved for the diagnosis of bone infection in the less clinically accessible sites such as the hip, pelvis and spine. Infections of bone and joints



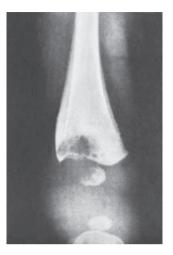


Fig. 7.3 (left) Acute osteomyelitis of the ulna in a child. (A) The initial film taken 2 days after the onset does not show any abnormality. (B) Two weeks later a faint shadow along the radial side of the ulna denotes new bone formation beneath the raised periosteum.

Fig. 7.4 (right) Osteomyelitis of the femur in an infant, three weeks after onset. Note new bone outlining the raised periosteum, and area of rarefaction in metaphysis and epiphysis. The infection spread to the knee joint.

A ccum ulation of isotope depends upon the rate of bone turnover and its vascularity, so that in the early stages of disease inadequate blood supply may result in a 'cold' lesion. More commonly, within a few hours or days of the onset of symptoms there is an increased uptake of isotope, giving a 'hot' scan at the site of the bone lesion. In the more obscure low-grade infections associated with prostheses and other surgical implants in bone, scanning with re-injected leucocytes labelled with ^{111m} indium may provide improved diagnostic accuracy.

MRI. In many centres this has now superseded isotope scanning as it provides more anatomical information on the infection.

Investigations. Blood culture may be positive in the incipient stage but this is not an invariable feature. Later there is a marked polymorphonuclear leucocy-tosis. The C-reactive protein and erythrocyte sedimentation rate is increased.

Diagnosis. A cute osteom y elitis is to be distinguished from py ogenic arthritis of the adjacent joint by the follow ing features:

- 1. the point of greatest tenderness is over the bone rather than the joint
- 2. a good range of joint movement is retained
- although the joint may be distended with fluid it does not contain pus (this may be confirmed by aspiration).

A cute osteom yelitis may also be confused with rheum atic fever, and, in infants, with vitam in C deficiency (scurvy) (p. 80). W henever possible the causative

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organism must be identified bacteriologically. It is important that blood for culture be taken before antibiotic therapy is commenced.

Complications. The important complications are:

- 1. septicaemia or pyaemia
- 2. extension of infection to the adjacent joint with consequent py ogenic arthritis (Fig. 7.5A)
- 3. retardation of grow th from damage to the epiphysial cartilage (Fig. 7.5B).

A cute osteom yelitis often passes into a state of chronic infection.

Treatment. Efficient treatment must be begun at the earliest possible moment.

General treatment. This is by rest in bed and system ic antibiotic therapy. started intravenously to ensure high blood levels. Initially, it is recommended antibiotics with good anti-Staphylococcus that broad-spectrum activity are third-generation cephalosporin combined with synthetic used, such asa а penicillin, but as soon as the causative organism has been identified the antibiotic to w hich i t i s most sensitive should be ordered. In Cases w here ultiple-resistant Staphylococcus aureus (MRSA) is suspected it may h e m appropriate to use vancom vcin instead of the penicillin. Antibiotics should continued for at least 4 weeks, even when the response has been rapid.



Fig. 7.5 Two complications of osteomyelitis. B Pyogenic arthritis, which led in this case to bony ankylosis. B Arrest of epiphysial growth, with consequent shortening. The normal humerus is shown for comparison. Local treatment. The question of operation and its timing is still controversial. Operation may be unnecessary if effective antibiotic treatment can be begun within 24 hours of the onset of symptoms, and this should always be the aim. But in practice diagnosis is not always so prompt, and in that event it seems wiser to undertake early operation, in order to release pus and to relieve pain, which is often severe. This should definitely be performed if there has not been a marked improvement to the antibiotic treatment within 48 hours. Release of pusmay also reduce the risk of ischaem ic bone necrosis; and furtherm ore it allows the organism to be identified and its sensitivity to antibiotics determined. An incision at the site of maximum tenderness is made dow n to the bone and subperiosteal pus is evacuated. It is advisable - though not always essential - to make one or two drill holes through the cortex to improve medullary drainage. In most cases the wound may safely be sutured. Thereafter the limb is splinted until the infection is overcome.

OSTEOMYELITIS COMPLICATING OPEN FRACTURE OR SURGICAL OPERATION

When acute infection complicates open fracture or surgical operation the organisms are introduced directly through the wound. Any part of the bone may be affected, depending upon the site of injury. Suppuration and necrosis occur as in haematogenous osteomyelitis, but the pus discharges through the primary wound rather than collecting under the periosteum. The infection often becomes chronic.

Clinical features. This type of osteom yelitism ay occur in children or in adults. The tem perature fails to settle after the primary treatment of the wound or rises a few days later. Pain is not a prominent feature because pus is not contained under pressure. Re-examination of the wound reveals a purulent discharge.

Radiographic features. In the early stages radiographs do not help significantly. Later there may be local rarefaction, and eventually sequestrum formation may be evident.

Treatm ent. The main principle of treatm ent is to secure free drainage through the wound, which may be enlarged if necessary for the purpose. A ppropriate antibacterial drugs should be ordered. Later, any bone fragment that has sequestrated should be removed.

CHRONIC OSTEOMYELITIS (Chronic pyogenic osteomyelitis)

Chronic osteomyelitis is nearly always a sequel to acute osteomyelitis. Occasionally infection is subacute or chronic from the beginning.

Cause. A swith acute osteom yelitis, the *Staphylococcus* is the usual causative organism, but streptococci, pneum ococci, typhoid bacilli, or other bacteria may be responsible.

Pathology. It is commonest in the long bones. It is often confined to one end of the bone, but it may affect the whole length. The bone is thickened and generally denser than normal, though often honeycombed with granulation tissue, fibrous tissue, or pus. Sequestra are commonly present within cavities in the bone. Often a sinus track leads to the skin surface: the sinus tends to heal and break down recurrently, but if a sequestrum is present it never heals permanently.

CHAPTER 7

Clinical features. The main symptom is usually a purulent discharge from a sinus over the affected bone. In other cases pain is the predominant feature which brings the patient to the doctor. Discharge of pus may be continuous or intermittent. Reappearance of a sinus that has been healed for some time is heralded by local pain, pyrexia, and the formation of an abscess. This is termed a 'flare-up', or 'flare', of infection.

On examination the bone is palpably thickened, and there are nearly alw ays a num ber of overlying scars or sinuses.

Im aging. *Radiographic exam ination*: The bone is often thickened and shows irregular and patchy sclerosis which may give a honeycombed appearance. If a sequestrum is present it is seen as a dense loose fragment, with irregular but sharply dem arcated edges, lying within a cavity in the bone (Fig. 7.6). *Radioisotope scanning* may show increased uptake in the vicinity of the lesion. In diffuse disease *MRI* and *CT* scanning may be of value for localisation of abscess cavities and sequestra, thus allowing accurate planning of operative treatment.

Complications. If the bone has been much weakened by disease pathological fracture may occur. Rarely, amyloid disease may complicate long-continued chronic osteomyelitis with persistent discharge of pus. A nother rare complication in cases of many years' duration is the development of squamous celled carcinoma in a sinus.

Treatment. An acute flare-up of chronic osteomyelitis often subsides with rest and antibiotics. If an abscess forms outside the bone it must be drained. If there is a persistent and profuse discharge of pus a more extensive operation is advised. The aim should be to remove fragments of infected dead bone



Fig. 7.6 Extensive chronic osteomyelitis of the tibia. The upper part of the shaft is thickened and shows patchy sclerosis. Two cavities are evident, each containing a sequestrum.

(sequestra) and to open up or 'saucerise' abscess cavities by chiselling away the overlying bone. Som etim es it is possible to obliterate a cavity with a flap of m uscle, or to exteriorise it and line its walls directly with split-skin grafts. The principles of treatm ent are (1) rem ove dead and foreign m aterial, (2) obliterate dead space, (3) if necessary, stabilise the skeleton, (4) obtain soft tissue cover, (5) if necessary, reconstruction of the bone defect, (6) possible appropriate antibiotic cover.

Brodie's abscess¹ (chronic bone abscess)

This is a special form of chronic osteom yelitis which arises insidiously, without a preceding acute attack. There is a localised abscess within the bone, often near the site of the metaphysis. A deep 'boring' pain is the predominant symptom.

Im aging. Radiographically, the lesion is seen as a circular or oval cavity surrounded by a zone of sclerosis (Fig. 7.7 A), but the site and extent of the lesion can be shown more accurately on an MRI scan (Fig. 7.7 B). The rest of the bone is normal.

Treatment is by operation. The cavity is de-roofed and the pus evacuated. W henever possible the cavity should be filled with a muscle flap to obliterate the dead space.

TUBERCULOUS INFECTION OF BONE

Tuberculous infection of bone is uncommon except in the vertebral bodies and in association with tuberculous infection of joints. Occasionally it occurs as an isolated lesion in a long bone or in a bone of the hand or foot.

Pathology. Tubercle bacilli reach the bone either through the blood stream or by direct extension from an adjacent focus of infection in joint or soft tissue. There is a typical tuberculous inflamm atory reaction. Part of the bone is destroyed and replaced by granulation tissue. A tuberculous abscess is commonly formed; it tracks beneath the soft tissues or tow ards the surface of the body. W ith treatment there is a tendency to healing, with fibrosis.

Tuberculosis of a vertebra

The infection typically affects the vertebral body. It m ay arise initially in the bone (Fig. 7.8A) or it m ay spread to the vertebra from the adjacent intervertebral disc. Tuberculous vertebral bodies collapse anteriorly but often retain their full depth behind, thereby becom ing wedge-shaped (Fig. 7.8B). An abscess usually tracks dow nw ards along the vertebral column; it m ay also extend backwards tow ards the spinal canal, where it m ay interfere with the function of the spinal cord.

Juxta-articular tuberculosis

The articular ends of bones are frequently eroded by tuberculosis beginning primarily in the joint. Less often there is an isolated focus of infection within the bone (Fig. 7.9). From such a lesion the infection may spread eventually to the neighbouring joint.

¹Sir Benjamin Brodie (1783–1862) English surgeon at St George's Hospital London who was also President of the Royal Society. He described the clinical presentation and pathology of the lesion in 1832.

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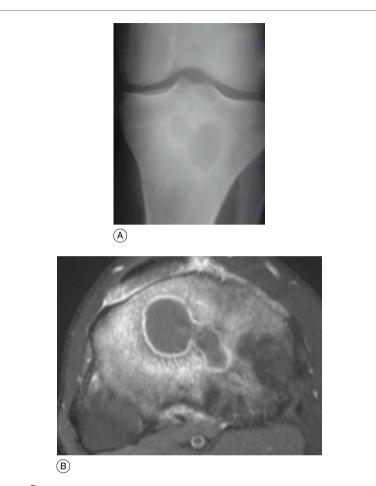


Fig. 7.7 (A) Radiograph of tibia with Brodie's abscess. There are two lucent areas in the metaphysis with a sclerotic margin and some generalised surrounding bone sclerosis. (B) Axial MRI scan contrast enhanced image of same tibia. There is a central area of low signal (fluid) which is surrounded by a bright rim of contrast enhancement. There is generalised marrow oedema (bright signal). These findings are diagnostic of a bone abscess.

Bony tuberculosis in the hand or foot

The metacarpals or phalanges are the bones most commonly affected (tuberculous dactylitis). Characteristically the bone is enlarged by a fusiform swelling which at first represents thickened and raised periosteum. Later, much of the original bone is destroyed, but at the same time new bone is laid down beneath the expanded periosteum, giving the affected metacarpal or phalanx a 'distended' appearance (Fig. 7.10). Similar changes may affect a bone of the foot, or occasionally a long bone.

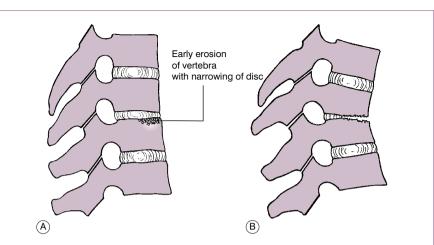


Fig. 7.8 Tuberculosis beginning in a vertebral body. The infection starts close to the anterior border and adjacent to an intervertebral disc (A). It soon involves the disc and may spread to adjoining vertebrae. The bone destruction is most marked anteriorly; so the affected vertebral bodies become wedge-shaped (B).

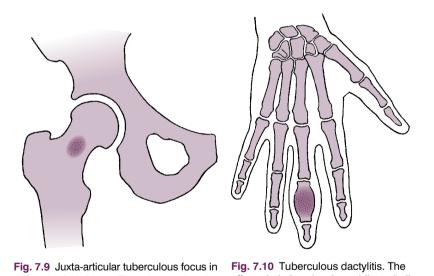


Fig. 7.9 Juxta-articular tuberculous focus in the neck of the femur. There is no sclerosis of the surrounding bone. If unchecked by treatment, such a focus of infection may spread to involve the joint. **Fig. 7.10** Tuberculous dactylitis. The affected phalanx has been 'distended' by destruction of the original cortex and the laying down of new cortical bone beneath the expanded periosteum.

C Li constitutional ill health. The i d o f 100 ral. ious tio n o f c o l d a h le sio n ith tuberculous joint disease the joint symptoms predom in ate sections on the individual joints). (se

Im aging. The typical radiographic features of tuberculous infection of bone are:

- 1. diffuse rarefaction around the site of infection
- erosion or 'eating aw ay' of bone, leaving a fluffy, ill-defined outline with no suggestion of a surrounding zone of sclerosis
- 3. in many cases a shadow in the soft tissues, denoting abscess formation.

On *radioisotope scanning* there is increased uptake of isotope in the vicinity of the lesion.

Investigations. Except in the case of quite small lesions the erythrocyte sedimentation rate is raised. The Mantoux test is positive. A spirated pus is yellow and creamy: only occasionally can organisms be identified by direct exam ination, but culture may prove its tuberculous nature. Biopsy of affected bone or surrounding soft tissue will show the histological features of tuberculosis.

Diagnosis. The diagnosis can often be presumed with fair certainty from a consideration of the history, clinical features, and radiographic findings. Features that lend support are a history of contact with tuberculosis, a positive M antoux test (particularly in children), a raised erythrocyte sedimentation rate, and evidence of a tuberculous lesion elsewhere. The diagnosis can be proved only by identifying the causative organism or by demonstration of the typical histological features in excised fragments of tissue.

Treatm ent. In most instances tuberculosis of bone is associated with infection of a joint, and the treatm ent is mainly that of the joint lesion (tuberculous arthritis, p. 98). The treatm ent of an isolated tuberculous focus in bone is along sim ilar lines, main reliance being placed upon a combination of antituberculous drugs, usually rifam picin and isoniazid for a period of six months, as outlined on page 102. Local collections of pus should be removed by aspiration or, som etimes, by operative drainage followed by immediate suture of the wound. Resolution is indicated by improvement in the general health and weight, decrease of erythrocyte sed imentation rate, and improved radiographic appearance.

SYPHILITIC INFECTION OF BONE

In W estern countries syphilitic infection of bone is now seen only rarely, but it is still found in som e parts of the world, and it is important that the possibility of its occurrence should be borne constantly in mind. Bone changes are a late manifestation of acquired syphilis, but they may appear early in life in patients with congenital syphilis. Similar bone changes may occur in yaws, a related disease seen commonly in many tropical countries.

Syphilis of bone can take many forms, but the two commonest types are syphilitic metaphysitis of infants, and osteo-periostitis (combined osteitis and periostitis) in children or adults.

Syphilitic metaphysitis presents as severe local limb pain in young infants in the first six months of life with congenital syphilis. It can affect several epiphyses, with replacement of the adjacent metaphysis by granulation tissue. These appear as a zone of sclerosis on radiographs and the Wasserman reaction is positive, though unlike osteomyelitis there is no leucocytosis. Treatment by intensive antisyphilitic drugs is rapidly effective.

Syphilitic osteo-periostitis occurs when the diaphysis or body of a bone is infected by syphilis. There is usually a combination of osteitis and periostitis, although one or other may predominate. Osteo-periostitis often occurs with



Fig. 7.11 Two examples of congenital syphilis of bone. (a) Metaphysitis in an infant. Note white lines at ends of metaphyses, with adjacent zones of rarefaction. (b) Osteo-periostitis in a child. New bone has been laid down in layers under the periosteum.

metaphysitis in infants (Fig. 7.11A); it may occur separately in older children with congenital syphilis (Fig. 7.11B), or in adults with acquired syphilis.

Clinical features. Deep boring pain, worse at night, and swelling are the predom inant symptom s. *On exam ination* there is either a localised fusiform swelling over the shaft of the bone or a diffuse thickening of the whole length of the bone.

R adiographic features. Syphilitic bone disease is represented by a variety of radiographic changes ranging from severe osteoporosis to dense sclerosis and may be easily confused with a malignant bone tumour. Occasionally the predominant change is bone destruction without new bone formation.

Investigations. The W asserm ann reaction is positive.

Treatm ent. The bone lesions usually respond well to intensive antisyphilitic measures.

PYOGENIC ARTHRITIS (Infective arthritis; septic arthritis)

In this form of arthritis a joint is infected by bacteria of one of the pyogenic groups. Typically there is acute joint infection of rapid development, but the infection may be subacute or even chronic. When pus is formed within the joint the condition is sometimes termed suppurative arthritis.

Cause. The staphylococcus, streptococcus, or pneumococcus is usually responsible - occasionally the gonococcus or other organisms.

Infections of bone and joints

Pathology. The organisms may reach the joint by three routes:

- 1. through the blood stream (haem atogenous infection)
- 2. through a penetrating wound
- focus of osteom yelitis n within t h io in t са th e m o r n taphy ses elbow upper uр m а t h an d t h (F ig 7.2, p. 87) alm ost m (i.e from t h betw e e n the knee an d ankle))

The subacute inflam matory reaction in io in t tiso r ith in the joint: the fln id ankly Τh e d flu id 347 is turb i d 0 fr 11 a ti n u ru le n t of the infection. The varies from ccord in g to 0 0 verity o II te o m norm al function, to total destruction of the joint and c o m plete resolution, with fibrous or bony ankylosis (Fig. 7.12).

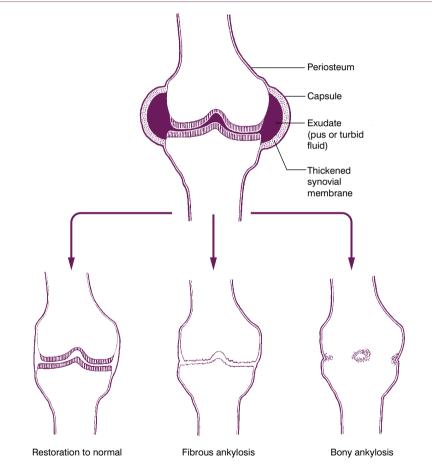


Fig. 7.12 Pyogenic arthritis, with possible results. In the active phase the joint is distended with pus or turbid fluid; the synovial membrane is inflamed and moderately thickened. The outcome varies with the intensity of the infection and the response to treatment. There may be: 1. restoration to normal; 2. fibrous ankylosis; or 3. bony ankylosis.

Clinical features. The onset is acute or subacute, with pain and swelling of the joint. There is constitutional illness, with pyrexia.

On exam ination the joint is sw ollen, partly from fluid effusion and partly from thickening of the synovial membrane. When the affected joint is superficial, the overlying skin is warmer than normal and it is often reddened. All movements are restricted; in severe cases they are almost totally prevented by protective muscle spasm. Attempted or forced movement increases the pain. In cases of haematogenous infection a boil or other primary focus of infection is often to be found elsewhere in the body. In other cases there may be a history of penetrating injury, or of bone infection adjacent to the joint.

Im aging. Radiographs in the early stages do not show any alteration from the norm al (Fig. 7.13A), though an ultrasound scan m ay reveal the presence of an effusion in the affected joint which can then be aspirated to aid diagnosis (Fig. 7.13B). Later, if the infection persists, there m ay be diffuse rarefaction of bone adjacent to the joint, loss of cartilage space, and possibly destruction of bone. Radioisotope bone scanning shows increased uptake of the isotope in the region of the joint.

Investigations. There is a polymorphonuclear leucocytosis. The C-reactive protein and the erythrocyte sedimentation rate are raised. Bacteriological examination of aspirated joint fluid usually identifies the causative organism.

Diagnosis. This is from other forms of arthritis (especially tuberculous arthritis, gouty arthritis, and haem ophilic arthritis), and from infections near the joint (especially acute osteom yelitis).

Prognosis. This varies widely according to the severity of the infection, the organism responsible, and the promptness with which efficient treatment is begun. M any joints can be saved intact, but many are destroyed more or less completely, with fibrous or bony ankylosis (Fig. 7.12).

Treatm ent. Very prompt treatm ent is essential if there is to be a reasonable prospect of preserving norm aljoint function.

Constitutional treatment. Rest in bed may sometimes be required if a major lower limb joint is affected, together with appropriate antibiotic drugs given system ically by intravenous injection until the acute symptoms subside. Whenever possible the causative organism must be identified by culture of the blood and of joint aspirate and its sensitivity to antibiotics determined, so that the most effective drug may be given. Until that information is available treatment should be begun with broad-spectrum antibiotics, such as a third-generation cephalosporin, that have high anti-staphylococcal activity.

Local treatment. The joint is rested, usually in a plaster splint. In the case of the hip or knee, sustained weight traction is useful in relieving spasm and pain. The fluid exudate, which is often purulent, is removed by aspiration or, if necessary, by incision. A spiration is repeated daily so long as the exudate continues to form. Rest is enforced until the infection is overcome, as shown by the subsidence of pyrexia and retrogression of the local signs. Thereafter active movem ents are encouraged in order to restore the greatest possible function to the joint.

TUBERCULOUS ARTHRITIS

In Britain the incidence of tuberculous arthritis, formerly common, decreased markedly in the years following the Second World War, probably because of the general improvement in living standards and the introduction of streptomy cin and other antituberculous drugs. Pasteurisation of milk and elimination of infected cattle have virtually abolished bovine infection. In some Asiatic and

Infections of bone and joints

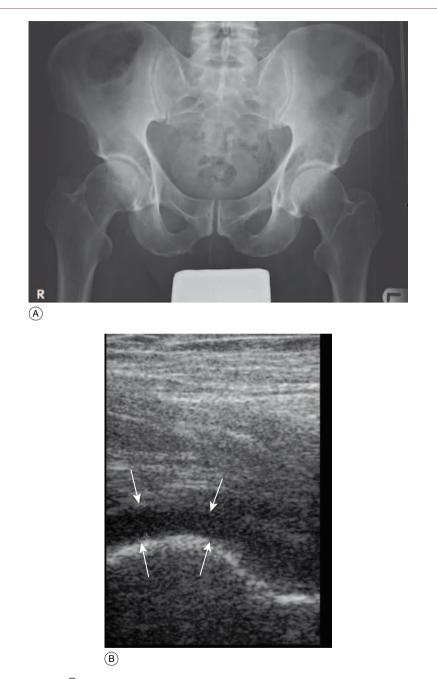


Fig. 7.13 A Radiograph of pelvis in patient with an early septic arthritis of the right hip presenting with joint pain. There is an apparently normal radiographic appearance in both hips. B Ultrasound scan of the same hip demonstrating a joint effusion. The fluid in the joint is seen as a dark area (between the arrowheads). The lower arrows indicate the femoral head. Ultrasound is very sensitive to the presence of joint fluid and is the investigation of first choice in joint sepsis.

infection is still com m on, and cases are now h erculous seen

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Ν b o s t often d th e in te 1.11 h i n d ncv iem e th a io in t 0 2 m c h here. The synovial membrane is much thickened (Fig. 7.14)

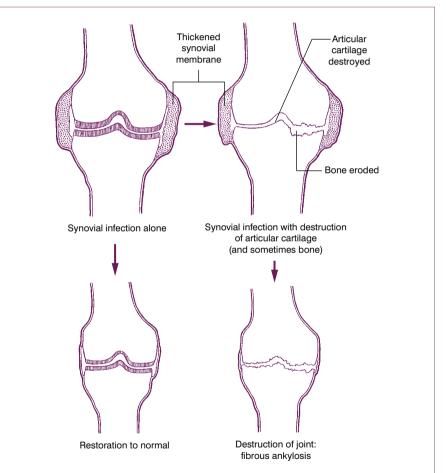


Fig. 7.14 Tuberculous arthritis, with possible results. When infection is purely synovial there is marked thickening of the synovial membrane but the articular cartilage is intact (note similarity to early rheumatoid arthritis). With efficient treatment begun at this stage restoration to normal is possible; but if neglected the disease progresses to involve the articular cartilage and bone: the joint is destroyed, and fibrous ankylosis is the natural outcome.

by the tuberculous inflam m atory reaction, which is of characteristic type, with round-cell infiltration and giant-cell systems. Unless the disease is arrested the articular cartilage is soon destroyed and the underlying bone is eroded. Som etimes the infection begins in bone adjacent to a joint rather than in the joint itself; thence it extends into the joint by direct continuity. The slow formation of an abscess - a 'cold' or chronic abscess in contradistinction to the florid abscess that may accom pany an acute pyogenic infection - is a common feature. The abscess often makes its way towards the skin surface and may eventually rupture, giving rise to a chronic tuberculous sinus. This may provide a route for the entry of secondary infecting organisms.

If healing occurs before the articular cartilage and bone have been dam aged the function of the joint is restored virtually to norm al; but if cartilage or bone has been dam aged before healing is secured permanent im pairment – often com plete loss of function – is inevitable (Fig. 7.15).

Clinical features. Children and young adults are most commonly affected. There is often a history of contact with a patient with active pulmonary tuberculosis. In general, the predominant symptoms are pain, swelling, and impairment of function of the affected joint. There is usually some impairment of the general health. On examination the characteristic features are increased warm th of the overlying skin, swelling from synovial thickening, and painful restriction of movement in all directions. Forced movement causes sharp pain and induces protective muscle spasm. The muscles controlling the joint are usually wasted. A n abscess or sinus is often apparent. A tuberculous lesion may be found elsewhere in the body.

Im aging. Radiographic features. The earliest change in tuberculous arthritis is diffuse rarefaction throughout a fairly wide area of bone adjacent to the joint. If the disease is arrested early there may be no further change; but if the

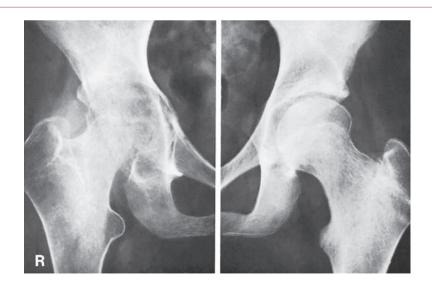


Fig. 7.15 Tuberculous arthritis of right hip. Note the rarefaction, loss of joint cartilage, and early erosion of bone surfaces. The normal side is shown for comparison.

infection progresses the cartilage space is narrow ed and the underlying bone is eroded (Fig. 7.15). As the disease heals the bones harden up again - that is, the rarefaction becomes gradually less apparent until the bone density is restored to normal

Radioisotope bone scanning shows increased uptake of the isotope in the region of the joint.

Investigations. The erythrocyte sedimentation rate is raised in the active stage. Its gradual decrease is an indication of healing. The Mantoux test is positive. A spiration of the joint may yield a little turbid fluid, in which organism s can seldom be demonstrated, but culture may prove its tuberculous nature. Exam ination of pus withdrawn from an abscess often reveals tubercle bacilli. Biopsy of thickened synovial m embrane shows the typical histological features of tuberculosis (caseous granulation and acid-fast bacilli)

Complications. These are:

1. sinus form ation

2. secondary infection through a sinus track

3. spread of disease to another part of the body.

O ther complications are peculiar to special regions - for example, compression of the spinal cord by an abscess in tuberculosis of the spinal column.

Course. This depends largely upon the conditions in which the patient lives, and upon the promptness with which treatment is begun and its efficiency. Under favourable conditions early treatm ent usually promotes gradual healing, with preservation of a useful or even a norm aljoint; but where conditions tend to be poor and the disease florid, the joint may be largely or totally destroved.

Treatment. The principles of treatment are the same no matter which joint is affected, with antibacterial drugs as the mainstay of treatment. Variations in detail will be discussed in the sections on individual joints.

Antibacterial drugs. There is now a choice of several antituberculous drugs, including rifam picin, isoniazid, pyrazinam ide, streptom ycin, and etham butol. Regimens vary: a common combination of drugs is rifampicin, isoniazid and pyrazinam ide, with the addition if appropriate (depending upon the resistance of the organism s) of streptom ycin or etham butol. The course of drug treatm ent should continue for 6-9 m onths, with streptom ycin or etham butol (if used) discontinued after 2 m on ths.

Careful watch must be kept for undesirable side effects, especially with etham butol, which may cause optic atrophy; and with streptomycin, which may cause auditory impairment. Liver function must be monitored during treatm ent because rifam picin, isoniazid, and pyrazinam ide may be harm ful to liver cells. Streptom ycin carries the additional disadvantage that it has to be adm inistered by intram uscular injection.

Local treatment varies according to the particular joint that is affected. Tuberculosis of a large joint such as the hip or kneem ay dem and a period of rest in bed, at any rate in the early stages; whereas a patient with disease of a smaller joint - particularly in the upper limb - may be up and about throughout the period of treatment. Imm obilisation of the affected joint in a plaster or splint is usually advisable in the early stages, both to relieve pain and to provide favourable conditions for healing. Splintage should generally be continued for 2 to 4 months, depending on the severity of the disease. Meanwhile abscesses should be aspirated or drained surgically.

CHAPTER 7

Subsequent m anagem ent depends on progress. If cartilage and bone are preserved intact and the local signs of inflam m ation subside, with im provem ent in the sed im entation rate, the outlook is good and activity m ay be progressively increased. If, how ever, the disease progresses to the point of eroding articular cartilage and underlying bone, a further period of im mobilisation m ay be required, and fusion of the joint - usually by operation - m ay become the ultim ate objective. In selected patients it m ay be feasible to undertake replacement arthroplasty of larger joints follow ing successful antibacterial treatment. This should only be considered when the disease has been quiescent clinically for at least a year with a norm al erythrocyte sed im entation rate. 103

8

Bone tumours and other local conditions

Co-written by Nigel Raby

TUMOURS OF BONE

Prim ary bone tum ours, both benign and malignant, are relatively uncommon in comparison with the malignancies arising in other tissues of the body. They are also much less common than metastatic (secondary) tum ours which affect the skeleton by blood stream spread from primary carcinoma of the breast, prostate, lung or kidney.

The importance of primary bone tumours is not their frequent occurrence, but the difficulty they may present in diagnosis and treatment and the need to distinguish them from a number of tumour-like lesions that affect bone. Tumours originating in bone arise from mesenchymal tissue and if malignant are termed sarcoma. They are normally classified by the predominant cell type in the lesion, which may be bone, cartilage or fibrous tissue (Table 8.1).

Clinical features. Bone tum ours m ay present clinically with local pain unrelated to activity, local sw elling, lim p, pathological fracture, or a com bination of these sym ptom s. M any benign tum ours m ay be asym ptom atic and are detected as a chance finding on a radiograph taken for unrelated indications. To reach an accurate and rapid diagnosis m ay require access to a skilled m ulti-disciplinary team of radiologist, pathologist, and oncologist, as well as an orthopaedic surgeon. This is particularly im portant where a malignant tum our is suspected since this m ay require com plex and extended m anagem ent utilising adjuvant therapy as well as surgical treatm ent.

Im aging of bone tum ours. Bone tum ours are still best evaluated by plain film s. M R scanning is required to identify the full extent of the tum our and its relationship to key anatom ical structures. H ow ever, the differentiation of the m ost likely tum our type is still best undertaken by careful evaluation of the plain film findings.

In evaluating any lesion of the bone the following key observations will allow a correct diagnosis to be made in the majority of cases.

A ge of the patient. M any tum ours are m ost com m only found in specific age groups. Ew ing's sarcom a and sim ple bone cysts occur in children and young adults. Chondrosarcom a generally affects patients over the age of 40.

Single or multiple lesions. Most true primary bone tumours are solitary lesions. The presence of multiple lesions suggests bone metastases, though less commonly these may occur in myeloma or lymphoma.

Site of tumour. The bone involved and the site of involvement; whether epiphysis, diaphysis or metaphysis is important. Certain tumours have a predilection for particular bones and some occur most typically in certain parts of the bone. Giant cell tumours are almost always found in a subarticular position, i.e. epiphyseal location.

M argin of the lesion. Slow -growing tum ours have well-defined som etim es sclerotic m argins and are m ost likely benign. Rapidly growing lesions will have ill-defined margins and appear to permeate diffusely into the surrounding

Table 8.1 Classification of primary bone tumours

Benign		Malignant
	Arising from bone	
Osteoma		Osteosarcoma
Osteoid osteoma		
Osteoblastoma		
Giant-cell tumour		
	Arising from cartilage	
Enchondroma		Chondrosarcoma
Osteochondroma (cartilage capped exostosis)		
Chondromyxoid fibroma		
Chondroblastoma		
	Arising from fibrous tissue	
Fibrous cortical defect Non-ossifying fibroma		Malignant fibrous histiocytoma (MFH)
Fibrous dysplasia		
	Tumours of uncertain origin	
Simple bone cyst		Ewing's sarcoma
Aneursymal bone cyst		Adamantinoma

bone. While this typically indicates a malignant process, other rapidly progressing conditions, such as acute osteomyelitis, can give a similar appearance.

Appearance of matrix. Lesions of mainly cartilage tissue will tend to show areas of calcification. A lesion arising from bone-forming cells may contain areas of ossification. If either of these findings is present then the differential diagnosis is narrow ed considerably.

Periosteal reaction. If present, a periosteal reaction gives clues as to the nature of the underlying lesion. A thick well-organised periosteal reaction implies a slow-growing lesion, as for example with osteoid osteoma. A periosteal reaction consisting of layers of thin periosteum implies rapid grow th and is generally indicative of a rapidly growing malignant lesion.

Breach of cortex. Destruction of the cortex indicates an aggressive invasive lesion.

Soft tissue mass. If present extension into soft tissues is also evidence of a rapidly growing aggressive lesion.

Of the above the most help ful in narrow ing the differential diagnosis is the age of the patient and the site of the tumour. With these two pieces of information alone it is possible to suggest the correct diagnosis in the majority of patients.

O ther investigations. Blood tests should be undertaken routinely, though these rarely provide a definitive diagnosis. A raised white cell count with an increased erythrocyte sedim entation rate and C-reactive protein suggests the possibility of a bone infection. Hypercalcaem ia suggests extensive bone resorption from hyperparathyroidism, or the presence of multiple bone metastases or myelom a deposits. Multiple myelom a can be confirmed when the plasm a proteins show a very high globulin level, while prostatic carcinom a spread is accompanied by a raised serum acid phosphatase.

Biopsy. In the majority of cases it is necessary to undertake a biopsy of material from the lesion for histological and bacteriological examination final definitive diagnosis. The biopsy may be an open procedure, closed needle or trephine technique may be used. The closed technique by CT scanning, but gives very little material for additional b e guided estigations, such as imm unohistochemistry or cytogenetics. Needle biopsy in v only be used where advice is available from an expert bone patholoe h o u l d with the necessary technical resources for processing sm all tissue sam ples. gist Once diagnosed the treatment of the lesion depends on whether it is benign or malignant and will be described in more detail for the individual types of tum our

BENIGN TUMOURS OF BONE

It would be inappropriate to give a detailed description of every type of benign general principles in their management will be illustrated for of the more common types encountered in practice. These are: fou

- osteoid osteom a (Fig. 8.1)
- chondrom a (Fig. 8.2)
- 3 osteochondroma (Fig. 8.3)
- giant-cell tum our (Fig. 8.4).

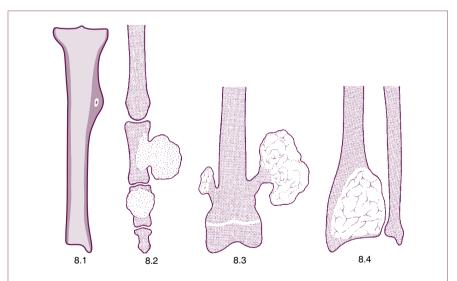


Fig. 8.1 Osteoid osteoma with central nidus surrounded by reactive sclerotic bone.

Fig. 8.2 Two types of chondroma: ecchondroma on proximal phalanx; enchondroma in middle phalanx. (See also Figs 6.4A, B)

Fig. 8.3 A small and a large osteochondroma. Originating at the growth cartilage, they have migrated away from it with growth of the bone. Each is capped by cartilage. (See also Fig. 6.3B)

Fig. 8.4 Giant-cell tumour (osteoclastoma). Note expansion of cortex and scanty fine trabeculae within the tumour. The tumour extends close up to the articular surface.

Osteoid osteoma

This is a benign circum scribed lesion that may arise in the cortex of long bones or occasionally in the cancellous bone of the spine. It affects young patients aged 10-35 and is three-times commoner in males.

Pathology. The characteristic feature is the formation of a small nidus of osteoid tissue, usually less than 0.5 cm diameter, surrounded by a reactive zone of dense sclerotic new bone formation (Fig. 8.1).

Clinical features. They usually present with increasingly severe, but well-localised, deep aching pain and sometimes local bone tenderness. The pain is worse at night and is eased by aspirin or NSAIDs, a diagnostic feature.

Im aging. Plain radiographs typically show local sclerotic thickening of the shaft that may obscure the small central nidus within the area of rarefaction (Fig. 8.5). The nidus is best seen on a fine cut CT scan (Fig. 8.6) and also exhibits intense uptake on an isotope bone scan.

Treatment. In younger patients some osteom as may resolve spontaneously after several months, but most require surgical treatment. Removal of the central nidus results in resolution of the reactive bone form ation and dramatic relief of symptoms. This can be achieved by open surgical excision or curettage, but increasingly less-invasive methods are being used. Where the necessary equipment is available, a CT-guided needle can be inserted into the nidus and the lesion ablated with radiofrequency coagulation.

Chondroma

This is a tum our composed of translucent hyaline cartilage, usually presenting in the 15-50 age group.

Fig. 8.5 (a) and (b) AP and lateral radiographs of tibia. There is an area of dense cortical thickening and sclerosis of the posterior tibial diaphysis. A small central lucency is only just visible. These are typical appearances of osteoid osteoma.



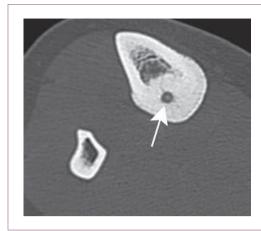


Fig. 8.6 CT scan demonstrates a central small lucency (arrow) containing a more dense central nidus within the thickened cortex. The appearance is diagnostic of an osteoid osteoma.

The two forms of chondrom a: in the commonest type the tu m d a n d i t (enchondrom a) (Fig. 8.2); in the other outw ard from bon eriosteal chondrom a o r ecchonalchondrom as the hands or feet, or from arise i n flatbones o r iliu m . Thev o fte n reach a large size and are more prone to a p u la change. Enchondrom as are fairly com m in the long bones, d e elop alignant o n th e sm all bones of the hands and feet. The affected bone is b u 50% occur in th e tum our and its cortex is m uch thinned; so pathological fracture ande d b v is c an d u sually the presenting feature. Many remain asymptomatic and discovered as chance findings on radiographs taken for other purposes. o n l v

Im aging. Central enchondrom as expand the bone with thinning, but not erosion, of the cortex and exhibit a variable degree of mineralisation or speckled calcification (Fig. 8.7).



Fig. 8.7 Radiograph of metacarpophalangeal joint of the little finger with a typical enchondroma in the proximal phalanx. The lucent lesion has produced slight medullary expansion with thinning of the overlying cortex. There is some calcification within the lesion indicating a lesion of cartilage origin. Multiple enchondromata of the major long bones occur mainly in the distinct, but rare, clinical condition known as dyschondroplasia (multiple chondromatosis or Ollier's disease) (p. 65). In this disorder, which begins in childhood, enchondromata arise in the region of the growing epiphysial cartilages (grow th plates) of several bones: they interfere with normal grow th at the epiphysial plate and consequently may lead to shortening or deform ity (see Fig. 6.4A).

Occasionally an enchondrom a undergoes malignant change, becoming a chondrosarcoma, usually in one of the major long bones rather than in the small bones of the hands or feet. Clinically this should be suspected when there is a sudden increase in size of the swelling or if the lesion becomes painful.

Treatment. A chondrom a is often best left alone. If it causes a fracture or is unsightly it should be removed by curettage and the defect filled with bone graft.

Osteochondroma (osteocartilaginous exostosis)

This is the commonest benign tumour of bone, usually presenting in the 10-20 age group.

Pathology. The tum our originates in childhood from the grow ing epiphysial cartilage plate, but as the bone grows in length the outgrow th gets 'left behind' and tends to point away from the adjacent joint. It frequently grows outwards from the bone like a mushroom with a bony stalk in continuity with the cortex of the underlying bone (Fig. 8.3). Less commonly the lesion may be sessile with a more broad-based origin. The bony stalk has a larger cap of cartilage which continues to grow until the cessation of skeletal growth.

The ordinary osteochondrom a is single; but in the condition known as diaphysial aclasis (multiple exostoses) (p. 63) the tum ours affect several or many bones. The risk of malignant change to a chondrosarcom a is higher in these multiple lesions than in the solitary lesion and should be suspected if the tum our continues to enlarge or becomes painful after puberty.

Clinical features. The tum our may be noticed as a circum scribed hard swelling near a joint, but is usually painless. It may become painful due to pressure effects on adjacent nerve or vascular structures, or from the form ation of an overlying pseudobursa, though increase in size and pain should always be regarded with suspicion.

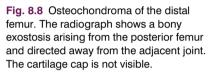
Im aging. Plain radiographs show the mushroom -like stalk of the bony tum our (Fig. 8.8), but not the larger cartilaginous cap until this calcifies once skeletal maturity is reached. Patients with known lesions should be warned to seek referral for further im aging if their swelling enlarges or becomes painful.

Treatm ent. The tum our should be excised if it causes pain or if it enlarges after puberty and must be sent for routine histological exam ination to exclude any malignant change.

Giant-cell tumour (osteoclastoma)

This is an important tumour because, though generally classed as benign, it tends to recur after local removal or curettage. It occurs most commonly in young adults in the 20-40 age group. In about 10% of cases it behaves as a frankly malignant tumour, metastasising through the blood stream to the lungs.





Pathology. The commonest sites are the lower end of the femur, the upper the tibia, the low erend of the radius, and the upper end of the hum erus en d that is. at those ends of the long bones at which most grow th occurs. It may also occur in the spine and sacrum. Characteristically it occurs in the end of the bone, occupying the epiphysial region and often extending alm ost to the joint surface (Fig. 8.4). It destroys the bone substance, but new bone form s beneath the raised periosteum, so that the bone end becomes expanded and pathological fracture is common.

H istologically the tum our consists of abundant m ononuclear oval or spindleshaped strom al cells profusely interspersed with giant cells that may contain as many as fifty nuclei (Fig. 8.9), hence the name 'giant cell tum our'. The giant c e l l s possibly represent fused conglomerations of the oval or spindle-shaped strom al cells, which may frequently show mitotic figures, though this is not necessarily indicative of malignant change.

Clinical features. The symptoms are pain at the site of the tum our and a gradually increasing local sw elling. Som etim es the patient is made suddenly that som ething is wrong by the occurrence of a pathological fracture. ination reveals a bony swelling which may be tender on firm palpation.

. Radiographs show lytic destruction of the bone substance, with Im aging sion of the cortex, but no sclerotic rim or periosteal reaction (Fig. 8.10). A bony trabeculae may remain within the tumour giving a faintly loculated appearance. The tum our tends to grow eccentrically, and often extends as far as th e articular surface of the bone. M agnetic resonance im aging will help to determ ine the amount of soft tissue extension of the tumour (Fig. 8.11).

Treatment. This depends upon the site of the tum our. Curettage of the contents with a high-speed burr is the standard method of treatment for most giant cell tum ours, though this is associated with a high rate (20-25%) of recurrence. This rate can be reduced to less than 10% by the use of adjuvant treatment

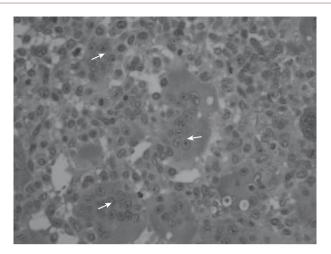
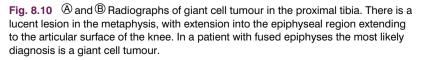
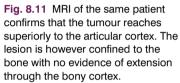


Fig. 8.9 Histology of giant cell tumour showing large osteoclastic multinucleate giant cells (arrows) with interspersed mononuclear tumour cells. The nuclei of the two cell types are very similar. (Haematoxylin and eosin \times 400.)









applied to the lining of the cavity after curettage. Methods used include the chemical phenol, freezing with liquid nitrogen, or the insertion of polym ethylm ethacrylate bone cem ent. In addition to its exotherm ic reaction on any residual cells, the cement has the added advantage of providing support to the subchondral bone and cartilage of the articular surface of the joint. In some bones, or after m ultiple recurrences, it m ay be possible to excise the tum our and replace it with allograft bone or a metal prosthesis, without undue functional com prom ise. Sites w here this is possible include the distal radius, distal fem ur, and proxim altibia.

Radiotherapy is sometimes used and is capable of bringing about permanent cure, but there is a risk that it may itself induce malignant change, perhaps m any years later. It should therefore be confined to tum ours at sites that are in accessible to operation, particularly in the spinal colum n and sacrum.

Chondromyxoid fibroma and chondroblastoma

Both of these benign bone tum ours are extrem elv rare and readers should consult larger textbooks for details of their clinical presentation, im aging and treatm ent.

MALIGNANT TUMOURS OF BONE

In this brief review only the five commonest primary malignant tumours of bone will be described together with the secondary or metastatic tumours.

- 1. osteosarcom a (osteogenic sarcom a) (Fig. 8.12)
- 2. chondrosarcom a of bone
- 3. malignant fibrous histiocytom a of bone
- 4. Ewing's tum our (Fig. 8.13)
- 5. myeloma (plasm acytom a) (Fig. 8.14)
- 6. secondary (metastatic) tumours (Fig. 8.15).

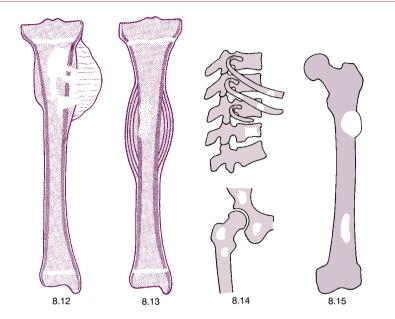


Fig. 8.12 Osteosarcoma. It arises in the metaphysis. Note the destruction of bone, the raising of the periosteum with new bone formed beneath it, and disruption of the cortex by the tumour. The appearance is variable, and the formation of neoplastic bone by the tumour may be profuse or scanty.

Fig. 8.13 Ewing's tumour. It arises in the diaphysis. Note the central area of destruction and concentric layers of subperiosteal new bone giving an 'onion-peel' appearance.

Fig. 8.14 Multiple myeloma. Small 'punched-out' osteolytic tumours are scattered throughout the skeleton, especially in bone containing abundant red marrow.

Fig. 8.15 Metastatic tumours in bone, as found in disseminated carcinoma. Note the circumscribed destruction of bone without any periosteal reaction. Metastatic tumours in bone are very much more common than primary malignant bone tumours.

Osteosarcoma (osteogenic sarcoma)

This is predom inantly a tum our of childhood or adolescence, occurring most com monly in the 10-25 age group. When it occurs in later life it is often a complication of Paget's disease (osteitis deformans) (p.66).

primitive bone-forming steosarcom a arises from stsites are the low erend of the femur, the upperend of the tibia. ofth d h u m e r 11 - that is, in those grow th . The tum ctive i s o c c u r r i n g our th e rtoftheshaftthatisadjacenttotheepip thatis, the sthe bone structure and eventually bursts into the surround in g epithough it seldom crosse t h e epiphysial ca rtila sis itself (Fig. 8.12) histological appearance varies widely. because тh ectiv S 11 P m а hе repre sented Thus th e tu m bе tis l a e l v of fibrous tissue. of cartilage or of m d vxom tissue: rе w i11 alw avs be found. i n s o m e th e tum our, areas of neoplastic new bone or osteoid tissue that indicate the

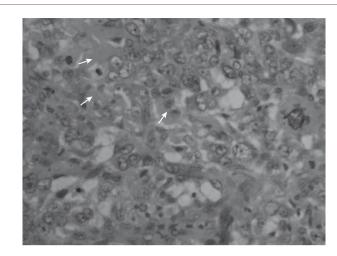


Fig. 8.16 Histological appearance of a typical osteosarcoma with areas of immature bone osteoid formation (arrows) and numerous atypical malignant stromal cells showing nuclear pleomorphism and mitotic activity. (Haematoxylin and eosin $\times 400$.)

e nature of the lesion, and in som e cases new ly form ed bone is abundant (Fig. 8.16). The tum our metastasises early by the blood stream especially to the lungs and som etim es to other bones.

Clinical features. The usual presentation is local bone pain associated with gradually increasing swelling. Exam ination reveals a diffuse firm thicken near the end of a bone, close to the joint. The overlying skin is warmer norm al because of the vascularity of the tum our; and the part may be so distended by tum our that the skin appears stretched and shiny.

Im aging. Plain radiographs show irregular medullary and cortical destruction of the metaphysis. Later the cortex appears to have been 'burst open' at one or m ore places by the soft tissue extension (Fig. 8.17), but there are alw ays vestiges the original cortex. MR scanning allows accurate delineation of the tum our and the extent of invasion of the soft tissues (Fig. 8.18). There is usually dence of new bone form ation under the corners of the aggressive periosteal reaction (Codman's triangle) (Fig. 8.17B). Occasionally well-marked radiating spicules of new bone are seen within the tum our ('sun-ray' appearance) (Fig. 8.17A). In a parosteal osteosarcoma, a variant that may occur in older patients with a better prognosis, there may be profuse form ation of new bone on the surface of the cortex.

Radioisotope (technetium) scanning will show increased up take at the site of the tum our and can provide additional inform ation on the intram edullary spread by any 'skip' lesions, though these are norm ally detected by MRI scanning.

chest radiograph may show pulmonary metastases (Fig. 8.19), but CT А scanning of the lung fields (Fig. 8.20) is now mandatory for pre-treatment staging as it can detect small pulmonary metastases before they are apparent in plain radiographs.

Diagnosis. In atypical cases an osteosarcom a may be confused with subacute osteomy elitis, or with other bone tum ours such as chondrosarcoma, m alignant fibrous histiocytom a, giant-cell tum our, Ew ing's tum our, or even

Bone tumours and other local conditions

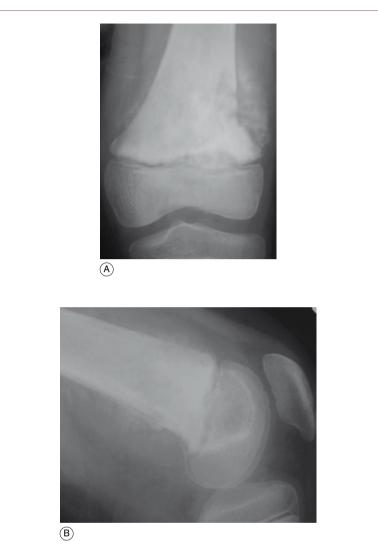


Fig. 8.17 (and **B** AP and lateral radiograph of knee. There is irregular sclerosis of the metaphysis which does not cross the epiphysis. The aggressive bone-forming lesion has breached the cortex with a periosteal reaction producing the characteristic Bryant's triangle and 'sun-ray' spiculation.

metastatic tumour. A representative piece of the tumour should always be removed by closed needle or open biopsy and sent for histological examination.

e n d u с c h o n i n nces in a d iu a n t t r a t m n t ad ded t o rg ical ognosis markedly for the better, with increased d p g ival time and often lasting cure.

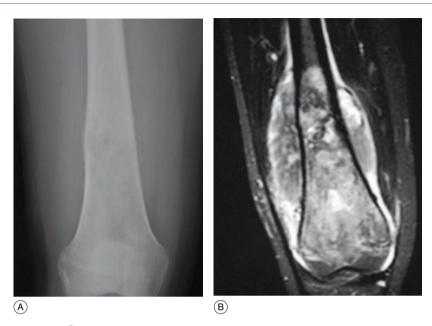


Fig. 8.18 A Radiograph of osteosarcoma of the femur. There is an area of ill-defined lucency in the mid shaft associated with some periosteal reaction. B MR of same patient. The area of marrow abnormality is seen to be extending far into the distal femur with a large soft tissue mass surrounding the femur not evident on the plain film.



Fig. 8.19 Pulmonary metastases in a case of osteosarcoma of the tibia. Such metastases are the usual cause of death.



Fig. 8.20 CT of chest showing two intrapulmonary metastases posteriorly in the left lung.

Treatment. The introduction of new powerful cytotoxic drugs for adjuvant chem otherapy has revolutionised the treatm ent of these tum ours, because of their ability to prevent or delay the appearance of pulm onary microm etastases. drugs currently used include high-dose methotrexate, doxorubicin, cisplatin, and ifosfamide in combinations which are the subject of multi-centre controlled trials. They all have major side effects and should only be used at treatm ent centres skilled in their use. Chem otherapy is usually com menced before surgical treatment, and is continued intermittently for 6 months to a year after ablation of the tum our. Com mencing chem otherapy before operative treatment allows the pathologist to assess the response of the tum our to the drugs by histological exam ination of the resected specimen. The ability of chem otherapy to control local recurrence and distant m etastatic spread has permitted the increasing use of 'limb salvage surgery' as an alternative to amputation. In selected cases, based on accurate surgical staging from biopsy and modern im aging techniques, it is possible to undertake radical resection and replacement with a metallic prosthesis or a massive bone graft. Recent reports have shown over 70% disease-free survival after 5 years by this approach in patients with osteosarcom a, with no increase in local recurrence rates when compared with amputation.

Chondrosarcoma of bone

A chondrosarcom a is a malignant tum our derived from cartilage cells, and it tends to maintain its cartilaginous character throughout its evolution.

Pathology. It may develop in the interior of the bone (central chondrosarcom a) or upon its surface (peripheral chondrosarcom a). A *central chondrosarcom a* occurs most com monly in the fem ur, the tibia, or the hum erus. It may arise *de novo*, without there having been a pre-existing lesion (Figs 8.21 and 8.22), or it may arise from malignant transformation of a previously existing enchondroma (especially in the condition know n as dyschondroplasia, Ollier's disease or multiple chondromatosis (p. 65).

A peripheral chondrosarcoma, on the other hand, tends usually to affect a flat bone such as the innom inate bone (Figs 8.23 and 8.24), the sacrum, or the





Fig. 8.21 Radiograph of proximal femur with a central chondrosarcoma. The lytic lesion has produced endosteal scalloping, indicating an aggressive lesion, and shows calcification indicating a chondroid matrix.

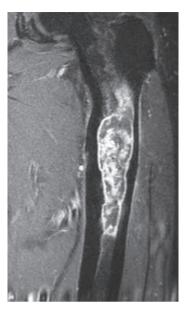


Fig. 8.22 MR of same patient. Demonstrates the extent of the femoral lesion which is similar to that seen on the plain film and is still confined to bone.



Fig. 8.23 Plain radiograph of the pelvis showing a large lobulated calcified mass arising from the right iliac wing, which proved to be a low-grade peripheral chondrosarcoma.



Fig. 8.24 MR of same patient as in Fig. 8.23 shows a much larger mass than is apparent on the plain film . This consists of non-calcified cartilage and suggests that the chondrosarcoma has developed in a cartilage-capped exostosis arising from the pelvis.

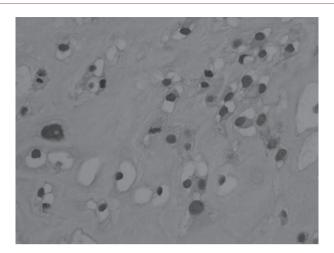


Fig. 8.25 Histological appearance of chondrosarcoma with an extensive chondroid matrix, containing scattered atypical chondrocytes with nuclear pleomorphism and some spindle cell morphology. (Haematoxylin and eosin ×400.)

scapula, and it generally arises from malignant transformation of a previously existing osteochondroma (especially in the condition of diaphysial aclasis or multiple exostoses (p.63)).

H istologically, a chondrosarcom a may be highly cellular (Fig. 8.25). The cartilage cell nuclei tend to be sw ollen, and double nuclei may be seen. These features, suggestive of malignancy, may be found in only a few microscopic fields, the remainder of the tissue appearing relatively benign.

Clinical features. The patient is usually in the 30-60 age group, who complains of pain and local swelling, often in an area where there was known to be a previous lesion, such as multiple exostoses or Ollier's disease. The tum our grows slow ly and may attain a large size.

Im aging. Radiographically, a central chondrosarcom a is seen to grow at the expense of the cortical bone with endosteal scalloping and may result in pathological fracture (Fig. 8.21). In contrast a peripheral chondrosarcom a shows as a large mass growing outwards from the surface of the bone (Fig. 8.23). Both types characteristically show blotchy areas of calcification within the tum our mass. *Magnetic resonance scanning* is essential to define the soft tissue extension of the tum our (Figs 8.22 and 8.24).

Prognosis. A chondrosarcom a grows slowly and does not metastasise early; so the prognosis, depending on the grade of the tum our, is somewhat more favourable than it is for osteosarcom a. Because of the variable grades and slow growth of chondrosarcom a the overall survival rate may be over 75%, though in high-grade lesions this may fall to 20%.

Treatm ent. Since adjuvant chem otherapy is not effective against chondrosarcom a, surgery must rem ain the treatment of choice. Wide surgical margins must be achieved to permit complete resection, though in some low-grade lesions or borderline malignancy it may be possible to undertake local excision or even curettage. In very large high-grade tumours or following local recurrence, amputation may still be required.

Malignant fibrous histiocytoma of bone

This rare highly malignant tum our includes many of the lesions once classified as fibrosarcoma, because their histology shows a predominance of fibroblasttype cells mixed with primitive histiocytes. It affects adults in the 20-60 age group, mainly occurring in the diaphysis of long bones, presenting with pain, sw elling and som etimes pathological fracture.

Im aging with radiographs and MR shows permeative bone destruction from a large soft tissue mass with no sclerosis or periosteal reaction.

Treatment is similar to osteosarcoma, requiring radical surgery and adjuvant chemotherapy.

Ewing's¹ tumour (endothelial sarcoma of bone)

Ewing's tumour (endothelial sarcom a of bone) is an uncommon but highly malignant sarcom a that arises in bone marrow.

Pathology. The tum our is commonest in the shaft of the femur, tibia, or hum erus. Unlike osteosarcom a, it arises in the diaphysis rather than the metaphysis of a bone. It probably develops from endothelial elements within the bone marrow, though the precise cell of origin is not known. The tum our tissue is soft and vascular. As it expands it gradually destroys the bone substance. There is a striking reaction beneath the periosteum, where abundant new bone is formed in successive layers (Fig. 8.13). Histologically the tum our consists of sheets of uniform small round cells (Fig. 8.26). The tum our metastasises early through the blood stream, especially to the lungs, and sometimes to other bones.

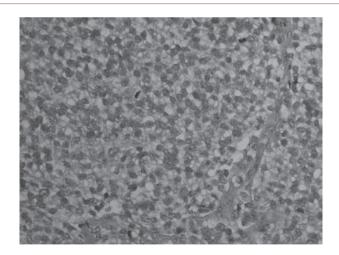


Fig. 8.26 Histological appearance of Ewing's sarcoma with sheets of cells, containing round or oval nuclei, but with very little intercellular stroma. (Haematoxylin and eosin \times 400.)

¹James Ewing (1866–1943) American pathologist who was founder and Director of Memorial Sloan-Kettering Cancer Center in New York and described the tumour in 1920.

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C linical features. C hild ren and adolescents in the 5-20 age group are the usual victim s. Typically, there is local pain with rapid ly increasing firm sw elling over one of the long bones, usually near the middle of the shaft (in contrast to osteosarcom a which arises at the metaphysis). Local symptoms may be accompanied by fever, weight loss and general malaise. On examination the swelling is diffuse or fusiform, and of firm consistency. The overlying skin becomes stretched and warmer than norm ald ue to the large size and vascularity of the tum our mass.

Im aging. *Plain radiographs* show destruction of bone substance with concentric layers of subperiosteal new bone ('onion-peel' appearance) (Fig. 8.27). *M R scanning* will reveal the extent of the large soft tissue mass of the tum our (Fig. 8.28). An isotope bone scan is also required in staging to detect any multifocal lesions. A radiograph or CT scan of the chest may show pulmonary metastases.

Diagnosis. In atypical cases there may be confusion with subacute osteomyelitis, because of the system ic disturbance and raised ESR. In particular, it may be confused histologically with a metastasis from a suprarenal neuroblastom a. A percutaneous needle biopsy should be undertaken when the tum our is suspected.

Prognosis. Until recent years Ewing's tum our was uniform ly fatal – usually from pulm onary metastases, with fewer than 15% of patients surviving beyond 5 years. The advent of adjuvant chem otherapy and improved radiotherapy has changed this gloom youtlook, and now 5-year survival rates can be expected in 50–60% of cases.

Treatment. Chemotherapy differs from that used for osteosarcom a and a number of different drug combinations have been used and continue to



Fig. 8.27 (left) Radiograph of Ewing's sarcoma in the proximal tibia in a child. The lateral cortex is destroyed and there is periosteal elevation at the lower margin of the lesion.

Fig. 8.28 (right) MR of the same patient as in Fig. 8.27. This shows there is extensive involvement of the tibial shaft, the cortex is breached and there is a large associated soft tissue mass.

olve. A combination of vincristine, cyclophosphamide, dactinomycin, doxorubicin is commonly recommended and is commenced as o p rative treatm ent. The tum our itself m t h prior to any b v radical operative excision with prosthetic replacement, or by am puta-Radiotherapy may be used as an alternative to operation, since the tio tu m our is radiosensitive. Surgical excision with a special prosthesis adjustable for progressive lim b grow th is preferred for low er lim b lesions, particularly in young children where leg length discrepancy and joint contractures may follow radiotherapy. Radiotherapy is usually reserved for upper limb tum ours and for tum ours at inaccessible sites such as the pelvis or spine.

Myeloma (myelomatosis; plasmacytoma)

This is a tum our of bone marrow, occurring in older adults aged 50-70, often presenting as a single lesion but later spreading to involve the bone marrow at other sites. It is usually ultimately fatal, though modern treatment regimens may produce very long-term remission for up to 10 years.

P athology. It arises from the plasm a cells of the bone m arrow and is dissem in nated to m any parts of the skeleton through the blood stream, so that by the time the patient seeks advice the tum our foci are usually multiple, affecting chiefly the bones that contain abundant red marrow. Less commonly the tum our may present as a solitary bone plasm acytom a (Fig. 8.29) with spread to other skeletal sites only after months or years. The lesions are mostly small and circum scribed (Figs 8.14 and 8.30) but occasionally large: the bone is simply replaced by tum our tissue and there is no reaction in the surrounding bone. Pathological fracture is common, especially in the spine (Fig. 8.30). Histologically the tum our consists of



Fig. 8.29 Radiograph of pelvis. There is a large lytic lesion of the right iliac wing. The imaging findings are non-specific, but biopsy indicated this to be a solitary plasmacytoma.



Fig. 8.30 Multiple myeloma. Left: Part of pelvis and femur, showing numerous small tumour foci. Right: Spine, showing diffuse rarefaction, with partial collapse of the bodies of the second and fourth lumbar vertebrae.

sm all round cells of plasm a-cell type: the cells m ay be som ew a m a s s hatlarger than norm al plasm a cells, and less uniform (Fig. 8.31).

Clinical features. In most cases the tumour affects adults past middle age. There is general ill health, with local pain at one or more of the tum our sites, etimes a pathological fracture. On examination the patient is pale from the associated anaem ia due to suppression of red marrow function. There is often local tenderness over the affected bones, but there may be no obvious swelling or deform ity unless pathological fracture has occurred. The patient is prone to develop infections due to the suppression of norm alantibody production.

Im aging. Radiographs show multiple punched out lytic lesions, especially in bones containing red marrow, such as ribs, vertebral bodies, pelvic bones, skull, and proxim alends of fem ur and hum erus (Fig. 8.30). Som etim es there is diffuse rarefaction of bone (Table 6.2, p. 77).

MRI scanning is potentially useful for imaging multiple skeletal lesions, particularly in suspected spinal involvement because of the superior soft tissue resolution it provides.

Investigations. There is microcytic anaemia. The erythrocyte sedimentation rate is increased. Bence Jones protein is present in the urine in more than half the cases. Serum globulin is increased, often som uch that the album in-globulin ratio (normally 2:1) is reversed. Marrow biopsy usually shows a profusion of plasma

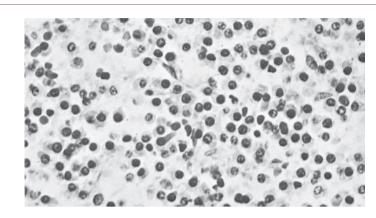


Fig. 8.31 Multiple myeloma. Sheets of cells resembling plasma cells. (Haematoxylin and eosin $\times 400.)$

cells which can be characterised by imm unohistochemistry and cytogenetics to give more help in planning treatment and predicting prognosis.

Diagnosis. Iliac or sternal marrow biopsy will often confirm the diagnosis when the clinical and radiographic features are equivocal.

Prognosis. The tum our is usually fatal, though its progress can often be checked for several years by the improving treatment regimens.

Treatment. The tumour foci respond to radiotherapy for a while, and pain is well relieved. The mainstay of chemotherapy in the past has been melphalan, an alkylating agent, which was sometimes used in conjunction with prednisolone. New erdrug combinations are showing improved results using thalidomide, or one of its analogues, with dexamethasone and a proteasome inhibitor, bortezomib. In a favourable case remission for up to 4 years may be gained. The possible place of bone marrow stem cell transplantation is also under trial. When hypercalcaemia is a problem treatment with bisphosphonates to inhibit excessive bone resorption may be required.

Secondary (metastatic) tumours in bone

Secondary malignant tumours in bone are much more common than primary tumours; but whereas most primary malignant bone tumours occur in children or young adults, secondary tumours generally occur in later life.

Pathology. The tum ours that m etastasise m ost readily to bone are carcinom as of the lung, breast, prostate, thyroid, and kidney (hypernephrom a). M etastases occur m ost com m only in the parts of the skeleton that contain vascular m arrow, especially the vertebral bodies, ribs, pelvis, and upper ends of the fem ur and hum erus. The bone structure is sim ply destroyed and replaced by tum our tissue (Fig. 8.15). Pathological fracture is therefore very liable to occur.

Clinical features. Pain is the usual main symptom, but sometimes the disability is insignificant until a pathological fracture occurs. The spine is frequently involved, often with progressive neurological symptom s as well as local pain, from pressure on nerve roots or the spinal cord. In advanced widespread metastatic disease the patient may develop symptoms of hypercalcaemia,

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with nausea, vom iting, dehydration, and even com a. The primary tum our can usually be dem onstrated.

A nalysis of the different types of clinical presentation has shown that 50% of patients present initially with bone pain, 25% with pathological fracture, 15% with paraplegia or paraparesis, and 10% with local swelling.

to have been eaten a Im aging. In plain radiographs the bone appears way so that there is a clear circum scribed area of lysis, without any reaction in the surround ing bone (Fig. 8.32). Exceptionally, bone is laid down within the m etastasis, sing marked sclerosis - the exact opposite to the usual osteolytic lesion. This type is alm ost confined to secondary deposits from prostatic carcinom a. In cases of diffuse infiltration there mav be widespread osteoporosis (Table 6.2, p. 77). A radiograph or CT scan of the chest should alw ays be obtained because of the possibility that m etastases m ay be present in the lungs.

Technetium isotope scanning is the best technique for detecting occult metastatic deposits in the skeleton, as areas of increased uptake (Fig. 2.14B). These may be apparent long before the lesions are visible in plain radiographs, making it a very sensitive screening method. *Magnetic resonance imaging* is an even more sensitive method of screening, particularly for the detection of spinal metastases.

Investigations. In prostatic metastases the content of acid phosphatase in the plasm a is usually increased above the norm alrange. The increase is specifically in the tartrate labile or 'prostatic' phosphatase. Hypercalcaem ia may sometimes occur when there is excessive bone resorption from widespread bone metastases.





Fig. 8.32 Typical appearance of a metastatic carcinoma in the humerus. The primary tumour was in the lung. With increasing destruction of bone, pathological fracture is likely to occur. ^(B) AP radiograph of tibia showing a solitary renal metastasis. There is a lytic expansile lesion in the proximal tibia with breach of the medial cortex indicating an aggressive lesion and the patient has a known renal carcinoma.

Treatm ent. R ad io therapy is a valuable palliative treatm ent, particularly in more localised disease. Chem otherapy is som etim es appropriate (see p. 117). R ad io-active io dine is valuable form etastases from carcinom a of the thyroid. Horm one analogue therapy m ay be appropriate for metastases from the breast or prostate, and in selected cases adrenalectomy and hypophysectomy have proved worthwhile in slow ing the progress of the disease when other measures have failed. In the presence of life-threatening hypercalcaem ia, treatm ent by bisphosphonates is valuable in that it inhibits further bone resorption and may also relieve bone pain. Local splintage m ay be required, but metallic internal fixation, or even custom prosthetic replacem ent of bone, is used increasingly for the treatm ent of im pending or pathological fracture of the long bones as a means of maintaining independent function. Strong analgesics and sedatives may be required and a multi-disciplinary team is essential for the overall management of severe intractable pain.

Bone changes in leukaemia and lymphoma

This is a convenient place to note that changes may occur in the skeleton in leukaem ia and in Hodgkin's disease or related lymphomas. In *leukaem ia* the changes are due to infiltration of bone by proliferating white cells, and they are seen most commonly in subacute lymphatic leukaem ia in children. Characteristically there are zones of rarefaction with delicate subperiosteal new bone formation in the metaphysial regions of the femur or humerus, or in the spine or pelvis. Leukaem ia is also an occasional cause of diffuse widespread rarefaction of the skeleton (Table 6.2, p. 77).

In *Hodgkin's disease* or the related *lym phom as* there may be osteolytic lesions in the proxim al lim b bones or in the spine or pelvis, denoting destruction and replacement by tum our tissue.

TUMOUR-LIKE LESIONS OF BONE

SIMPLE BONE CYST (Solitary bone cyst; unicameral bone cyst)

Sim ple bone cysts occur mostly in the long bones of children or adolescents, com monly affecting the metaphysis of the proximal humerus or femur. They also occur occasionally in the small bones of the adult carpus, especially in the scaphoid or lunate bone.

Pathology. The cyst begins as a spherical lesion, but as it enlarges it tends to become oblong with its long diameter in the axis of the bone. In the long bones it tends to lie centrally in the shaft rather than to grow eccentrically, and the remaining cortex may appear expanded equally in all directions. The cyst contains clear fluid. It weakens the bone and often leads to pathological fracture. It is often stated that after a fracture through the wall of a cyst spontaneous filling in of the cyst may occur, but in fact this is by no means alw ays the case.

H istologically, a bone cyst has only a very thin connective-tissue lining. Its w all contains abundant osteoclasts, a fact that has led to confusion with giantcell tum our.

Clinical features. Solitary bone cysts seldom cause symptoms unless a pathological fracture occurs and are usually a chance radiological finding.

Im aging. Plain radiographs show a circum scribed area of lucency with only a thin surrounding zone of sclerosis (Fig. 8.33A). The cyst may appear faintly

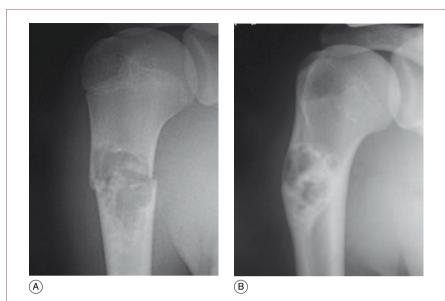


Fig. 8.33 (A) Radiograph of simple bone cyst in the humerus of a child. There has been a pathological fracture through the lytic lesion with cortical fragments visible in the cyst. (B) Same patient some nine months later showing that the fracture has healed and the cyst is showing evidence of infilling with dense sclerotic bone and minimal angulation.

loculated and the overlying cortex may be thinned, or if fractured, a cortical fragment may drop into the cyst ('fallen fragment').

Diagnosis. A cyst must be differentiated from other osteolytic lesions. It may be confused with a bone abscess, with a lipoid or eosinophilic granulom atous deposit, with localised fibrous dysplasia, or occasionally with a tum our. It should be remembered also that cyst formation in bones may be a feature of hyperparathyroidism, which must therefore be considered in differential diagnosis. A solitary bone cyst is distinct from an aneurysmal bone cyst (see below).

Treatment. Sm all uncomplicated cysts do not require treatment, since they tend to heal after skeletal maturity (Fig. 8.33B), but they should be kept under periodic observation. A large cyst may be curetted and packed with bone chips, but percutaneous aspiration and injection of corticosteroid solution or autogenous bone marrow into the cyst have now replaced operative treatment as the principal method of management. If fracture occurs each case must be treated on its merits: most heal with conservative treatment, but if internal fixation is required it should be combined with bone grafting.

ANEURYSMAL BONE CYST

A neurysm al bone cysts also occur in children or young adults, usually before epiphyseal closure, but they are distinct from the sim ple bone cysts described above. Their origin is unknown: the term 'aneurysm al' signifies no more than a seem ing 'blown-out' distension of one surface of the bone. There is no relationship to arterial aneurysm. The cyst may bulge into the soft tissues, contained only by periosteum and a thin shell of new ly form ed cortex. The lining consists of connective tissue with num erous vascular spaces and som e giant cells; the cyst contains fluid blood.

Im aging. Plain radiographs show the cyst to be situated eccentrically in the bone; it presents a characteristic 'blow n-out' appearance, as already mentioned (Fig. 8.34). These features distinguish it from the ordinary simple bone cyst, which is placed more centrally in the shaft and expands the bone uniform ly without periosteal reaction. CT or MRI scanning may provide additional information on the extent of cortical destruction and may also demonstrate the multiple fluid levels that are typical of aneurysmal bone cysts.

Treatm ent. At m ost accessible sites the cyst should be curetted out and filled with bone chips. How ever, if the bone that is affected can be removed without consequent disability – for instance the fibula or a rib – the relevant part of the bone may be excised together with the cyst.

LOCALISED FIBROUS DYSPLASIA OF BONE (Monostotic fibrous dysplasia)

In this condition a solitary area of bone is partly replaced by fibrous tissue, in which scanty bone trabeculae m ay persist. The cause is unknow n, as also is its relationship to polyostotic fibrous dysplasia (p. 68). It is not related to the fibroblastic changes seen in association with the 'brown cysts' of hyperparathyroid ism (p. 73).



Fig. 8.34 (and (B) Radiographs of aneurysmal bone cyst in the ankle of a child. There is an abnormal 'blown-out' appearance of the distal fibula in the metaphysis, but the epipyhseal plate is not crossed. These features make aneurysmal bone cyst the most likely diagnosis.

CHAPTER 8

Pathology. One of the lim b bones is usually the site affected, com monly the central fibrous lesion expands the medullary cavity at the expense of the bone, which is weakened and may fracture.

Clinical features. The lesion occurs in children and young adults who may present with local pain in the affected bone, though in many there are no symptoms and diagnosis may be on the basis of a coincidental X-ray finding.

Im aging. Plain radiographs show a zone of lucency within the bone, often with a hom ogeneous 'ground-glass' appearance and a thick sclerotic rim (Fig. 8.35). In larger lesions softening of the bone and repeated microfractures may result in progressive deformity, such as the 'shepherd's crook' of the proxim al fem ur.

Treatm ent. This depends on the bone affected and the extent of the lesion. Sim ple curettage and autogenous bone grafting is ineffective, but for larger lesions cortical bone grafts with internal fixation may som etim es be required to control deform ity.

METAPHYSIAL FIBROUS DEFECT (Fibrous cortical defect, non-ossifying fibroma)

This is a benign fibrous tissue defect in the metaphysial region of the cortex of a long bone, found accidentally from time to time in a child or young adult undergoing radiological examination for injury or for some other unconnected reason. The lesion is symptom less.

Im aging. Radiographs show a characteristic, well-defined notching of the cortex of the affected long bone (Fig. 8.36). Typically it has a scalloped, sclerotic border.

Treatment. O ther than observation for a period, treatment is not required, but if the diagnosis is in doubt the lesion should be excised.

Fig. 8.35 Radiograph of fibrous dysplasia deposit in the proximal femur. The lytic lesion has a thick sclerotic margin and the lesion itself has the 'ground glass' appearance typical of fibrous dysplasia.





Fig. 8.36 Radiograph of tibia of an adolescent with an asymptomatic fibrous cortical defect. There is a lytic lesion with a sclerotic rim which is eccentrically placed in the metaphysis. The cortex is intact and there is no expansion of the bone.

OTHER LOCAL AFFECTIONS OF BONE

There is a miscellaneous group of solitary lesions of bone that do not fall into the category of infection or tum our. The most im portant mem bers of the group are osteochondritis juvenilis and localised fibrous dysplasia of bone.

OSTEOCHONDRITIS JUVENILIS (Osteochondrosis)

The term osteochondritis juvenilis, or simply osteochondritis, is used to describe certain obscure affections of developing bony nuclei in children and adolescents. The term has also been used, wrongly, for some other affections of epiphyses or apophyses that are more likely traumatic in origin. Typically, a bony centre affected by osteochondritis becomes temporarily softened, and while in the softened state it is liable to deformation by pressure. The disease runs a course of variable length (often about 3 years), but eventually spontaneous rehardening occurs. The precise cause of the disease is unknown, but it is widely believed that temporary interruption of the blood supply to the affected epiphysis is the predominant factor. It should be noted that osteochondritis juvenilis is entirely distinct from osteochondritis dissecans (p. 153).

Sites. Osteochondritis juvenilis is recognised at the following sites (Table 8.2), though the pathology may not be identical at each site:

- 1. the upper epiphysis of the femur (Perthes' or Legg-Perthes' disease, p.366)
- 2. Kienböck's disease of the lunate bone (p. 310) presents sim ilar features and may be included in this group despite the fact that it occurs in fully developed adult bone
- 3. the nucleus of the navicular bone (Köhler's disease, p. 445)

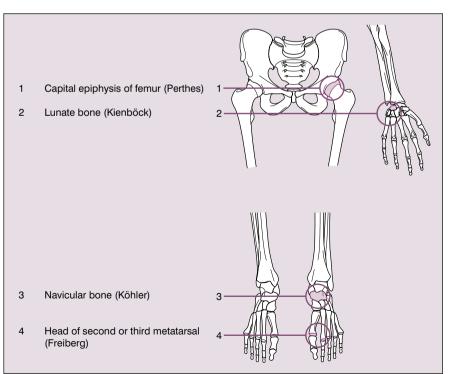
4. the disorder of the head of the second or third m etatarsal know n as Freiberg's disease (p. 462) m ay possibly fall into the category of osteochondritis juvenilis, but there is a tendency now to ascribe it instead to osteochondritis dissecans.

sim ilar radiographic change in the central epiphysis of a vertebral body (Calvé's disease, p. 235) is now generally ascribed to eosinophilic granulom a than to osteochondritis. And the affection of the 'r in g epiphy ofthe bral bodies in the thoracic region of the spine know n Scheue ann's se or adolescent kyphosis (p.232), again formerly thought to be an examof osteoch ondritis, is also now believed to be of different pathology. In brief, the sites shown in Table 8.2 are now regarded as those wh chondritis com monly occurs

Radiological appearances that bear some resemblance to the changes of osteochondritis are also seen in cases of pain at the apophysis of the tibial tubercle (O sgood - Schlatter's disease, p. 415) and at the apophysis of the calcaneus (Sever's disease, p. 448). These conditions were formerly thought to be examples of osteochondritis, but it is now recognised that they are traum atic in origin. There is sim ply a chronic strain of the apophysis from the pull of the tendon that is inserted into it. This type of lesion is now usually term ed *apophysitis*.

Pathology. In a typical example of osteochondritis the histological and radiological evidence suggests that the affected bony centre undergoes partial necrosis, possibly from interference with its blood supply. The necrotic bone is invaded by granulation tissue, broken up, and eventually removed by osteoclasts. During





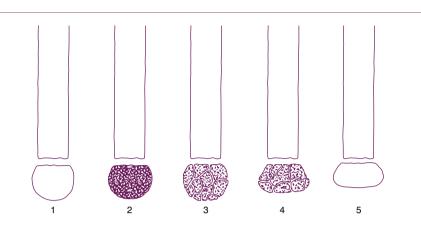


Fig. 8.37 The cycle of changes in osteochondritis. 1. Normal epiphysis before onset.
2. The bony nucleus undergoes necrosis, loses its normal texture, and becomes granular.
3. The bony nucleus becomes fragmented during the process of removal of dead bone.
4. If subjected to pressure the softened epiphysis becomes flattened.
5. Re-ossification with restoration of normal bone texture, but deformity may persist. The cycle occupies 2–3 years.

this stage of fragmentation the centre is liable to deformation if subjected to pressure (Fig. 8.37). The dead tissue is gradually replaced by new living bone trabeculae and eventually the bone texture is restored to normal; but if deformation has been allowed to take place there is permanent alteration of shape.

Clinical features. The age at which the condition arises varies according to the particular bone affected. In general, it occurs during the stage of active development of the bony nucleus. The main symptom is local pain. If the affected epiphysis form spart of a joint, the function of the joint is disturbed and joint movement aggravates the pain. The general health is not im paired.

Im aging. Radiographic examination. The cycle of changes can be follow ed in serial radiographs taken at intervals of a few months. First there is a slight and often patchy increase in density of the bony nucleus. Next the patchy appearance passes to one of fragmentation, representing irregular absorption of dead bone by osteoclasts and the commencing deposition of new bone. At this stage some flattening of the nucleus may be apparent by comparison with the normal side. Later there is a gradual return to norm al bone texture, but any flattening that has occurred will remain. Radioisotope bone scanning may show absence of uptake of the isotope ('cold scan') during the stage at which the epiphysis is avascular.

Prognosis. O steochondritis in itself is harm less to the general health, but if it leads to distortion of a joint surface it predisposes to osteoarthritis w hich, in the case of a large joint such as the hip, m ay cause serious disability in later years.

Treatm ent. The treatm ent depends largely upon the site of the affection. When the bony nucleus is relatively unimportant (as for instance that of the navicular bone) treatm ent may be unnecessary, or it may be sufficient to protect the part in a plaster for six or eight weeks while the pain is severe. But in the case of osteochondritis involving a major joint such as the hip every effort must be made to prevent distortion of the softened epiphysis.

Further details of these disorders will be found in the chapters dealing with individual regions.

9 Arthritis and other joint disorders

ARTHRITIS

The term arthritis is used here to include both inflammatory and degenerative lesions of a joint.¹ It im plies a diffuse lesion affecting the joint as a whole. It does not include localised mechanical disorders such as loose body formation or tears of the menisci of the knee, which are better designated as internal derangements. Nor should it embrace acute injuries of joints.

Clinically, arthritis is generally characterised by pain and restriction of movement at a joint, arising spontaneously; in superficial joints these features are usually accompanied by obvious swelling or thickening. If a joint is not swollen and if it moves freely and painlessly through its normal range it is very unlikely that it is affected by arthritis.

Types of arthritis

For convenience the infective types of arthritis, specifically pyogenic and tuberculous arthritis, have been dealt with in Chapter 7 together with the bone infections caused by the same organisms. Although other types of arthritis, particularly rheum atoid arthritis, have a major inflamm atory component they have not been shown to be associated with a specific infective organism or virus. They are therefore considered here together with degenerative osteoarthritis and the less common types of arthritis associated with metabolic disturbances such as gout.

The incidence of different types varies greatly from country to country and from continent to continent, racial influences often being important. Thus osteoarthritis is very common in the white races, but is relatively uncommon among Africans and Asians.

The types of non-infective arthritis that are common, taken worldwide, are:

- 1. rheum atoid arthritis and juvenile chronic arthritis
- 2. osteoarthritis
- 3. gouty arthritis
- 4. haem ophilic arthritis
- 5. neuropathic arthritis (Charcot's osteoarthropathy)
- 6. the arthritis of rheum atic fever
- 7. ankylosing spondylitis.

¹The term arthrosis is sometimes used to denote a degenerative lesion of a joint, arthritis being used only for inflammatory lesions. But the use of the word 'arthrosis' to denote degeneration is without valid etymological grounds, and can be justified only on the basis of common usage.

RHEUMATOID ARTHRITIS (Rheumatoid polyarthritis)

R heum atoid arthritis is a chronic inflam m ation of joints, often associated with mild constitutional symptoms. It nearly always affects several joints at the same time (polyarthritis). Joint changes of a similar nature also occur in a number of other conditions such as juvenile chronic arthritis (Still's disease), Reiter's syndrome, psoriasis, lupus erythem atosus, and other connective tissue or collagen diseases.

Cause. The cause is unknown. At present only two possibilities attract serious consideration:

- 1. that the disease is due to auto-immunity
- 2. that it is caused by infection.

The hypothesis of auto-immunity, possibly to type II collagen, is based mainly on the observation that the serum of many patients with rheumatoid arthritis contains an antibody known as rheumatoid factor, which reacts with the body protein gamma globulin. When the antibody is present the disease is termed 'sero-positive', as contrasted with sero-negative arthritis when the antibody is absent. The source of the antigen, and many other details of the mechanism by which rheumatoid factor is formed, are unknown.

The hypothesis of infection is likewise without sure foundation. Infection – possibly by a virus or by organisms of the mycoplasma or diphtheroid group – may result in liberation of antigenic type II collagen from the patient's own articular cartilage.

Pathology. The synovial membrane is thickened by chronic inflammatory changes: characteristically it is infiltrated with macrophage-like cells and T-cell lymphocytes (Fig. 9.1). Later the articular cartilage is gradually softened and eroded, and the subchondral bone may also be eroded, characteristically at the joint margins - probably from the action of lytic enzymes and inflammatory mediators produced in the thickened synovial membrane. The eroded surfaces become covered by a soft membrane of inflammatory tissue known as 'pannus'.

The pathological changes are not confined to joints. The synovial lining of tendon sheaths may be similarly inflamed and thickened, both in the hands and in the feet. The contained tendons may become softened and may rupture, aggravating any existing deformity. Inflammatory nodules may form in the soft tissues.

A fter months or years of activity the disease process tends to become less active, usually leaving a number of joints that are permanently damaged, with consequent deformity, instability, or ankylosis.

Clinical features. The patient is usually a young or middle-aged adult, and is more likely to be a woman than a man. Any joint may be affected, but the incidence is higher in the more peripheral joints such as the hand joints, wrists, feet, knees, and elbows than in the lum bar or thoracic spine, shoulders, or hips. The onset is gradual, with increasing pain and swelling of a joint. Soon a num ber of other joints are sim ilarly affected. Pain and stiffness are often worst when activity is resum ed after resting. O ften there is constitutional disturbance, with tiredness and anaem ia, and occasionally fever.

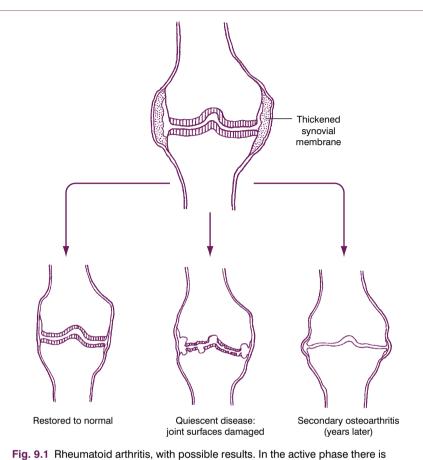


Fig. 9.1 Rheumatoid arthritis, with possible results. In the active phase there is marked thickening of the synovial membrane. Later, the articular cartilage is often eroded and in severe cases there may be some destruction of bone. The possible results are: 1. restoration to normal (only after mild disease of short duration); 2. continuing mildly active disease with permanently damaged joint surfaces and restricted movement; and 3. secondary osteoarthritis from wear-and-tear degeneration of the damaged joint surfaces.

O n te d o lle from ening. The is clin ical d eum atoid n 0 sitiv t h n r h facto

Ιt th e condition hich i m stud y o f th e cervical in e. m inor p m d su b lu x a tio n d m etim es lead to o f a n in te io in to f such degree that the spinal cord is endangered, and it is im portant alw ays to be wary of this possibility.

Arthritis and other joint disorders

Extra-articular features may include enlargement of lymph nodes, muscle wasting, subcutaneous rheum atoid nodules, and anaem ia.

Imaging. Radiographic features: At first there is no alteration from the norm al. Later, there is diffuse rarefaction in the area of the joint. Eventually destruction of joint cartilage may lead to narrow ing of the cartilage space and , in severe cases, to localised erosion of the bone ends (Fig. 9.2) especially in periarticular sites. Radioisotope bone scanning show s increased uptake of the isotope in the region of affected joints.

Investigations. Both the erythrocyte sedim entation rate and C-reactive proteins are raised during the active phase. The rheum atoid factor is present in the serum of 80% of patients with rheum atoid arthritis and is detected by the latex fixation or Rose-W aaler sheep cell agglutination tests.

Diagnosis. For a diagnosis of rheum atoid arthritis four of the following seven criteria must be present.

1. Morning stiffness in and around joints lasting more than 1 hour

- 2. A rthritis of three or more joints simultaneously
- 3. A rthritis in at least one area in a wrist, metacarpal or proximal in terp h a la n g e a l jo in t
- 4. Symmetrical arthritis
- 5. Rheum atoid nodules
- 6. Positive rheum atoid factor
- 7. Radiological changes typical of RA on hand and wrist X-rays.

The clue to the diagnosis is the simultaneous involvement of several joints, with raised sedimentation rate. The presence of rheum atoid factor in the blood is highly suggestive, though the tests are not specific for rheum atoid arthritis; and rheum atoid factor may be absent in about 20% of patients even in wellestablished rheum atoid arthritis.



Fig. 9.2 Joint damage in rheumatoid arthritis. Left. Long-established rheumatoid arthritis of the knee. Note the rarefaction and loss of cartilage space. Right. Destruction of the elbow joint in a case of severe rheumatoid arthritis of long duration.

A search should always be made for evidence of one of the distinct clinical entities that may be associated with joint changes of a rheumatoid type. The most important of such conditions are:

- 1. psoriasis
- 2. Reiter's syndrom e (urethritis, arthritis, conjunctivitis, and hyperkeratotic eruptions on the skin)
- 3. lupus erythem atosus (scaly erythem a of face or other parts)
- 4. scleroderma.

These conditions are all sero-negative, and they may be associated with ankylosing spondylitis.

Course. There is a tendency for rheum atoid arthritis to become quiescent after rem aining active for months or years. In most cases there is permanent im pairment of joint function. In certain joints – especially in the knees – degenerative changes are often superimposed upon the previous rheumatoid condition, and lead to increasingly severe disability even though the original rheum atoid affection is no longer active.

Treatm ent. The treatm ent of rheum atoid arthritis is still evolving, but no specific cure has been found. Innum erable drugs have been tried, but it is by no m eans certain that any of them has an influence on the duration of the disease or on its eventual outcome in a particular case. Undoubtedly some drugs can mitigate the symptoms, particularly the group of non-steroid al anti-inflam m atory drugs (N SA ID s) which also have an analgesic effect in addition to their action in reducing synovial inflam m atory changes.

Methods of treatment may be classified into the following categories:

- 1. rest and constitutional treatment
- 2. drugs, which include mainly the various non-steroidal anti-inflam matory agents; the 'second-line' drugs such as gold salts, sulfasalazine, and penicillam ine; and (rarely) the 'third-line' corticosteroids
- 3. in tra-articular injections of hydrocortisone
- 4. physiotherapy
- 5. occupational therapy
- 6. operation.

R est and constitutional treatm ent. Rest is thought to be beneficial, especially in the early stages of the disease and during an exacerbation. At m any centres patients are adm itted to hospital at the outset for a period of rest, and som etim es this tem porary rem oval from the hom e environm ent, with skilled nursing, regular food, and proper sleep, has a rem arkably good effect on the general health, w hich is often im paired in these cases. Rest for individual joints is also helpful during the initial active stage of inflam m ation, provided it is not enforced for too long. Convenient light splints for this purpose m ay be m ade from expanded polystyrene, or plaster of Paris m ay be used. Splintage is seldom required for m ore than a few weeks and should be follow ed by graduated exercises under the supervision of a physiotherapist.

Drugs. Drugs used in rheum atoid arthritis fall mainly into the categories of the NSAIDs, and the potent anti-inflam matory agents grouped under the heading of corticosteroids. A logical plan is to use aspirin since it has both analgesic and mild anti-inflam matory properties, but to be effective it may have to be given in fairly large doses. A lternative first-line drugs should probably be chosen from the group of NSAIDs, which includes indometacin, ibuprofen, naproxen, phenoprofen and piroxicam. Due regard must be paid to the risk of side effects: gastric pain is a common complaint with most of these drugs, and more serious complications, such as gastric bleeding, are seen occasionally.

A different class of anti-rheum atic agents, to be regarded as second-line drugs, includes the potentially toxic group of com pounds containing gold salts, usually given by intra-muscular injection. These must be used with care, but they are thought to be sometimes beneficial and therefore justified in severely afflicted patients who have failed to respond to the first-line drugs. Sulfasalazine, a derivative of sulphapyridine, is now also used increasingly as a second-line drug. Its mode of action is uncertain, but it has the advantage over gold salts of oral administration and fewer side effects. A nother drug in this second-line category is penicillamine, the effect of which is com parable to that of gold. This also is potentially toxic for the kidneys and must be used with caution. A lso included in this category are certain im muno-suppressive agents, such as azathioprine and methotrexate.

Newerdevelopments in drug therapy have centred on biological molecules manufactured by genetic engineering that can block or reduce the production of destructive cytokines and enzymes from the cells of the rheumatoid synovium. The first of these, anti-tumour necrosis factor (TNF) has given very encouraging results in modifying the disease, but no long-term results are yet available.

The place of corticosteroids in rheum atoid arthritis is still controversial. There is wide agreement that because of their serious side effects they should be avoided altogether in the great majority of patients. There may be a small proportion of severely afflicted patients in whom the advantages outweigh the hazards.

Intra-articular injections. Injections of corticosteroids (usually hydrocortisone) into an affected joint can produce worth-while relief, but the disad vantages have precluded their widespread use. The main disad vantages are:

- 1. risk of infection, especially with repeated injections
- 2. risk of accelerating a degenerative reaction, the mechanism of which is not yet clear
- 3. the short duration of the relief obtained
- repeated injections at several sites m ay become so irksome to the patient as to be unacceptable.

In general, it is wise to avoid repeated injections.

Physiotherapy. Physiotherapy is widely used and generally beneficial, even though some of the benefitm ay result from suggestion or 'placebo effect' rather than from a direct effect on the disease process. Heat in the form of infra-red radiation or short-wave diathermy is commonly used, but probably the most useful contribution of physiotherapy is active exercises including hydrotherapy, designed both to keep joints as mobile as possible and to maintain useful function in the muscles that control them.

Occupational therapy. Occupational therapy is useful mainly in helping seriously disabled patients to find ways in which they can more easily carry out the various activities of everyday life - bathing, toilet, cooking, feeding, boarding public transport, and many others. Many useful aids for the disabled are available, and those that are appropriate should be brought to the patient's notice.

Operation. Operation has an important place in treatment, but each operation must be considered as a component in the overall plan of management and not as a substitute for other measures. Operation may be applicable to the early stages of the disease, or it may be used in the later stages to salvage a joint that has been permanently damaged and remains a source of persistent pain.

In the early stages the operation most commonly used is synovectomy excision of thickened and inflamed synovial membrane from joint or tendon sheath. As well as relieving pain, this may possibly slow down the inflammatory process and so help to preserve articular cartilage in an affected joint. It is undertaken mainly in the knee and wrist, and in the small joints and tendon sheaths of the hand.

Operation may also be required in the hand for repair or replacement of ruptured tendons, or for correction of finger deformities. In the painful elbow there is often a place for excision of the diseased radial head, and at the wrist excision of the lower end of the ulna may bring worthwhile relief in selected cases.

Operations used in the later stages of joint disease are arthroplasty and arthrodesis. Arthroplasty is applicable particularly to the hip and knee, and som etim es to the shoulder or elbow, and to the joints of the fingers and toes. Arthrodesis is usually the operation of choice for the joints of the spine, the wrist and the ankle.

Further details are given in the sections on individual joints.

JUVENILE CHRONIC ARTHRITIS (Juvenile rheumatoid arthritis; Still's disease)

Juvenile chronic arthritis is uncommon. In the past the general term 'Still's disease' was often used broadly to cover all its manifestations, but alm ost certainly the disease is not a single entity. Rather it comprises a number of conditions that are more or less distinct, though features common to all are pain, swelling and stiffness of joints. Recognised types include:

1. sero-positive polyarthritis (adult type occurring in children)

- 2. classical Still's disease
 - (a) with system ic manifestations
 - (b) with polyarthritis, and
 - (c) with pauciarticular arthritis (i.e.minimal joint involvement)
- 3. sero-negative polyarthritis with sacro-iliitis

4. arthritis associated with psoriasis, ulcerative colitis or Crohn's disease.

These subgroups vary in age of onset, sex incidence, course, com plications, and prognosis.

Sero-positive juvenile rheum atoid arthritis is sim ilar in all respects to the sam e disease in adults. It tends to begin rather late in childhood and affects girls more often than boys.

Classical Still's disease begins in early childhood. In the system ic type there is swinging pyrexia with enlargement of lymph glands and of the spleen, with joint involvement simultaneously or later. The eventual outlook is favourable, as it is with the sero-negative polyarticular and pauciarticular variants – though the pauciarticular disease is complicated rather frequently by iridocyclitis necessitating local or system ic steroid therapy.

The sero-negative disease with sacro-iliitis is commoner in boys than in girls and tends not to begin until late in childhood: it may lead on to ankylosing spondylitis in early adult life. Most such patients show a positive test for HLA-B27 antigen and there is often clinical overlap between these patients and relatives with ankylosing spondylitis, Reiter's disease, ulcerative colitis, or Crohn's disease. It is thus probable that there is a hereditary factor in the causation.

Treatm ent. This is similar to that for rheum atoid arthritis in adults, with reliance on aspirin in the first instance and resort later if necessary to non-steroidal anti-inflam matory agents and possibly – in florid sero-positive disease – to gold therapy or penicillam ine. Corticosteroid therapy should usually be avoided except for patients with iritis or iridocyclitis. General managem ent includes adequate rest, tem porary splinting of inflam ed joints, graduated exercises with the physiotherapist, and occasionally operation – for instance, correction of fixed deform ity or arthroplasty of the hip.

OSTEOARTHRITIS (Degenerative arthritis; arthrosis; osteoarthrosis; hypertrophic arthritis; post-traumatic arthritis)

O steoarthritis is a degenerative wear-and-tear process occurring in joints. The joints may have been impaired by congenital defect, vascular insufficiency, or previous disease or injury. It is by far the commonest variety of arthritis.

Cause. It is caused by wear-and-tear that exceeds the capacity of the articular cartilage to renew and repair itself. If a joint were never put under stress it would never become osteoarthritic. Hence the relatively lightly stressed joints of the upper limb are, in general, less prone to osteoarthritis than the heavily stressed joints of the lower limb. Nearly alw ays, how ever, there is a predisposing cause that accelerates the wear-and-tear process and there is now evidence that this may have a genetic basis. Alm ost any abnorm ality of a joint may be responsible, indirectly, for the development of osteoarthritis – often many years later. The main predisposing factors are:

- 1. congenital failures of norm al developm ent, such as hip dysplasia
- 2. irregularity of joint surfaces from previous fracture
- 3. internal derangem ents, such as a loose body or a torn meniscus
- previous disease, leaving a dam aged articular cartilage (for exam ple, rheum atoid arthritis or haem ophilia)
- 5. mal-alignment of a joint from any cause (for example, bow leg)
- 6. obesity.

A ge alone is not a cause of osteoarthritis, though it may be associated with an impaired capacity for tissue repair after injury, and this may be an indirect causative factor.

Pathology. Any joint may be affected, the lower limb joints more often than the upper. The articular cartilage is slowly worn away until eventually the underlying bone is exposed (Fig. 9.3). This subchondral bone becomes hard and glossy ('eburnation'), though it may also show the presence of degenerative cysts. Meanwhile the bone at the margins of the joint hypertrophies to form a rim of projecting spurs known as osteophytes. There is no primary change in the capsule or synovial membrane, but the recurrent strains to which an osteoarthritic joint is subject often lead to slight thickening and fibrosis.

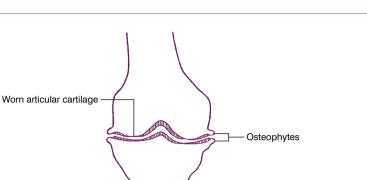


Fig. 9.3 Osteoarthritis. The main changes are in the articular cartilage and underlying bone. The cartilage is gradually worn away, disappearing first at the points of greatest pressure. The subchondral bone becomes sclerotic, and at the joint margins it hypertrophies to form osteophytes.

Clinical features. M ost patients with osteoarthritis are past middle age. W hen it occurs in younger patients there is usually a clear predisposing cause such as previous injury or disease of the joint. The onset is very gradual, with pain that increases alm ost im perceptibly over months and years. M ovem ents slow ly become more and more restricted. In some joints (notably the hip) deformity is a common feature in the later stages. This means that the joint cannot be placed in the neutral (anatomical) position.

On exam ination slight thickening is often found on palpation; it is mainly a bony thickening caused by the marginal osteophytes. There is no increased warm th. Movem ents are impaired slightly or markedly according to the degree of arthritis; in the larger joints movem ent is accompanied by palpable or audible crepitation of a rather coarse type. Fixed deform ity (that is, inability of the joint to assume the neutral anatom ical position) is often found in the hip, and som etimes at the knee and in other joints.

Radiographic features. The characteristic features of osteoarthritis are:

- 1. dim inution of cartilage space
- 2. subchondral sclerosis
- 3. subchondral cysts
- 4. spurring or 'lipping' of the joint margins from the formation of osteophytes (Figs 9.3 and 9.4).

Diagnosis. This is usually made clear by the history, clinical findings, and radiographic features. Osteoarthritis is not easily confused with inflam matory forms of arthritis, because there is no synovial thickening, no increased local warm th, and no muscle spasm; radiographs show sclerosis rather than rarefaction, and the erythrocyte sedimentation rate is not increased.

Course. O steoarthritis usually increases slow ly year by year. In many cases the disability never reaches the stage at which treatment is required. In others increasing pain, stiffness, or deform ity drives the patient to demand measures for its relief. Arthritis and other joint disorders

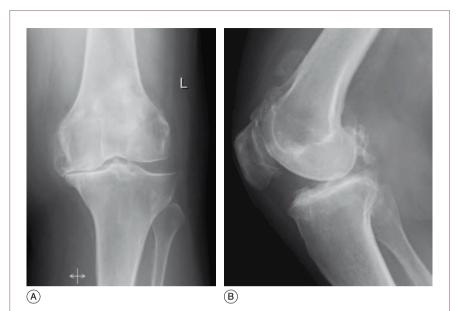


Fig. 9.4 (A) and (B) Radiographs of knee showing advanced osteoarthritis. There is marked joint space narrowing on the medial side and in the patello-femoral joint. Sclerosis of the sub-chondral bone and osteophyte formation at the joint margins are all typical features of osteoarthritis.

Treatm ent. The management of osteoarthritis exemplifies well the three categories of treatment that should be considered in every orthopaedic problem - namely:

- 1. no treatm ent, but advice and reassurance only
- 2. conservative treatment
- 3. operative treatment.

In many cases treatment is not required. The patient may have sought advice only because of anxiety lest some grave disease be present. Reassurance, with advice to restrict excessive stresses on the affected joint with weight reduction where appropriate, is all that is required.

When more active treatment is called for, conservative measures should usually be tried first. The methods available include physiotherapy (often by local heat and muscle-strengthening exercises), analgesic drugs, supportive bandages or orthoses to norm alise stresses, and, in selected cases, local (intraarticular) injections of hydrocortisone or hyaluronate. How ever, repeated steroid injections are of questionable benefit in osteoarthritis and may accelerate joint degeneration. In addition, the stress that is put upon the affected joint should be reduced - for instance, in the case of the joints of the low er limb, by restricting the amount of walking or by the use of a stick (cane) or crutch.

When severe disability, particularly rest or night pain and limitation of function, is unrelieved by conservative treatment, operation may be justified. A mong the operations available are osteotomy to realign a joint; arthroplasty (the construction of a new joint) (p.40); and arthrodesis (elimination of the joint by fusion) (p. 39). O steotom y is useful m ainly at the knee to correct varus or valgus deform ity, and is occasionally used at the hip, but will only provide pain relief for a period of a few years. A rthroplasty has become the operation of choice in the m ajority of patients particularly when osteoarthritis affects the hip and knee, where it can provide good painless function in 95% of patients after 10-15 years. For a few joints, particularly in the hands and feet, arthrodesis m ay still be the operation of choice. Further details of treatment will be given in the sections on individual joints.

GOUTY ARTHRITIS (Podagra; urate crystal synovitis)

Gout is the clinical manifestation of a disturbed purine metabolism. It is characterised by deposition of uric acid salts – especially sodium biurate – in connective tissues such as cartilage (of joints, or of the ear), the walls of bursae, and ligaments.

Cause. The precise cause of the disturbance of metabolism is unknown. There is an inherited predisposition to the disease. In susceptible persons an attack may be induced by excessive consumption of purine-rich foods such as liver, kidneys, sweetbreads, shellfish, beer, or heavy wines. An attack may also be precipitated by recent injury or operation.

Pathology. The prim ary fault is an impaired excretion of uric acid by the kidneys. In consequence the level of urate in the plasm a is increased, som etimes to 0.5 m mol/litre or more (normal = 0.1-0.4 m mol/litre (2.0-7.0 mg/100 ml)). In the blood the uric acid is in solution in a loose combination with proteins; it comes readily out of solution as a sodium salt (sodium biurate) to be deposited in the form of crystals in certain connective tissues, especially those that have been injured or those that have a sluggish blood supply, such as the articular cartilage of the joints of the foot. The deposited crystals set up an inflam matory reaction. In acute gout the deposit is microscopic in amount and is soon reabsorbed, with restoration of the tissue to normal. In chronic gout, how ever, widespread deposits of sodium biurate in joint cartilages, ligaments and the articular ends of bones lead to considerable disorganisation of affected joints. G outy deposits, know n as tophi, are also common at other sites, notably in the olecranon bursa and in the cartilage of the ear, where they may form prominent rounded nodules.

Clinical features. The patient is nearly alw ays over 40, and is more likely to be a m an than a w om an, in the ratio of 10:1. The chief clinical m anifestations are arthritis and bursitis.

Arthritis. Gout affects principally the peripheral joints such as the joints of the toes, tarsus, and ankle, and the small joints of the hands. It occurs in recurrent attacks. The first attack is usually in the great toe; later attacks may affect other joints. In an acute attack the onset is sudden - often during the night. The affected joint is sw ollen, red, and glossy. Pain is very severe. Movements are greatly restricted because of the pain. The attack subsides after a few days and the joint is norm al betw een attacks.

In chronic gout several joints may be affected together. They are thickened and nodular, and painful on movement.

Bursitis. The bursa most commonly affected by gout is the olecranon bursa. It becomes distended with fluid, and there may be palpable deposits of uric acid salts. Other manifestations. Deposits of uric acid salts (tophi) are common in the ear cartilages, where they form palpable nodules. Similar tophimay also occur at other sites.

Radiographic features. In acute attacks of articular gout the joints do not show any radiographic change. In chronic gout the deposits of uric acid salts in the bone ends show as clear-cut erosions adjacent to the articular surfaces, for the deposits are transradiant (Fig. 9.5).

Investigations. There is sometimes a mild leucocytosis and the erythrocyte sed imentation rate may be increased. The plasma uric acid content is raised. A spiration of swollen joints may yield a small quantity of turbid fluid, but never organisms. Polarised light microscopy of synovial fluid usually reveals needle-shaped crystals show ing negative birefringence.

Diagnosis. A cute gout has to be distinguished from other forms of arthritis of acute onset, especially from acute pyogenic arthritis, acute 'pseudogout' (see below), haem ophilic arthritis, and rheum atic fever. Features suggestive of gout are: a history of previous attacks, with symptom-free intervals; a raised plasma urate content; the presence of tophi in the ears or elsew here; detection of crystals in synovial fluid; and a favourable response to treatment.

Chronic gout involving several joints may simulate rheum atoid arthritis.

Course. Goutusually occurs in recurrent acute attacks. Early attacks subside in a few days, leaving the joint clinically norm al. In chronic gout the affected joints are gradually disorganised, and perm anent disability is inevitable.

Treatment. For acute attacks reliance is usually placed upon a non-steroidal anti-inflammatory drug such as indometacin or naproxen. Colchicine is also effective. The affected joint should be rested until the attack has subsided.



Fig. 9.5 (A) and (B) Radiograph of finger showing gouty arthritis in the distal interphalangeal joint. There is marked soft tissue swelling from the deposit of urate crystals and well-defined 'punched out' juxta-articular erosions.

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A large effusion in a major joint such as the knee should be aspirated and replaced by an instillation of hydrocortisone.

For patients with frequent attacks or with chronic gout, especially if the plasm a urate level is persistently raised, long-term drug therapy to reduce the plasm a urate level may be required. The two types of drug available are represented by:

- probenecid, which paralyses renal tubular reabsorption of urates and thus increases their excretion in the urine
- allopurinol, which reduces the form ation of uric acid by inhibiting the enzym e xanthine oxidase.

Provided its long-term use is not associated with toxic reactions, allopurinol is probably to be preferred because it does not increase the load of urate in the urine, with its hazard of stone form ation.

PYROPHOSPHATE ARTHROPATHY (Pseudogout)

W ith the general acceptance of the idea that joint manifestations in gout are caused by the presence of urate crystals, it has more recently come to be appreciated that sim ilar manifestations may be induced by the crystals of other salts. In most such cases the crystals are composed of calcium pyrophosphate show ing positive birefringence, and characteristically calcification of articular cartilage or of menisci is demonstrable radiologically (Fig. 9.6). Arthritis of this type has been termed 'pseudogout'. It usually presents as a chronic arthritis with characteristic calcification of cartilage, but it may occur in an acute form mimicking a joint infection, from the shedding of crystals into the synovial fluid. The diagnosis can be confirmed by the finding of pyrophosphate crystals in the aspirated joint fluid. Treatment of an acute attack should be by rest, aspiration of joint fluid with intra-articular steroid injection, and a non-steroidal anti-inflam matory agent.

HAEMOPHILIC ARTHRITIS

Joint manifestations are common in haemophilia, but examples are seen only infrequently because haemophilia is itself an uncommon disease.

Fig 9.6 AP radiograph of knee with pseudogout or pyrophosphate arthropathy. There is a characteristic line of calcification within the joint space due to crystal deposition within the menisci and deeper layers of the articular cartilage.



Pathology. The term 'haem ophilia' is used loosely to embrace a group of different defects in the process of coagulation of the blood. Classical haem ophilia, the commonest of the group, occurs in males but is transmitted by females. There is an inherited deficiency of a specific clotting factor known as antihaem ophilic factor (Factor VIII). In consequence the clotting time of the blood is prolonged and there is a tendency to undue bleeding, external or internal, when even quite small vessels are cut or torn. Joint manifestations are caused by haem orrhage into a joint, occurring after a minor strain or even without any known injury. The joints most commonly affected are those most vulnerable to strain – especially the knee, elbow, and ankle. The joint cavity is distended with blood (haem arthrosis), which is later slow ly reabsorbed if the joint is rested. Recurrent haem arthroses lead eventually to degenerative changes in the articular cartilage and to fibrosis of the synovial mem brane.

Clinical features. The patient, often a young boy, may be a known sufferer from haem ophilia or can recall previous episodes of bleeding. He suddenly finds that a joint has become painful and sw ollen. On exam ination the findings vary according to the phase and duration of the arthritis. In the absence of specific treatment the joint remains sw ollen for several weeks after the acute onsetpartly from effused blood and partly from the synovial thickening that results from interstitial extravasation. The overlying skin is abnormally warm. Joint movements are restricted and very painful.

In the quiescent phase between attacks of haem arthrosis there is moderate thickening of the joint from synovial fibrosis, movements are slightly impaired, and often there is some degree of fixed deformity – for instance, inability to straighten the knee fully.

D iagnosis. Because of the synovial thickening, increased w arm th of the skin, and restriction of joint m ovem ents, haem ophilic arthritis is easily m istaken for acute or chronic infective arthritis. The history of previous episodes of bleeding, the sudden onset, and the recurrent nature of the attacks are important diagnostic features: the prolonged clotting time of the blood is confirm atory evidence.

Im aging. In the later stages of the disease, particularly in those patients who have multiple bleeds from poor control of their clotting factor, the joints may show extensive surface erosions, juxta-articular bone cysts, with bone destruction and deform ities (Fig. 9.7).

Treatment. When the necessary facilities are available, the correct treatment for a recent acute incident is to promote coagulability of the blood by the administration of antihaem ophilic factor in the form of Factor VIII concentrate or of cryoprecipitate, and then to treat the joint as for ordinary traumatic haemarthrosis by aspiration and temporary support in a plaster splint. Early treatment on these lines should reduce the incidence of irreversible fibrosis of the synovial membrane, hitherto a cause of serious permanent disability.

Failing adequate supplies of antihaem ophilic factor, resort must be had to prolonged splintage.

In the chronic degenerative phase that follows repeated haemarthroses it is often necessary to give permanent support to the joint by means of a moulded plastic splint or other appliance. Operation must be avoided whenever possible, though it may if necessary be undertaken safely, provided that adequate cover by antihaem ophilic factor can be provided.

The future outlook for haem ophilic patients is much improved by the newfound ability to manufacture Factor VIII in commercial quantities by genetic



Fig. 9.7 AP and lateral radiograph of knee in chronic haemophiliac arthropathy. There are marked joint abnormalities in all three joint compartments with oversized epiphyses, build-up of osteophytes and reactive sclerosis.

engineering technology. If such a product can be developed to the point of being effective when taken by mouth the advantage will clearly be even greater.

NEUROPATHIC ARTHRITIS (Charcot's osteoarthropathy)

In neuropathic arthritis a joint is disorganised by repeated minor injuries because it is insensitive to pain.

Cause. The underlying cause is a neurological disorder interfering with deep pain sensibility, although in a third of patients no demonstrable neurological deficit is present. In patients with involvement of joints of the lower lim b the commonest cause in the past was tabes dorsalis, a manifestation of syphilis; but tabes is now uncommon, and there has been a corresponding decline in the incidence of neuropathic arthritis in the lower limb. O ther causes are diabetic neuropathy, cauda equina lesion, and in some countries leprosy. In those with upper limb involvement the usual cause, apart from leprosy, is syringom yelia.

Pathology. A ny of the large joints m ay be affected, including the joints of the spine. The knee, ankle, and subtalar joint are most commonly affected in the low er lim b, and the elbow in the upper lim b. In a normal joint harm fulstrains are prevented by a protective reflex whereby muscle contraction is evoked by incipient pain. When joint sensibility is destroyed the protective function of pain is lost. Strains are unrecognised and, cumulatively, they lead to severe degeneration of the joint. The changes may be regarded as a much exaggerated form of osteoarthritis. The articular cartilage and subchondral bone are worn away, but at the same time there is sometimes massive hypertrophy of bone at the joint margins. The ligam ents become lax and the joint is unstable. Indeed it is often subluxated or even dislocated.

Clinical and radiographic features. The patient is usually in adult life. The main symptoms are swelling and instability of the affected joint. Since the joint is insensitive pain is slight or, sometimes, absent. On examination the joint is thickened,



Fig. 9.8 Neuropathic arthritis of the elbow. There is marked absorption of bone, with pathological dislocation. The underlying cause was syringomyelia.

m ostly from irregular hypertrophy of the bone ends. The range of m ovem ent is m oderately restricted, and there is m arked lateral laxity leading to instability. In extrem e cases the joint m ay be dislocated. Further exam ination w ill reveal evidence of the underlying neurological disorder. Radiographs show severe disorganisation of the joint (Fig. 9.8). The changes are basically those of osteoarthritis, but enorm ously exaggerated. There is a loss of cartilage space and some absorption of the bone ends, often w ith considerable hypertrophy of bone at the joint m argins.

Treatm ent. In m ost instances the best treatm ent is simply to provide support for the joint by a suitable appliance. Som etim es operation m ay be undertaken to fuse the joint, but fusion m ay be difficult to achieve. The primary neurological disorder will usually dem and appropriate treatm ent.

ARTHRITIS OF RHEUMATIC FEVER

In adolescent children and young adults arthritic manifestations are a prominent feature of rheum atic fever. This has now become an uncommon disease in Western countries; so joint manifestations from this cause are hardly ever seen except in under-developed parts of the world.

Cause. Rheum atic fever is ascribed to a sensitivity reaction associated with infection by a haem olytic streptococcus. There m ay be an inherited predisposition to the disease.

Pathology. A ny joint may be affected. The synovial membrane is acutely inflamed, but there is no suppuration. Clear fluid is effused into the joint.

Clinical features. The patient is usually a child over 10, or a young adult. There is constitutional illness, with m alaise and pyrexia. A joint becomes painful and sw ollen, and soon afterwards other joints are likewise affected. On examination an affected joint is sw ollen, partly from contained fluid and partly from

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synovial thickening. The overlying skin is warmer than normal. Movements are markedly restricted, and painful if forced. Other features of rheumatic fever, such as carditis and chorea, should be looked for. Radiographs of affected joints do not show any alteration from the normal.

Investigations. There is a mild leucocytosis. The erythrocyte sedim entation rate is increased.

Diagnosis. Arthritis of rheum atic fever has to be distinguished from other forms of arthritis – especially from acute pyogenic arthritis, rheum atoid arthritis, gout, and haem ophilic arthritis – and from acute osteom yelitis. Features suggestive of rheum atic fever are: onset in adolescence; affection of several joints together or in succession; severe pain with signs of acute inflam mation, but without suppuration; a mild rather than a marked leucocytosis; a concomitant cardiac lesion; and a rapid favourable response to salicylates.

Treatm ent. For joint involvem ent alone salicylates are adequate, but prednisolone or a related steroid m ay be required if the heart is affected. A therapeutic course of penicillin should also be given to elim inate streptococci, and thereafter tw ice-daily oral penicillin should be continued w ell into adult life to reduce the risk of recurrent attacks.

ANKYLOSING SPONDYLITIS (Spondylitis ankylopoietica; Marie–Strümpell arthritis)

A s the name implies, ankylosing spondylitis is primarily a disease of the spine, though in a few cases the arthritic changes involve also the proximal joints of the limbs, especially the hips. Briefly, it is a chronic inflammatory affection of the joints and ligaments of the spine, beginning in the sacro-iliac joints. It progresses slowly, the changes gradually creeping up the spinal column from below. The natural outcome is bony ankylosis of the affected joints (Fig. 9.9) but the disease may be arrested at any stage short of this.



Fig. 9.9 AP radiograph of sacroiliac joints in advanced ankylosing spondylitis showing typical complete fusion of the joints.

Typically, ankylosing spondylitis affects men in early adult life, with a strong hereditary link to the HLA-B27 gene. A fter remaining active for several years it tends eventually to become quiescent, alw ays leaving some degree of permanent stiffness of the spine. A fuller description is given in Chapter 13 (p. 229).

DISLOCATION AND SUBLUXATION OF JOINTS

The cause of dislocation or subluxation of a joint may be congenital, spontaneous, traumatic, or recurrent. By definition, a joint is subluxated when its surfaces are partly displaced but retain some contact one with the other (Fig. 9.10B). A joint is dislocated or luxated when its articular surfaces are wholly displaced one from the other, so that all apposition between them is lost (Fig. 9.10C).

CONGENITAL DISLOCATION OR SUBLUXATION

The most important representative of this group is congenital (developmental) dislocation of the hip (p.343). Congenital club foot (talipes equino-varus) (p.434) may be regarded as congenital subluxation of the talo-navicular joint. Congenital displacement of other joints is rare: an example that is seen occasionally is congenital dislocation of the head of the radius.

TRAUMATIC DISLOCATION OR SUBLUXATION

Injury is by far the commonest cause of dislocations. Traumatic dislocations are described in textbooks of fractures and joint injuries, and they will not be considered further here.

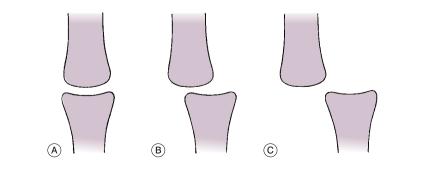


Fig. 9.10 To show the difference between subluxation and dislocation of a joint. (A) The normal state: joint surfaces congruous. (B) Subluxation: incomplete loss of contact between the joint surfaces. (C) Dislocation: total loss of contact between the joint surfaces.

SPONTANEOUS (PATHOLOGICAL) DISLOCATION OR SUBLUXATION

D is placement may occur spontaneously at any joint in consequence of a structural defect or of destructive disease. It is encountered frequently in the spine, where the stability of the intervertebral joints may be impaired by structural defects, by previous injury, or by destructive arthritis (pyogenic, rheumatoid, or tuberculous). In the foot, it is common for a phalanx to become dislocated dorsally at the metatarso-phalangeal joint in cases of severe clawing of the toes; and in the hands interphalangeal subluxation may occur in rheumatoid arthritis. A nother example is the dislocation of the hip that som etimes complicates severe tuberculous arthritis or pyogenic arthritis. Spontaneous subluxation or dislocation is also a common feature of neuropathic arthritis (p. 147).

RECURRENT DISLOCATION OR SUBLUXATION

Certain joints are liable to repeated dislocation or subluxation. Usually, but not alw ays, there has been an initial violent dislocation which causes perm anent dam age to the ligam ents or articular surfaces. The joints most often affected are the shoulder (p. 263), the patello-fem oral joint (p. 409), and the ankle (p. 433).

INTERNAL DERANGEMENTS OF JOINTS

The term internal derangement implies a localised mechanical fault which interferes with the smooth action of a joint. An internal derangement is distinct from arthritis, which is nearly always a diffuse lesion involving the joint as a whole (see p. 133).

Internal derangem ents will be considered in three groups:

- 1. interposition of soft tissue
- 2. loose body form ation
- 3. osteoch on dritis dissecans.

INTERPOSITION OF SOFT TISSUE IN JOINTS

The smooth action of a joint may be obstructed by a displaced mass of soft tissue within it. The soft tissue most often responsible is an intra-articular fibrocartilage, especially a meniscus in the knee (p. 399). As a rule a fibrocartilage can be displaced only when it is torn. O ther soft tissues that are occasionally interposed are synovial fringes and ligamentous tags.

Clinical features. Disorders of this type are common only in the knee. The characteristic features are recurrent sudden 'locking' or giving way of the joint, with later an effusion of clear fluid within it.

LOOSE BODIES IN JOINTS

In tra-articular loose bodies may be derived from bone, cartilage, or synovial membrane. They may be entirely free within the joint or they may retain a pedicle of soft tissue. Causes. The commonest causes of loose bodies are:

- 1. osteochondritis dissecans (1 to 3 loose bodies)
- 2. osteoarthritis (1 to 10 loose bodies)
- 3. chip fracture of the articular end of a bone (1 to 3 loose bodies)
- 4. synovial chondrom atosis (50 to 500 loose bodies).

Pathology. Osteoch ondritis dissecans (see below). The loose body is derived from a part of the articular surface that undergoes necrosis and separates.

Osteoarthritis. The bodies may be derived from marginal osteophytes, in which case they often retain firm soft-tissue attachments and may cause little trouble. Free bodies may be derived from shed flakes of articular cartilage: nourished by synovial fluid, these gradually enlarge.

Fracture of articular margin (osteochondral fracture). Fractures only occasionally cause intra-articular loose bodies. A well-recognised example is a fracture-separation of the medial epicondyle of the humerus, which may be sucked into the elbow jointwhile still retaining its muscle attachments.

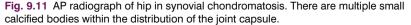
Synovial chondrom atosis (osteochondrom atosis). This is a rare but wellrecognised disease of synovial membrane. A large number of villous folds become pedunculated and their bulbous extremities undergo metaplasia to cartilage. Eventually they separate from their pedicles to become free mobile bodies, and many of them become calcified. The disease may affect any joint or even the synovial lining of a bursa.

Clinical features. Loose bodies do not necessarily cause symptoms unless they become caught between the joint surfaces. In that event the characteristic feature is sudden painful but usually momentary locking of the joint, succeeded after some hours by an effusion of clear fluid within it.

Im aging. A radiograph of the affected joint will reveal the presence of multiple loose bodies, characteristically surrounding the margins of the articular surfaces (Fig. 9.11).

Treatm ent. W hen a loose body causes trouble it should be rem oved . In synovial chondrom atosis this m ay be com bined with subtotal synovectom y.





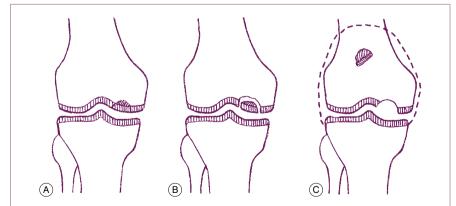
OSTEOCHONDRITIS DISSECANS

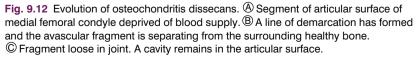
O steochondritis dissecans is a localised disorder of convex joint surfaces in which a segment of subchondral bone becomes avascular and, with the articular cartilage that covers it, may slowly separate from the surrounding bone to form a loose body.

Commonsites. The only joints commonly affected are the knee and the elbow. In the knee the site of the lesion is nearly alw ays the medial femoral condyle, and in the elbow, the capitulum of the humerus. Rarely the hip joint (femoral head) and the ankle joint (talus) are affected. The disorder of a metatarsal head know n as Freiberg's disease (p. 462) is thought by some to be an example of osteochondritis dissecans and by others to represent osteochondritis juvenilis. It shows some features common to both conditions.

is unknown. Im pairm ent of blood supply to the C The precise cause ent of hone and cartilage - nossibly by throm bosis of an end affecte artery hae postulated. The significance of injury is uncertain. There is probably the disease, for it may occur in several joints of the tibility to inborn su ecan sam e patient, or in several members of a family.

ology. А o f th e articular surface of a bone becomes avascular segment (Fig. 9.12A), and a line demarcation slowly forms between o f segment and the surrounding normal bone (Fig. 9.12B). The affected g m e n t i n size: in t h knee e n m easures about one to three centim etres in depth. It is alw ays on the convex diam eter and halfa centim etre i n io in t rface If th all it is som etim es re-attached spontaneously, especially in segment is s m lescents: but i n o s t cases it finally separates to form a loose body in the its articular cartilage (Fig. 9.12C). The resulting cavity in io in t. still covered h v of the bone fills with fibrous tissue, but there is inevitably articular surface som e irregularity of the joint surface which predisposes to the later developm ent of osteoarthritis





Clinical features. The patient is an adolescent or a young adult. The early symptoms and signs are those of a mild mechanical irritation of the joint – namely a tendency to aching after use, with recurrent effusion of clear fluid. A fter separation of a fragment from the articular surface the clinical features are those of an intra-articular loose body: recurrent sudden locking of the joint accompanied by sharp pain and follow ed by effusion.

Radiographs show a clearly defined shallow excavation in the articular surface of the bone, with a discrete bone fragment lying either within the cavity or elsew here in the joint. How ever, the osteochondral fragment may only appear on X-ray as a small thin flake of bone. Earlier changes can be seen more clearly on MRI scans and allow the clinician to monitor the progress of any healing or separation of the fragment.

Treatm ent. Until a loose body has separated or appears 'ripe' for separation, treatm ent should be expectant. In the case of a sm all lesion in early adolescence rest in plaster for two m on ths m ay allow spontaneous re-attach m ent of the fragm ent. W hen a fragm ent has separated it should usually be rem oved, though in the case of a large fragm ent it m ay be practicable to fix it back in position w ith a pin. Further details will be found in the appropriate sections on the knee (p. 405), the elbow (p. 286), and the foot (p. 445).

10 Soft tissue tumours and other diseases

Co-written by Nigel Raby

SWELLINGS AND TUMOURS OF SOFT TISSUE

Soft tissue swellings are a common presentation to primary care physicians and a cause of great anxiety to patients when they discover a lump in their lim b or trunk which they interpret as a cancer. In fact malignant tum ours are very rare and benign tum ours are much more common in a ratio of more than 100:1. These tum ours frequently cause problems in diagnosis and treatment because of the difficulty in differentiating them from other, much commoner, causes of lumps and swellings in the limbs. These include cysts and ganglia around joints, norm al muscle variants, muscle rupture, haem atoma, vascular aneurysm, and myositis ossificans.

Normal muscle variants

These can present as a clinically palpable mass. They have presumably been present for years but for some reason the patient has only just noticed the swelling. One of the commonest sites is at the ankle where an accessory soleus muscle may mimic a soft tissue mass. Know ledge of the normal anatomy will assist in making the diagnosis along with the observation that the area of interest has identical signal to adjacent muscle on all MR sequences. The palmar aspect of the wrist is another area where anom alous developments in the flexor tendons may sometimes result in compression of the ulnar or median nerves in their fibro-osseous tunnels.

Muscle tears

Symptomatic muscle tears are not usually a problem since there is typically a history of traum a and painful onset of sw elling. Clinically there is therefore no suggestion that this is a soft tissue mass. However some patients, particularly in an older age group, present with a painless sw elling with no clear history of any single incident to account for it. Characteristically this is seen in the anterior thigh. The reason is spontaneous rupture of rectus femoris muscle. The proxim al muscle can contract unopposed with a resulting soft tissue mass palpable in the thigh. In cases of clinical doubt an M R I scan will confirm that the sw elling is muscle and demonstrate the defect at the site of rupture (see Fig. 18.29, p. 414).

Haematoma

An acute tissue haem atom a, whether from injury or post-surgery, should not pose a problem for clinical diagnosis. Difficulty can occur when a large deep haem atom a does not resolve and enters a chronic phase that may mimic the swelling from a recurrent lesion. The MRI scan should aid diagnosis show ing a peripheral dark rim from the presence of iron-containing haem oglobin breakdown products (Fig. 10.1).

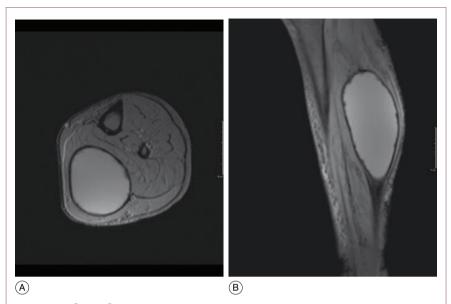


Fig. 10.1 (a) and (b) T2 weighted axial and sagittal MR scans of a chronic haematoma in the calf. There is a well-circumscribed mass which is of high signal in the posterior compartment. The rim is very low (dark) signal indicating haemosiderin deposition seen with breakdown of blood.

Aneurysm

O ccasionally an aneurysm originating from a deep vesselm ay mimic a soft tissue tumour, but careful clinical examination will normally identify arterial pulsation. Imaging with MR and digital arteriography can confirm the nature of the lesion and the vessel of origin.

Synovial cysts and ganglia

G anglia are of unknown origin situated typically around joints and contain m ucoid tissue. Traum a and synovial herniation are suggested as causative factors. They do not usually have a dem onstrable connection with the underlying joint. They are seen m ost com m only around the wrist and ankle, but also occur near the knee arising from the proxim al tibio fibular joint (Fig. 10.2).

Synovial cysts are a synovial lined outpouching which connects with the underlying joint space.

These therefore occur around joints most commonly and are typically seen especially in the knee. Popliteal (Baker's) cysts (Fig. 18.32A, p. 418) and cysts associated with meniscal tears can present as palpable soft tissue masses. Ultrasound is the easiest method of confirming that these are cystic and not solid lesions.

Myositis ossificans (heterotopic ossification)

This is an uncommon but troublesome lesion because of its apparent malignant behaviour. It presents as a painful and tender lump in a limb muscle, with or without a history of recent trauma to the site. Imaging is crucial to obtain the correct diagnosis and MRI and ultrasound are the most useful in the

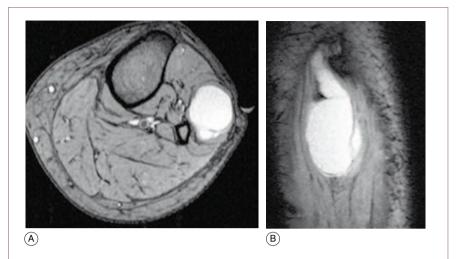


Fig. 10.2 (a) and (b) T2 weighted axial and sagittal MR scans showing a large ganglion arising from the proximal tibio-fibular joint. The high signal of the well-circumscribed mass in the anterior compartment suggests a fluid content. The sagittal image demonstrates the long thin proximal extension from the joint.

very early stages as they can detect the presence of calcification in the lesion which is the key to diagnosis (Fig. 10.3A). Later imaging with CT scanning will reveal a diagnostic rim of ossification at the periphery of the well-circum scribed lesion. Plain radiographs after several weeks will show some calcification in the muscle which should indicate the correct diagnosis (Fig. 10.3B). How ever, in some patients where the early changes are not recognised these appearances may be misinterpreted and may lead to a presumed diagnosis of soft tissue osteosarcom a. This assumption may be reinforced if a biopsy is performed, as this will show a very active lesion containing imm ature mesenchymal cells with atypical nuclei and osteoid form ation. No active treatment is required, other than careful observation, as the lesion will resolve in 2–3 months.

TUMOURS OF SOFT TISSUE

The soft-tissue tum ours that are met with in orthopaedic practice arise from the connective tissues or blood vessels of the lim bs or trunk. They may be benign or malignant. They usually present clinically as painless soft-tissue lumps, and cause symptom sonly when quite large.

BENIGN TUMOURS OF SOFT TISSUE Benign peripheral nerve sheath tumours

Tum ours arising from nerves are of two types: schwannom as and neurofibrom as.

Schwannoma

These are just a little less common than neurofibromas. They are slow growing and painless with no neurological symptoms. They are typically less than

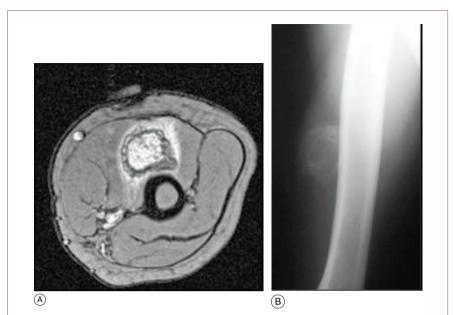


Fig. 10.3 ^(A) T2 weighted axial MR scan of the arm with myositis ossificans in the biceps muscle. Inside the mass of high signal there is a ring of low signal representing calcification. MR or ultrasound will detect calcification long before it is visible on plain films. ^(B) Radiograph of humerus in the same patient as Fig. 10.3A. This was obtained several weeks after the MR scan and the calcification within the muscle is now evident and a diagnosis of myositis ossificans is most likely.

5 cm in size. The tum our usually lies eccentric to the nerve which is displaced. Surgical excision can thus be undertaken with sparing of the nerve.

Neurofibroma

These are a little commoner and present as a soft, circumscribed, rounded, and slightly tender swelling in the skin or deeper tissues. They are more often associated with neurological symptoms. Pathologically they are not separate from the nerve which can be seen entering and leaving the tumour. Thus resection of the tumour requires sacrifice of the involved nerve.

H istologically the tum our is composed of cellular fibrous tissue arranged in w horls. The tum ourm ay be solitary; but in the condition known as multiple neurofibrom atosis (von Recklinghausen's disease) (p. 70) num erous tum ours are associated with pigmented areas in the skin. A neurofibrom a growing within the spinal canal is an important cause of compression of the spinal cord or cauda equina.

Im aging with MR scanning can identify the nature of the lesion and some-times its neural origin (Fig. 10.4).

Lipoma

A lipom a is a common tumour that may arise in almost any part of the body. It usually occurs in the subcutaneous tissues, but may also develop more deeply as an intramuscular lesion. It forms a soft, often large, lobulated mass enclosed within a thin capsule. It consists of fat, usually with little connective tissue



Fig. 10.4 Coronal T2 weighted MR scan of a schwannoma in the medial aspect of the arm, just proximal to the elbow. The high signal in the round lesion suggests nerve tissue and this extends as a 'tail' at the superior and inferior ends making it likely that this is most likely a nerve sheath tumour.

strom a. When the lesion is deep to fascia and of a large size it may be difficult to differentiate on clinical grounds from malignant liposarcom a. Imaging by MRI may be diagnostic of lipoma if it shows a homogeneous white lesion on the T1 weighted image with the same density as the subcutaneous and intramedullary fat (Fig. 10.5). How ever where there is less than 75% of fat in the lesion, or if the septation is nodular rather than linear, there is a possibility of malignancy and a biopsy is required prior to surgical excision.

Treatment, if required, is by local excision and the specimen when removed must always be sent for histological examination.

Haemangioma

H aem angiom a is a benign tum our of blood vessels, usually present at birth. capillary haem angiom a form sa dark red, irregular, slightly raised blotch on А the skin ('portwine stain'). It is usually congenital. A cavernous haem angiom a is composed of widely dilated vascular channels with intervening connective tissue. It forms a localised or diffuse tum our within the skin, subcutaneous tissue, or muscle. A characteristic feature of diagnostic importance is that the tum our is compressible and may varv i n size from dav to day. It may cause symptoms from its cosmetic appearance, or from the complication of thrombosis, which may be associated with local pain and swelling. When a cavernous haemangioma occurs in a massive form in a limb it may lead to marked increase in grow th of the lim b as a w hole (elephantiasis).

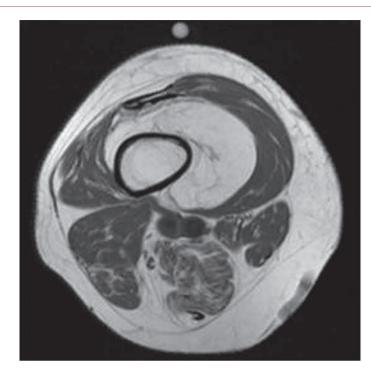


Fig. 10.5 Axial T1 weighted scan of thigh showing a large mass deep to the quadriceps muscles wrapped around the femur. This high signal, which is the same as subcutaneous and marrow fat, confirms that this is a lipoma.

Im aging by MR scanning shows characteristic clusters of abnorm al dilated blood vessels giving a variegated serpiginous appearance.

Treatment. Superficial capillary haem angiomata fall within the province of the plastic surgeon or dermatologist. Some are amenable to laser ablation therapy. A localised deep cavernous haem angioma is usually amenable to excision. Extensive diffuse tumours cannot be eradicated, but improvement may follow transcutaneous arterial embolisation. In the worst cases amputation may be required.

Musculo-aponeurotic fibromatosis (desmoid tumour)

This rare tum our occurs mostly in young adults as a slow ly grow ing hard sw elling in the musculo-aponeurotic tissues, particularly in the trunk and shoulder regions. When it involves the abdom inal wall or arises intra-abdom inally it is known as an abdom inal desmoid tum our. It is important because of its histological resem blance to malignant sarcom a and the characteristic infiltrative grow th locally. Im aging by MRI scans will show a variable degree of heterogeneity (Fig. 10.6), which is not diagnostic, but will show the extent of the lesion and any involvem ent of neuro-vascular structures. Biopsy and histological exam ination will differentiate it from sarcom a and fortunately it has a more benign course and never metastasises. How ever, there is a high 30-40% risk of local recurrence, even after radical wide-margin excision, suggesting that it may arise from multicentric foci in the sam e lim b.



Fig. 10.6 Coronal T1 weighted scan of right hip affected by fibromatosis. There is an ill-defined mass of mostly low (dark) signal overlying the greater trochanter and infiltrating the gluteal muscle. The low signal indicates either calcification, or as in this case dense fibrous tissue. This suggests fibromatosis, but a biopsy is still required for definitive diagnosis.

MALIGNANT TUMOURS OF SOFT TISSUE

M alignant tum ours of soft tissue (soft-tissue sarcom as) are uncom com adult m alignant neoplasm s. Of mesenchym al orig i s e such a s fascia, aponeurosis, tendon s h term uscle, and synovial membrane. Such c u la lu n ta a tu m sents oth i n diagnosis an d i n treatm ent. It m av b hard t o d istin g u ish benign соu rpart, presenting as a progressive butusuellin It is of firm c o n s i s t e n c y an d may t o b e w ell loca lised, though this a false im pression. It m ay spread widely with in the u a llv s o ft and the pseudocapsule forms no barrier. Metastasis s 11 e s surround in g occurs through th blood , m a in ly t o lungs

i s a i d e d b y stig atio n o f t h tu m ours m agnetic resonance i m aging (M R I). M R I scans pro vide good definition of the anatom ical exte mour of its relationship to the neurovascular structures (Fig. 10.7), thereby allow a n d in g correct planning o f ical treatment. However the n ot reliably d iffe ren tia te betw an d m alignant lesions, w hich ultim ately benien m depend on exp rt histological exam ination from a representative biopsy

Biopsy must be planned in such a way as to minimise the spillage of malignant cells. It may be by needle aspiration or localised incision, but never by local excision of the tumour (excision biopsy).

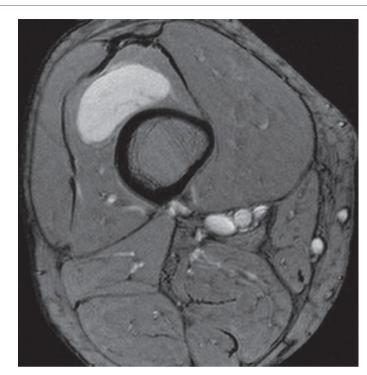


Fig. 10.7 High-grade soft tissue sarcoma of the thigh seen in an axial T2 weighted scan. The mass of high signal lies within the vastus intermedius, but has no features which allow a specific diagnosis to be made and a biopsy is required.

The results of the surgical treatment of most types of soft-tissue sarcom a have been improved by adjuvant therapy with radiation or potent chemotherapeutic agents used in combination as for bone sarcomas. Radiotherapy may be used after operative excision, to reduce the risk of local recurrence, but does not remove the need for adequate surgical treatment, which demands excision with wide margins of healthy tissue rather than simple local excision or enucleation.

Malignant fibrous histiocytoma

This tum our is com posed predom inantly of histiocytic-type cells, but may also include spindle cells resem bling fibroblasts. It was form erly included under the diagnosis of fibrosarcom a. It is now regarded as the commonest malignant softtissue tum our in older adults. It has a poor prognosis, with local recurrence or metastasis to the lungs in more than half the patients.

Liposarcoma

This is the second commonest of the soft-tissue sarcomas, usually occurring in the deep tissues. It grows as a lobulated mass, usually in the buttock or thigh, and may often attain an enormous size (Fig. 10.8). It has a wide range of behaviour, depending upon its histological appearance and the amount of myxomatous



Fig. 10.8 Magnetic resonance image of large low-grade liposarcoma in the buttock, showing typical lobulated appearance of the soft tissue mass.

content. Tum ours show ing predom inantly pleom orphic and round cells have a poor prognosis, but the presence of myxoid tissue improves the outlook.

Im aging with MRI scans is not diagnostic. These lesions do not contain macroscopic fat despite their name. MR scanning is generally non-specific and there is no fat signal from most of these lesions. Treatment is by radical excision or amputation, with the possible addition of adjuvant radiotherapy or chemotherapy in selected cases. Recurrence or metastasis is generally slow.

Synovial sarcoma (malignant synovioma)

This highly malignant but rare tum our was once thought to arise th e synovial lining of joints or tendon sheaths because of its proximity these structures. Pathologically it forms a solid, whitish, fleshy mas but insidious invasion of the soft tissues. It is most common i n an d m iddle-aged adults. It has a poor prognosis, with early pulm on ary etastaor spread to local lymph nodes. Histologically the tumour is composed masses of fusiform cells, but the picture is characterised by the formation spaces or clefts lined by cuboidal cells which suggest the formation of a synovial cavity – hence the name given to this tum our. Treatment is by wide excision if this is practicable, with pre-operative and post-operative radiotherapy. When the tum our involves a joint am putation offers the best hope ofsurvival

Rhabdomyosarcoma

This rare variety of soft-tissue sarcom a which arises from skeletal muscle occurs mainly in children or young adults. It affects particularly the trunk or lower limbs. It forms a rapidly growing mass. Histologically it is characterised by cells showing longitudinal and cross striations typical of primitive myoblasts. It metastasises early, mainly to the lungs.

MANAGEMENT OF SOFT TISSUE SWELLINGS

W hile the above descriptions and classification of lesions is helpful, in clinical practice it is likely that after taking a history and exam ining the patient a definitive diagnosis is not possible.

It is often stated that small superficial lesions are likely to be benign and that larger ≥5 cm lesions, especially if deeply placed, are likely to be malignant. While this is statistically correct there are far too many lesions that break this rule of thumb to make it a sensible basis for clinical management.

It is now m and a tory to proceed to som e sort of im aging to confirm the suspected diagnosis. Ultrasound scanning is the quick estand easiest way of determining the nature of the majority of soft tissues wellings. Cystic lesions, hae matomas, muscle tears and some lipomas can be identified this way. For the rest an MRI scan will be needed. When a definite diagnosis cannot be made then a biopsy is required.

The practice of removing lesions without going through these steps leads unfortunately to the rare but disastrous occasions when a lesion is excised and this turns out on histology to be a malignant sarcoma. The patient's best chance of a surgical cure is then seriously compromised.

OTHER SOFT TISSUE DISEASES

Soft tissues constitute a much larger part of the locom otor system than the bony skeleton, but the disorders that affect them receive much less attention from orthopaedic surgeons. In the past they were regarded as the province of the rheumatologist or sports medicine specialist and attracted little surgical interest. This is now changing with the introduction of more sophisticated investigations, particularly laboratory tests utilising molecular biology techniques and im proved im aging with ultrasound and M R I. Today's surgeons require a greater understanding of the diseases that affect muscles, tendons, ligaments, and connective tissue to enable them to work as part of the multi-disciplinary team needed for their management.

INFLAMMATORY LESIONS OF SOFT TISSUE Bursitis

Inflammationmay occur in a normally situated bursa or in an adventitious bursa. It may arise frommechanical irritation or frombacterial infection.

Irritative bursitis

This is caused by excessive pressure or friction, occasionally by a gouty deposit. There is a mild inflam matory reaction in the wall of the bursa, and there is usually an effusion of clear fluid within the sac. Exam ples are the common 'bunion'

CHAPTER 10

that forms over a prominent metatarsal head in hallux valgus, prepatellar bursitis or 'housemaid's knee', olecranon bursitis (sometimes caused by gout), and subacromial bursitis.

Treatment. In many cases the inflammation subsides with rest if continued pressure or friction is prevented. If the sac is distended the fluid may be aspirated, and the instillation of hydrocortisone through the aspiration needle may help to prevent recurrence. In resistant cases cure can be effected only by operative excision of the bursa.

Infective bursitis

There may be acute inflammation from infection by an organism of the pyogenic group, or chronic inflammation as in tuberculous bursitis. Examples of acute pyogenic bursitis are infected bunion, infected prepatellar bursitis, and infected olecranon bursitis. A bursa that is sometimes affected by tuberculosis is the trochanteric bursa.

Treatm ent. Treatm ent of acute suppurative bursitis is by surgical drainage and antibacterial drugs. In chronic bursitis excision of the bursa is required.

Tenosynovitis

The term tenosynovitis implies inflammation of the thin synovial lining of a tend on sheath as distinct from its outer fibrous sheath. Like bursitis, tenosynovitis may be caused by mechanical irritation or by bacterial infection.

Irritative (frictional) tenosynovitis and peritendinitis

This is caused by excessive friction from over-use. The synovial sheath is mildly inflamed and there is an exudate of watery fluid within it, visible on ultrasound scanning (Fig. 10.9). A similar traumatic inflammation may affect the flimsy paratenon surrounding those tendons that are devoid of synovial sheaths. This is termed paratendinitis and is a common problem around the wrist and hand. The controversial condition known as repetitive stress syndrome comes into this category (p. 327).

Infective tenosynovitis

Bacterial infection of a tendon sheath may be acute or chronic. A cute infective (suppurative) tenosynovitis is caused by an organism of the pyogenic group. There is an acute inflam matory reaction in the wall of the sheath, with a purulent exudate from it. It is an uncommon condition, but it is well recognised in the flexor tendon sheaths in the hand (p. 316).

In chronic bacterial tenosynovitis, also an uncommon lesion in Western countries, the infection is often tuberculous. The synovial wall is much thickened and there is a fibrinous exudate. The flexor sheaths of the forearm and hand are the usual sites (compound palmar ganglion, p. 317).

Tenovaginitis

In tenovaginitis there is a mild chronic inflamm ation or thickening of the fibrous wall of a tend on sheath as distinct from the synovial lining. The cause is unknown: it is not due to bacterial infection. The only common sites are the mouths of the



Fig. 10.9 Sagittal ultrasound scan showing tenosynovitis of the wrist. The arrow indicates a flexor tendon and the dark area above this represents excessive fluid within the tendon sheath.

fibrous flexor sheaths in the fingers or thum b ('trigger' finger, p. 329), and the sheaths of the extensor pollicis brevis and abductor pollicis longus tendons at the radial side of the wrist (de Quervain's syndrom e, p. 328).

POLYMYALGIA RHEUMATICA

This connective tissue disorder has been recognised with increased frequency in older patients presenting with pain and stiffness in the muscles of the neck and shoulder girdle, or som etimes the low back and buttock regions. Because of these features it may be confused with degenerative disc disease, though characteristically the associated symptoms of malaise, low -grade fever, night sweats, and loss of weight should lead to the diagnosis. It tends to be commoner in women than in men, usually affecting patients over the age of 60 years, and in about one-third of cases it is associated with the condition of giant-cell arteritis. This is a more serious disease as it may lead to sudden blindness because of involvem ent of the cranial arteries.

The clinical features are ill-defined muscle pain around the shoulders or low back, with associated stiffness, and the characteristic features of system ic disturbance. W hen giant-cell arteritis is also present there may be marked tenderness over the temporal arteries. There may be marked elevation of the erythrocyte sedimentation rate, but the rheumatoid factor is negative. W hen associated giant-cell arteritis is suspected on clinical grounds, urgent administration of prednisolone in high doses is advisable pending confirmation of the diagnosis by biopsy, in order to reduce the risk of blindness. Both conditions show a good response to steroid therapy, usually in a dose of 15 mg of prednisolone daily. O nce the clinical features have subsided this may be reduced to a maintenance dose of 5 mg daily.

FIBROMYALGIA (FIBROSITIS)

Fibrom yalgia, form erly term ed fibrositis, is a clinical rather than a pathological entity. Som e deny its existence. Certainly its nature is obscure. Nevertheless

the term is a useful label for a common clinical condition that at present lacks a complete explanation. The main features are pain in certain muscles, with tenderness when they are gripped or squeezed. Small firm nodules may be felt. Joint movements are full and there are no other objective signs. The condition is commonest in the muscles of the upper back, especially in the trapezius area, and affects women more frequently than men. There may be associated tiredness, sleep disturbance, and depression. Treatment, if required, is by non-steroid al anti-inflammatory medication and active exercises.

1 1 Neurological disorders

CEREBRAL PALSY (Spastic paralysis: spastic paresis; Little's disease)

The term cerebral palsy em braces a num ber of clinical disorders, mostly arising in childhood, the feature common to all of which is that the primary lesion is in the brain. The incidence of these disorders is such that cerebral palsy constitutes a major social and educational problem.

Cause. There is no single cause. Any event that results in damage to the brain may be responsible. Thus the causes may be classified into three groups: pre-natal, natal, and post-natal. Pre-natal causes include congenital defective development of the nervous system, and erythroblastosis leading to icterus gravis in the child, with consequent damage to the basal nuclei (kernicterus). N atal causes include damage to the brain and intracranial bleeds from birth injury, and anoxaem ia with consequent cerebral anoxia. Prematurity is believed to be an important factor. Post-natal causes include infections such as pertussis, encephalitis, and meningitis, head injuries, and, in later life, cerebrovascular accidents (stroke). In children it is not alw ays easy to ascribe the fault in a given case, but probably the com monest causes are damage to the brain during difficult labour and cerebral anoxia during birth.

Types. A number of clinical types may be recognised, of which the most important are:

1. spastic paresis

2. athetosis.

Mixed types also occur.

SPASTIC PARESIS

Pathology. Part of the motor cortex of the brain is replaced by areas of gliosis. There is degeneration of the pyramidal tracts.

Clinical features. U sually within the first year it is noticed that the child has difficulty in controlling the movem ents of the affected lim bs, and there is delay in sitting up, standing and walking. Commonly the upper and lower lim bs of one side are affected (hem iplegia). Less often there is involvement of a single lim b (monoplegia), of both lower lim bs (paraplegia), or of all four lim bs (tetraplegia¹). The trunk and face muscles may also be affected. On exam ination the features that are found constantly are weakness, spasticity, and imperfect

voluntary control of movement. Usually there is also deformity, and in some cases there may be mental deficiency, impaired vision, or deafness. These various features are best considered separately.

Weakness. There is no true paralysis, but there may be fairly marked weakness of muscles. The weakness seldom affects all the muscles of a limb equally; often there is marked muscle imbalance which may lead to deformity.

Spasticity. The muscles are 'stiff': they resist passive movement of the joints, but when steady pressure is applied for some time they slowly relax, allowing the joint to be moved. When the pressure is released the spasm immediately returns. The tendon reflexes are exaggerated and muscle clonus may be elicited.

Lack of voluntary control. This is a striking feature, especially in severe cases. When the patient attempts to move a single group of muscles, other groups contract at the same time.

Deform ity. When spasm and muscle imbalance are pronounced they lead eventually to the development of fixed deform ity. The stronger muscles hold the limb constantly in an unnatural position, and secondary adaptive changes take place in the muscles and periarticular tissues. The commonest deform ities in the upper limb are flexion contracture of the elbow, pronation deform ity of the forearm, flexion of the wrist, and adduction of the thumb. In the low er limb the common deform ities are adduction of the hip, flexion of the knee, and equinus of the ankle.

M ental deficiency. Im pairm ent of m ental capacity is som etim es present, but usually intelligence is norm al. Lack of control of the facial and speech m uscles m ay suggest m ental im pairm ent w hen in fact none exists. It is im portant that the m edical advisers be not m isled in this respect. Defective vision and deafness m ay also retard the child's progress.

The severity of the disability varies widely from case to case. In the mildest examples the child is able to lead a normal active life with very little handicap, whereas in the worst cases the patient is almost helpless.

Prognosis. Since an essential part of the brain is destroyed and cannot be replaced, complete cure is impossible. All that can be hoped for is improvement. To achieve even this requires endless patience on the part of the patient and the attendants. Yet perseverance is nearly alw ays well rew arded, and there are few cases in which worth-while improvement cannot be gained. Thus a patient form erly dependent upon others in many daily activities may often gain independence, and many who were previously unable to work become capable of earning their own living.

Treatm ent. Up to the age of about 5 years treatm ent m ay be carried out at non-residential centres, but after the age of 5 a child who is considerably disabled should be adm itted to a special residential school where adequate facilities and trained staff are available.

The methods of treatment available are muscle training, corrective splinting, speech therapy, and operations on tendons, bones, or nerves.

Muscle training. This is an important part of the management of all except the mildest cases, and it is best carried out by a physiotherapist with experience of this very demanding work. The principles of muscle training are to teach the child to relax spastic muscles, to develop the use of individual muscle groups, and to improve coordination. Repetitive rhythmic movements are valuable. Stage by stage the child is instructed in dressing, toilet, feeding, and walking.

Corrective splinting. Splints or plasters are especially useful in overcom ing the deform ities induced by spastic muscles. Deform ity is first corrected by gradual stretching of the contracted muscles, if necessary under anaesthesia. The lim b is held by plaster in the over-corrected position for 6-8 weeks. Thereafter removable braces or splints (orthoses) may be used indefinitely to prevent recurrence of the deform ity.

Speech therapy. Many spastic children have a speech defect which, with constant grim acing and salivation, may lead one to suppose that there is mental deficiency when in fact this is not so. In these cases the speech therapist is som etim es able to achieve a marked improvement.

O perative treatment. O perations for spastic paralysis should be approached with caution: striking benefit may be achieved in appropriate cases, but injudicious operation in unsuitable cases has often led to disappointing results. Operation may be upon tendon, joint, or nerve.

Tendon division or elongation. Division or lengthening of the tendon of a spastic m uscle reduces its m echanical advantage and im proves m uscle balance. Exam ples are lengthening of the calcaneal tendon in a case of spastic equinus deformity, and tenotomy of the adductors of the hip for adduction deformity.

Tendon transfer. At certain sites transfer of the insertion of a muscle that is aggravating deform ity may so modify the muscle's action that it acts beneficially instead of as a deform ing force. An exam ple is the transfer of the insertion of the ham string tendons from the tibia to the back of the femoral condyles in a case of flexion deform ity of the knee: this elim inates the undesirable action of the spastic ham strings in flexing the knee, while enhancing their desirable action as hip extensors

Arthrodesis. When skeletal grow this complete it is sometimes of benefit to fuse a joint in a position of function, to elim inate persistent deform itv from the pull of spastic muscles. Thus a wrist that lies constantly flexed may be fused in a neutral or slightly extended position, with consequent improvement in function.

Osteotomies. Division of the bone to correct angular and rotational deform ities may be of value especially in the lower limb.

Neurectomy. The principle is to divide part or the whole of a nerve that supplies an overacting spastic muscle. A nexample is division of the anterior branch of the obturator nerve to overcom e spastic adduction at the hip.

ATHETOSIS

Pathology. The main damage is in the basal nuclei.

Clinical features. The principal feature is the occurrence of generalised overlaid involuntary movements which have no pattern and which interfere with the perform ance of norm alm ovem ents. Any part or the whole of the muscular system may be affected.

In mild cases the child is able to lead a fairly normal life, but in the worst exam ples the patient may be unable to sit up, walk, feed him self, or express him self in words, even though the mental state may be good.

Treatm ent. The first essential in treatm ent is to teach the child general relaxation. Once this has been achieved, purposeful voluntary movements can be taught. Splints and appliances may be required, but in pure athetosis there is no place for operations on the lim bs. In som e cases of severe athetosis im provementhas been reported after surgical ablation of the globus pallidus.

Neurological disorders

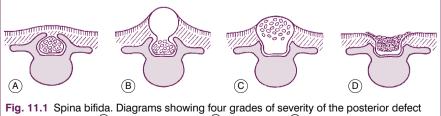
SPINA BIFIDA

term spina bifida implies a failure of the enfolding of the nerve elements with in the spinal canal during early developm ent of the embryo. The defect varies in degree and in its site (Fig. 11.1). In the mildest cases there is no more a failure of fusion of one or more of the vertebral arches posteriorly in lum bo-sacral region. This is often of no clinical significance. Less often the posterior bony deficiency is marked on the surface by an abnormality of the overlying skin, in the form of a dimple, a tuft of hair, a lipomatous mass or a dermal sinus. In these cases there may be an underlying abnormality involvnerves of the cauda equina. These relatively minor varieties of spina bifida. in which the defect is not obvious at the skin surface, are termed spina bifida occulta. This contrasts with spina bifida aperta, in which there is a major defect of enfold ing of the nerve elem ents, involving not only the bony vertebral arches but also the overlying soft tissues and skin, and often the meningeal membranes enclosing the spinal canal, so that the neutral tube itself is exposed and open. This major variant of spina bifida may occur anywhere in the spine but is commonest in the thoraco-lumbar region, and it is attended by grave impairment of nerve function

SPINA BIFIDA OCCULTA (Occult spinal dysraphism)

As noted above, the bony defect is simply a failure of fusion of the vertebral arches posteriorly (Fig. 11.1A). When there is neurological involvement the overlying skin nearly always shows an abnormality, as already described.

Im pairm ent of nerve function may be caused in some such cases by tethering of the dura, and through this the spinal cord, to the skin surface by a fibrous mem brane. Traction on the cord becomes gradually worse as the spinal column elongates disproportionately to the spinal cord: this can cause slow progression of the neurological deficit. A rather sim ilar effect is caused by tethering of the distal end of the spinal cord by the filum term inale. Rarely, too, a bifid cord is transfixed by a delicate bar of bone crossing the spinal canal in the antero-posterior plane (diastem atom yelia) with consequent tethering and progressive neurological im pairm ent. In yet other cases the neurological fault may be a consequence of myelodysplasia, a congenital defect of developm ent of nerve tissue.



of the spinal canal. (A) Spina bifida occulta, (B) meningocele, (C) myelomeningocele, (D) rachischisis. In cases of occult spinal dysraphism there is no close correlation between the severity of the bony defect and the degree of neurological impairment. O ften there is no neurological involvement; but on the other hand it may be severe. Clinically, the common manifestation of nerve involvement is muscle imbalance in the lower limbs, often with selective muscle wasting and deformity of the foot which often takes the form either of equino-varus or of cavus.

Investigation and treatment. The patient may be brought for advice because of an abnormality of the skin over the lumbo-sacral region, because of abnormality of the feet or perhaps just a limp, or because of urinary incontinence. A plain radiograph will show the extent of the bony deficiency.

If evidence of neurological im pairm ent is lacking, treatm ent is not required. If neurological im pairm ent or incontinence is present – and especially if there has been progressive deterioration – further investigations, including MR scanning and radiculography, are required. These may point to the presence of one of the structural lesions mentioned above, and in such a case neurosurgical intervention may be required: its object is to prevent further deterioration rather than to promote com plete recovery.

SPINA BIFIDA APERTA (Overt spinal dysraphism; variations include rachischisis, myelomeningocele and meningocele)

The neurological deficit that com plicates the more severe forms of spina bifida leads to varying degrees of motor, sensory, and visceral paralysis, and the consequent orthopaedic disability in the low er limbs may be complex. The number of children demanding orthopaedic care for such disabilities has increased in recent years because a far higher proportion of children born with myelo-meningocele survived when the associated hydrocephalus was controlled by a ventriculo-cardiac or ventriculo-peritoneal shunt. Nevertheless the incidence is likely to fall dramatically since the advent of antenatal screening for alphafetoprotein, high-resolution ultrasound, and amniocentesis, with the option of term ination of pregnancy in positive cases. It is also to be hoped that the incidence of spina bifida will be substantially reduced by the administration of folic acid to women before or at the commencement of pregnancy.

The cause is unknown: genetic factors may play a part but environmental factors are also probably involved. In particular, the influence of certain drugs - notably anti-epileptic drugs such as sodium valproate - has been recognised. Folic acid in a dosage of 5 mg daily taken before the commencement of pregnancy, or very early in pregnancy, offers some protection against the disorder.

Pathology. The basic structural defect – failure of total closure of the em bryonal neural tube or of mesoderm al tissue to invest it – varies in degree. In the most serious defect, rachischisis, the neural tube is open and exposed on the surface (Fig. 11.1D). Cerebrospinal fluid leaks from the exposed upper end of the central spinal canal. In myelom eningocele the neural tube is closed by a mem brane but the skin covering is deficient. The spinal cord and the nerve roots are displaced posteriorly into the sac and are outside the line of the vertebral canal (Fig. 11.1C). In meningocele the bulging sac consists of meninges and fluid only, the nerve elements being norm ally situated (Fig. 11.1B). The skin may or may not be intact. The distinction between closed lesions, with intact skin, and open lesions in which skin is deficient and nerve tissue is exposed on the surface of the body, is fundamental because open lesions may demand operation within a few hours of birth to close the defect, if indeed active intervention is deemed advisable.

The neurological lesion. Neurological deficit may be primary or secondary. Primary paralysis is present at birth and implies failure of development of part of the spinal cord (myelodysplasia). This varies widely in degree. In a fairly common example there may be normal innervation down to the level of the fourth lumbar segment and failure of development below that level. But the lesion may be either less extensive or more extensive than this.

Secondary paralysis develops after birth, either from drying or infection of exposed nerve tissue when closure of an open lesion has been delayed; from stretching of tethered nerve fibres as grow th occurs; or from compression of nerve tissue within the abnorm al spinal canal.

Clinical assessment. It is difficult in small infants to assess accurately the extent of motor and of sensory paralysis, and particularly to determ ine the state of bladder function. Nevertheless the important objective at the outset is to determ ine the level at which norm al function of the spinal cord ceases. This is done by observing what movem ents the child makes, and correlating these with the root level. Sensibility can be determ ined by stimulating the skin lightly with a pin moved upwards from the limbs to the trunk until the child is awakened.

M otor paralysis. M otor paralysis affects m ainly the low er lim bs and to som e extent the trunk. The extent of lim b paralysis corresponds to the degree of dysplasia or of secondary damage in the spinal cord. It varies from the very mild, in which there may be no more than minor weakness of a single muscle group, to the very severe, in which there is total paralysis of the lim bs. In the instance quoted above of normal cord function down to the fourth lum bar segment with loss of function below that, motor power is present only in the flexors and adductors of the hips, the quadriceps and the tibialis anterior: the remain-ing muscles are paralysed. This is a fairly common distribution but only one of an alm ost infinite variety. This uneven paralysis, with consequent muscle im balance, leads commonly to secondary contractures with fixed deform ity of hips, knees, or feet. It may also lead to dislocation of the hip, a common sequel to gluteal and abductor paralysis in the presence of strong flexors and adductors.

Sensory paralysis. Motor paralysis is nearly always accompanied by sensory paralysis of approximately the same distribution. This makes treatment more difficult because the use of corrective splints is hampered by the risk of pressure sores on the insensitive skin.

Visceral paralysis. Incontinence of bladder and bowel is present in a high proportion of patients.

Hydrocephalus. A ssociated hydrocephalus, usually due to the Arnold - Chiari malformation of the hind-brain, is commonand was formerly largely responsible for the poorrate of survival among children with severe spina bifida.

Treatm ent. Every child with major neurological or visceral dysfunction from spina bifida should be admitted immediately to a special centre where a team of experienced specialists – including paediatrician, paediatric surgeon, neurosurgeon, and orthopaedic surgeon – may cooperate in deciding upon a programme that is best suited to the child. The team must first decide whether or not any surgical treatment, including closure of an open defect, is to be advised. This selective approach arose from review of large series where closure was universal: in the worst cases, with gross neurological deficit or hydrocephalus, the results were disastrous. In these it is probably better to adopt an expectant attitude, accepting the situation and relying simply on carefulnursing and feeding. It has to be taken as inevitable that many of these badly affected infants will fail to survive.

The problems that are to be tackled when more active treatment is undertaken are often very complex. No firm rules can be laid down because there is so much variation between individual cases. It is sufficient here to indicate the main principles of orthopaedic treatment. These are:

- 1. to correct deform ity
- 2. to maintain correction
- 3. to promote the best possible function in the affected.

In general, orthopaedic treatm entshould be deferred until the age of 1 to 3 years, to ensure that the child is thriving well and that the problem s of hydrocephalus and renal function are satisfactorily controlled. This may have required a ventriculo-cardiac or ventriculo-peritoneal shunt to drain the excess cerebrospinal fluid, and urinary diversion to an artificial bladder for reasons of hygiene.

Correction of deformity. Deformity, whether of the hip, knee, or foot, should be corrected in the sim plest way possible with the object of providing a lim b that is straight, mobile, and with a plantigrade foot - that is, a limb that is best suited for weight bearing. This may be achieved by a combination of splintage and surgical treatm ent, depending on the level of paralysis and the joints affected. Splints and plasters are useful for controlling flail joints and for maintaining correction after operative procedures, but they must be fitted and used with care because of the risk of pressure sores involving the insensitive skin. W hen fixed deform ity is present as a result of unbalanced or spastic m uscle action operation is needed to d ivid e or elongate tight structures - tendon, muscle, ligament, or joint capsule in order to achieve a neutral anatom ical position. Paralytic dislocation of the hip is common and may necessitate posterior transfer of the iliopsoas muscle to the greater trochanter (to act as a hip abd uctor), som etim es com bined with fem oral or pelvic osteotom v, to m aintain stability. In the m ore severe lesions, w here w heelchair locom otion is inevitable, it m ay be better to leave the dislocation unreduced while preserving mobile hips. Spinal deformity, often a combination of kyphosis and scoliosis, may require surgical correction and fusion, but the complications of pseudarthrosis and pressure sores are common.

Development of lim b function. Even when lower lim b paralysis is severe it is often possible to get the child walking with crutches once deformities have been overcome. In many cases external bracing in the form of lim b calipers or swivel walkers is also required, and prolonged training by a skilled physiotherapist is essential if maxim al function is to be achieved.

POLIOMYELITIS (Anterior poliomyelitis; infantile paralysis)

Poliom yelitis is a virus infection of nerve cells in the anterior grey matter of the spinal cord, leading in many cases to temporary or permanent paralysis of the muscles that they activate. In many countries the incidence of the disease increased so much in the years succeeding the Second W orld W ar that its management - or rather the management of the paralytic disabilities that it produces - became one of the foremost problems of orthopaedic surgery. However, in the 1950s the incidence decreased very markedly in Western countries, in consequence of nationwide programmes of prophylactic vaccination; so much so that the disease has now been virtually eliminated. Nevertheless it is still encountered in certain countries of Asia and Africa.

Cause. It is caused by infection with a virus, of which at least three types have been identified.

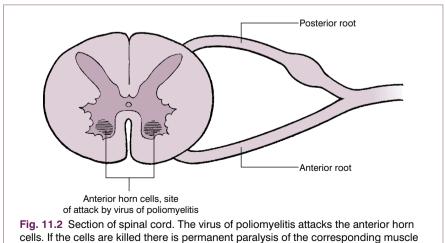
Pathology. A fter gaining access to the body through the nasopharynx or the gastro-intestinal tract, the virus finds its way to anterior horn cells of the spinal cord (Fig. 11.2) and som etim es to nerve cells in the brain stem. A ccording to the virulence of the infection the cells may escape serious harm, or they may be dam aged or killed. If cells are dam aged there is paralysis of the corresponding muscles but recovery is possible; if the cells are killed paralysis is perm anent. The extent and distribution of the lesions vary widely from case to case.

Clinical features. A lthough it is still com monest in children, poliom yelitis often attacks young adults. For descriptive purposes the disease is conveniently divided into five stages.

Stage of incubation. This is the interval between infection and onset of symptoms. It is thought to be about 2 weeks. There are no symptoms.

Stage of onset. This lasts about 2 days. The sym ptoms are like those of influenza: headache, pains in the back and lim bs, and general malaise. Exam ination may show mild pyrexia, often with neck rigidity if flexion is attempted, and tenderness of muscles. Lum bar puncture may show an increase of round cells in the cerebrospinal fluid. In many cases the disease does not progress beyond this stage, the patient making a rapid and complete recovery.

Stage of greatest paralysis. This stage, when it occurs, lasts about 2 months. Paralysis develops rapidly and is usually at its greatest within a few hours, thereafter remaining unchanged throughout this stage. The extent and distribution of the paralysis vary enormously. There may be no paralysis at all, or it may be total. In this stage muscle pain continues, and unparalysed muscles are often painful if stretched. If the respiratory muscles are paralysed preservation of life will be dependent upon the use of a ventilator.



fibres. If the cells are damaged but not killed the paralysis is recoverable.

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Stage of recovery. When any recovery of power occurs it may continue for about 2 years.¹ The degree of recovery varies within the widest limits. There may be complete recovery or there may be none.

Stage of residual paralysis. Paralysis or weakness persisting after two years is permanent. Its degree and extent vary from insignificant local weakness to alm ost total paralysis of the trunk and all four limbs. Weakness or paralysis is accompanied by obvious wasting of the affected muscles. This in turn is associated with defective grow the of the bones and consequent shortening if the disease occurs in childhood.

Prognosis. In round figures, it may be stated that half of all patients clinically infected with poliomyelitis have no paralysis at any time. Of those with paralysis, 10% die (usually from respiratory paralysis); 30% recover fully; 30% have moderate permanent paralysis; and 30% have severe permanent paralysis.

Prophylaxis. In Britain prophylactic vaccination is by an attenuated living virus, taken by mouth.

Treatm ent. No specific treatm ent is available. In few diseases is the doctor so powerless to influence recovery: the patient either will or will not recover his muscle power, depending upon the severity of the neurological damage; and there is very little that the doctor can do about it. The main duties of the orthopaedic team are to prevent deform ity, to assist returning muscle power by graduated exercises, and to reduce residual disability in the final stage by the provision of appropriate appliances or by operations on joints or muscles. The treatm ent appropriate to each stage of the disease is best considered separately.

Stage of onset. The patient should rest in bed and may be given sedatives as required.

Stage of greatest paralysis. In this stage artificial respiration by a ventilator m ay be necessary to preserve life if the respiratory muscles are paralysed. Paralysed lim bs m ay have to be supported by splints in a neutral position to prevent the development of contractures with consequent deformity. Fixed equinus deform ity of the ankle and foot is particularly liable to develop in cases of paralysis of the anterior leg muscles unless the foot is maintained at a right angle to the leg. Joints should be put through a full range of movement daily, so far as pain allows. Muscle pain may be eased by warm th, as from hot packs. W hether or not the patient must remain in bed in this stage will depend upon the degree and distribution of the paralysis.

Stage of recovery. The patient should be under the close supervision of a skilled physiotherapist. Any muscle that is seen to be regaining power must be exercised, gently and patiently at first, but later very strenuously, to encourage the greatest possible redevelopment. It should be remembered that power may improve partly as a result of recovery of the damaged nerve cells, but partly also from hypertrophy of muscle fibres that have escaped paralysis. When possible, walking should be resumed at this stage, if necessary with the aid of appliances, crutches, or sticks.

Stage of residual paralysis. The disability in this stage can often be reduced either by the provision of suitable external appliances (orthoses), or by operation. Appliances (orthoses). The purpose of external appliances or orthoses is to support joints that are no longer adequately controlled by muscles. They are

It will be observed that the figure 2 appears in the stated duration of each of the first four stages – 2 weeks, 2 days, 2 months, 2 years. These are only very approximate figures, but they are easily memorised.

required more often for the lower limbs and spine than for the upper limbs. The following are commonly prescribed:

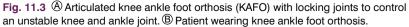
- 1. spinal brace, to support a weakened spine
- abdom inal support, to check abdom inal protrusion when the abdom inal muscles are weak
- 3. knee caliper (Fig. 11.3), to hold the knee extended in cases of severe quadriceps paralysis
- 4. below-knee brace to stabilise a flail ankle or foot (Fig. 11.4)
- ankle foot orthosis (Fig. 11.5), to hold the foot up when the dorsiflexor muscles are paralysed.

Operative treatment. Two main groups of operations are available:

- 1. arthrodesis of joints
- 2. muscle or tend on transfers.

Arthrodesis is a valuable method of stabilising joints that have lost their controlling muscles. It is particularly applicable to the shoulder, elbow, wrist, spine, ankle, and foot.

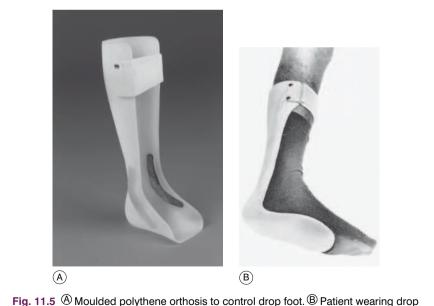
In *muscle* or *tendon transfer* operations the object is to use a healthy muscle to replace the function of one that is paralysed. The method finds its chief application in the upper limb. Examples are the transfer of part of the pectoralis major muscle to replace the function of paralysed elbow flexors, transfer of wrist flexors to serve as extensors of the fingers, and transfer of a flexor digitorum superficialis tendon to replace a paralysed opponens muscle.

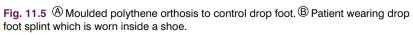


Neurological disorders



Fig. 11.4 ^(A) Moulded polythene ankle foot orthosis (AFO) to control ankle instability. ^(B) Patient wearing ankle foot orthosis.





PERIPHERAL NERVE LESIONS

D isorders of the peripheral nerves come largely within the sphere of the neurologist, but the orthopaedic surgeon is concerned with lesions that have a mechanical basis and with those that lend them selves to reconstructive surgery.

Pathology. Nerves may be damaged by laceration, contusion, traction, compression, friction, burns, or ischaem ia. A ccording to its severity, a nerve lesion may be classified as neurapraxia, axonotmesis, or neurotmesis. In neurapraxia the damage is slight and it causes only a transient physiological block. Recovery occurs spontaneously within days or weeks. In axonotmesis the internal architecture of the nerve is preserved, but the axons are so badly damaged that peripheral degeneration occurs. Recovery can occur spontaneously, but it depends upon regeneration of the axons and may take many months (1 mm/day is the usual speed of regeneration). In neurotmesis the structure of the nerve is destroyed by actual division or by severe scarring. Recovery is possible only after excision of the damaged section and end-to-end suture of the stum ps, or after nerve grafting.

Clinical features. The effects of com plete loss of conductivity of a nerve are m otor, sensory, and autonom ic. They are localised to the distribution of the nerve affected. M otor changes: The m uscles are paralysed and w asted. Changes occur in the electrical reactions, but they take betw een tw o and three w eeks to develop. These changes were described on page 27. Sensory changes: There is loss of cutaneous, deep, and postural sensibility. A utonom ic changes: These include loss of sw eating, loss of pilom otor response to cold ('goose-skin'), and tem porary vasodilation w ith increased w arm th, w hich, how ever, is follow ed later by vasoconstriction and cold ness.

Complications. Injury to a peripheral nerve trunk is occasionally follow ed by severe burning pain in the distribution of the nerve. This is term ed causalgia. It is a complication of incomplete rather than of complete lesions, and with few exceptions it is confined in the upper limb to the brachial plexus or the median nerve, and in the low er limb to the sciatic nerve or the tibial nerve. Relentless pain makes this a very disabling complication, the only effective treatment of which is by sympathetic denervation of the limb.

Treatm ent. O pen injuries. If a nerve is believed to have been divided – for exam ple, by a penetrating injury – the wound should be explored and the nerve identified. If the nerve is severed the ends should be exam ined carefully to determ ine the extent to which they have been dam aged by laceration or bruising. Only in the case of a clean-cut division with minim al dam age to the severed ends should prim ary suture be carried out. If these criteria are not satisfied it is better sim ply to tack the ends together with one or two sutures and to delay definitive repair – preferably with a magnification technique – until 2 or 3 weeks after the injury. At that time the extent of the scarring, and consequently the length of nerve to be resected, can be determ ined accurately, and thickening of the nerve sheath makes suture technically easier.

Closed injuries. In closed injuries com plicated by nerve paralysis it is usually assumed that the nerve is in continuity, and expectant treatment is adopted at first. If signs of recovery are not observed within the expected time (calculated from the site of injury and length to be regenerated) exploration is advised. Evidence of muscle re-innervation may be derived from electromy ography at an earlier stage than from clinical examination. Such exploration should seldom be delayed for more than 3 or 4 months, because long delay prejudices successful repair if the nerve has been divided.

W hen a nerve lesion has been caused by stretching, com pression, or ischaem ia the essential principle of treatm ent is to ensure that the harm ful conditions are relieved , if necessary by operation to free the nerve or to rem ove a com pressing agent

Nervegrafting. When the gap to be bridged between healthy neurones proxim ally and distally is large, nerve grafting is preferable to attem pted direct suture under tension. A thick nerve may be bridged by multiple grafts from a thinner nerve - for exam ple the sural nerve. By m icrosurgical techniques it is also now possible to transfer a nerve com plete with its blood supply, to bridge a m ajor defect. Freeze-thaw ed muscle grafts have been used experim entally as an alternative to nerve grafts. They may provide a chem otactic stim ulus for nerve regeneration as well as providing a microskeleton to guide axonal fibres across the gap, which should not exceed 3 cm.

BRACHIAL PLEXUS INJURIES

Injuries of the brachial plexus are a major cause of partial or complete loss of function of the upper limb. Most of such injuries are caused by forcible distraction of the upper extremity away from the neck by violent depression of the shoulder. The main injury is sustained by the upper roots of the plexus, which may be stretched, torn, or even avulsed from the spinal cord. There is consequent paralysis of the muscles supplied through the upper roots - chiefly the abductor and lateral rotator muscles of the shoulder and the flevors of the elbow (Erb type of paralysis). A less common type of brachial plexus injury is caused by forcible elevation of the arm and shoulder. This tends to drag on the low erroots of the plexus, with consequent motor and sensory paralysis mainly in the forearm and hand (Klumpke type of paralysis). In the most severe injuries the whole plexus is torn or avulsed and there is total paralysis of the upper lim b.

Brachial plexus lesions in infants

In infants, brachial plexus injuries are usually caused during delivery (obstetrical palsy), and the risk is greatest in difficult breech deliveries. The upper arm type (Erb's palsy) is the more common. Soon after birth it is noticed that the child does not move the arm as he normally should. Unopposed action of the unparalysed muscles tends to bring the arm into a position of adduction and m edial rotation, and secondary contracture of the soft tissues may lead to fixed deform ity in that position.

Prognosis depends upon the severity of the stretching injury. If this was mild full recovery may occur, though it may take many months; but in a severe case there may be permanent loss of power and sensibility. The prognosis is less favourable in the rare lower arm type of lesion (Klumpke type) than in the commoner upper arm type.

Treatment. In a mild case the mother should be taught to move the limb frequently through the full range, to prevent fixed contracture. In a severe case seen early it may be possible, if the requisite expertise is available, to restore continuity of the dam aged nerves by early operation. In late cases with permanent paralysis and deform ity there is a place for late reconstructive operations such as corrective (rotation) osteotom y of the hum erus, arthrodesis of the shoulder or tend on transfer operations

Brachial plexus lesions in adults

In adults brachial plexus injuries are usually caused by forcible depression of the shoulder. By far the commonest cause is a motorcycling accident.

It is important to distinguish between preganglionic lesions, in which the nerve roots are avulsed from the spinal cord, and postganglionic lesions, in which the nerves are torn more distally. Preganglionic lesions are irrecoverable, whereas there is potential for some recovery in postganglionic lesions. Clinical and electrical tests may indicate the approximate site of the lesion, but special investigations are needed for more accurate assessment. Initially, spinal root im aging by radiculography may show dural pouches at the sites of nerve avulsion. CT scanning with contrast gives the best information on the extent of the dam age and is superior to MRI scanning. In the last resort surgical exploration may be needed to localise the lesion definitively, especially in the first few days after injury when the prospect of successful repair is most favourable. The measurement of intra-operative nerve action potentials is valuable: when these are present distal to the lesion a substantial number of large fibres have survived the injury, so excision and grafting are unnecessary.

Treatm ent. For irrecoverable (preganglionic) lesions all that can be done is to m ake the best use of any function that rem ains. Tendon or m uscle transfers, to replace the action of paralysed m uscles, m ay be appropriate in selected cases, and arthrodesis of the shoulder m ay som etim es be indicated if strong scapular m uscles and useful hand function are preserved.

If, how ever, it is confirmed at operation that the roots have been torn across rather than avulsed, repair by nerve grafting may be attempted with some hope of success. Nerve transfers that have been used include: redirection of the accessory nerve to the suprascapular nerve to improve should erfunction; and transfer of the third or fourth intercostal nerve to the musculocutaneous nerve to restore elbow flexion. Even limited recovery is well worth-while, and may reduce the level of severe causalgic pain; nevertheless the outlook for good recovery of motor and sensory function is alw ays very doubtful, especially in the forearm and hand, and severe permanent disability is usually to be expected. This page intentionally left blank

Part 3

REGIONAL ORTHOPAEDICS

In this part the features of the common disorders of the trunk and limbs will be outlined against the background of the systematic descriptions covered in Part 2. For each region emphasis will be placed on those diseases producing unique clinical features, or where the investigation and treatment of the condition is specific to the anatomical site. At the beginning of each chapter an outline of the important points in history taking and clinical examination is provided.

12 Neck and cervical spine

The commonest orthop aedic cause of neck disorders is degeneration of a cervical intervertebral disc. This may lead to protrusion of part of the disc contents (prolapsed cervical disc) or, more often, it may give rise to secondary osteoarthritic changes in the intervertebral joints (cervical spondylosis). These conditions together make up a large proportion of the disabilities of the neck encountered in an orthopaedic out-patient department. A nother major cause of prolonged pain and stiffness of the neck is the common post-traum atic musculo-ligam entous strain known generally as whip lash injury.

A disorder of the cervical spine often interferes with the roots of the brachial plexus, causing radiating pain, muscle weakness, or sensory im pairment in the corresponding upper limb. Indeed, the clinical importance of a cervical disorder often lies in its neurological effects rather than in the local lesion itself.

SPECIAL POINTS IN THE INVESTIGATION OF NECK COMPLAINTS

HISTORY

It is important to ascertain the relationship of the present symptoms to any previous neck disorder. Has there been any previous injury to the neck? Or a sudden jerk of the head that might have jarred the cervical spine? Is there a history of 'stiff neck' - a common feature in the early stages of prolapsed cervical disc?

If pain in the upper lim b is an associated sym ptom, it is important to determ ine its exact distribution. Pain caused by pressure upon a nerve root in the cervical region follows a clearly defined course which depends upon the particular nerve root involved, and it is usually severe. It commonly extends down the upper arm into the forearm and hand, radiating to one or more of the fingers. It is often accompanied by paraesthesiae, described as 'pins and needles' or 'num bness'. In contrast, pain referred down the lim b from a lesion of the shoulder or humerus is more diffuse and ill defined, and it seldom extends below the elbow.

EXPOSURE

The patient must be stripped to the waist. Preferably he should stand, or he may sit upon a stool.

STEPS IN CLINICAL EXAMINATION

A suggested routine for clinical exam ination of the neck is sum marised in Table 12.1.

 Table 12.1
 Routine clinical examination in suspected disorders of the neck

1. LOCAL EXAMINATION OF NECK, WITH NEUROLOGICAL AND VASCULAR SURVEY OF UPPER LIMBS

Inspection

Bone contours: ?deformity Soft-tissue contours Colour and texture of skin Scars or sinuses

Palpation

Skin temperature Bone contours Soft-tissue contours Local tenderness

Vascular state of upper limb Colour Temperature Pulses

Movements Flexion-extension Lateral flexion Rotation ? Pain on movement ? Crepitation on movement

Neurological state of upper limb Muscular system Sensory system Sweating Reflexes

2. EXAMINATION OF POTENTIAL EXTRINSIC SOURCES OF NECK SYMPTOMS

Symptoms suggestive of a neck disorder may arise from the ears or throat. Symptoms in the upper limb suggesting a neck disorder with involvement of the brachial plexus may arise from shoulder, elbow, or nerve trunks in their peripheral course

3. GENERAL EXAMINATION

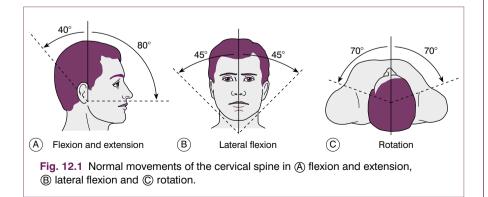
General survey of other parts of the body. Neck symptoms may be only one manifestation of a more widespread disease

DEFORMITY

The cervical spine norm ally has sligh t an terior curvature (lordosis). Straightening of this curve, or an angulation in the reverse direction (kyphosis), is sometimes significant and may suggest an underlying abnormality. Any lateral or rotational deformity (torticollis) must also be noted.

MOVEMENTS

The movements to be examined are flexion, extension, lateral flexion to right and left, and rotation to right and left (Fig. 12.1). Flexion-extension movem ents occur mainly at the occipito-atlantoid joint but to some extent throughout the



Neck and cervical spine

cervical spine. Lateral flexion takes place throughout the cervical spine. Rotation occurs largely at the atlanto-axial joint, with a sm all range of movem ent at the other joints. It is important to find out whether movem ent causes pain and, if so, whether the pain is felt locally in the neck or whether it is referred down the upper limbs. It should be noted also whether movem ent is accompanied by audible or palpable crepitation.

NEUROLOGICAL EXAMINATION OF UPPER LIMBS

This is an essential step in the investigation of the neck because cervical lesions so often interfere with the brachial plexus.

M uscular system. The muscles of the shoulder girdle, arm, forearm, and hand must be examined for wasting or fasciculation, a comparison being made on the two sides. The tone and power of each muscle group are then tested in turn and a comparison is made with the opposite limb. It is worth remembering the major root innervation for each muscle group when testing; C 5 to deltoid, C 6 biceps and wrist extensors, C 7 triceps and wrist flexors, C 8 finger flexors, and T 1 to intrinsic muscles of hand.

Sensory system. Exam ine the patient's sensibility to touch and pin prick. In appropriate cases test also the sensibility to deep stimuli, joint position, vibration, and heat and cold. The nerve roots supplying the sensory dermatomes in the upper limb are shown in Fig. 12.2. In the assessment of sensory loss it should be remembered that the middle or long finger, representing the central axis of the limb, is innervated mainly from the seventh cervical nerve. The radial half of the hand is innervated by the proximal roots of the brachial plexus (C 5, C 6) whereas the ulnar half is innervated from the more distal roots (C 8, T 1).

Sweating. Feel whether the digits are moist or dry. Sweating is dependent upon intact sudomotor nerve fibres.

Reflexes. Compare on the two sides the biceps jerk (mainly C6), the triceps jerk (mainly C7), and the brachioradialis jerk (mainly C6).

From the findings elicited it should be possible to determ ine whether there is a neurological disturbance and, if so, whether it is of upper or lower motor neurone type, and the identity of the roots, trunks, or branches involved.

VASCULAR EXAMINATION OF THE UPPER LIMB

The subclavian artery is sometimes interfered with by a lesion of the neck. The efficiency of the circulatory system in each upper limb must therefore be determined. Judge and compare on the two sides the colour and warm th of the forearm, hand and fingers. Test and compare the radial pulses, first with the limb at rest, then with the shoulder depressed and the head rotated tow ards the side exam ined.

EXTRINSIC CAUSES OF NECK SYMPTOMS

O ccasionally neck symptoms have their origin outside the neck itself. Thus pain may be referred to the neck from the ears or throat. These sites should be examined routinely for evidence of disease.

Symptoms in the upper limb that might suggest the possibility of a neck disorder involving the brachial plexus may in fact have their origin in the shoulder or elbow, or at any point along the peripheral distribution of the nerve trunks.

Neck and cervical spine

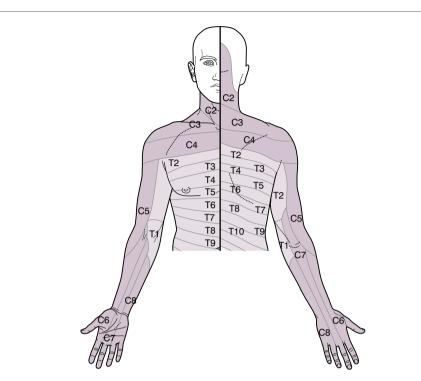


Fig. 12.2 Dermatomes of the upper limb. A knowledge of these in testing sensory impairment will assist in determining the level of root involvement in cervical spine disease.

DIAGNOSTIC IMAGING

Radiographic examination. Routine radiographs of the cervical spine include lateral projection. A d ditional projections a n ro-posterior an d а are often ired when it is desired to show а particular structure more clearly. Fora y of the dens (od on to id process) of the axis a special antero-posterior projection is made through the open mouth. Occasionally oblique projections are required for a proper investigation of the intervertebral foram ina and the facet joints, and is also valuable in revealing the size and shape of a cervical rib.

Other techniques of im aging. Magnetic resonance im aging (MRI) is used increasingly to demonstrate the relationship between the bony and neurological structures in the cervical spine. Computerised tomography (CT scanning) and radioisotope scanning may sometimes be required to demonstrate pathological changes in the bony structures.

DEFORMITIES AND CERVICAL INSTABILITIES

INFANTILE TORTICOLLIS ('Congenital' torticollis; muscular torticollis)

In infantile torticollis (wry neck) the head is tilted and rotated by contracture of the sternom astoid muscle of one side. Strictly this is not a true congenital

deform ity because it arises after birth. With improvements in obstetrical practice it is now seen much less often than it was in the past.

Cause. This is uncertain. Probably there is interference with the blood supply of the sternom astoid muscle, caused by injury during birth.

Pathology. In the established condition, part of the affected muscle is replaced by contracted fibrous tissue. In some cases contracture is known to have been preceded, in early infancy, by a tum our-like thickening of the muscle ('sternom astoid tum our'), the histology being that of m uscle infarction and replacem ent by fibrous tissue.

Clinical features. The child, often between 6 months and 3 years old when brought for consultation, is noticed to hold the head on one side. On exam ination, the contracted sternom astoid muscle is felt as a tight cord. The ear on the affected side is approximated to the corresponding shoulder. In long-established cases there is retarded development of the face on the affected side, with consequent asymmetry (Fig. 12.3).

Diagnosis. The condition has to be distinguished from other forms of wry neck, including structural deform ities of the cervical spine, ocular torticollis, muscle spasm from a local inflammatory lesion such as infected glands, and psychogenic (hysterical) torticollis. The important diagnostic features are the history, the cord-like contracted sternom astoid muscle, and the facial asymmetry. Imaging of the spine with plain radiographs is important to exclude any underlying vertebral abnorm alities or subluxations.

Treatment. If the condition is seen at the stage of 'sternom astoid tum our', repeated stretching of the muscle under the supervision of a physiotherapist is effective. In established cases the contracted muscle should be divided at its low er attachm ent. A fter operation corrective exercises should be encouraged.

CONGENITAL SHORT NECK (Klippel–Feil syndrome)

This is an uncommon non-familial congenital malformation of the cervical spine characterised clinically by short neck and limitation of head movements. The cause is unknown.



Fig. 12.3 Infantile torticollis. Note the tense cord-like left sternomastoid muscle and the facial asymmetry.

The degree of abnormality varies widely. The bony deformity consists in fusion of two or more of the cervical vertebrae. Clinically, the neck appears short or absent, and the hair-line is low. The neck may also be webbed to the shoulder. Movements of the head are restricted. Radiographs show the underlvine bony abnormality, but operation is seldom indicated.

CONGENITAL HIGH SCAPULA (Sprengel's shoulder¹)

Congenital high scapula is an uncommon congenital deformity characterised by an abnormally high position and relative fixity of the scapula. The cause is unknown. The anomaly represents a failure of the scapula – originally a cervical appendage – to descend during development to its normal thoracic position. The scapular muscles are ill developed and may be represented only by tough fibrous bands.

C linically, the scapula on one or both sides is abnormally high. Its attachments seem almost rigid and it does not rotate freely during abduction of the arm. The range of shoulder abduction is consequently impaired, but the functional disability is slight.

Treatm ent. The condition is often best left alone, but som e cases are suitable for operation. The upper part of the scapula (above its spine) is excised after division of the contracted levator scapulae m uscle and of tight fascial bands. The blade of the scapula is then divided vertically throughout its length near the vertebral border. This allows the main (lateral) part of the scapula to be displaced downwards relative to the medial strip, and the two parts are re-united with sutures through drill holes.

CERVICAL SUBLUXATION AND DISLOCATION (Spontaneous subluxation of the cervical spine; cervical spondylolisthesis)

Most displacements of the cervical spine are caused by injury, but in some circumstances there may be spontaneous displacement, usually forwards, of a cervical vertebra upon the one next below it.

Causes and pathology. There are three types, caused by:

- congenital failure of fusion of the dens (od ontoid process) with the axis vertebra
- 2. inflam matory softening of the transverse ligam ent of the atlas
- 3. instability from previous injury or from rheum atoid arthritis.

Congenital or acquired non-fusion of dens. Occasionally the dens fails to fuse with the body of the axis by bone, being attached only by fibrous tissue (os odontoideum). Under the constant stress of superim posed weight the fibrous bond slow ly stretches, allow ing the dens, and with it the atlas and skull, to slide gradually forwards upon the axis (Fig. 12.4A). A similar condition may exist after fracture of the dens, but this would be preceded by a history of trauma. Instability may also be present in patients with Down's syndrom e and radio-logical screening may be indicated in patients with this condition.

¹Otto Sprengel (1852–1915) Head surgeon at Children's Hospital in Dresden, Germany. Described the deformity in 1891.

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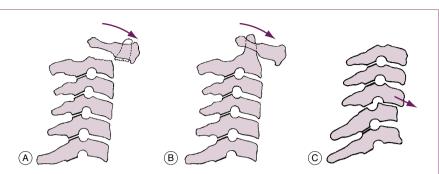


Fig. 12.4 Three types of cervical spondylolisthesis or spontaneous subluxation. (A) Displacement of atlas with the dens permitted by congenital or post-traumatic non-fusion of the dens with the axis. (B) Displacement of atlas on axis, from softening of the transverse ligament of the atlas. (C) Subluxation of a cervical vertebra upon the one next below it from instability of the intervertebral joint after previous injury. Instability may also be caused by rheumatoid arthritis.

Inflam m atory softening of the transverse ligam ent of the atlas. In this type the underlying cause is an inflam m atory lesion in the upper part of the neck, such as rheum atoid arthritis or a severe local infection of the throat or glands. There is rarefaction of the atlas, with softening of the transverse ligam ent. In consequence the atlas is able to slide forw ards upon the axis (Fig. 12.4B).

Instability from previous injury or from arthritis. A traumatic fracturedislocation or subluxation at any level in the cervical spine may cause permanent instability, with a liability to slow redisplacement months or years after the initial injury (Fig. 12.4C).

In all types the upper segment is displaced forwards in relation to the lower. The spinal canal becomes progressively more flexed and narrowed, and there is always a grave risk of compression of the spinal cord.

Clinical features. In the inflam matory type there is complaint of 'stiff neck'. The head is held rigidly, the cervical muscles being in spasm. In subluxation from congenital or post-traum atic instability there are discomfort and stiffness in the neck, and flexion deform ity is apparent. Radiographs will show the displacement, its level and its type (Fig. 12.5).

Complications. In all types the complication to be feared is compression of the spinal cord. The first symptoms appear in the upper limbs and consist of root pain, paraesthesiae, motor weakness, or sensory impairment. Eventually, increasing cord compression may lead to spastic paralysis below the level of the lesion, and to bladder and bowel dysfunction.

Treatm ent. This depends upon the underlying cause and upon whether or not neurological disturbance is present.

Inflammatory type. The displacement is reduced by head traction, which is continued for two weeks. Thereafter the neck is immobilised in extension in a plaster jacket for 2 months. A tlanto-axial fusion may be required.

Congenital or post-traum atic instability. If subluxation is not complicated by neurological disturbance, treatm ent m ay be expectant (observation only), by a plastic collar to give support, or by local fusion of the spine, according to the



Fig. 12.5 Lateral radiograph of upper cervical spine in rheumatoid arthritis showing atlanto-axial subluxation. The anterior arch of the atlas has displaced anteriorly because of destruction by the rheumatoid inflammatory process of the transverse ligaments that normally hold it against the odontoid process of the axis. As a result the odontoid peg (arrow) will compress the anterior aspect of the spinal cord and medulla with severe neurological complications.

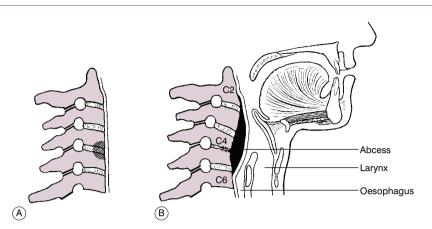
severity of the displacementand of the local symptoms. If neurological disturbance is present, treatm ent is by prelim inary skull traction to reduce the displacem ent, followed by operative fusion of the affected segments of the spine.

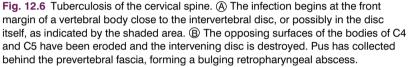
TUBERCULOSIS OF THE CERVICAL SPINE (Tuberculous cervical spondylitis)

Tuberculosis is far less common in the cervical spine than in the thoracic and lum bar regions. It is now seldom seen in Britain, but it still occurs commonly in Africa and in Eastern countries. The general features of tuberculosis of bone were described in Chapter 7 (p. 92).

Pathology. The infection begins in the front of a vertebral body, or in an intervertebral disc (Fig. 12.6A). Destruction of bone and intervertebral disc leads to anterior collapse with consequent cervical kyphosis (Fig. 12.6B). The degree of destruction varies widely, depending upon the virulence of the organism a n d the resistance of the patient. Form ation of pus leads either to a retrophary ngeal abscess (behind the prevertebral fascia), which may eventually point at the posterior margin of the sternomastoid muscle, or, if the pus tracks posteriorly,

Neck and cervical spine





to a suboccipital abscess. The spinal cord m ay be dam aged by direct pressure of an abscess, or by secondary throm bosis of the vessels of the cord.

C linical features. The disease occurs m ainly in children and young adults. There is pain in the neck and occiput, aggravated by movement. In addition, one or more of the following symptoms may be present: difficulty in swallowing; abscess or sinus at the side or back of the neck; neurological symptoms from spinal cord dysfunction, the upper limbs being affected before the lower. O nexamination the head is held rigidly, often supported by the hands. The cervical muscles stand out in spasm. One or more of the spinous processes may appear prominent, due to cervical kyphosis. There is local tenderness on firm palpation over the spinous processes. All movements of the head and neck are restricted, and cause pain if forced. An abscess may be present in the suboccipital region, behind the sternom astoid muscle, or behind the pharynx (see below). A ssociated tuberculous lesions elsew here are common.

Im aging. Radiographs alw ays show dim inution of disc space, usually som e destruction of bone (Fig. 12.6B), and som etim es an abscess shadow. M R I scans will provide m ore detailed inform ation on the extent of the soft tissue abscess and assist in planning surgical drainage.

Investigations. The erythrocyte sedimentation rate is raised in the active stage. The Mantoux test is positive. Pus obtained by aspiration of an abscess may yield tubercle bacilli.

Complications. Retropharyngeal abscess. This causes difficulty in swallowing (dysphagia), and the posterior wall of the pharynx is seen to bulge forwards in the midline. Eventually the abscess may point behind the sternomastoid muscle. If neglected, it may rupture into the pharynx.

Spinal cord dysfunction. If the spinal cord is affected there will be neurological signs (sensory, motor, and visceral) at and below the level of the lesion, which may progress to com plete paralysis. Diagnosis. Important diagnostic features are the history of tuberculous contact or disease, spasm of the neck muscles with restriction of all movements, abscess formation, and the radiographic findings.

Treatment. The principles of treatment are the same as for other forms of skeletal tuberculosis. A ntibacterial therapy: combinations of antituberculous drugs were described on page 102. Local treatment is by support for the cervical spine by a halo splint or by a plastic collar until the disease is quiescent – often a matter of several months.

Operation is sometimes required and the following are the main indications:

- to drain a retropharyngeal abscess that threatens to rupture or to cause asphyxia
- in a florid case, to rem ove necrotic bone and debris and then to embed a bone graft in the cavity
- 3. to decompress a spinal cord dam aged by pressure of abscess or granulation tissue
- 4. in the quiescent stage, to fuse the affected region of the spine if it is judged to be unstable.

PYOGENIC INFECTION OF THE CERVICAL SPINE (Pyogenic cervical spondylitis)

In fection of the cervical vertebrae or intervertebral discs with pyogenic organism s is uncom mon. It is usually caused by the staphylococcus, streptococcus, or pneum ococcus, and occasionally by other bacteria, including salm onella organism s or *Brucella abortus*.

Pathology. The organisms reach the spinal column by the general blood stream (from a septic focus elsewhere), by lymphatic channels (from a local infection, for instance in the pharynx), or possibly by the spinal venous plexus (from a focus in the pelvis). As in tuberculous spondylitis, there is destruction of bone and intervertebral disc, with or without abscess formation. The spinal cord may be dam aged by direct pressure or by throm bosis.

Clinical features. The onset is usually acute or subacute, with pyrexia. The clinical features resemble those of tuberculous spondylitis (p. 192), but the course is more rapid. A suppurative process elsewhere in the body (for instance, in the pharynx or pelvis) is usually present. *Radiographs* show local osteoporosis or erosion of bone, diminution of disc space, and som etimes sub-ligamentous new bone formation.

Investigations. The erythrocyte sedimentation rate and C-reactive protein level is raised and polymorphonuclear leucocytosis is to be expected.

Diagnosis. The condition must be distinguished from tuberculous spondylitis; the relatively rapid onset and course, with pyrexia and leucocytosis, and identification of the causal organism in pus, are the main diagnostic criteria.

Treatm ent. A ppropriate antibiotic drugs (see p. 89) should be given system ically. The cervical spine must be immobilised in a rigid collar or brace; som etim es sustained head traction with a halo splint is required for relief of spasm. When there is an abscess it should be drained, especially if the spinal cord is threatened. Spontaneous fusion of the affected vertebrae usually makes operative fusion unnecessary.

RHEUMATOID ARTHRITIS (General description of rheumatoid arthritis, p. 134)

The cervical spine is the third most commonly affected in rheumatoid polyarthritis, after the hands and feet. In sero-positive disease up to 50% will show evidence of destructive synovitis in the vertebral joints. It is im portant that this be recognised, because there is a risk that destruction of the intervertebral joints may allow gradual forward subluxation of a cervical vertebra upon the one next below it, with danger to the integrity of the spinal cord. There is a particular risk of subluxation at the atlanto-axial joint due to softening of the transverse ligament of the atlas (see Fig. 12.5). Destructive changes may also occur at multiple levels below the axis vertebra and may result in subluxation causing progressive spinal cord or nerve root compression. It is important to remember that these destructive changes may occur insidiously without significant symptoms because of the involvement of the upper and low er lim b joints; thus they may be overlooked until the onset of paralysis.

W arning symptoms that should alert the clinician to impending cord damage are sensory paraesthesia and sensations of 'electric shocks' in the hands with increased muscle tone and spasticity in the legs. Dizziness, tinnitus and vertigo may also occur and are indicative of vertebral artery insufficiency.

Treatment. If the patient experiences significant neck pain and erosion of the intervertebral joints or subluxation at any level are demonstrated radiologically, the neck should be splinted with a moulded soft plastic collar. In a few patients when neurological impairment becomes progressive MRI scanning is required to evaluate the extent of spinal cord compression. If this is present more active surgical treatment is indicated; initially with skull traction or a halo brace to correct the subluxation, followed by posterior spinal fusion.

ANKYLOSING SPONDYLITIS

A nkylosing spondylitis is a disease that creeps up the spine from below having originated in the sacro-iliac joints and the lum bar spine. In a high proportion of cases – though by no means in all – it extends to involve the cervical region, with aching pain and permanent stiffness – sometimes total rigid ankylosis – of the intervertebral joints. Very occasionally the neck may become ankylosed in an extreme degree of flexion producing a 'chin on chest' deform ity. When this interferes with swallowing and the ability to see ahead it may justify surgical correction by osteotomy and fusion. This is very high-risk surgery with a 20% mortality rate and should only be undertaken in specialised centres by surgeons with the necessary skills. The disease of ankylosing spondylitis as a whole will be described in Chapter 13 (p. 229).

CERVICAL SPONDYLOSIS (Cervical spondylarthritis; cervical spondylarthrosis; cervical osteoarthritis; cervical osteoarthrosis)

D egenerative changes are common in the cervical spine. Indeed, they are found almost universally in some degree in persons over 50 years of age. Beginning in the intervertebral discs, they affect the posterior intervertebral (facet) joints secondarily, causing pain and stiffness of the neck, sometimes with referred symptoms in an upper limb. **Cause**. The primary degenerative changes may be initiated by injury, but usually the condition is simply a manifestation of normal ageing processes.

Pathology. Degenerative arthritis occurs most commonly in the lowest three cervical joints. The changes affect first the central intervertebral joints (between the vertebral bodies) and later the posterior intervertebral (facet) joints. In the central joints there is degenerative narrowing of the intervertebral disc, and bone reaction at the joint margins leads to the formation of osteophytes (Fig. 12.7A). In the posterior intervertebral joints the changes are those of osteoarthritis in any diarthrodial joint - namely, we aring away of the articular cartilage and the formation of osteophytes (spurs) at the joint margins (Fig. 12.7B).

Secondary effects. O steep hytes commonly encroach upon the intervertebral for a mina, reducing the space for transmission of the cervical nerves (Fig. 12.7B). If the restricted space in a for a men is reduced still further by traumatic oedem a of the contained soft tissues, manifestations of nerve pressure are likely to occur. Exceptionally, the spinal cord itself may suffer damage from encroachment of osteophytes within the spinal canal.

C lin ical features. The symptoms are in the neck or in the upper limb, or both. N eck symptoms consist chiefly of aching pain in the back of the neck or in the trapezius area, a feeling of stiffness, and 'grating' on movement. U sually slight, they are liable to periodic exacerbations, probably from unremembered strains or repetitive movements: exacerbations may be interspersed with periods of freedom from pain. O ccipital head ache may be a feature if the upper half of the cervical spine is affected.

In the upper lim b there m ay be a vague, ill-defined and ill-localised 'referred' pain spreading over the shoulder region, or there m ay be m ore serious sym ptom s from interference w ith one or m ore of the cervical nerves in their foram ina. The m ain feature of nerve root irritation is radiating pain along the course of the affected nerve or nerves, often reaching the digits. There m ay also be paraesthesiae in the hand, in the form of tingling or 'pins and needles'. Noticeable muscle w eakness is uncom m on.

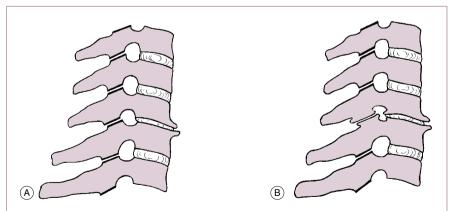


Fig. 12.7 Osteoarthritis of the cervical spine. At first there is simply degeneration and narrowing of the intervertebral disc, with the formation of osteophytes anteriorly (A). Later, the posterior or facet joints are affected: the articular cartilage is worn away and marginal osteophytes may encroach upon the intervertebral foramen (B).

On exam ination, the neck may be slightly kyphotic. The posterior cervical muscles may be somewhat tender but they are not in spasm. Movements are not markedly diminished except during acute exacerbations or when the degenerative changes are very advanced. Audible crepitation on movement is common. In the upper limb objective findings are usually slight or absent, for nerve pressure is seldom great enough to produce well-defined objective neurological signs (compare prolapsed intervertebral disc). Thus demonstrable motor weakness or sensory impairment is exceptional. Depression of one or more of the tendon reflexes is, how ever, fairly common.

R adiographic features. There is narrow ing of the intervertebral disc space, with form ation of osteophytes at the vertebral margins, especially anteriorly (Fig. 12.8A). A single vertebral level may be affected - often at the C5-C6 or C6-C7 level - or there may be changes at more than one level. Encroachment of osteophytes upon an intervertebral foramen is demonstrated best in oblique projections (Fig. 12.8B) or on CT scans. In a few patients with clinical evidence of neurological impairment M R I scanning may be indicated to identify nerve root or cord compression.

Diagnosis. Distinction has to be made from :

- O ther causes of neck pain. These include prolapsed cervical disc, tuberculous or pyogenic infection, tum ours involving the vertebral colum n, and fibrom yalgia.
- 2. O ther causes of upper lim b pain (Fig. 12.9). These are as follows: central lesions - tum ours involving the spinal cord or its roots; cervical spondylolisthesis. Plexus lesions - tum ours at the thoracic inlet (Pancoast); cervical rib; prolapsed intervertebral disc. Shoulder lesions with radiating pain in the upper arm. Skeletal lesions such as a tum our, infection, or Paget's disease of a bone of the upper extrem ity. Elbow lesions such as tennis elbow or arthritis. D istal nerve lesions such as friction neuritis of the ulnar nerve at the elbow or com pression of the median nerve in the carpal tunnel.

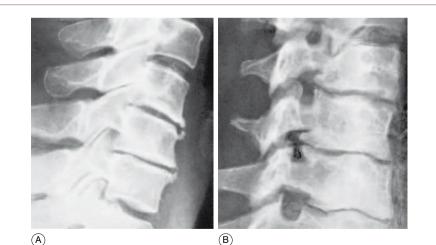
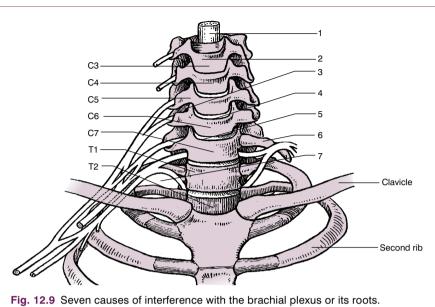


Fig. 12.8 Cervical spondylosis. Note in the lateral view (A) the narrowed intervertebral space, with marginal osteophyte formation, at C5–C6 and at C6–C7. The oblique view (B) shows severe encroachment of osteophytes upon an intervertebral foramen (compare with the normal foramen below).



- 1. Tumour of cord. 2. Tumour of spinal column. 3. Tumour of nerve root.
- 4. Prolapsed cervical disc. 5. Cervical spondylosis (osteoarthritis). 6. Cervical rib. 7. Tumour at thoracic inlet.

Treatm ent. There is a strong tendency for the symptom s of cervical spondysubside spontaneously, though they may persist for many structural changes are clearly perm anent. Treatm ent is thus aim ed tow ards isting natural resolution of tem porarily inflamed or oedematous soft tis-In mild cases such m easures include anti-inflam m atory analgesic drugs muscle relaxants as well as various forms of physiotherapy. Ultrasound, e diathermy, massage, and intermittent traction have all been none have been shown to be effective in large clinical trials. Som e benefit shown for mobilisation and strengthening exercises. Manipulation is recommended, but in the presence of extensive osteophytes it is hazardous because it m ay dam age the spinal cord; it should therefore be em ployed xtrem e caution, and only by those fam iliar with a gentle technique. In the severe cases it is wise to provide restand support for the neck by a closely fitting protective cervical collar (Fig. 12.10A), but this should only be worn for weeks until the acute symptoms subside to prevent atrophy of the spinal a few muscles

In the exceptional cases in which radiculopathy or myelopathy is progressive and bony im pingement can be demonstrated by imaging, surgical decompression may be required. For nerve root compression this can be achieved by a foram inotomy procedure, but where cord compression is present the type of operation is dictated by the site of bone impingement. In the commoner anterior compression from osteophytes on the vertebral body, an anterior discectomy combined with an interbody fusion gives best results. When compression is posterior from thickening of the laminae, a posterior laminectomy is required with a lateral facet joint wiring and fusion. 197

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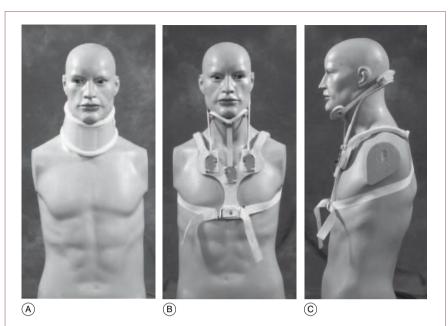


Fig. 12.10 Cervical collars used in the treatment of painful neck disorders. The simple polythene support (A) gives only symptomatic relief and minimal support. The more rigid adjustable orthosis (B) and (C) can be fitted to limit flexion and extension of the spine and provides some stability in more severe disease.

PROLAPSED CERVICAL DISC

D is placement of intervertebral disc material in the cervical spine is much less common than it is in the lumbar region. It is characterised by pain and stiffness in the neck, often with neurological manifestations in the upper limb and occasionally with signs of spinal cord compression.

Cause. Sudden jarring injury may be a predisposing factor, though a history of injury cannot be obtained in every case. Probably an intrinsic degenerative change in the substance of the disc makes it prone to rupture and displacement.

Pathology. The disc between C5-C6 and that between C6-C7 are those most frequently affected. Part of the gelatinous nucleus pulposus protrudes through a rent in the annulus fibrosus at its weakest part, which is postero-lateral; or part of the annulus itself may be displaced. If slight, the protrusion bulges against the pain-sensitive posterior longitudinal ligament, causing local pain in the neck. If large, the protrusion herniates through the ligament and may impinge upon the nerve leaving the spinal canal at that level (postero-lateral prolapse) (Fig. 12.11A), or occasionally upon the spinal cord itself (central prolapse) (Fig. 12.11B). Healing is probably by shrinkage and fibrosis of the extruded material rather than by its reposition within the disc. Secondary effects: Prolapse of a disc accelerates its degeneration and predisposes to the development of osteoarthritis (cervical spondylosis) in later years.

Clinical features. Central protrusions. These lead to manifestations of spinal cord compression and may be confused with spinal cord tum ours or other

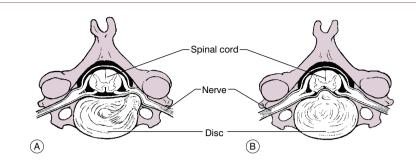


Fig. 12.11 Prolapsed cervical disc. (A) shows a postero-lateral prolapse, with compression of the issuing nerve. (B) shows the much less common central prolapse, with impingement upon the spinal cord.

central neurological disorders. They fall within the province of the neurosurgeon rather than the orthopaedic surgeon.

Postero-lateral protrusions. A typical clinical picture is as follows. The patient sustains an injury to the neck – often a jarring or twisting strain – which may seem slight at the time and may cause no immediate effects. Hours or days later there is a rapid development of acute 'stiff neck' with severe pain made worse by coughing or similar strains. Later still, the pain begins to radiate over the should er and throughout the length of the upper limb; it is felt strictly in the course of a cervical nerve, and characteristically it is severe. Paraesthesiae are felt in the digits. On examination, there is limitation of certain neck movements by pain, but movement in at least one direction (often lateral flexion) is free. In the upper limb there is a full range of joint movements. There are slight muscle wasting and slight sensory impairment in the distribution of a cervical nerve. The corresponding tendon reflex (biceps jerk in C5-C6 lesions; triceps jerk in C6-C7 lesions) is depressed or absent.

Variations. The characteristic features described are not always present. Variations are common. Thus a history of injury is not always obtainable. The symptoms may be confined to the neck, the upper limb being spared; or they may be confined entirely to the upper limb. Motor changes (wasting and weakness) may be marked, sometimes amounting to almost complete paralysis of a muscle or a group of muscles; or on the other hand they may be absent. Similarly, wide variations in the degree of sensory impairment are noted.

Im aging. Radiographs characteristically show a normal appearance in the first attack, but narrow ing of one of the disc spaces (usually C5-C6 or C6-C7), denoting long-standing disc degeneration, is often demonstrable. Magnetic resonance imaging may show the displaced disc material and its relationship to the nerve roots and cord (Fig. 12.12).

Diagnosis. Prolapsed cervical disc has to be differentiated:

- 1. from other causes of neck pain
- 2. from other causes of upper limb pain (Fig. 12.9).

The main conditions that may be confused with it are the same as those listed in the differential diagnosis of cervical spondylosis (p. 196). A confident diagnosis is justified only when a suggestive history is associated with the signs of a

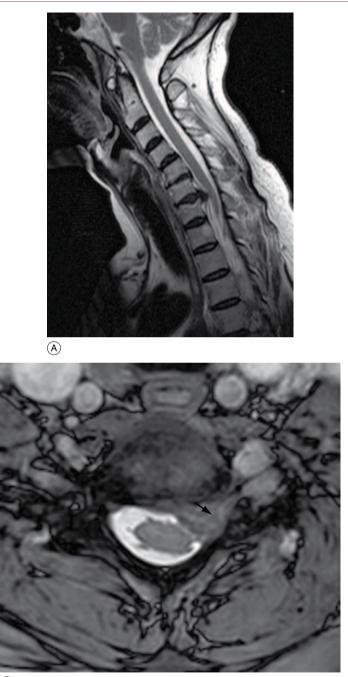




Fig 12.12 (A) and (B) Sagittal and axial MR scans showing a posterior cervical disc protrusion at the C6–C7 level. On the axial scan (B) the disc material is seen lying on the left side of the canal extending into the exit foramen (arrow) and compressing the underlying C6 nerve root.

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lesion of a single cervical nerve, and provided alw ays that other possible causes have been excluded by careful investigation.

Relationship between prolapsed disc and cervical spondylosis

The clinical features of the two conditions are sim ilar. Distinction is difficult if the radiographs show arthritic changes, because the arthritis may be only incidental and itself symptom less. Nerve pressure is probably greater in prolapsed disc than in osteoarthritis: consequently the symptoms tend to be more clearly defined and pain very severe; and the objective signs are more marked.

Course. There is a strong tendency to spontaneous recovery, but symptoms often persist with decreasing severity for as long as six months or more.

Treatm ent. This depends upon the nature and severity of the individual case. W hen the symptoms are slight no treatm ent other than perhaps a mild analgesic drug is required. In the more severe cases treatm ent is advisable, especially in the early acute stage. If the neck is 'stiff' and if movements aggravate the neck and lim b pain, rest for a few weeks in a supportive collar made from heat-moulded reinforced plastic or a more rigid adjustable orthosis (Fig. 12.10) is the most satisfactory method. Pain is usually severe, necessitating fairly intensive analgesic therapy. As the acute symptoms gradually subside, physiotherapy in the form of graduated neck exercises to restore full mobility and muscle strength is often helpful.

In cases of intractable radicular pain or myelopathy surgical treatment may be required. Removal of the affected degenerative disc m achieved through antero-lateral approach to th e (Fig. a n vertebral bodies 12.13). This displaces the sterno-mastoid muscle and contents of the carotid sheath laterally, with the strap muscles, trachea and oesophagus moved medito expose the pre-vertebral fascia. It is important to confirm the correct with intra-operative radiography before disc intervertebral space D istraction of the vertebral bodies facilitates rem oval of the disc and the space created is then filled with a block of autogenous cortico-cancellous bone graft

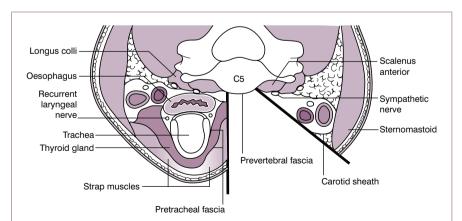


Fig 12.13 Surgical approach to the anterior aspect of the cervical spine. In the mid-cervical spine, dissection between the trachea and oesophagus medially and the carotid sheath laterally is relatively avascular compared with the posterior approach through thick muscle layers.

to produce an anterior interbody fusion. The technique can also be applied to disc degeneration at more than one level by the use of a longer strut graft (see Fig. 4.4A), usually reinforced with a plate and screws. Postoperatively the neck is immobilised in a light collar until there is radiological evidence of bone healing.

Because of the loss of movement that follows intervertebral fusion, attempts are now being made to replace the degenerate disc with an artificial prosthetic replacement, but as yet the procedure is experimental and no long-term results are available.

CERVICAL RIB

A cervical rib is a congenital over-development, bony or fibrous, of the costal process of the seventh cervical vertebra. It often exists without causing symptoms, especially in the young, but in adult life the tendency to gradual dropping of the shoulder girdle may lead to its causing neurological or vascular disturbance in the upper limb.

Pathology. The over-developed costal process may be unilateral or bilateral. It may be of any size from a small bony protrusion, often with a fibrous extension, to a complete supernumerary rib. The subclavian artery and the low est trunk of the brachial plexus arch over the rib. In a proportion of cases the nerve trunk suffers damage at the site of pressure against the rib; this accounts for the neurological manifestations. The vascular changes are probably sim ilarly accounted for by local damage to the subclavian artery, from which throm botic embolimay be repeated ly discharged into the peripheral vessels of the upper limb.

Clinical features. Cervical rib is often symptom less. When symptom soccur, they usually begin during early adult life. They may be neurological, vascular, or combined.

Neurological manifestations. The sensory symptoms are pain and paraesthesiae in the forearm and hand, most marked towards the medial (ulnar) side, and often relieved temporarily by changing the position of the arm. The motor symptoms include increasing weakness of the hand, with difficulty in carrying out the finer movements.

On exam ination, there is usually an area of sensory impairment - som etimes complete anaesthesia - in the forearm or hand. The affected area does not correspond in distribution to any of the peripheral nerves, but may be related to the lowest trunk of the brachial plexus. There may be wasting of the muscles of the thenar eminence or of the interosseous and hypothenar muscles.

Vascular manifestations. The changes that have been observed range from dusky cyanosis of the forearm and hand to gangrene of the fingers. The radial pulse may be weak or absent.

Radiographic features. Radiographs show the abnormal rib: if small, it is seen best in oblique projections (Fig. 12.14). In cases of suspected vascular obstruction arteriography is required.

D iagnosis. Radiographic dem onstration of a cervical rib does not prove that it is the cause of sym ptoms. The condition has to be distinguished:

- 1. from other causes of pain and paraesthesiae in the forearm and hand (Fig. 12.9)
- 2. from other causes of muscle wasting in the hand, including neurological disorders and muscular dystrophy
- 3. from other causes of peripheral vascular changes in the upper limb including Raynaud's disease.

Neck and cervical spine



Fig. 12.14 Cervical rib. Typical appearance of a small supernumerary rib. This one caused severe neurological symptoms and signs. A cervical rib is shown best in an oblique radiograph such as this.

The diagnosis of symptomatic cervical rib depends upon the detection of the characteristic neurological signs or vascular disturbance in association with a demonstrable supernum erary rib. Prolapsed intervertebral disc at C7-T1 gives a similar clinical picture neurologically, and indeed it may often be the true cause of symptom sascribed to a cervical rib; but in prolapsed disc there is a strong tendency to natural recovery, which is not the case with cervical rib. A rteriography may be conclusive by revealing obstruction of the subclavian artery.

Treatm ent. This depends upon the severity of the subjective and objective m anifestations. In mild cases physiotherapy in the form of 'shrugging' exercises, to im prove the tone of the elevator muscles of the shoulder girdle, is adequate. But if the neurological or vascular signs are well marked, and especially if they are increasing, operation is advisable. First the scalenus anterior muscle is divided. If this does not dem onstrably release the low est nerve trunk from constricting pressure the scalenus medius should be divided and the abnorm alrib rem oved.

Occlusion of the subclavian artery may be amenable to reconstruction by vein grafting if the diagnosis is made before irreversible changes in the limb have occurred.

SCALENUS SYNDROME (First rib syndrome; thoracic outlet syndrome)

Occasionally the neurological manifestations characteristic of cervical rib occur in the absence of a demonstrable skeletal abnormality. They have been ascribed to trapping of nerves between the first rib and the clavicle (costoclavicular compression), or between the first rib and the scalenus anterior m uscle; and to stretching of the low est trunk of the brachial plexus over the norm al first rib. M ore often, they are caused by a tough fibrous band in the scalenus m edius m uscle, which m ay lead to kinking of the low est trunk of the brachial plexus, dem onstrable at operation. The sym ptom s are easily confused with those from a prolapsed intervertebral disc between C7 and T1. Treatment should be conservative at first, as for prolapsed disc. Gradual improvement w ould support the diagnosis of disc prolapse. But if the sym ptoms persist with undiminished intensity for a long time a true scalenus syndrom e is probably the cause. In that event it may be justifiable to explore the plexus, to divide the scalenus anterior and the scalenus medius, and if necessary to excise the first rib.

SOFT-TISSUE STRAIN OF THE NECK ('Whiplash' injury)

Soft-tissue strain of the neck - commonly termed whiplash injury - is a common cause of persistent pain and stiffness in the neck. It occurs frequently in occupants of cars struck violently from behind by other vehicles ('rear-end shunts'). Similar strains may also occur in head-on collisions.

M echanism of injury and pathology. At the moment of impact the head is first throw n backwards as the vehicle in which the victim is seated is suddenly jolted forwards, often without any warning. This is followed by rebound flexion of the neck, often so extreme that the chin abuts against the manubrium of the sternum, and by a second extension movement. It is assumed that there is strain of the deep muscles and ligaments of the cervical spine. In the great majority of cases in which the patient attends at a hospital, radiographs do not show any structural damage in the spinal column.

Clinical features. At impact the patient usually feels jolting or 'w renching' of the neck or of one or other shoulder; but often there is no severe pain initially and the patient may think at first that he has escaped significant injury. How ever, within hours of the accident - occasionally as late as a day or more afterwards - there is increasing pain and 'stiffness' in the back of the neck, often with extension of the pain to the top and back of one or other shoulder. The neck pain is usually accom panied by severe headache, which may be persistent. *Exam ination* shows restriction of the range of movem ent of the cervical spine, usually in all directions at first, but later more localised.

Symptoms from whiplash injury of the neck are often very slow to subside, and whereas some patients show full recovery in a matter of weeks, it is common for patients to complain of lingering neck and shoulder pain, with or without recurrent headaches, for as long as one or two years, and sometimes even longer. In long protracted cases it is often found that the patient has become demoralised, and consequent psychological upset may delay recovery.

Treatment. W hiplash strain does not respond well or regularly to any particular form of treatment: as is so often the case with soft-tissue strains, time is the best healer. In general, the principles of treatment should be to provide support and rest for the neck in the initial stages, in the form of a protective cervical collar. But after a week or so the emphasis should be rather on the restoration of mobility by regular exercises within the limits imposed by pain, preferably under the supervision of a physiotherapist.

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TUMOURS IN RELATION TO THE CERVICAL SPINE AND EMERGING NERVES

Tum ours involving the cervical spine or the related nerves may arise:

- 1. in the spinal column itself
- 2. in the meninges or, rarely, the spinal cord
- 3. in the fibrous components of a peripheral nerve (neurofibroma)
- 4. in adjacent soft tissues.

Tum ours of the spinal column are more often malignant than benign, and predom inantly metastatic rather than primary tum ours. A meningeal tum our (meningioma) is an uncommon cause of compression of the spinal cord. A tum our arising in nerve (neurofibroma) occurs occasionally within an intervertebral foramen, where it may grow inwards to compress the spinal cord and outwards tow ards the surface ('dum b-bell' tum our). A tum our at the apex of the lung (Pancoast's tum our) is a well-recognised cause of severe pain from invasion of the brachial plexus.

Clinical features. The effects of these tum ours vary according to their site and nature. Broadly, there may be:

- 1. local destruction and collapse of cervical vertebrae
- 2. spinal cord compression
- 3. interference with the brachial plexus.

Destruction and collapse of cervical vertebrae. The commonest cause is a metastatic carcinoma (Fig. 12.15). The clinical features are local pain and, usually, flexion deformity. The spinal cord or the issuing cervical nerves may be involved, with corresponding signs of spinal cord compression or peripheral nerve defect.

Spinal cord compression. Interference with the function of the spinal cord may be caused by tum ours of the cord itself or of its meninges, by tum ours of nerves (neurofibrom a), or by tum ours of the bony spinal column. The clinical



Fig. 12.15 Partial destruction of the body of the third cervical vertebra by a metastasis from a renal carcinoma.

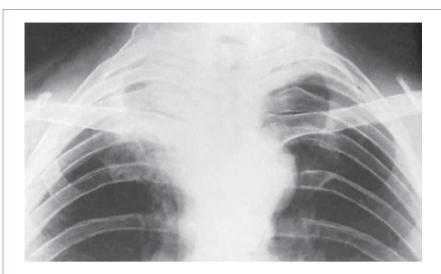


Fig. 12.16 Tumour at the thoracic inlet (apical lung carcinoma or Pancoast's tumour) causing well-marked opacity at the apex of the right lung. This tumour should always be borne in mind in the differential diagnosis of pain in the upper limb.

m anifestations depend upon the location of the tum our. Typically, root pain at the level of the lesion is followed by lower motor neurone changes at the same level and by progressive upper motor neurone paralysis and visceral dysfunction below the lesion.

Interference with the brachial plexus. Nerves form ing the brachial plexus m ay be involved by tum ours of the nerves them selves (neurofibrom a), by bone tum ours, or by tum ours at the thoracic inlet (Fig. 12.16). The predom inant features are severe pain along the course of the nerve or nerves affected (neck or upper lim b) and increasing m otor and sensory im pairm ent in the distribution of the nerves.

Im aging. Plain radiographs will usually help in discovering a tum our arising in the bones of the spinal column or eroding the bones from outside (Fig. 12.15). They may also reveal a tum our at the thoracic in let (Fig. 12.16). Com puterised tom ography or magnetic resonance im aging may give more precise inform ation. Radiographs of the chest may reveal an apical lung tum our or pulm on ary metastases.

13 Trunk and spine

Pain in the back is the commonest symptomencountered in orthopaedic practice. Indeed, if accident cases are excluded, it probably accounts for nearly a third of all orthopaedic out-patient attendances.

W hen this huge mass of material is sifted and categorised it is found that the cases fall into two broad groups. In the first group clear-cut physical signs, with or without distinctive radiographic changes or other abnorm al findings, allow a precise determ ination of the nature of the lesion and of its site. The diagnosis is positive, and rational treatment can be applied. In the second group, alm ost as large as the first, there are few or no abnorm al findings on clinical exam ination or from im aging investigations; so the pathology is unclear. Diagnosis is largely a matter of conjecture, and treatment is empirical. For want of more accurate know ledge these rather vague and unsatisfactory cases are generally classed as 'chronic ligamentous strain' or 'postural back pain'.

Lum bar back pain is often accompanied by radiating pain in the buttock, thigh, or leg, usually on one side but occasionally on both sides. This pain is generally referred to as sciatica, though the term should strictly be reserved for pain in the distribution of the sciatic nerve. It should be noted that sciatica is often a much more disturbing and persistent symptom of back disorders than the back pain itself, which indeed may be slight or transient.

SPECIAL POINTS IN THE INVESTIGATION OF BACK AND SCIATIC SYMPTOMS

History

Special attention should be paid to the mode of onset of the symptoms, whether they are periodic or constant, whether they are getting worse or better, and what relieves them or aggravates them. The precise location of the back pain and its character should be determ ined. The patient should be asked to what he or she attributes the symptoms: a history of a jarring strain, a fall, or an unaccustom ed lifting job may be pertinent. Exacerbation of the pain on coughing or sneezing, which raises intracranial pressure, is indicative of an organic lesion.

Significance of sciatica. If pain radiates into the lower lim b its character and exact distribution must be ascertained. Two distinct types of sciatica can be recognised. If the pain is severe and radiates in a well-defined course that can be outlined on the skin surface, and especially if it is accompanied by motor, sensory, or reflex impairment, it suggests mechanical interference with nerve fibres of the lumbar or sacral plexus, as for instance by a prolapsed disc or a tumour. On the other hand, if it takes the form of a vague diffuse ache, ill defined in its distribution, it is more likely to be a 'referred' pain originating in a disordered joint or ligament.

Exposure

The patient should be stripped com pletely, except for undergarm ents and, in w om en, a brassière.

Steps in routine examination

A suggested plan for the routine clinical exam ination of the back is sum marised in Table 13.1.

Assessment of deformity

A ny visible or palpable alteration of shape or posture of the spinal column should be noted. Deformity may occur in the sagittal plane, in the form of kyphosis (excessive forward curve or stoop) or lordosis (hollow back); or it may occur in the coronal plane as a lateral curvature (scoliosis). Combined curves and rotational deformity may also occur.

Table 13.1	Routine clinical examination in suspected disorders of the back
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1. LOCAL EXAMINATION OF THE BACK, WITH NEUROLOGICAL SURVEY OF THE LOWER LIMBS

(Patient standing)

Inspection

Bone contours and alignment: (?visible deformity) Soft-tissue contours Colour and texture of skin Scars or sinuses

Palpation

Skin temperature Bone contours Soft-tissue contours Local tenderness **Movements** Spinal joints Flexion Extension Lateral flexion Rotation ? Pain on movement ? Muscle spasm Costo-vertebral joints Range indicated by chest expansion Sacro-iliac joints (Impracticable to assess range) ? Pain on movement imparted by lateral compression of pelvis

(Patient recumbent)

Palpation of iliac fossae Examine specifically for abscess or mass

Neurological state of lower limbs Straight leg raising test Muscular system Sensory system Reflexes

2. EXAMINATION OF POTENTIAL EXTRINSIC SOURCES OF BACK PAIN AND SCIATICA

This is important if a satisfactory explanation for the symptoms is not found on local examination. The investigation should include:

- 1. the abdomen
- 2. the pelvis, including rectal examination
- 3. the lower limbs
- 4. the peripheral vascular system
- 3. GENERAL EXAMINATION

General survey of other parts of the body. The local symptoms may be only one manifestation of a widespread disease

The spinal column. The joints of the spinal column must necessarily be congroup, for it is impracticable to study the movement of sid ered each ioint in d e The movements to be examined are flexion, extension, lateral n d e n t l v right and left, and rotation to right and left. It should be noted particularly whether the spinal muscles go into protective spasm when movement is attem pted. Flexion: Instruct the patient to stretch the fingers tow ards the toes, keeping the knees straight. It is im portant to judge what proportion of the moveoccurs at the spine and how much is contributed by hip flexion (Fig. 13.1). patients can alm ost reach their toes, despite a stiff back, sim ply by flexing unusually far at the hips. (Norm ally the ham strings lim it hip flexion to about 90° when the knees are straight.) The range may be expressed roughly as a percentage of the normal, or as the distance by which the fingers fail to reach the floor. A more accurate assessm ent is made by measuring the linear widening of the interspinous spaces as indicated by a tape m easure laid along the line of the spinous processes, which may be marked with a pen. The excursion of the spinous processes between full extension and fullest flexion may thus be measured on the tape. An excursion of four centim etres between the twelfth thoracic spinous process and the first sacral prom inence between full extension and fullest flexion indicates good lum m obility. Extension: Instruct the patient to arch the spine backw ards, looking up at the ceiling. Iudge the range and express approxim ately as a percentage of the normal or measure the excursion as described above. I ateral flerion. Instruct the patient to slide each hand in turn down the lateral side of the corresponding thigh. Observe the range. Rotation: With the feet fixed, the patient rotates the shoulders each side in turn. Hold the pelvis steady, and note the range of spinal tow ards rotation as distinct from that which occurs at the knees and hips

Related joints. The costo-vertebral joints: The mobility of the costo-vertebral joints is judged from the range of chest expansion. The normal difference in chest girth between full inspiration and full expiration is about 7 or 8 cm.

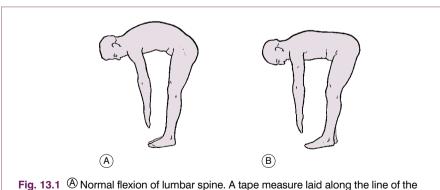


Fig. 13.1 ^(A) Normal flexion of lumbar spine. A tape measure laid along the line of the spinous processes will show widening of the interspinous spaces as the column flexes. ^(B) Apparent or false flexion due entirely to movement at the hips, the hamstrings being unusually lax. A tape measure laid along the line of the spinous processes shows little excursion of their tips. In assessing trunk flexion it is important to judge in this way how much of the movement occurs at the spinal joints and how much at the hips.

Trunk and spine

A marked reduction of chest expansion is of particular significance when ankylosing spondylitis is suspected. *The sacro-iliac joints*: It is not practicable to measure the range of sacro-iliac movement. But the joints should be moved passively to determ ine whether pain is produced, as it will be in arthritic conditions of the joints. A simple method is to gripeach iliac crest and compress the pelvis strongly from side to side.

Palpation of iliac fossae and groins

Palpation of the iliac fossae and groins is an essential step in the exam ination of the back. Its specific purpose is to determ ine whether or not there is a soft-tissue thickening or abscess. It should be remembered that a 'psoas' abscess originating from a tuberculous lesion of the lumbar spine first becomes palpable deep in the iliac fossa. Such an abscess is felt most easily by pressing the flat palmar surface of the hand and fingers against the flat inner aspect of the iliac bone. To do this the surgeon must stand at the side of the couch corresponding to the side being exam ined - that is, he must stand on the right of the patient to examine the right iliac fossa and on the left to exam ine the left iliac fossa (Fig. 13.2).

Neurological examination of the lower limbs

D isorders of the back are so frequently accompanied by radiating pain, paraesthesiae, or other manifestations in the lower limb that a neurological survey should be carried out as a routine.

Straight leg raising test. Holding the knee straight, lift each low er lim b in turn to determ ine the range of pain-free m ovem ent (norm al = 90°; often m ore in w om en) (Fig. 13.3). W hen associated w ith clearly defined sciatica (and in the absence of gross disease of the hip), m arked im pairm ent of straight leg raising by pain suggests m echanical interference w ith one orm ore of the roots of the sciatic nerve. The pain is easily explained. Even a norm al sciatic nerve is tautened by straight leg raising, though not to the point of causing pain by dragging on the meningeal sheath that encloses the nerve root. If a nerve is already stretched or anchored, as by a protruded piece of an intervertebral disc or a tum our, the further tautening entailed in lifting the lim b is sufficient to cause pain.

When a nerve is tensely stretched, raising the straight leg on the unaffected side may cause pain on the affected side. This sign, term ed the crossed sciatic



Fig. 13.2 Palpating the iliac fossae for abscess. This is an essential step in the routine examination of the spine.



Fig. 13.3 The straight leg raising test, an important part of the neurological examination of the lower limbs.

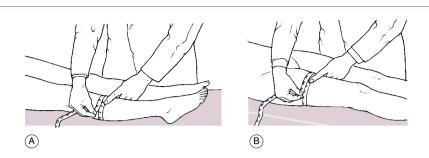


Fig. 13.4 (A) Girth measurement at the widest part is a reliable method of comparing the bulk of the calf muscles on the two sides. (B) Measurement is less reliable in comparing the bulk of the thigh muscles because of the conical shape of the thigh and the difficulty of taking the measurement at an exactly comparable level on each side.

reflex, is a well-recognised feature of prolapsed lum bar intervertebral disc with nerve pressure.

M uscular system. Exam ine the muscles for wasting, hypertrophy, and fasciculation. Note the tone and test the power of each muscle group, comparing it with its counterpart in the opposite limb. Circum ferential measurement is a reliable method of comparing the bulk of the calf muscles, the girth being measured at the widest part or 'equator' (Fig. 13.4A). Circum ferential measurement of the thighs, on the other hand, tends to be inaccurate, and may be misleading, on account of the conical shape of the thigh (Fig. 13.4B). Often a more accurate assessment of the relative volume of the two thighs is obtained from inspection and palpation. If the thighs are measured, the girth should be taken on each side at an equal distance above the knee – 12 or 15 cm above the upper margin of the patella is usually a convenient level.

Power of the muscles is estimated in comparison with the opposite side. Not only the major muscle groups should be tested: significant information may emerge from assessing the power of the toe muscles, and in particular of the extensor hallucis longus, which characteristically is weakened by lesions (such as prolapsed intervertebral disc) involving the fifth lumbar nerve.

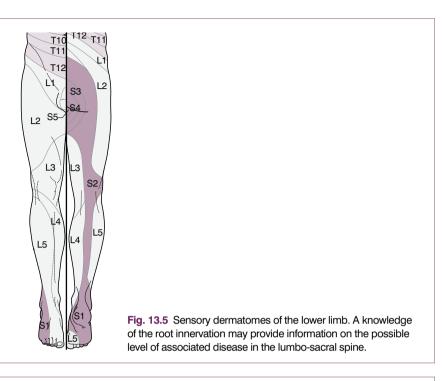
Sensory system. Exam ine the patient's sensibility to touch and pin prick, paying particular attention to the sites of any impairment. A knowledge of the innervation of the dermatomes (Fig. 13.5) is essential as this may give an indication of the level of any nerve roots affected. When indicated, test also the sensibility to deep stimuli, joint position, vibration, and heat and cold.

Reflexes. Compare on the two sides the knee jerk (dependent mainly on the L4 nerve) and the ankle jerk (mainly S1). It is important to note not only the presence or absence of the response, but also any difference of intensity (Fig. 13.6). Test the plantar reflex.

Electrom yography. Electrom yographic exam ination of selected m uscles in the low er leg m ay have an occasional place in helping to establish whether or not there is degeneration in the innervating lum bar or sacral nerve, as indicated by abnorm al potentials in the resting m uscle. For instance, abnorm al potentials in the lateral half of the gastrocnem ius m uscle or in the extensor digitorum brevis suggest degeneration of the fifth lum bar nerve, whereas abnorm al potentials in the medial half of the gastrocnem ius or in the soleus indicate the first sacral nerve.

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Trunk and spine



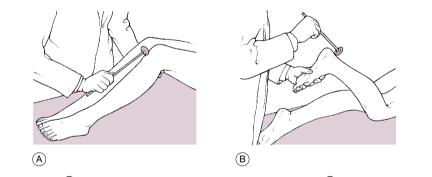


Fig. 13.6 The patellar reflex is dependent mainly on L4 nerve. ^(B) In testing the calcaneal reflex (mainly S1 nerve), slight inequalities between the two sides can best be detected if the patient lies prone, with the knee flexed 45° and the ankle at 90°.

Imaging

Rad graphic examination. If th e com plaintis clearly localised to the thoracic antero-po an d lateral radiographs o f th a t area ususterior w ill a 11 suffice. If th spine i s the part com plained of, radiogr sh o u l d m -posterior and lateral views of the lum bar spine but also in c lude not only ante stone view of the sacro-iliac joints, pelvis, and hip joints. In cases of doubt a t l additional projections may be required. O blique projections – from half right and half left – are essential for the proper study of the sacro-iliac joints and the posterior intervertebral (facet) joints of the lum bar region. If a spinal tum our is suspected further im aging with m agnetic resonance scanning is required.

O ther m ethods of im aging. Radioisotope bone scanning (p. 21) is of particular value in exam ination of the spinal colum n, especially in the early detection of m etastatic deposits.

Computerised tomography (CT scanning) (p.12) is valuable in selected cases. It gives cross-sectional im ages of the trunk that reveal bony abnorm alities very clearly.

M agnetic resonance im aging (MRI) is even more informative in demonstrating the intervertebral disc substance, the nerve roots, other soft tissues, and their relationship to the bony structures.

D iscography (radiography after injection of radio-opaque fluid into the nucleus pulposus) indicates the integrity or otherwise of the disc, but the technique has been largely superseded by magnetic resonance imaging.

Extrinsic sources of back pain and sciatica

The back offers m any pitfalls in diagnosis. Som etim es there are no local sym ptom s to indicate that the spine is the seat of the disorder, pain being referred entirely to the buttock or to the low er lim b. Thus patients often com plain only of pain 'in the hip' or 'in the leg' when the true source of the trouble is the lum bar spine. Conversely, the sym ptom s m ay suggest a spinal lesion when in fact they arise from an affection of the abdom en, pelvis, or low er lim b, or from occlusion of a major artery or a leaking aortic aneurysm. Finally, it should alw ays be rem em bered that back sym ptom s m ay be no more than a local manifestation of a generalised skeletal disease.

Thus the investigation of back or sciatic symptoms must extend further than a study of the spine itself; it must include an examination of the abdomen, pelvis, lower limbs, and vascular system, and a general survey of the rest of the body.

CONGENITAL ABNORMALITIES AND DEFORMITIES

LUMBAR AND SACRAL VARIATIONS

M in or variations of the bony anatomy are common, especially in the lumbar and sacral regions. M ost are of little practical importance. They include: deficient or rudimentary lowest ribs; incomplete or complete incorporation of the fifth lumbar vertebral body in the sacrum (sacralisation of the fifth lumbar vertebra); persistence of the first sacral segment as a separate vertebra (lumbarisation of the first sacral vertebra); and over-development of the fifth lumbar transverse process on one or both sides with, in marked cases, a false joint between the hypertrophied process and the ilium (Fig. 13.7A). In the lastmentioned condition the false joint is sometimes a source of pain.

HEMIVERTEBRA

In this anom aly a vertebra is form ed in one lateral half only. The defect may occuratany level. The body of the half-vertebra is wedge-shaped, and the spine is angled laterally at the site of the defect (Fig. 13.7B). This anom aly is a rare cause of scoliosis.

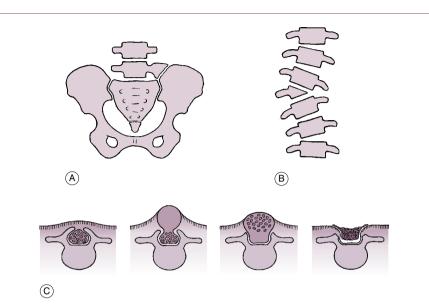


Fig. 13.7 Three congenital anomalities of the spine. A Hypertrophied transverse process forming false joint with ilium. $^{\textcircled{B}}$ Hemivertebra, an occasional cause of scoliosis. ${\mathbb G}$ Four examples of spina bifida. In all, the neural arch of the vertebra is deficient posteriorly. In the first diagram, representing spina bifida occulta, there is no other deficiency; the skin and soft tissues are intact. In the second diagram overlying soft tissues are also deficient and the spinal theca bulges backwards to form a meningocele. In the third diagram nerve elements are also displaced backwards within the bulging sac (myelomeningocele). In the final diagram skin is deficient as well, and nerve elements are exposed on the surface (rachischisis).

SPINA BIFIDA (Spinal dysraphism)

basic fault in spina bifida is a failure of the em bryonic neural plate to fold closed neural tube, or of mesodermal tissue fully to invest the it d o es in the normalembryo to form the vertebral arch with its d the surrounding muscles and ligaments. Different grades shown in Figure 13.7C. of th anom alv are

In most cases spina bifida is of minor degree and not a cause of disability. Indeed it is often found incidentally during radiography for some other reason. The importance of spina bifida lies in the fact that in the more severe forms there is a co-existing lesion of the nerve elements. The subject of spina bifida with neurological involvement was discussed in Chapter 11 (p. 171).

SCOLIOSIS

The term scoliosis denotes lateral curvature of the spine. The deform ity may be uctural', im plying a permanent change in the bones or soft tissues, or it may om ore than a tem porary disturbance produced by reflex or postural activbе ity of the spinal m uscles. Five types can be recognised:

- infantile scoliosis, a type seen in very young children which may either resolve to normal or become progressively worse
- primary or 'idiopathic' structural scoliosis, a well-defined group of unknown cause arising in children
- secondary structural scoliosis, a m iscellaneous group in w hich the curvature is secondary to a dem onstrable underlying disorder
- 4. com pensatory scoliosis
- 5. sciatic scoliosis, a tem porary deform ity.

Infantile scoliosis

Infantile scoliosis begins in the first year of life as a simple curve, usually convex to the left, without known cause. There are two subgroups - resolving and progressive - and it is usually possible to distinguish them by the radiographic appearance.

Idiopathic structural scoliosis

Id iopathic scoliosis is the commonest and the most important type of structural scoliosis. It begins in childhood or adolescence and tends to increase progressively until the cessation of skeletal grow th. It sometimes leads to severe and ugly deformity, especially when the thoracic region is the part affected. The exact cause of the grow th disturbance is unknown: the children are otherwise healthy. The condition is much commoneringirls than in boys. This fact, together with its frequent onset at puberty, suggests a possible link with the horm onal control of bone grow th. Recent evidence has suggested a genetic link with the disorder and several candidate genes are currently under investigation.

Pathology. A ny part of the thoraco-lum bar spine may be affected. There is a prim ary structural curve, with secondary compensatory curves above and below. The pattern of curve and its natural evolution are fairly constant for each site, and the follow ing types are recognised: lum bar scoliosis, thoraco-lum bar scoliosis, and thoracic scoliosis (Fig. 13.8 A). The lateral curvature is constantly accompanied by rotation of the vertebrae on a vertical axis, the body of the vertebra rotating tow ards the convexity of the curve and the spinous process aw ay from the convexity. By thrusting the ribs backw ards on the convex side this rotation increases the ugliness of the deform ity (Fig. 13.8).

Clinical features. The onset is usually in middle childhood - often between the ages of 10 and 12 years, at the time of the adolescent grow th spurt.

In children deformity is usually the only symptom. Pain is occasionally a feature in adults with long-standing deformity, particularly with structural curves in the lumbar region of the spine.

Course and prognosis. The outlook depends upon the age at onset and upon the site of the prim ary curve. The ultim ate visible deform ity tends to be worst in thoracic scoliosis and least in lum bar scoliosis. The curvature tends to increase until the end of the period of spinal grow th, but not significantly thereafter. In general, therefore, the earlier the onset the worse the prognosis.

Treatm ent. The first essential is to assess the prognosis for progression of the deform ity from a consideration of the age of onset and the site and severity of the curve. This requires the identification of the first and last vertebrae in the prim ary curve and the measurem ent of the Cobb angle between them on an erect AP radiograph of the spine (Fig. 13.9). When the prognosis is good (for instance, in most cases of lum bar scoliosis) expectant treatment, with regular





Fig. 13.8 (a) Idiopathic scoliosis in an adolescent girl. The main curve is in the thoracic region. There is marked rotation of the vertebrae, causing posterior prominence of the ribs on the side of the convexity. In lumbar scoliosis the deformity is much less noticeable. (b) In forward flexion the ugliness of the deformity caused by the backward rotation of the ribs on the convex side of the curve becomes more apparent.

uired. clir logical re m o n t h s, ma B I poor (as i n thoracic scolio sis i s 4 5 - 5 0) active treatm ent i s advised. This u sitates d uch surgical endeavour has been spent in t h for an m a u s t correctin g the deform ity and m the corth o d o f a in t until early h ile fusion occurs Surgical treatm ent is u su a llv deferred of height which m fusion of a a d o m im is e th e loss a v lt from of the growing spine. To prevent further deterioration in the significant length aiting period, conservative management with various C 11 P durin t h is w types orth otic bracing has been used

the brace most commonly employed M ilw aukee For man w a s th e brace. This used the principle of three-point correction by distracting the spine additional lathei e e n а n elvic band and an occipito-cervical support. with applied to the chest wall at the apex of the curvaera pressure from а nad ture. Recently doubt has been cast on the effectiveness of this type of bracing, and because of frequent problems of acceptance by the patient, an alternative

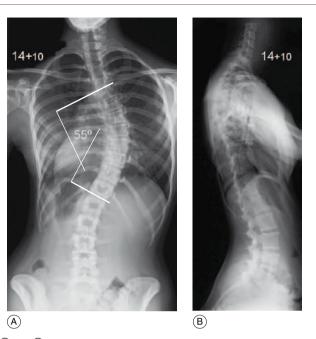


Fig. 13.9 (A) and (B) Radiographs of thoraco-lumbar spine in an adolescent girl with an idiopathic scoliois. The measurement of the Cobb angle on the AP film shows a severe curve of 55° that would justify surgical treatment.

under-arm thoraco-lum bar jacket, or Boston brace (Fig. 13.10), has been used. This provides only two-point correction and it acts by flattening the lum bar lordosis; thus it is most suitable for low er curvatures with an apex below the ninth thoracic vertebra.

The principle of surgical treatment is to fuse the joints of all the vertebrae with in the primary curve, after having first achieved the greatest possible correction of the curvature. W hen surgical treatment w first in troduced correction was obtained by pre-operative traction or corrective plaster casts. It is now routinely gained at the time of operation by the use of an internal corrective im plant. For many years the device used for this purpose was the Harrington distraction rod. This was inserted posteriorly in the concavity of the curve between two hooks placed under the laminae of the top and bottom brae and then forcibly elongated to produce straightening. The results from th is technique were encouraging, with up to 50% correction of the lateral curvature, though this was not reflected in improvement of the cosmetic deformity, which largely results from vertebral rotation. This led to a search for other methods of correction including the use of anterior interbody fixation devices, though these necessitated thoracotomy with its associated morbidity in terms of decreased lung function. Currently most specialist surgeons favour posterior correction with multiple-level segmental pedicle screw fixation devices (Cotrel-Dubousset instrum entation) (Fig. 13.11). This was an advance over the Harrington instrum entation because it im proved correction in both the sagittal and coronal planes.



Fig. 13.10 Front and back view of a thoraco-lumbar moulded orthosis used for the conservative treatment of scoliois. The brace does not correct the deformity, but may prevent further deterioration of minor curves until skeletal maturity is reached.

O ther methods of fixation and correction may be required for more severe curvatures, or when abnorm al vertebral pathology exists, as in congenital curvatures which may include a kyphotic component.

The place of these various specialised techniques has not yet been finally established: they all carry a risk of neurological com plications and require in traoperative spinal cord monitoring, which is only available in specialist centres.

It must be emphasised that it is impossible to prevent the increase of a progressive scoliotic deform ity by exercises alone, though these are an im portant adjunct to bracing, and useful in preserving mobility. The aim of all treatment m ust be to m inim ise progression, or to correct the deform ity to an acceptable level at skeletal maturity. It is difficult and often impracticable to correct longstanding deformity in adults by any method.

Secondary structural scoliosis

In this group the spinal curvature is secondary to a demonstrable underlying abnorm ality.

Causes. The three com m onest underlying causes are congenital abnorm alities (especially hem ivertebra), poliom yelitis with residual weakness of the spinal m uscles (paralytic scoliosis), and neurofibrom atosis.

Pathology. In congenital hem ivertebra there is a sharp angulation at the site of the anom aly, with compensatory curves above and below (Fig. 13.7B). Scoliosis following poliomyelitis is explained by unequal pull of the muscles on the two

Trunk and spine

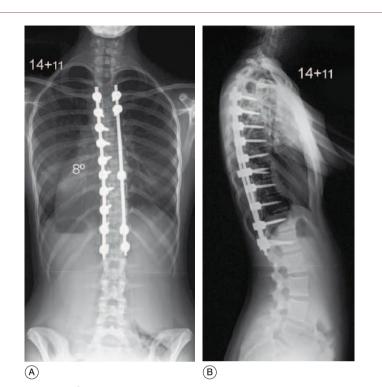


Fig. 13.11 (a) and (b) Radiographs of the same patient shown in Figure 13.9 after surgical correction and fusion with segmental pedicle fixation which has reduced the curve to 8° .

sides. The mechanism of scoliosis complicating *neurofibromatosis* is not clear; in this type the deformity may be very severe.

Clinical features. In most cases the visible deformity is the only symptom. The age of onset, site, nature, and severity of the curve vary with the underlying cause.

Complications. In exceptional cases of severe long-standing scoliosis the sharp angulation of the spinal cord over the apex of the deform ity may cause interference with cord function, with consequent neurological manifestations leading in the worst cases to total paralysis below the level of the obstruction.

Treatment. In most cases treatment is along the lines suggested for idiopathic scoliosis.

Compensatory scoliosis

Lum bar scoliosis is seen as a compensatory device when the pelvis is tilted laterally – as, for instance, when the low er lim bs are unequal in length, or when there is a fixed abduction or adduction deform ity at one or other hip. In such a case it is only by curving the lum bar spine through an angle equal to the pelvic tilt that the trunk can be held vertical. Usually there is no intrinsic abnorm ality of the spine itself, and the scoliosis disappears autom atically when the pelvic tilt is corrected. In cases of many years' duration, how ever, the lum bar scoliosis may become fixed by adaptive shortening of the tissues on the concave side.

Sciatic scoliosis

Sciatic scoliosis is a tem porary deform ity produced by the protective action of muscles in certain painful conditions of the spine.

Cause. In many cases the underlying cause is a prolapsed intervertebral disc im pinging upon a lum bar or sacral nerve. But the deform ity may also be observed in some cases of acute low back pain (p.241), the pathogenesis of which is not entirely clear.

Pathology. The curve is in the lumbar region. The abnormal posture is assumed involuntarily in an attempt to reduce as far as possible the painful pressure upon the affected nerve or joint, usually from a lumbar disc protrusion.

Clinical features. The predom inant feature is severe back pain or sciatica, aggravated by movements of the spine (see prolapsed lum bar intervertebral disc, p. 236). The onset is usually sudden. The scoliosis is poorly compensated; so the trunk may be tilted over markedly to one side (see Fig. 13.27, p. 238). The curvature is not associated with rotation of the vertebrae.

Treatment. The treatment is that of the underlying condition.

KYPHOSIS

K yphosis is the general term used to define excessive posterior curvature of the spinal column. The deform itym ay take the form of a long rounded curve ('round back'), or therem ay be a localised sharp posterior angulation ('hump back').

In the thoracic region there is norm ally a considerable posterior curvature: thoracic kyphosis exists only if this curve is excessive. In the cervical and lum bar regions there is norm ally an anterior curvature (lordosis): any reversal of this constitutes cervical or lum bar kyphosis.

Causes. Kyphosis is a manifestation of an underlying disorder of the spine. The causes are numerous. The follow ing are the most important:

- 1. tuberculosis of the spinal colum n
- 2. wedge compression fracture of a vertebral body
- 3. Scheuermann's kyphosis
- 4. ankylosing spondylitis
- 5. osteoporosis
- 6. destructive tum ours of the spinal colum n (especially metastatic carcinoma).

Treatm ent. The treatm ent is that of the underlying condition. Often the deform ity is best accepted unless it is unduly severe.

LORDOSIS

Lordosis is the opposite deform ity to kyphosis. The term denotes excessive anterior curvature of the spinal column ('hollow back'). In practice, lordosis is seen only in the lumbar region, where a slight anterior curve is normal. Strictly, the term lordosis should be used only when this normal curve is exaggerated.

Causes. Spinal disorders tend to cause kyphosis or scoliosis rather than lordosis. In m any cases lordosis is simply a postural deformity, predisposed to by lax muscles and heavy abdomen. Sometimes it is compensatory, balancing a kyphotic deformity above or below, or a fixed flexion deformity of a hip.

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TUBERCULOSIS OF THE THORACIC OR LUMBAR SPINE (TUBERCULOUS SPONDYLITIS; POTT'S DISEASE)

Tube rculosis of thoracic or lum bar vertebral bodies was formerly one of the i 1 1 n revalent

a t the anterio 0 r a l dis (Fig. 13.12A). The disc its e l f ally i n a t t h e destruction varies wide destruction of one intervertebral partial diec vertebrae, most marked anteriorly (Fig . 13.12B). ten d over several spinal segments; or, on other m th e han thev ed to a single intervertebral disc, without e nthone (Fig. 13.13A). A nterior collapse of the affected vertebrae lead to an an t yphosis (Figs 13.12B, 13.13B and 13.14). angula

A bscess form ation is usual. In the thoracic region pus collects around the spinal column. paraspinal abscess (F ig. 13.14): or thesu ribs From the lower thoracic or lum e e n ah in d th e fascial sheath of the psoas m 11 6 0 erally ent behind the iliacus fascia to form c 0 m scess). An abscess occasionally points i n iliac fo a h рo i n t h thigh. А m ost instances of skeletal tuberculosis, the inflam mation is i n lo w and chronic rather than acute: hence the term 'cold abscess' for the quiet suppuration that is a common feature.

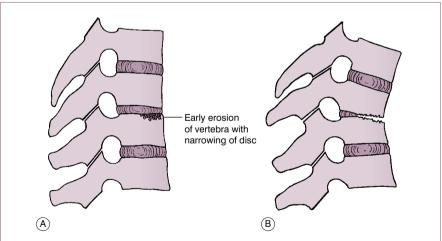


Fig. 13.12 Tuberculosis of the spine. The infection begins anteriorly near an intervertebral disc, which is soon destroyed (A). It may spread to adjacent vertebrae, which collapse in front, with consequent angular kyphosis \mathbb{B} .

Percival Pott (1714–1788) London surgeon who worked at St. Bartholomew's Hospital and described the paraplegia from spinal disease in 1779 as well as the ankle fracture that bears his name.

Trunk and spine

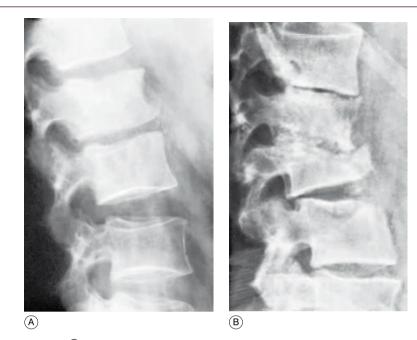


Fig. 13.13 (A) Early tuberculous lesion causing a narrowed lumbar disc space in a young adult. Narrowing of a disc space without osteophytic spurring of the vertebral margins always suggests infection. (B) Severe tuberculous erosion of two lumbar vertebrae, with anterior collapse. The vertebra below also shows erosion at its upper anterior corner. One intervertebral disc is destroyed and the one above is much narrowed.

Secondary effects. An abscess or mass of granulation tissue encroaching upon the spinal canal may interfere with the spinal cord or with a spinal nerve. In cases of long-standing severe kyphosis the spinal cord is occasionally damaged by the bony ridge at the site of deform ity.

Clinical features. The disease is commonest in young adults. One or more of the following symptoms may be present:

- 1. pain in the back
- 2. stiffness of the back
- 3. visible deformity of the back (kyphosis)
- 4. localised swelling (abscess)
- 5. weakness of legs or visceral dysfunction from involvement of the spinal cord.

On exam in ation, the patient often looks ill. There may be visible or palpable angular kyphosis. There is local tenderness on firm palpation or percussion over the affected vertebrae. All spinal movements are greatly restricted and when they are attempted the spinal muscles go into protective spasm. An abscess may be detected over the thoracic wall or in the flank, iliac fossa, or upper thigh. Signs of spinal cord compression ('Pott's paraplegia') or of a nerve root lesion may be present. Tuberculous lesions are often manifest elsewhere.

Im aging. On radiographic examination the earliest signs are narrowing of an intervertebral space (Fig. 13.13A) and local vertebral osteoporosis. Later, there is

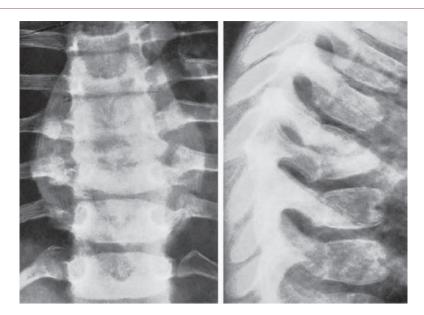


Fig. 13.14 Tuberculosis of the thoracic spine in a child. Note in the antero-posterior view the typical fusiform appearance of a paraspinal abscess, an almost constant feature of thoracic spinal tuberculosis. In the lateral view two vertebral bodies are seen partly collapsed in a wedge-shaped mass; the disc between them has been destroyed.

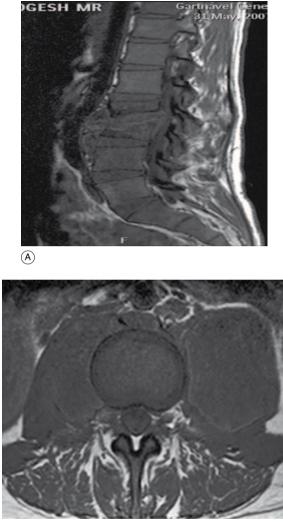
usually destruction of bone at the anterior margin of one or more of the vertebral bodies, leading to anterior collapse and wedge-shaped deform ity of the affected vertebrae (Figs 13.13B and 13.14). An abscess shadow is nearly always visible: in the thoracic region it is seen as a fusiform paraspinal shadow (Fig. 13.14); in the lumbar region it is indicated by lateral bulging of the psoas outline, usually on one side. In the healing stage the bone outline in the area of destruction becomes sharper, and norm al density is regained. Abscesses may become calcified. *M agnetic resonance im aging (M R I)* is useful in defining the extent of the softtissue abscess more clearly, especially if there are signs of spinal cord dysfunction (Fig. 13.15). *U ltrasound scanning* is useful in defining the extent of an abscess.

Investigations. The erythrocyte sedimentation rate is raised in the active stage. The Mantoux test is positive. Tubercle bacilli can sometimes be isolated from aspirated pus.

Complications. These include:

- 1. chronic discharging sinus
- 2. tuberculous infection of other organs, such as meninges, kidneys, or lungs
- 3. interference with the spinal cord, causing weakness or paralysis in the
- lower lim bs with or without sensory im pairm ent or disturbance of bladder and bowel function ('Pott's paraplegia').

Paraplegia may arise early – that is, during the active stage of the disease – when it is caused by the pressure of pus or granulation tissue; or it may arise many years after healing has occurred, from mechanical impedance of the spinal cord where it is sharply angled at the apex of a severe kyphos ('late onset paraplegia').



(B)

Fig. 13.15 (A) Tuberculous infection of the lumbar spine shown on sagittal MR scan. The L2 disc is destroyed as are the adjacent end vertebral endplates and a soft-tissue mass is seen anterior to the spine with some abnormal soft tissue also extending into the spinal canal. (B) An axial T2 scan demonstrates large fluid-filled para-spinal masses, which are the 'cold' psoas abscesses typical of tuberculous infections.

Prognosis. The prognosis is worse in certain Asian and African countries where the disease tends to be more florid, than in Britain, North America and the Antipodes where it is usually mild and responsive to treatment.

Treatm ent. Treatm ent of spinal tuberculosis is now much more often ambulatory than it was in the past, largely because of the efficacy of antituberculous drugs. Now adays treatment may entail only a briefstay in hospital - or indeed it may often be carried out entirely on an out-patient basis.

Conservative treatment. Conservative management relies almost entirely upon antibacterial agents. Results from long-term controlled trials have now shown that short-course regimens based on isoniazid, rifam picin and pyrazinamide for six to nine months are as effective as longer-term treatment for up to 18 months with the addition of streptom ycin. In more severe disease local treatment for the spine may be required by a short period of bed rest or immobilisation by a plaster jacket for relief of pain, but in most cases antibiotic treatment can be continued on an ambulant outpatient basis. A djuvant operation may be required in certain circum stances, mainly for the drainage of an abscess.

- An abscess that is superficial should be either aspirated or drained by sim ple incision followed by im mediate suture of the wound
- 2. A paraspinal abscess in the thoracic region may be drained from the back by removing the head and neck of a rib and the adjacent transverse process (costo-transversectomy).

W ith this regimen, satisfactory healingm ay be expected in a high proportion of patients, though often with some residual kyphosis.

Operative treatm ent. The alternative management is by radical operation as developed by Hodgson in Hong Kong. This may promote more rapid healing. The affected part of the spinal column is approached anteriorly and all diseased bone is excised. Thereafter the gap is bridged by bone grafts. A djuvant antibacterial agents are given. By this method the duration of treatment is shortened and kyphosis may often be prevented or corrected.

R elief of paraplegia. If paraplegia from compression of the spinal cord does not show rapid improvement after the commencement of antibacterial therapy the spinal canal should be decompressed by operation. Occasionally this may be achieved by costo-transversectomy alone (see above), particularly if a paraspinal abscess is the chief factor responsible for the compression. More reliably, it may be done by clearance of pus, necrotic tissue and diseased bone from the region of the spinal theca, either through an anterior approach or through a lateral route by unilateral excision of the pedicles of three or four vertebrae (lateral rhachotomy; antero-lateral decompression).

A ssessment of cure. Signs of quiescence are: good general health; dim inishing blood sedim entation rate; and arrest of the destructive process with hardening of the bony outlines as seen radiographically.

PYOGENIC INFECTION OF THE THORACIC OR LUMBAR SPINE (Pyogenic spondylitis; osteomyelitis of the spined; discitis)

Pyogenic infection of the spine is uncommon. It has often been confused with tuberculous spondylitis, which it may resemble clinically and radiographically, though it tends to run a more acute course.

Cause. It is caused by infection with the staphylococcus, streptococcus, pneum ococcus, or occasionally with other bacteria such as the typhoid bacillus or other salm onella organism s, or *Brucella abortus*.

Pathology. Organisms usually reach the spinal column through the general blood stream, from a septic focus elsew here. O ther possible routes are through the

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spinal venous plexus from a focus in the pelvis, or through lymphatic channels from a neighbouring focus. As in tuberculous spondylitis, there is destruction of an intervertebral disc and erosion of the adjacent bone, with or without abscess form ation. The spinal cord may be dam aged by pressure, or by throm bosis of its vessels.

Clinical features. The clinical picture is inconstant: there are remarkable variations in the severity of the symptoms from case to case. The onset is often acute or subacute, and may be accompanied by pyrexia, with local pain and restriction of all movem ents by muscle spasm. A suppurative process elsew here in the body is usually present or has recently subsided; or infection may follow operation for removal of displaced disc material, with consequent 'discitis'.

Im aging. Radiographs show local rarefaction or erosion of bone, dim inution of disc space, and som etim es sub-ligam entous new bone form ation. M R I scanning m ay also reveal the extent of soft tissue and bone involvem ent by the infective abscess (Fig. 13.16). A fter healing, spontaneous bony fusion of affected vertebrae is often observed.

Investigations. The erythrocyte sedimentation rate is raised. Polymorphonuclear leucocytosis is to be expected. Serological studies can occasionally incriminate a particular organism, such as one of the salmonella group.

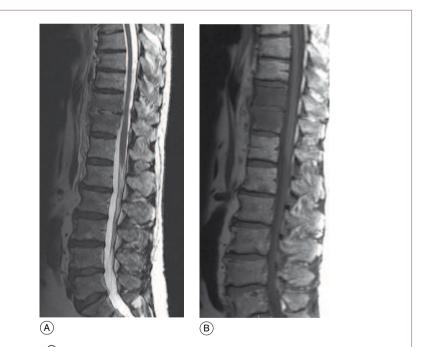


Fig. 13.16 (A) Sagittal MR scan of thoraco-lumbar spine with disc infection. In the lower thoracic region there is a narrowed disc space (arrow) which shows high signal on T2 indicating the presence of fluid. The discs above and below this level appear normal. (B) Sagittal T1 image of the same patient showing that the vertebrae on either side of the disc are of much lower signal. This indicates the presence of marked bone oedema and combined with the fluid in the narrowed disc allows a diagnosis of infective discitis to be made.

Treatm ent. A ppropriate antibacterial drugs are given. The spine is rested, at first in bed, but later with a suitable brace, until healing occurs. A n abscess m ay require early drainage, especially if the spinal cord is threatened.

RHEUMATOID ARTHRITIS OF THE SPINAL JOINTS (General description of rheumatoid arthritis, p. 134)

It has been noted above that rheum atoid arthritis often affects the cervical spine. Joints of the thoracic and lum bar spine may likewise be affected, but clinical manifestations are relatively uncommon. They consist in aching pain of a rather diffuse type, with impairment of spinal movements. The symptoms develop insidiously, without preceding injury. Examination of the limbs will usually reveal typical rheumatoid changes in several joints.

OSTEOARTHRITIS OF THE THORACIC AND LUMBAR SPINE (Spondylarthritis; spondylarthrosis; spondylosis)

O steoarthritis of the thoracic or lum bar intervertebral joints is found very commonly in those used to heavy work, but it is not necessarily accompanied by symptoms.

Cause. Predisposing factors are:

- 1. previous injury to the spinal joints
- previous disease involving the joints (for example, Scheuermann's kyphosis or an intervertebral disc lesion).

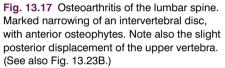
As in other joints the cause of degeneration is unknown, but may be the manifestation of an ageing process in the cartilage tissue.

Pathology. The changes affect the central intervertebral (body-to-body) joints and the posterior intervertebral (facet) joints. One segment or several segments may be affected. In the central joints, which are affected first, there is degeneration with consequent narrowing of the intervertebral disc, and hypertrophy of bone at the joint margins leads to the formation of osteophytes (Fig. 13.17). In the posterior intervertebral (facet) joints the changes are those of osteoarthritis in any diarthrodial joint - namely, attrition of the articular cartilage and osteophyte formation (spurring) at the joint margins. These changes in the facet joints are probably the more important from a clinical point of view.

Secondary effects. Rarely, osteophytes encroach upon an intervertebral foram en sufficiently to interfere with the function of the issuing nerve. Thinning of the articular cartilage of the posterior intervertebral (facet) joints reduces the stability of the affected segm ent and predisposes to one type of spondylolisthesis (p. 242). In severe cases the osteophytes around the facet joints may encroach on the spinal canal resulting in the syndrom e of spinal stenosis (p. 245).

Clinical features. Spinal osteoarthritis can exist in quite marked degree without causing symptoms. But there is often a complaint of aching pain in the affected area, worse on activity or after prolonged standing or sitting in one position, and especially after stooping or lifting. Pain is often worse first thing in the morning, and there may be a feeling of stiffness when rising from a sitting position. In the lumbar region there is a tendency to acute exacerbations of pain, usually arising suddenly and lasting a few weeks. These are possibly explained by strain or momentary subluxation of an unstable degenerate joint. Interference with a nerve Trunk and spine





in a narrow ed intervertebral foram en leads to radiating pain in the distribution of the affected nerve (girdle pain or sciatica according to the level affected).

On examination in the quiet phase, the objective findings are slight. Spinal movements may be moderately restricted, especially flexion; but there is no muscle spasm. If there is interference with a lum bar nerve root straight leg raising on the affected side is likely to be restricted. A part from this, objective neurological signs are exceptional. During an acute exacerbation of pain there may be marked im pairment of spinal movements, with muscle spasm.

R adiographic features. The changes are most obvious in the central (bodyto-body) intervertebral joints, which show narrowing of the intervertebral space and osteophyte formation (spurring) at the joint margins (Fig. 13.17). Later the posterior intervertebral (facet) joints also show changes: there is narrowing of the joint space with sharpening of the margins of the facets. These changes are seen clearly only in oblique projections or on CT scans.

D iagnosis. O steoarthritis has to be distinguished from other causes of back pain and from other causes of radiating nerve pain (girdle pain or sciatica) (see Fig. 13.29, p. 240). It should be remembered that the demonstration of osteoarthritic changes in the radiographs does not necessarily mean that the arthritis is the cause of a patient's symptoms, for spinal osteoarthritis is common and often painless. The diagnosis is always presumptive rather than proved, and it is justified only when other possible causes have been excluded by careful consideration of the history, clinical examination, and radiographs.

Treatm ent. This depends upon the severity of the disability. In mild cases treatm ent is unnecessary: explanation and reassurance suffice.

Thoracic spine. In osteo arthritis of the thoracic spine the symptoms are seld om severe, and if treatment is required a course of active spinal exercises to strengthen the posterior muscles is usually sufficient.

Lumbarspine. In lumbar osteo arthritis with moderate disability a well-fitted surgical corset (orthotic brace) will usually afford adequate relief. Physiotherapy, mainly by exercises and passive mobilisation, may also be helpful. Heavy lifting and similar strains to the back should be strictly avoided. Rarely, if the pain from a localised lesion is bad enough to cause serious hardship, operative fusion of the affected segments of the spine may be required.

ANKYLOSING SPONDYLITIS

In ankylosing spondylitis there is chronic inflam mation, progressing slow ly to bony ankylosis, of the joints of the spinal column and occasionally of the proximal limb joints.

Cause. This is unknown, but may represent an auto-immune response to an infecting organism. The condition is distinct from rheumatoid arthritis, although it has sometimes been loosely termed 'rheumatoid spine'. There is a strong hereditary link to the HLA-B27 gene, which is present in 80-90% of patients. There is also a relationship with certain types of sero-negative chronic juvenile arthritis in members of the family.

Pathology. The disease usually begins in the sacro-iliac joints, whence it usually extends upwards to involve the lumbar, thoracic, and often the cervical spine. In the worst cases the hips or shoulders are also affected. The articular cartilage, synovium, and ligaments show chronic inflammatory changes and eventually they become ossified. A fter several years the inflammatory process becomes quiescent.

C linical features. The disease has a strong m ale preponderance (M :F = 3:1) and it nearly alw ays begins between the ages of 16 and 25. The early symptoms are aching pain in the lower back and increasing stiffness. Later, the pain migrates upwards. D iffuse radiating pain down one or both lower limbs is also common. On examination the predominant finding is marked limitation of all movements in the affected area of the spine ('poker back'). When the thoracic region is involved chest expansion is markedly reduced - often to less than 2.5 cm (normal = 7.5 cm) - from ankylosis of the costo-vertebral joints: this is an important diagnostic feature. In a few cases the hips or shoulders are affected, with pain and limitation of movement.

Im aging. Radiographs in the early stage show fuzziness and widening of both the sacro-iliac joints, so that the joint outline is no longer clearly defined (Fig. 13.18). M RI scanning is farm ore sensitive in detecting these early changes in the sacro-iliac joints (Fig. 13.19). Later, the sacro-iliac joints are completely obliterated and, if the disease progresses, the intervertebral joints in the lum bar, thoracic, and som etim es even the cervical region undergo bony ankylosis, with prominent anterior bridging of the vertebral bodies producing the so-called 'bam boo spine' (Fig. 13.20).

Investigations. The erythrocyte sedimentation rate and C-reactive protein levels are raised while the disease is active. In 90% of cases the test for HLA-B27 antigen is positive.

D iagnosis. In the early stages ankylosing spondylitis has to be distinguished from other causes of back pain and sciatica (see Fig. 13.29, p. 240). The marked lim itation of spinal movement, the reduced chest expansion, the typical radiographic features, and the raised erythrocyte sed imentation rate are diagnostic.

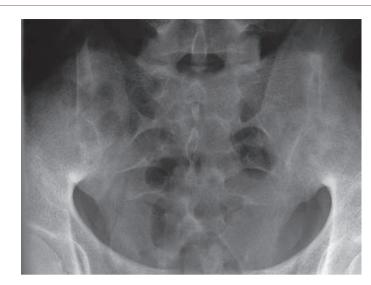


Fig. 13.18 AP radiograph of sacroiliac joints. The joints are completely fused showing the typical appearances of advanced sacroiliitis seen in ankylosing spondylitis.

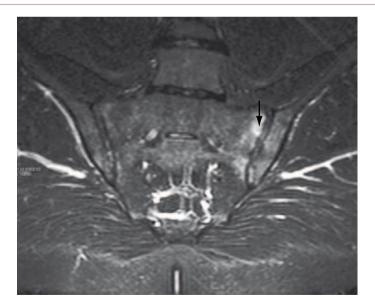


Fig. 13.19 Coronal T2 weighted MR scan of sacroiliac joints in ankylosing spondylitis. There is oedema seen as high signal on either side of the left SI joint (arrow), which indicates an active sacroiliitis. The MR scan is much more sensitive than plain radiographs at detecting early changes in the disease.

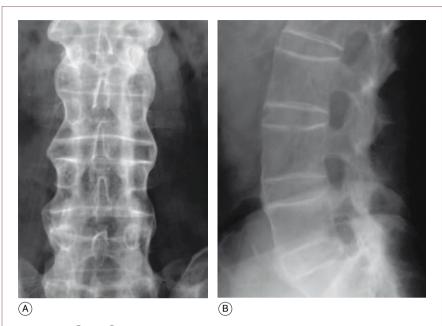


Fig. 13.20 (A) and (B) Radiographs of a fused lumbar spine in advanced ankylosing spondylitis. There is ossification of the anterior longitudinal ligament and of the annulus of the discs at all levels giving the so-called 'bamboo spine' appearance typical of the disease.

Course and complications. The disease usually ceases to progress after ten or fifteen years, leaving permanent stiffness, the extent of which varies widely from case to case. Complications include fixed flexion deformity of the spine (Fig. 13.21A), intercurrent respiratory infections, and iridocyclitis, which in severe cases may lead to blindness. There is also a relationship with Crohn's disease (regional ileitis), which may co-exist.

Treatm ent. Treatm ent is rather unsatisfactory, in that no method is known by which the disease process can be halted and spinal mobility preserved. In most cases the mainstay of treatment is a non-steroidal anti-inflam matory agent in the first instance. Steroid drugs are inappropriate except for ophthalm ic complications. The advent of new biological drugs based on monoclonal antibodies has allowed anti-tum our necrosis factor alpha (antiT N F- \mathbf{C}) to be used in the early stages of the disease with moderate success, but the long-term results are not vet available.

A part from these measures, treatment should be directed tow ards preserving function and preventing spinal deformity. A ctivity rather than rest should be prescribed. Special exercises should be practised to make the most of such movement as remains. The patient should adopt the habit of sleeping flat on a firm mattress, ideally in the supine position with a single pillow, to maintain normal spinal alignment.

If a severe flexion deform ity of the spine occurs through neglect of these precautions it can result in severe functional disability. This is particularly the case when the hips are involved and develop flexion contractures in addition to the spinal deform ity. Relief may be obtained by replacement arthroplasty of both

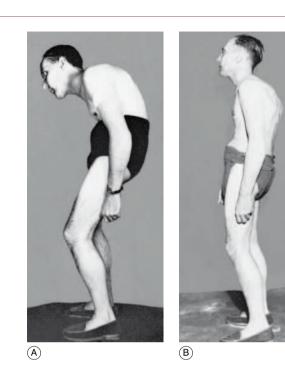


Fig. 13.21 (A) Patient with long-standing ankylosing spondylitis complicated by rigid flexion deformity. (B) After corrective osteotomy in the lumbar region.

hips to restore an upright stance. In a few patients where this fails it may be necessary to undertake a corrective wedge osteotom y of the spine in the lum bar region followed by internal fixation (Fig. 13.21). This is high-risk surgery and should only be performed by surgeons experienced in the procedure.

SCHEUERMANN'S KYPHOSIS (Adolescent vertebral osteochondritis; adolescent kyphosis)

Form erly term ed osteochondritis, Scheuerm ann's disease¹ is now regarded as unrelated to osteochondritis juvenilis (p.130) and should no longer be so called. Basically, it seems to be an intrusion of part of the intervertebral disc into the vertebral end plate at multiple levels, mostly in the thoracic region. This leads to a rounded kyphosis. The cause and precise nature of the affection are uncertain. It is uncommon.

Pathology. The vertebral bodies ossify from three centres – a prim ary centre for the middle of the body, and secondary centres for the upper and low er surfaces. These secondary centres, know n as the ring epiphyses, appear at about the time of puberty in the cartilaginous end plates that separate the vertebral

¹Holger Scheuermann (1877–1960) a famous Danish radiologist who worked at the Cripples Hospital in Copenhagen and described the deformity and its cause in 1921.

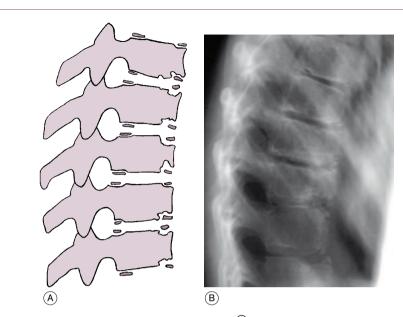


Fig. 13.22 Scheuermann's vertebral kyphosis. A In the active stage the upper and lower margins of the vertebral bodies are irregularly indented in front, and the corresponding parts of the ring epiphyses appear isolated. B Radiograph of the lower part of the thoracic spine of a man aged 20 with established kyphosis from wedging of affected vertebrae.

the adjacent intervertebral discs. In Scheuerm ann there norm al developm ent of the cartilage disturbance o f th e plates an d rin g p o s s i b l v because they are dam aged by bursting of the disc conthrough the cartilage into the subjacent vertebral body (Fig. 13.22A). The occur predom in an tly near the anterior margins of the vertebrae. eight-thrust is borne. In consequence the disc is som ew hat naranteriorly, and through deficient grow th of the affected part of the ring epiphysis the vertebral body becomes slightly wedge-shaped (Fig. 13.22B). The deformity predisposes to the later development of osteoarthritis.

Characteristically Scheuerm ann's disease affects several vertebrae in the thoracic region. O ccasionally sim ilar changes are confined to a single vertebra , and this localised form of the disease is as common in the lumbar as in the thoracic region.

Clinical feature s. The patient is usually 13 to 16 years old, and often a bov а girl. In the active stage there is pain in the thoracic w ith than som e m onths the pain subsides, leaving a rounded kyphoseverity (Fig. 13.23A). In later life there may be renewed pain fro elopment of osteoarthritis. On examination there i s slight or rounded kyphosis in the thoracic region. In the active stage there is m oderate tenderness on firm palpation over the affected vertebrae

Radiographic features. In the active stage of the disease the affected bral bodies show deep notched defects at their anterior corners, an d the corresponding parts of the ring epiphyses may be irregular in shape and size Trunk and spine

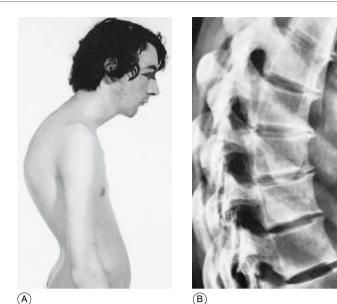


Fig. 13.23 (A) Established Scheuermann's kyphosis, showing the characteristic curvature. (B) The late effect of Scheuermann's adolescent kyphosis: slight wedging of several thoracic vertebral bodies with consequent rounded kyphosis and marked spurring of the contiguous corners of the vertebral bodies anteriorly, denoting osteoarthritis.

(Fig. 13.23B). The disc spaces are slightly narrow ed but never totally destroyed. A fter healing, there is slight antero-posterior wedging of the affected vertebral bodies. Years later, osteoarthritic spurring of the anterior vertebral margins is observed, probably as a result of the vertebral malalignment (Fig. 13.23B).

Diagnosis. In its characteristic form the affection is easily diagnosed from the history, clinical appearance, and radiographs. If localised to a single vertebra it may easily be confused with tuberculous spondylitis. Radiologically, the chief points of distinction are that in osteochondritis the margins of the notched defect in the vertebral body tend to be sclerotic rather than rarefied, and a paraspinal abscess shadow (alm ost a constant feature of thoracic spinal tuberculosis) is never seen. Furtherm ore, the erythrocyte sedim entation rate is not raised in Scheuerm ann's kyphosis.

Course and prognosis. The affection is self-lim iting, the active stage lasting for one or two years. If the epiphyses become deformed, permanent wedging of the affected vertebrae, with consequent slight or moderate kyphosis, remains as a cosmetic blemish. Osteoarthritis often supervenes in later life but it is not of major significance clinically.

Treatment. In a mild case treatment is often unnecessary. If pain is troublesome, support for the spine in extension, by a brace or plaster jacket, may be advisable. Bracing may have to be continued for up to six months, according to progress. Meanwhile active exercises to strengthen the posterior spinal muscles are encouraged. In the worst cases – a small minority – operative correction m ay be considered. Operation entails excision of intervertebral discs, with interbody grafting, in the affected region of the spine, and it usually entails posterior instrum entation to provide correction and stability. It is a major procedure and clearly must not be undertaken without very careful assessment of every facet of the problem, since at best only 40% of the deformity can be corrected.

CALVÉ'S VERTEBRAL COMPRESSION (Vertebra plana; vertebral osteochondritis)

W hereas in Scheuerm ann's disease it is the vertebral ring epiphyses that are affected, Calvé's disease affects the central bony nucleus of a vertebral body. It is generally confined to a single vertebra. It is uncom mon.

Pathology. From its radiological features and benign course, Calvé's disease was regarded as an osteochondritis. Histological studies have shown that the majority of cases are in fact caused by an *cosinophilic granuloma* (p. 72).

In a typical case the bony nucleus of one of the vertebral bodies, usually in the thoracic region, becom es soft and is condensed into a thin wafer. Later, this may re-develop to a more norm al size though it is doubtful if it is ever restored to full height. The intervertebral discs above and below are intact and unaffected.

Clinical features. The affection occurs in children of 2 to 10 years of age. The com plaint is of pain, usually in the thoracic region of the spine. On examination, there m ay be slight localised kyphosis. Percussion of the spinal column reveals deep tenderness in the affected region. Movements of the spine as a whole are impaired little, if at all.

Radiographic features. Radiographs show the characteristic extreme flattening of the affected vertebral body, which appears greatly increased in density (Fig. 13.24): it has been likened to a coin seen end on.

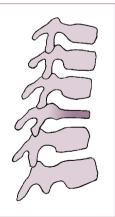


Fig. 13.24 Calvé's disease of vertebral body. The bony nucleus has shrunk into a thin dense wafer. The adjacent intervertebral discs are intact. The usual cause is eosinophilic granuloma.

¹Jacques Calvé (1875–1954) French orthopaedic surgeon; worked in TB Hospital at Berck Plage and described the vertebral condition thought to be an osteochondritis, in 1925.

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Treatm ent. Calvé's disease is non-progressive, and in practice treatm ent is required only for as long as the symptom slast. If pain is severe the child should be keptrecum bent in bed, but in most cases he may safely resume an active life without external support within a few weeks.

PROLAPSED LUMBAR INTERVERTEBRAL DISC

Herniation of part of a lum bar intervertebral disc is a common cause of combined back pain and sciatica.

Cause. Prolapse of a disc is often precipitated by injury, but it m ay also occur in the absence of any rem em bered injury. Spontaneous age-degeneration of the disc is probably an important predisposing factor.

Pathology. The discs between L5 and S1 and between L4 and L5 are those most often affected. Part of the gelatinous nucleus pulposus protrudes through a rent in the annulus fibrosus at its weakest part, which is postero-lateral (Figs 13.25 and 13.26); or sometimes the torn annulus itself protrudes backwards. If it is small, the protrusion bulges the pain-sensitive posterior longitudinal ligament, causing pain in the back. If it is large, the protrusion herniates through the posterior ligament and may impinge upon an issuing nerve to cause sciatic pain. The nerve affected is that which leaves the spinal canal at the interspace next below the site of the disc lesion. Thus the first sacral nerve is impinged upon by a prolapse between L5 and S1, the fifth lum bar nerve by a prolapse betw een L4 and L5, and so on. Natural healing is by shrinkage and fibrosis of the extruded disc material; not by its reposition within the disc.

Secondary effects. Progressive degeneration of the disc leads, after months or years, to altered joint mechanics, with ultimate involvement of the posterior intervertebral (facet) joints as well as the central (body-to-body) joints.

Clinical features. In a typical case of disc prolapse at the L4-L5 or L5-S1 level the clinical picture is clearly defined. The patient is aged between 18 and 60. A few hours or days after jarring or straining the back he or she is seized, while twisting, stooping, or coughing, with agonising pain in the lum bar region. Any

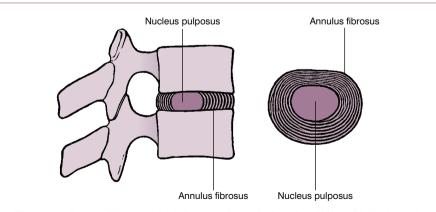


Fig. 13.25 A normal intervertebral disc seen in sagittal section (left) and in horizontal section (right).



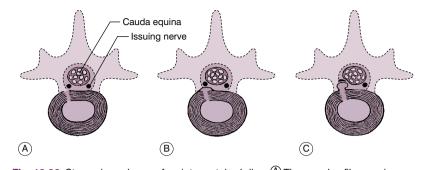


Fig. 13.26 Stages in prolapse of an intervertebral disc. ^(A) The annulus fibrosus is torn but there has been no extrusion of the nucleus pulposus. ^(B) Extrusion of nuclear material through the rent. The posterior longitudinal ligament is stretched but the protrusion has not reached the nerve. ^(C) The protrusion is larger and the nerve is stretched over it. Sometimes a fragment of the torn annulus itself protrudes backwards.

m ovem ent of the back is im possible. The acute pain gradually lessens in severity, but after a few days a radiating pain is felt in one or other buttock and dow n the back or side of the thigh to the calf and foot. Tingling or num bness is felt in the calf or foot. The pain is aggravated by coughing or sneezing.

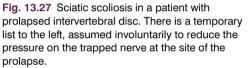
the patient with a fully developed acute attack stands either exam in ation scoliosis (sciatic scoliosis) (Fig. 13.27) or with lum bar with the norm al obliterated. Forw ard flexion is greatly restricted also may sion. Lateral flexion, on the other hand, is usually free a n d nainless one side if not to both. Straight leg raising is restricted on the affected - an important clinical sign. Careful tests m arkedlv reveal side, usually mav asting or weakness in the distribution of the affected nerve, and tendon jerk (knee jerk in L3-L4 lesions; ankle jerk in L5-S1 rresponding lesions) is im or absent

typical cases are common. Thus a definite history of injury or strain is often lacking. The pain may egin gradually rather than suddenly. bе confined to th e back and never radiate t o th e er lim b lum bag O n ther hand, the pain is som etim mild in the back. The severity lim b a n d i s relatively o f and its exact distribution depends e level of rolapse: for instance, in the relatively uncom m on cases of m id -lum bar th e L4) prolap pain radiates tow ards the groin and the front of the thigh than to the back of the thigh and leg. rather

In a severe case in which the prolapse is alm ost central there may be pressure upon the cauda equina, with consequent loss of bladder sensibility and retention of urine. This is the dangerous cauda equina syndrom e, which must be regarded as an acute surgical emergency, for in the absence of immediate effective treatment serious permanent disability is likely to ensue (see below, p. 241).

Im aging. Radiographic features. In a case of acute prolapsed disc plain radiographs do not show any abnorm ality, and the purpose of radiography is mainly to exclude other causes of back pain and sciatica. It is only when a disc has





been deranged for many months or years that appreciable narrowing of the disc space and spurring of the joint margins, denoting secondary degenerative arthritis (osteoarthritis), are observed.

M agnetic resonance im aging (M R I scanning) can show the intervertebral disc substance and the nerve roots: the bulging disc m aterial can thus be visualised directly, particularly on sagittal projection (Fig. 13.28). Discography has only an occasional place as a diagnostic tool to confirm the level of sym ptom atic disc disease.

Correlation of pathology with clinical features. The initial injury or strain m arks the tim e when the annulus fibrosus is torn or dam aged. The nucleus pulposus is very gelatinous and an interval elapses before it becom es extruded. Bulging of the extruded material beneath the posterior longitudinal ligament corresponds to the stage of acute back pain. Herniation through the ligament with im pingement against the adjacent nerve is responsible for the radiating lim b pain and, in low lum bar lesions, the restriction of straight leg raising.

Diagnosis. Prolapsed intervertebral disc must be differentiated from other causes of pain in the back or leg (Fig. 13.29). A dramatically sudden onset is alw ays suggestive of a mechanical derangement and especially of a prolapsed disc, whereas pain that increases relentlessly without intermission suggests a progressive lesion, inflammatory or neoplastic. A lthough the clinical features are often highly suggestive, definitive diagnosis rests upon appropriate im aging, preferably by magnetic resonance scans.

Treatm ent. Conservative treatment is successful in relieving the symptoms in a high proportion of cases – probably at least nine out of ten, though most of this improvement may be the result of natural healing. Prolonged bed rest,



Fig. 13.28 B and B Magnetic resonance images showing herniation of an intervertebral disc at the L5–S1 level. The indentation of the anterior aspect of the cauda equina is clearly seen in the sagittal plane and the postero-lateral protrusion of disc material confirmed in the transverse image.

other than for a few days when symptoms are most acute, should be avoided. The patient should be encouraged to mobilise but the lumbar spinemay be supported with a moulded plastic jacket or a well-fitted spinal orthosis (Fig. 13.30). The patient should be encouraged to discard the support as soon as the severe pain has subsided and mobilise the spine with physiotherapy supervision.

Inti iscal injection of chymopapain. Chymopapain is an with enzvm e property of dissolving fibrocartilaginous tissue. In je c t e d in to th e disc causes partial dissolution of the nucleus pulposus and, in a of protruding disc material. This treatment w popular for been discarded because of the risk of nerve utha s n o w dam age the enzyme into the spinal canal. In the long term there is t o leakage o f ked o f the disc space as seen radiologically. Intradiscal in je c m ethod of treatment that has been slow gain tio n of chymopapain а i n acceptance, largely because the potential dangers were not at first fully in g assessed. It may be used in selected cases as a possible alternative to excision e disc, with the advantage that operation is avoided. In most reported series the success rate in cases that would otherwise entail operation is in the order of 80%. Rarely, in advertent leakage of the enzym e into the spinal canal has led to nerve dam age and even death, but when the method is used with proper skill and with due precautions the risks are probably no greater than those of operation.

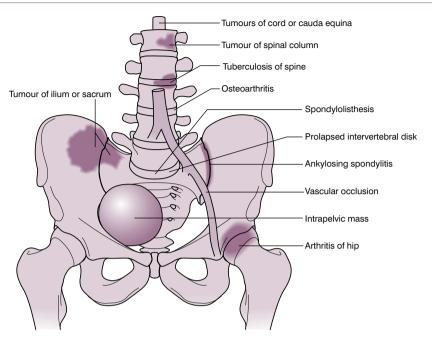


Fig. 13.29 Eleven causes of pain in the back or lower limb. All must be considered in differential diagnosis of prolapsed intervertebral disc.



Fig. 13.30 Reinforced surgical corset used for mild cases of prolapsed intervertebral disc and for certain types of chronic low back pain.

Operative treatment. Excision of the displaced disc material, or discectomy, is indicated in the following circumstances:

- when the sciatic pain is so excruciating from the beginning that it prevents sleep and leads to deterioration of the general health
- w hen severe sciatic pain is unrelieved by appropriate conservative treatm ent continued for at least 8 w eeks

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4. when severe neurological disturbance suggests massive prolapse with compression of the cauda (cauda equina syndrome). In this last condition operation must be carried out as an emergency procedure because the attendant impairment of bladder, bowel, and sexual function quickly becomes irreversible.

A t operation the disc is exposed from behind by retraction of the posterior spinal m uscles aw ay from the m id line, excision of the ligam entum flavum and perhaps part of a lam ina at the appropriate level, and gentle retraction of the theca. The protruded part of the disc forms an obvious rounded bulge, over which the emerging spinal nerve m ay be seen tightly stretched. The extruded material is rem oved, together with as much of the remaining nuclear tissue as can be pulled out from between the vertebral bodies. M any surgeons now favour excision by a magnification technique, the so-called 'microdiscectom y', utilising the operating microscope through a limited interlam inar approach using a sm all 'stab' incision. This obviates the need for extensive stripping of muscles from the back of the spinal colum n and reduces the associated post-operative morbidity, allow ing the patient a more rapid return to norm al activity.

ACUTE LOW BACK PAIN (LUMBAGO)

Back pain is a symptom rather than a disease. In a typical acute attack the patient is suddenly seized with agonising pain in the lumbar region of the spine, usually while stooping, lifting, turning, or coughing. The pain is often so severe that any movement is difficult and the patient is 'stuck'. With rest, the pain gradually subsides, but in some cases the acute back pain is accompanied by sciatica, suggesting irritation of a lumbar or sacral nerve.

The pathogenesis of acute low back pain is not entirely clear. Indeed there m ay be m ore than one cause. Probably in m any cases the underlying lesion is a prolapsed disc that has not yet been retropulsed far enough to interfere with a nerve root (Fig. 13.26B). It is in these cases that sciatica m ay develop later, as the size of the prolapse increases. But other exam ples of acute back pain are m ore convincingly ascribed to some other m echanical fault, such as sudden nipping of synovial m em brane in one of the facet joints, or m om entary subluxation at an intervertebral joint that is unstable on account of disc degeneration or degenerative arthritis. N erve irritation m ay also be the result of leakage of in flam m atory cytokines from the degenerative lum bar disc. In m ost cases acute attacks of pain m ay recur at intervals of m onths or years, with intervals of relative freedom betw een the attacks.

Treatment should be conservative and similar to that used for prolapsed lum bar intervertebral disc. Mobility should be maintained and prolonged bed rest discouraged. Mobilisation and postural retraining under physiotherapy supervision has been shown to be beneficial.

SPONDYLOLYSIS

In spondylolysis there is a defect in the neural arch of the fifth (rarely the fourth) lum bar vertebra. There is loss of bony continuity between the superior and the inferior articular processes, the deficiency being bridged by fibrous tissue

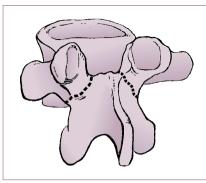


Fig. 13.31 Site of the defect in spondylolysis. There is lack of bony continuity at the isthmus of the neural arch (pars interarticularis) on each side.

(Fig. 13.31). If this stretches or gives way, the consequent vertebral displacement constitutes one variety of spondylolisthesis (see below).

Though the defect was formerly regarded as congenital it is now widely believed that it may be caused by injury; or, more specifically, it may be the result of a stress fracture in child hood or adolescence.

C linically, spondylolysis (the defect without displacement) is often symptom less, but it is som etimes a cause of deep lumbar back pain. *Radiographically*, the defect is usually best shown in oblique projections or on a CT scan.

Treatment. This is often unnecessary. A ching may be relieved by a surgical corset or belt. If pain is unusually troublesome an attempt may be made to close the defect in the pars interarticularis on each side by transfixing it with a screw and laying in slender bone grafts; or alternatively, local fusion of the spine may be undertaken (see p. 245).

SPONDYLOLISTHESIS (Lumbar spondylolisthesis)

Spondylolisthesis is the term applied to spontaneous displacement of a lumbar vertebral body upon the segment next below it. D isplacement is usually forwards: only rarely does backward displacement occur (retrospondylolisthesis).

Cause. There are three predisposing factors leading to spondylolisthesis of three distinct types:

- 1. congenital malformation of the articular processes (rare)
- 2. spondy lolysis (a defect in the pars interarticularis of the neural arch which may be developmental or the result of stress fracture) (p. 241)
- 3. osteoarthritis of the posterior (facet) joints.

Pathology. In the normal spine forward displacement of a vertebral body is prevented by engagement of its articular processes with those of the segment next below it. In spondylolisthesis there is a failure of this check mechanism, and the attachments of the intervertebral disc alone are not strong enough to hold the vertebral bodies in alignment.

In the first type of spondylolisthesis, the least common, there is a congenital basis for the displacement. The posterior intervertebral joints are unstable because the articular processes are congenitally malformed or even rudimentary: thus they form no bar to forward displacement of the spinal column (Fig. 13.32).

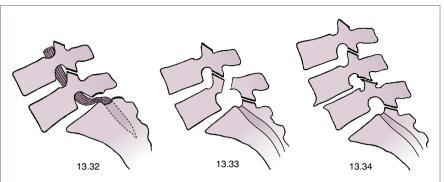


Fig. 13.32 (Left) Spondylolisthesis secondary to congenital malformation of the articular processes at the lumbo-sacral joint. The cauda equina is trapped between the body of the sacrum and the lamina of the displaced fifth lumbar vertebra. In this type of spondylolisthesis neurological signs are to be expected.

Fig. 13.33 (Middle) Spondylolisthesis due to defect of the neural arch of a vertebra, in this case affecting the fifth lumbar vertebra. The body and superior articular processes have slipped forwards, leaving the spinous process and inferior articular processes in normal relationship with the sacrum. (Radiographically the defect is seen best in oblique projections.)

Fig. 13.34 (Right) Spondylolisthesis secondary to osteoarthritis. Wearing down of the cartilage of the posterior intervertebral (facet) joints has permitted slight forward displacement of the fourth lumbar vertebra on the fifth. The condition may occur at any level in the lumbar spine.

This defect occurs most often at the lumbo-sacral joint. Displacement may be severe and, since the whole vertebra is displaced complete with its neural arch, the cauda equina may be trapped, with consequent severe neurological disturbance (Fig. 13.32).

In the second type, which is the best recognised, a defect in the neural arch of a vertebra allows separation of its two halves (see spondylolysis, and Fig. 13.33). The body, with the pedicles and superior articular processes (and the whole of the spinal column above it), slips forwards, leaving behind the lam inae and inferior articular processes (Fig. 13.33). The fifth lum bar is the vertebra usually affected, the fourth occasionally. Displacement may gradually increase, especially during adolescence, and it sometimes reaches a severe degree. There may be minor irritation of one of the issuing nerves, with consequent sciatica; but despite severe bony displacement serious interference with the nerves of the cauda equina is exceptional in this type of spondylolisthesis.

In the third type of spondylolisthesis (som etim esterm ed pseudospondylolisthesis), seen fairly commonly, the arthritic posterior intervertebral facet joints become unstable with degeneration of the articular cartilage and osteophyte formation displacing the joint surfaces (Fig. 13.34). It may occur at any level in the lumbar spine – most commonly between the fourth and fifth lumbar vertebrae. In this type the vertebral displacement is occasionally backwards rather than forwards (see Fig. 13.17), but in either case displacement is never severe, and neurological disturbance is unusual.

The intervertebral disc at the site of vertebral slipping is inevitably dam aged, and disc prolapse may occur.

C linical features. The clinical features of spondylolisthesis are inconstant: they depend to some extent upon the nature of the causative lesion and upon the degree of displacement. Thus in spondylolisthesis from under-development of the articular processes (Fig. 13.32), and in that from a defect of the pars interarticularis (Fig. 13.33), the patient is usually a young adult, whereas displacement from degeneration of the facet joints in osteoarthritis (Fig. 13.34) is seen characteristically in patients beyond middle age. In some cases the deform ity is entirely symptom less. When symptoms occur they take the form of chronic backache, with or without sciatica. The back pain is worse on standing.

On exam ination there is often a visible or palpable 'step' above the sacral crest, due to the forw ard displacement of the spinal column; but this is obvious only when the displacement is severe. Spinal movements are restricted only slightly, if at all. Abdomen: When displacement is severe the spinal column is projected forwards and the lumbar vertebral bodies may be palpable through the abdominal wall. Lower limbs: M inor irritation of a sciatic root is often evidenced by impairment of straight leg raising; but severe neurological disturbance is seldom observed except in the rare cases in which congenital malformation of the articular processes allows dislocation of the whole vertebra complete with its neural arch (Fig. 13.32).

Radiographic features. Lateral and oblique views will som etim es demonstrate a defect of the neural arch (Fig. 13.35), but CT scans will show this more clearly (Fig. 13.36).

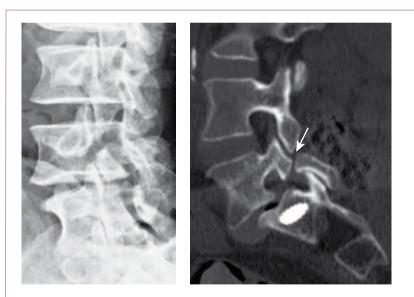


Fig. 13.35 Oblique radiograph of the lower lumbar region of a patient with spondylolisthesis, showing a defect of the pars interarticularis of the neural arch of the fourth lumbar vertebra (centre of illustration). Oblique radiographs such as this are important in the differentiation of spondylolisthesis caused by a neural arch defect from the other two types of spondylolisthesis.

Fig. 13.36 Sagittal CT scan of lumbar spine to show a defect in the pars interarticularis of the L5 vertebra (arrow). This has led to a forward slip of the L5 vertebra on the sacrum.

Non-operative treatment. Moderate symptoms are often adequately relieved by a well-fitted surgical corset and this should be tried before operation is considered.

O peration. This is justified only when the disability (from back pain or neurological disturbance) is severe. The operation entails the release of stretched or compressed nerves, followed by fusion of the affected segments of the spinal column. Fusion of the spine is norm ally achieved by bridging the vertebrae with bone grafts, usually obtained from the ilium, though sometimes allograft bone may be used. In *posterior fusion* the grafts are fitted between or along-side the spinous processes, superficial to the laminae. In *anterior fusion* blocks of bone are inlayed in deep slots cut in the vertebral bodies after excision of most of the intervertebral disc from the front. In *lateral fusion* bone grafts are joint, between the transverse processes above and the lateral masses of the sacrum below. Each method has its special application, but the choice also depends largely on the nature of the pathology to be treated and the surgeon's individual preference.

SPINAL STENOSIS (Claudication of the cauda equina)

In the syndrom e of spinal stenosis standing and walking beyond a certain duration are associated with increasingly severe pain in the gluteal region and lower lim b on one or both sides, ascribed to cramping of nerves and their blood vessels in a constricted spinal canal.

Pathology. The dimensions of the spinal canal in the lumbar region show considerable variation between individuals. The cross-sectional shape of the canal also varies, it being sometimes rounded and sometimes almost triangular. Thus in some persons there is a congenital narrowing or constriction of the canal which, though providing adequate room for the cauda equina in the absence of other pathology, nevertheless allows little or nom argin of safety, so that if the canal becomes further narrowed from secondary causes such as the formation of osteophytes about the facet joints, or bulging of an intervertebral disc, the normal functioning of nerves of the cauda equina will be impaired by lack of room and constriction of their blood supply. To some extent the constriction seems to be selective rather than uniform throughout the cauda equina, the nerves lying in the narrow lateral recesses of a triangular canal being particularly vulnerable. For a long time the impairment of nerve function is interm ittent rather than permanent, being rapidly reversible when the patient assumes a sitting posture.

Clinical features. The clinical history is characteristic. The patient, often an elderly man, complains that after walking for a matter of 10–15 minutes, he develops a heavy aching sensation in one or both lower limbs, and that this steadily increases to such an extent that eventually he is forced to sit down. In most cases sim ilar symptoms develop when the patient stands for a while, even without walking. Relief is obtained only by sitting or by lying with the hips and knees drawn up in a sitting posture: it is not sufficient just to stop walking. Sitting relieves the symptoms within a few minutes because on flexion of the spine the canal is widened, and the patient can then resum e walking or standing for a further period.

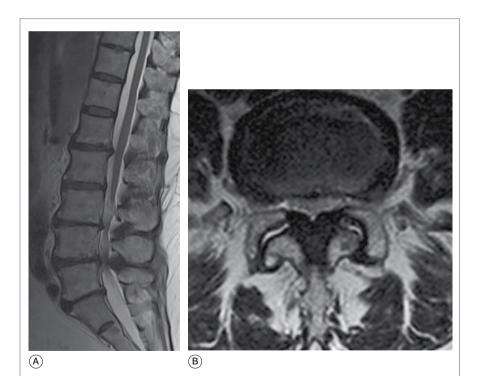
Trunk and spine

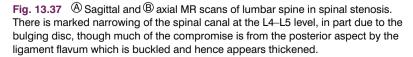
Examination may reveal little abnormality, though frequently there are features to suggest degenerative change in the lum bar spine - for instance im pairment of spinal mobility.

Im aging. Plain radiographs may give the impression that the spinal canal is narrow er than usual and they may show further constriction of the canal by posterior osteophytes upon the margins of the vertebral bodies or in relation to the facet joints. Magnetic resonance imaging (MRI) shows very clearly the shape of the spinal canal, and may also show bony or soft-tissue outgrow ths encroaching upon either a norm al or a congenitally constricted canal (Fig. 13.37).

Diagnosis. The spinal stenosis syndrom e bears superficial resemblance to intermittent claudication from vascular disease. Confusion should be avoided, how ever, because of the important distinction that pain in spinal stenosis, unlike that from arterial disease, comes on not only with walking but also with standing, and is relieved only by sitting or by flexing the spine. Moreover, examination of the vascular system shows no abnormality.

Treatment. M ild symptoms may be controlled by appropriate modification of activities – for instance by using a bicycle instead of walking, and by the avoidance of prolonged standing. In the fully established case with severe intractable symptoms, treatment should be by operation to decompress the





spinal canal by removal of intruding osteophytes and enlargement of the lateral recesses at the level of the constriction. Decom pression may have to be carried out over a num ber of segments, depending upon the longitudinal extent of the constriction as shown by appropriate im aging.

TUMOURS OF THE TRUNK AND SPINE

TUMOURS IN RELATION TO THE SPINAL COLUMN. SPINAL CORD. OR EMERGING NERVES

Classification and pathology. As in the cervical region, tum ours involving the spine or related nerves m ay arise:

- 1 in the hony spinal column itself
- 2. in the meninges or, rarely, the spinal cord
- 3. in the fibrous component of a peripheral nerve (neurofibroma)
- 4. in adjacent soft tissues.

Tumours of the spinal column may be benign (for instance chondroma, giant-cell tum our, haem angiom a, osteoblastom a) but are more often malignant. Such tum ours may be primary (sarcoma, multiple myeloma, chordoma), but metastatic tumours predominate. A meningeal tumour (meningioma) is an occasional cause of compression of the spinal cordor cauda equina. Nerve compression may also be a consequence of a neurofibrom a growing within the spinal canal.

Clinical features. The effects of these tum ours vary according to their site and character. Broadly, the effects may be placed in three groups:

Local destruction of the skeleton. The common est cause is a malignant tumour of the bones of the spinal column (Fig. 13.38) - usually a metastatic carcinoma. The predom inant symptom is pain, which is constant and increases relentlessly in its severity. Frequently there are associated neurological m anifestations from involvem ent of the spinal cord or nerve roots. Som etim es deform ity, from collapse of the bony structure, is evident clinically; or there may be marked restriction of spinal movement, with protective muscle spasm.

Compression of the spinal cord. This may occur from tum ours of the spinal cord itself or of its meninges, from tumours of nerves (neurofibroma), or from tum ours of the bony spinal colum n. The clinical manifestations depend upon the exact location of the tum our. Typically, when the spinal cord is slow ly com pressed, initial root pain (girdle pain in thoracic involvem ent, lower lim b pain in lum bar involvem ent) is follow ed by low erm otor neurone paresis at the segmental level corresponding to the site of the tumour, by progressive sensory and uppermotorneurone paralysis below the lesion, and often by bladder or bow eldvsfunction.

Interference with peripheral nerves. Peripheral nerves - especially the nerves of the cauda equina - may be involved by tum ours of the nerves them selves (neurofibrom a), by tum ours of the spinal colum n (benign or m alignant), or by tum ours in the peripheral course of the nerves (for exam ple, a tum our of a rib, or a tum our arising from or within the pelvis). The clinical features depend upon the particular nerve or nerves affected and upon the extent of the involvem ent. Typically, there will be constant, progressive, and ultim ately severe pain along the course of the affected nerve, with sensory impairment, increasing

Trunk and spine



Fig. 13.38 Partial collapse of the second and fourth lumbar vertebrae in a patient with myelomatosis. Note that the intervertebral discs are not destroyed.

m otor weakness, and depression of reflexes in the distribution of the nerve. Retention of urine is usually a prom inent feature of a tum our interfering with the cauda equina.

Im aging. *Plain radiographs* will usually help in discovering a tum our arising in the bones of the spinal colum n (Fig. 13.38), or eroding the bone from outside. In cases of vertebral destruction by a tum our the adjacent intervertebral discs are typically preserved. This point helps in the distinction from erosion and collapse due to infection, in which the discs are destroyed at an early stage (compare Figs 13.13A and 13.38).

Radiographs of the chest m ay reveal a prim ary lung tum our or a m etastasis; and radiographs of the rest of the skeleton m ay be helpful in the diagnosis of dissem inated tum ours. *M agnetic resonance im aging* is indispensable in show ing the full extent of the tum our and the extent to which the adjacent tissues have been infiltrated (Fig. 13.39).

Radioisotope scanning may show evidence of a lesion before it is evident radiographically. CT scanning is capable of show ing even quite small tumours with in the vertebrae.

D iagnosis. The possibility of a tum our has to be borne in m ind constantly in the differential diagnosis of back pain and low er lim b pain, especially when associated with radiological signs of vertebral erosion or collapse or with neurological disturbance affecting the trunk, low er lim bs, or viscera (Fig. 13.29).

A history of insidious onset, with relentless increase of symptoms without remission, always suggests the possibility of tumour. Careful search should always be made for a primary tumour elsewhere in the body.

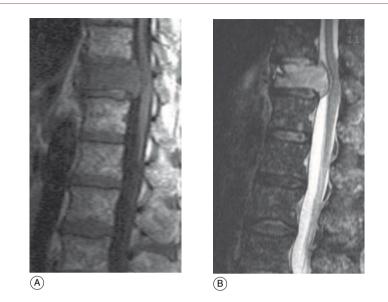


Fig. 13.39 (A) and (B) Sagittal T1 and T2 weighted MR scans of spinal metastasis. The T12 vertebra is replaced by abnormal marrow signal and there is some collapse with retropulsion of tissue into the spinal canal, features typical of a metastatic deposit in the spine.

Treatment. This is dependent on the site and nature of the tumour, but it should be remembered that many of these patients will survive for a considerable period of time and may require more active treatment than analgesic therapy alone for their increasing pain. Radiotherapy to the bone lesions and sometimes operative spinal decompression and fusion may be required in selected cases.

OTHER TUMOURS OF THE TRUNK Tumours of the sternum and ribs

The sternum and ribs contain abundant red marrow, favourable to the development of blood-borne metastatic tumours or of deposits in myelomatosis or the lymphomas. Histological examination of the sternal marrow (obtained by sternal puncture) is often of diagnostic importance in suspected metastasising tumours, for the material will often show tumour cells even in the absence of clinically evident metastases.

Tumours of the scapula

The commonest tumour of the scapula is a chondroma. It grows outwards from the flat body of the bone and is therefore classed as an ecchondroma. It may attain a large size. Although it is often benign at first, there is a risk of malignant change, with the development of a chondrosarcoma. For that reason a chondrom a that appears to be enlarging should always be excised with an adequate margin of healthy bone. A large part of the scapula can be removed without causing serious disability.

Tumours of the pelvic girdle

The pelvic bones, like the scapula, are sometimes the seat of a chondroma (ecchondroma). It may reach a large size, and there is risk of malignant change to chondrosarcoma.

The considerable content of red marrow also renders the pelvic bones liable to carcinom atous metastatic deposits, and they are also a common site of tum our deposits in myelom atosis.

CHRONIC LOWER LUMBAR LIGAMENTOUS STRAIN (Postural back pain)

The terms chronic ligamentous strain and postural back pain are used to cover an ill-defined group of affections characterised by persistent backache without dem onstrable pathology. These conditions are common - in fact they form a considerable proportion of the cases of back pain seen in orthopaedic practice.

Cause. It is assumed that the spinal muscles fail in their function of protecting the deep ligaments in maintaining posture. Predisposing causes include childbirth, overweight, general flabbiness of muscle, and debilitating illness.

Pathology. No precise lesion is demonstrable.

Clinical features. The pain is characteristically in the lum bar or lum bo-sacral region. It tends to be worse on activities such as stooping, or after prolonged standing or sitting in one position. *On exam ination* there may be no abnorm al physical signs but in many cases there is some restriction of spinal movem ent. *Radiographs* are norm al.

Diagnosis. This depends upon the exclusion of demonstrable pathological lesions by careful clinical and radiographic examination. A history of long-continued lumbar backache, with a total lack of clinical or radiological abnorm alities, should always suggest this group of affections.

Course and prognosis. A ching often persists intermittently for many years despite treatment. Nevertheless in most cases the condition is a source of nagging discomfort rather than a serious handicap to most ordinary day-to-day activities.

Treatment. Often reassurance alone is required. Treatment may be required for short-term exacerbations, but should be focused on activity modification, weight loss, active exercises to strengthen the spinal muscles and postural correction under physiotherapy supervision. Other more invasive treatments such as local injections of anaesthetic solution or hydrocortisone should be avoided if possible.

COCCYDYNIA

In its widest sense, coccydynia includes any painful condition in the region of the coccyx. In practice, the term is restricted to the clinical entity in which persistent pain continues for many weeks or months after a local injury, despite the absence of demonstrable pathology. Eventually it is a self-limiting affection, but it may cause severe discomfort while it lasts - often for many months.

CHAPTER 13

Cause. Typically coccydynia develops after an injury - usually a fall on the 'tail'. O ccasionally a history of injury is lacking.

Pathology. In some cases there is probably a strain of the sacro-coccygeal joint; in others the lesion is thought to be simply a contusion of the periosteum over the lower sacrum or coccyx. Rarely, a crack fracture of the coccyx or sacrum is demonstrated.

Clinical features. There is pain localised to the sacro-coccygeal area, worse when sitting. In severe cases there is also pain on defaecation. Usually the patient is free from pain when standing or lying. On examination there is localised tenderness over the sacro-coccygeal region. In some cases the pain can be reproduced by moving the coccyx. In the absence of a fracture, radiographs do not show any alteration from the norm al.

Diagnosis. It is important to consider other causes of pain in this area, especially infections of the sacro-coccygeal joint and tumours of the sacrum or coccyx. Investigation should include rectal examination, and radiographs must always be obtained.

Treatm ent. In m ost cases treatm ent is not required. A ll that is necessary is to exclude serious organic disease, and then to reassure the patient that the condition is harm less and that it may be expected to resolve spontaneously if left alone. In resistant cases manipulation and local injection of steroids have been used but none of these methods is uniformly successful. In unusually severe and persistent pain surgical excision of the coccyx may be required.

OSTEOPOROSIS

The vertebrae of the thoracic and lum bar spine are one of the commonest sites affected by osteoporosis, or so-called 'brittle bone' disease. This is a general affection of the skeleton and is described in more detail on page 81. It is commonest in postmenopausal women, but it can also affect men in the same age group. Its onset is insidious, but crush fracture of the vertebral body is the commonest of the fragility fractures associated with this condition. Its onset may be associated with an episode of minor trauma, but there is often no significant injury and only minor local pain. More commonly, the patient presents with progressive loss of height and an increasing kyphotic deform ity of the thoracic spine. This results from collapse of the thoracic vertebrae at several levels with anterior wedging of the bodies (Fig. 13.40). In advanced cases the radiographs show little difference between the density of the bone and the intervertebral discs.

Treatment. G reater aw areness of the m orbidity of this condition in a rapidly increasing elderly population has led to more active m edical and surgical interventions. All patients should be investigated to determ ine the cause and extent of their bone loss and, where appropriate, medical treatment instituted to prevent further progression. In selected cases where local pain is more severe and of recent onset, a new minimally invasive surgical treatment of balloon kyphoplasty may be considered. Using radiographic screening a percutaneous probe is inserted into the centre of the collapsed vertebral body and is then replaced with a balloon-like device which is inflated with contrast medium until the vertebral body height is restored. Finally the space is injected with sem i-liquid polymethylm ethacrylate cement which once solidified will restore the vertebral bone stability. 251



Fig. 13.40 Lateral radiograph of osteoporotic spine in an elderly female patient. There are multiple vertebral fractures with collapse in the mid thoracic region resulting in a rounded kyphotic deformity.

Disorders of the sacro-iliac joint

Sacro-iliac lesions are a rather uncommon but nervertheless important cause of back symptoms or of referred pain in the lower limb. Of the various types of arthritis, ankylosing spondylitis is the best recognised. Tuberculous arthritis is seen occasionally, but mainly indeveloping countries.

EXTRINSIC DISORDERS SIMULATING SPINAL DISEASE ABDOMINAL DISORDERS

Peptic ulcer, renal and perirenal infections, renal calculus, and biliary calculus and cholecystitis m ay all produce retroperitoneal pain which m ay be felt in the back as well as the abdomen. Consideration of the other associated symptoms and abdom inal signs should lead to the correct diagnosis.

PELVIC DISORDERS

Intrapelvic tumours interfering with the sacral plexus or its branches, may cause pain in the sciatic distribution simulating sciatica from a spinal cause. A full pelvic examination should form part of the routine investigation of lower limb pain and in cases of doubt magnetic resonance imaging may be helpful in diagnosis.

Trunk and spine

LOWER LIMB DISORDERS

Pain from an arthritic hip may sometimes simulate sciatic pain from a spinal lesion, but characteristically is referred from the groin down to the front of the thigh rather than on its posterior aspect. A full examination of the hip and if necessary radiology should establish the true diagnosis.

VASCULAR DISORDERS

A rterial occlusion in the low er lim b and m ore rarely aortic aneurysm m ay present with m uscle pain on exercise which m ay be confused with sciatica from a spinal cause. For this reason a full exam ination of the vascularity of the lim b is essential to establish the true diagnosis. 253

14 The shoulder region

The mechanics of the shoulder are rather complex. The shoulder 'joint' in fact comprises three components - the gleno-humeral joint or shoulder joint proper, the acrom io-clavicular joint, and the sterno-clavicular joint. The gleno-humeral joint allows a free range of abduction, flexion, and rotation, under the control of the scapulo-humeral and pectoral muscles. The other two joints together allow 90° of rotation of the scapula upon the thorax and a moderate range of anteroposterior gliding of the scapula, under the control of the cervico-scapular and thoraco-scapular muscles.

D isorders of the shoulder include most varieties of arthritis; but it is notable that osteoarthritis - common in most joints - is less common in the glenohumeral joint. A sifto make up for this, the shoulder exhibits several affections peculiar to itself - notably tears of the musculo-tendinous cuff, the painful arc syndrome, and 'frozen' shoulder. Together these form a large proportion of shoulder disabilities.

The recent developm ents in soft tissue im aging and arthroscopy have revolutionised the diagnosis and treatm ent of m any of these disorders. Open operative procedures have now been replaced in specialist centres by minimally invasive arthroscopic techniques with equally successful outcom es.

Pain in the shoulder and arm is notoriously prone to misinterpretation, and special care is required to differentiate intrinsic pain arising in the shoulder from extrinsic pain referred from the cervical spine, the thorax, or the abdomen.

SPECIAL POINTS IN THE INVESTIGATION OF SHOULDER SYMPTOMS

History

Characteristics of shoulder pain. It is important to find out the precise location and distribution of the pain. True shoulder pain is seldom confined to the shoulder itself. Typically, it radiates from a point near the tip of the acromion down the lateral side of the upper arm to about the level of the deltoid insertion. It is unusual for true shoulder pain to extend below the elbow.

Pain arising in the acromio-clavicular joint or sterno-clavicular joint is localised to the joint itself and does not radiate down the limb.

Referred pain in the shoulder region. The pain referred from an irritative lesion of the brachial plexus often extends from the base of the neck, over the top of the shoulder, and thence into the arm. Unlike true shoulder pain, it frequently radiates below the elbow into the forearm or hand, and it may be accompanied by paraesthesiae – often described as 'pins and needles' or 'a num b feeling'. Pain may also be referred to the shoulder from a lesion in the thorax or upper abdomen.

Exposure

The patient must be stripped to the waist. The examination is conducted most easily with the patient standing; alternatively he may sit upon a high stool. For the greater part of the examination the surgeon stands behind the patient, so that he may observe more easily the position of the scapula.

Steps in routine examination

A suggested plan for the routine exam ination of the shoulder is sum marised in Table 14.1.

Movements at the shoulder

In exam ining shoulder movements it is important to determine how much of the movement occurs at the gleno-humeral joint and how much is contributed by rotation of the scapula. An accurate distinction between the two types of movement can be made only by grasping the lower half of the scapula so that its movements can be detected (Fig. 14.1). In the normal shoulder about half the range of abduction occurs at the gleno-humeral joint and half by scapular rotation. D isorders of the shoulder generally cause restriction of gleno-humeral movement rather than of scapular movement. If the shoulder joint proper (the

Inspection	Power
Bone contours alignment	Cervico-scapular and thoraco-
Soft-tissue contours	scapular muscles (controlling scapula
Colour and texture of skin Scars or sinuses	movement)—Test elevation of scapula retraction of scapula, abduction-
Palpation	rotation of scapula
Skin temperature	Scapulo-humeral muscles (controlling
Bone contours Soft-tissue contours	movement at gleno-humeral joint)— Abduction, adduction, flexion,
Local tenderness	extension, lateral rotation, medial
Movements	rotation
Distinguish between true gleno-humeral movement and scapular movement during abduction, flexion, extension, lateral rotation, and medial rotation ? Pain on movement	Acromio-clavicular joint Examine for swelling, increased warmth, tenderness, pain on movement, and stability
? Muscle spasm ? Crepitation on movement	Sterno-clavicular joint Examine for swelling, increased warmth, tenderness, pain on movement, and stability

This is important if a satisfactory explanation for the symptoms is not found on local examination. The investigation should include:

- 1. the neck, with the brachial plexus
- 2. the thorax, with special reference to the heart and pleura
- 3. the abdomen, for subdiaphragmatic lesions

3. GENERAL EXAMINATION

General survey of other parts of the body

Table 14.1 Routine clinical examination in suspected disorders of the shoulder

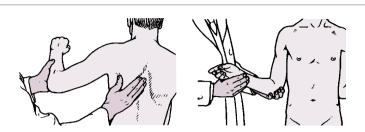


Fig. 14.1 (left) Examining shoulder abduction. One hand grasps the scapula while the other steadies the elbow. In this way the proportion of the total range contributed by gleno-humeral movement and by scapular rotation can be assessed.

Fig. 14.2 (right) Examining shoulder rotation. The elbow is supported by the examiner's hand and flexed to the right angle to eliminate forearm rotation. The forearm thus serves as a pointer to indicate the range of rotation at the shoulder.

gleno-hum eral joint) is fused, either naturally or by operation, a range of abduction of up to 60 or 80° is possible by scapular movem ent alone.

Stand behind the patient. A bduction: Instruct the patient to try to raise both arm s sidew ays from the body so that the palm s of the hands meet above the head. M easure the range, and observe w hat proportion of the movem ent takes place at the gleno-hum eral joint and how much is contributed by rotation of the scapula upon the thorax. Flexion: Instruct the patient to raise the arm s forwards tow ards the vertical. A gain observe (by means of the hand upon the scapula) w hat proportion of the movem ent occurs at the gleno-hum eral joint and how much is contributed by rotation the chest wall. Extension: A sk the patient to raise the ard (external) rotation: The elbows are held in to the sides and are flexed 90° (Fig. 14.2): the forearm s then serve as convenient pointers to indicate the angle of rotation (norm al range = 80°). M edial (internal) rotation: Instruct the patient to place the back of his hand in contact with his lum bar region and to carry the elbow forwards, bringing the finger tips up as high as possible between the shoulder blades (norm al range = 110°).

Estimation of muscle power

In estimating the power of the shoulder muscles two groups must be distinguished:

- 1. the cervico-scapular and thoraco-scapular muscles
- 2. the scapulo-hum eral muscles.

The cervico-scapular and thoraco-scapular muscles. These control movements of the scapula. Estimate the power of each group in turn and compare on the two sides. Elevators of the scapula (levator scapulae, upper fibres of trapezius): Instruct the patient to shrug the shoulders against the resistance of the examiner's hands. Retractors of the scapula (rhom boids and middle fibres of trapezius): Instruct the patient to brace the shoulders back. Abductor-rotators of the scapula (serratus anterior, with middle and lower fibres of trapezius): Instruct the patient to push horizontally forwards with the hand against a wall (Fig. 14.3) or sim ply to raise the

Fig. 14.3 Examination for weakness of the serratus anterior. If the serratus anterior is weak or paralysed winging of the scapula occurs when the arm is raised from the side or pushed forward against resistance.

arm from the side. If the serratus anterior is weak, winging of the scapula (backward projection of its vertebral border) will be observed (Fig. 14.3).

The scapulo-hum eral muscles. These control movements of the glenohum eral joint. Estimate the power of each muscle group, testing in turn the abductors, adductors, flexors, extensors, lateral rotators, and medial rotators. If the patient has lost the power to initiate active gleno-hum eral movement from the dependent position, determine whether he can maintain abduction when the lim b has been raised with assistance to 90°. A bility to *sustain* abduction but not to *initiate* it is characteristic of isolated rupture of the supraspinatus tendon (see Fig. 14.12, p. 267).

The acromio-clavicular and sterno-clavicular joints

The clavicle may be regarded as a link, jointed at each end, connecting the scapula to the sternum (Fig. 14.4). Movem ent of the scapula must occur about a fulcrum at one or both ends of this link. In the norm al shoulder movem ent of the scapula, with consequent movem ent at the acromio-clavicular and sterno-clavicular joints, occurs mainly:

- 1. during elevation of the arm above 90°
- 2. when the shoulders are braced backwards or drawn forwards.

To exam ine the acrom io-clavicular and sterno-clavicular joints stand in front of the patient. Exam ine the joints on each side for deform ity, swelling, increase of local tem perature, local tenderness, and pain on movement – especially at the extrem es of elevation of the arm and backward bracing of the shoulders. Observe whether there is any tendency to subluxation or dislocation of the joint on movement.

Radiographic examination

Gleno-humeraljoint. The routine shoulder film is a plain antero-posterior projection with the limb in the anatomical position. When additional information is required a special axillary projection with the arm abducted 90° (giving a lateral view of the humerus) should be obtained. Further films showing the

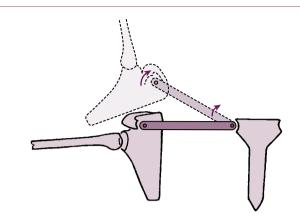


Fig. 14.4 The mechanics of scapular rotation. The clavicle serves as a link, jointed at each end, by which the scapula is held away from the sternum. Full rotation of the scapula entails movement both at the acromio-clavicular joint and at the sterno-clavicular joint.

upper end of the humerus in varying degrees of rotation are som etimes informative. *Arthrography*, after injection of radio-opaque fluid into the joint, will show whether or not the capsule is intact.

A crom io-clavicular joint and sterno-clavicular joint. Special projections are used to show each of these joints.

Other imaging techniques

Radioisotope scanning, computerised tomography, ultrasonography, and magnetic resonance imaging must each be considered in appropriate circumstances. Double contrast arthrography combined with computerised tomography or magnetic resonance imaging may be particularly valuable in demonstrating the extent of soft tissue damage in recurrent dislocation of the shoulder (see Fig. 14.10).

Arthroscopy

A rthroscopy has become a well-established method of investigation for difficult shoulder problems, as well as being used increasingly for closed operative treatment. The use of both anterior and posterior portals allows direct access to the glenoid fossa, the capsule, and the articular surfaces, as well as the rotator cuff musculature and sub-acromial space.

Extrinsic sources of shoulder and arm pain

In many cases in which the main complaint is of pain in the shoulder or arm there is no local abnorm ality, the symptoms being referred from a lesion elsewhere. Thus pain over the shoulder is a common symptom in affections of the neck, especially when the brachial plexus or its roots are involved. Shoulder pain is also a feature of irritative lesions in contact with the diaphragm, either Fortunately, with careful interrogation and clinical exam ination there is little difficulty in distinguishing intrinsic from extrinsic lesions. The important point is that intrinsic lesions of the shoulder alw ays give rise to local physical signs that are readily dem onstrable on exam ination. If the shoulder is clinically norm al it is improbable that it is the seat of disease, and attention should be directed tow ards possible sources of referred pain.

DISORDERS OF THE SHOULDER (GLENO-HUMERAL) JOINT

PYOGENIC ARTHRITIS OF THE SHOULDER (General description of arthritis, p. 96)

Pyogenic arthritis of the shoulder is uncommon. It may complicate a penetrating wound, or it may be a haem atogenous (blood borne) infection. In children infection may spread to the shoulder from a focus of osteomyelitis in the upper metaphysis of the humerus (p. 279).

The clinical features resemble those of pyogenic arthritis of other joints. The onset is rapid and is accompanied by pyrexia. The shoulder is swollen and abnormally warm, and all movements are greatly restricted. Treatment follows the lines suggested on page 98.

TUBERCULOUS ARTHRITIS OF THE SHOULDER (General description of tuberculous arthritis, p. 98)

Tuberculous arthritis of the shoulder has become a rare disease in Western countries. It occurs much less commonly than tuberculosis of the spine, hip, and knee. A swith tuberculosis elsewhere, it occurs more commonly in African countries and in the East than in most countries of Europe and in North America.

The pathological and clinical features correspond to those of tuberculous arthritis in any major joint. Treatment with antituberculous drugs follows the general principles outlined on page 102. In early cases good recovery of function may occur, but in more advanced cases of bone and joint destruction surgical intervention with arthrodesis of the joint may be required.

RHEUMATOID ARTHRITIS OF THE SHOULDER (General description of rheumatoid arthritis, p. 134)

The shoulder is commonly affected by rheumatoid arthritis, though less commonly than the more peripheral joints such as hands, wrists and feet. Often both shoulders are affected simultaneously with other upper limb joints, with consequent serious impairment of function.

As in other superficial joints, the main clinical features are local pain and stiffness, increased warm th, sw elling from synovial thickening, and marked restriction of movement. There is wasting of the deltoid muscle, with consequent flattening of the shoulder contour (Fig. 14.5A). Radiographs show rarefaction of bone, narrowing of the cartilage space, and eventually erosion of bone at the joint margins (Fig. 14.5B). The shoulder region



Fig. 14.5 Rheumatoid arthritis of the shoulder. In ^(A) note the marked flattening of the contour from muscle wasting. The radiograph in ^(B) shows rarefaction of the bones, with narrowing of the joint space from loss of articular cartilage.

Treatment. This is mainly that for rheumatoid arthritis in general, as described on page 137. Exercises are important in maintaining a useful range of movement.

Operative treatment. Severe disability often results from the bone and cartilage destruction produced by the inflam matory rheumatoid synovitis. When this occurs replacement arthroplasty of the joint may be indicated to restore mobility and relieve pain. Early designs used a metal humeral head prosthesis with a stem cemented into the shaft of the bone (Fig. 14.6). This articulated with a small concave polyethylene prosthesis to resurface the glenoid socket. Pain relief follow ing this surgery is usually good, but full active movement, particularly in abduction, is never restored. The main problems that compromise the result are loosening of the glenoid prosthesis because of inadequate bone support and the degeneration of the scapulo-humeral muscles. New er prosthetic designs to address these problems, including surface replacements and reversed prostheses are under trial, but no long-term results are yet available.

OSTEOARTHRITIS OF THE SHOULDER (General description of osteoarthritis, p. 140)

Unlike most other joints, the shoulder is seldom affected by osteoarthritis. When it is affected there is usually a clear predisposing factor, such as previous injury or disease, avascular necrosis of the humeral head, or senility. The rarity of osteoarthritis of the shoulder is explained by its freedom from pressure stresses.

Pathology. The articular cartilage is worn away. The underly ingbone becomes eburnated and at the joint margins it hypertrophies to form osteophytes.



Fig. 14.6 Replacement arthroplasty of the gleno-humeral joint for rheumatoid arthritis of the shoulder, using a two-piece Neer prosthesis.

Clinical features. The patient is usually elderly: osteoarthritis is exceptional in the shoulders of younger patients. The main complaint is of pain in the shoulder and down the upper arm.

On examination there is no increase of local skin temperature and no synovial thickening. But a soft sw elling due to effusion of fluid into the joint is common. Movements are restricted.

Radiographs show narrowing of the cartilage space: the joint outlines are clear-cut and often show some sclerosis; there is 'spurring' from osteophyte form ation at the joint margins (Fig. 14.7).

Fig. 14.7 Osteoarthritis of the shoulder in an old woman. Note loss of articular cartilage, marginal osteophytes and sclerosis at the joint surfaces. Osteoarthritis is uncommon in the shoulder.



Treatm ent. In most cases active treatment is unnecessary once the nature of the affection has been explained. If treatment is called for, conservative measures should usually be relied upon and gentle exercises are often helpful. If there is a large effusion it should be aspirated. Only exceptionally would operation be justified: if it were, replacement arthroplasty (see under rheum atoid arthritis, p. 260) would usually be advised, but arthrodesis might occasionally be appropriate.

'FROZEN' SHOULDER (Adhesive capsulitis; periarthritis)

'Frozen'shoulder is a comm on but ill-understood affection of the gleno-humeral joint, characterised by pain and uniform limitation of all movements but without radiographic change, and with a tendency to slow spontaneous recovery under appropriate treatment.

Cause. This is unknown. There is no evidence of infection. Injury is an inconstant factor and its significance is doubtful. Nevertheless it is accepted that symptoms of 'frozen' shoulder do often begin a few weeks after some form of injury.

Pathology. This is not fully understood, though the intense fibroblastic response may represent an auto-immune reaction similar to that seen with Dupuytren's contracture of the hand. There is a loss of resilience of the joint capsule, with adhesions between the synovial folds. Whatever their nature, the changes are reversible, and in most cases the range of joint movement is eventually restored to near normal.

Clinical features. The patient com plains of severe aching pain in the shoulder and upper arm, of gradual and spontaneous onset. Pain is often severe enough to disturb sleep. *On examination* the only finding is uniform impairment of all gleno-humeral movements – abduction, flexion, extension, rotation – which are often reduced to about a quarter or half of their norm al range. In a severe case much of the shoulder movement that remains is contributed by scapular movement, which is unimpaired. *Radiographs* do not show any abnormality.

Diagnosis. The characteristic feature of 'frozen' shoulder is the uniform lim itation of all gleno-humeral movements without evidence of inflammatory or destructive changes.

Course. There is a tendency towards spontaneous recovery, usually within 6-12 months. The pain subsides first, leaving gleno-humeral joint stiffness, which thereafter gradually resolves with active use of the limb. If movements are not practised deliberately some permanent restriction of movement may remain.

Treatment. In the early, acutely painful stage the arm is rested in a sling, which is removed for short periods each day to permit gentle assisted shoulder exercises. Generally, non-steroidal anti-inflam matory drugs should be prescribed in addition to conventional analgesics. Steroid injections into the gleno-humeral joint may be of value in some patients with persistent severe pain. When the pain lessens, active exercises are intensified and continued for weeks or months until full movement is regained. If mobilisation is very slow after the pain has abated the shoulder may be manipulated gently under anaesthesia to break down residual adhesions. Manipulation may be required at some stage in up to a third of all cases, or arthroscopic distension with saline may be used as an alternative method. It is important to warn the patient at the beginning that recovery may take many months, but at the same time to give assurance that eventually recovery is likely to be complete.

RECURRENT ANTERIOR DISLOCATION OF THE SHOULDER

Traum atic dislocation of the shoulder is liable to cause structural changes in the gleno-hum eral joint which predispose to repeated dislocations. Rarely, dislocation may occur repeatedly in a patient with unduly lax ligaments, in the absence of trauma.

Pathology. This is two fold (Figs 14.8 and 14.9 A):

- 1. The capsule, and with it the glenoid labrum, is stripped from the anterior m argin of the glenoid rim (Bankart lesion) but retains an attachm ent farther down the neck of the scapula, where it becomes continuous with the periosteum. Thus there is created an intra-capsular 'pocket' in front of the glenoid m argin, into which the hum eral head m ay be displaced (Fig. 14.8).
- 2. The articular surface of the hum eral head is dented postero-laterally (H ill-Sach), as if it were a table tennis ball, probably by impact against the sharp anterior corner of the glenoid fossa at the initial dislocation (Figs 14.8, 14.9 and 14.10).

The consequent defect in the contour of the articular surface allows the head to slip over the front of the glenoid when the arm is in lateral rotation, abduction, and extension. The dislocation is anterior, and it must be emphasised that the humeral head always remains within the capsule, in contradistinction to non-recurrent dislocation, in which the humeral head is displaced through a rent in the capsule.

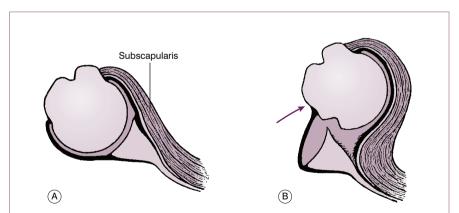


Fig. 14.8 Horizontal section of left shoulder showing the pathology of recurrent dislocation. The diagram on the left shows the normal condition. In the right-hand diagram the humeral head is shown dislocated forwards. It has stripped the capsule from the margin of the glenoid, creating a pocket in front of the neck of the scapula into which the humeral head is displaced. Note that the humeral head has been dented by the sharp glenoid margin, producing the typical defect of the articular surface.

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Fig. 14.9 ^(A) Typical defect of articular surface of humeral head (arrow), found in most cases of recurrent dislocation of the shoulder. ^(B) Radiographic appearance with the arm in 80° of medial rotation. The defect (arrow) is seen in profile at the upper and outer quadrant of the humeral head.



Fig. 14.10 Axial MR arthrogram of a patient with recurrent anterior shoulder dislocation. The large arrow indicates the presence of a bony defect (Hill-Sachs lesion) in the humeral head posteriorly. The smaller arrow points to a defect in the anterior cartilaginous labrum of the glenoid (the Bankart lesion). This has allowed the escape of contrast medium beneath the lax anterior capsule and predisposes the patient to further episodes of anterior dislocation.

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Clinical features. The patient is usually a fit young adult, accustomed to sporting activities. Nearly always, recurrent dislocation follows an initial violent dislocation, often in a heavy fall. Thereafter dislocation recurs with trivial violence, characteristically during combined abduction, lateral rotation, and extension (for example, in putting on a coat).

On examination no clinical abnorm ality is apparent, but it may be found that the patient becomes apprehensive when the arm is placed in a position of abduction, extension, and lateral rotation – the position often adopted when putting on a coat.

Im aging. Routine radiographs with the lim b in the anatom ical position do not show any abnorm ality, but special profile view staken with the arm in 60-80° of m edial rotation show the characteristic bony defect of the hum eral head (Fig. 14.9B). The defect is not seen in any other projection, but it can be shown more clearly by computerised tom ographic (CT) im aging or by magnetic resonance im aging (M RI). An M RI scan combined with arthrography provides the most detailed inform ation on the bone and soft-tissue pathology (Fig. 14.10).

Treatm ent. Conservative treatm ent is not effective and if dislocation recurs frequently operation is justified. The two treatm ent principles used to prevent further dislocation are to either repair the defect in the glenoid labrum (Bankart¹ operation), or to create an overlapping buttress of m uscle or bone on the anterior m argin of the glenoid (Putti-Platt² or Bristow operations). Traditionally this required an open procedure through an anterior incision but increasingly this has been replaced by closed arthroscopic techniques for repair. How ever, it m ust be emphasised that the results in term s of functional outcom e are identical with open or closed methods. Arthroscopic surgery, though m ore convenient for the patient, should only be undertaken by surgeons trained in the necessary specialist skills and equipped with the sophisticated equipment required.

Recurrent anterior dislocation from ligamentous laxity

There is a separate small group of patients in which the defects in the anterior capsule are not present. Instead, there is general laxity of the ligaments about the shoulder, with a volum inous capsule that allows subluxation or even full dislocation of the humeral head to occur without preceding injury. Such patients can often displace the humerus voluntarily and with increasing ease, and displacement may often be either anterior or posterior. The humeral head always remains within the lax capsule, and there is no capsular rupture.

Treatm ent. These patients should be dissuaded from repeatedly demonstrating their ability to subluxate or dislocate the joint, which can som etim es becom e an obsessive neurosis or at least a 'party trick'. If operation is called for, a bone-block operation, by which the area and depth of the glenoid fossa are increased by a suitably shaped bone graft, is generally to be recom mended.

RECURRENT POSTERIOR DISLOCATION

Posterior dislocation of the shoulder is much less common than anterior dislocation. Often - indeed usually - the cause is an electric shock or an epileptiform

¹Blundell Bankart, a technically brilliant English orthopaedic surgeon working in London, described the shoulder lesion in recurrent dislocation and the operation for its repair in 1923. ²Vittorio Putti, Professor of Orthopaedics in Bologna, and Sir Harry Platt of Manchester, later President of the Royal College of Surgeons of England, were jointly credited with developing this operation in 1923. 265

convulsion, and it is not uncomm on for both shoulders to be dislocated together. The dislocation is prone to become recurrent. The pathology is analogous to that of recurrent anterior dislocation:

- the capsule, glenoid labrum and periosteum are stripped from the back of the neck of the scapula
- the hum eral head is dented supero-medially rather than postero-laterally as in recurrent anterior dislocation.

D islocation occurs on abduction and medial rotation.

Operative repair may be effected by reefing the infraspinatus tendon in a sim ilar way to that used on the subscapularis for anterior dislocation. An alternative method is to deepen and widen the glenoid socket by screwing a suitably shaped block of iliac bone to the back of the neck of the scapula (boneblock operation).

Like recurrent anterior dislocation, recurrent posterior dislocation may som etim es occur spontaneously, without previous injury, in a patient with ligam entous laxity.

COMPLETE TEAR OF ROTATOR (TENDINOUS) CUFF (Torn supraspinatus)

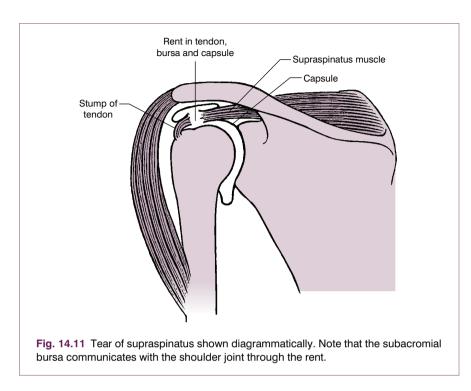
It is important to distinguish complete tears of the rotator tendinous cuff from incomplete tears. The clinical effects are different. Whereas an incomplete tear is one cause of the 'painful arc syndrome' (p. 268), without obvious loss of power, a complete tear impairs seriously the ability to abduct the shoulder.

Cause. The tendon gives way under a sudden strain, usually caused by a fall. The injury is not necessarily a severe one; indeed it often seem s to be m ild. A ge-degeneration of the tendon is a constant predisposing factor.

Pathology. The tear is mainly of the supraspinatus tendon, but it may extend into the adjacent subscapularis or infraspinatus tendons. The tear is close to the insertion of the tendons and usually involves the capsule of the joint, with which the tendons are blended. The edges of the rent retract, leaving a gaping eliptical hole which establishes a communication between the shoulder joint and the subacromial bursa (Fig. 14.11). In general, it may be said that a tendon that ruptures is usually already degenerate: thus rupture occurs mainly in the elderly.

Clinical features. The patient is usually a m an over 60: only occasionally is a younger patient affected. A fter a strain or fall he com plains of pain at the tip of the shoulder and down the upper arm, and of inability to raise the arm.

On exam in ation there is local tenderness below the lateral margin of the acromion. When the patient attempts to abduct the arm no movement occurs at the gleno-humeral joint but a range of about $45-60^\circ$ of abduction can be achieved, entirely by scapular movement (Fig. 14.12A). There is, how ever, a full range of passive movement; and if the arm is abducted with assistance beyond 90° the patient can sustain the abduction by deltoid action (Fig. 14.12B). Thus the essential and characteristic feature in cases of torn supraspinatus tendon is inability to initiate gleno-humeral abduction. The usual explanation is that the early stages of abduction demand the combined action of the deltoid muscle, which supplies the main motive force, and the supraspinatus, which stabilises the humeral head in the glenoid fossa (like the workman's foot against a ladder that is being raised from the ground).



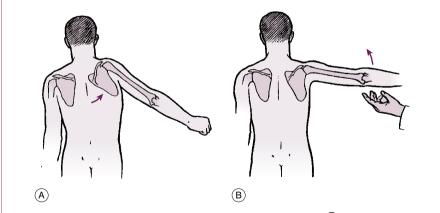


Fig. 14.12 Complete tear of tendinous cuff (torn supraspinatus). Active abduction from the resting position is possible only by scapular rotation, the deltoid being unable to initiate gleno-humeral abduction without the help of the supraspinatus. [®] When the limb is raised passively beyond the horizontal abduction can be sustained actively by the deltoid.

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The shoulder region

Diagnosis. Complete tear of the rotator cuff must be distinguished from other causes of impaired gleno-humeral abduction, especially the painful arc syndrome and paralysis of the abductor muscles (as from poliomyelitis or nerve injury). Inability to initiate gleno-humeral abduction, with power to sustain abduction once the limb has been raised passively, is characteristic of a widely torn supraspinatus. In the painful arc syndrome the power of abduction is retained but the movement is painful.

Im aging. Exam ination by ultrasound scanning can identify a complete tear of the rotator cuff, but MR scans provide more detailed information on associated pathology in the surrounding structures (Fig. 14.13).

Treatm ent. In older patients operation should usually be avoided, because the degenerate state of the tendon makes satisfactory repair impracticable: the disability tends to becom e gradually less noticeable, and indeed the power of active abduction (by deltoid action alone) may sometimes be regained despite the persistence of a large tear.

In younger patients operation should be undertaken to repair both partialthickness and full-thickness tears. As with other shoulder surgery this can be carried out as an open or an arthroscopic procedure depending on the experience of the surgeon. At the same operation it may be necessary to perform an acrom ioplasty to reduce im pingement on the rotator cuff and to prevent repeat rupture. Thereafter passive movements may be begun within a few days but attempts to lift the arm actively should be deferred for 4 weeks, when provisional healing of the tendon may be expected to have occurred. The results of operation are not uniformly satisfactory, probably because of the poor quality of the degenerate tendon.

PAINFUL ARC SYNDROME (Supraspinatus syndrome)

This is a clinical syndrome characterised by pain in the shoulder and upper arm during the mid-range of gleno-humeral abduction, with freedom from pain at the extremes of the range. The syndrome is common to five distinct shoulder lesions.



Fig. 14.13 Coronal T2 weighted MR scan of shoulder. There is a defect in the rotator cuff indicating a cuff tear (arrow). Most commonly this involves the supraspinatus tendon.

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Cause. The pain is produced mechanically by nipping of a tender structure between the tuberosity of the humerus and the acromion process and coracoacromial ligament.

Pathology. Even in the norm al shoulder, the clearance betw een the upper end of the humerus and the acrom ion process is small in the range of abduction betw een 45 and 160°. If a sw ollen and tender structure is present beneath the acrom ion it is liable to get nipped during the arc of movem ent in which the clearance is small (Fig. 14.14A), with consequent pain. In the neutral position and in full abduction the clearance is greater and pain is less marked or absent (Figs 14.14B and 14.14C).

Five primary lesions can give rise to the syndrome (Fig. 14.15). In general, though, these labels only represent variations of a process of degeneration which is the underlying defect.

- 1. M inor tear of supraspinatus tendon. Tearing or strain of a few degenerate tendon fibres causes an inflam m atory reaction w ith local swelling, but power is not significantly impaired as it is after a complete tear of the tendinous cuff.
- 2. Supraspinatus tendinitis. In this condition there is believed to be an inflam matory reaction provoked by degeneration of the tendon fibres.
- 3. Calcified deposit in supraspinatus tendon. A white chalky deposit form s within the degenerate tendon, and the lesion is surrounded by an inflam matory reaction. A s the chalky 'cyst' becomes increasingly tense, local pain becomes agonisingly acute.
- 4. Subacromial bursitis. The bursal walls are inflamed and thickened from mechanical irritation.
- Injury of greater tuberosity. A contusion or undisplaced fracture of the greater tuberosity is a frequent cause.

Clinical features. Whatever the primary cause, the clinical syndrome has the same general features, though they vary in degree. With the arm dependent pain is absent or minimal. During abduction of the arm pain begins at about

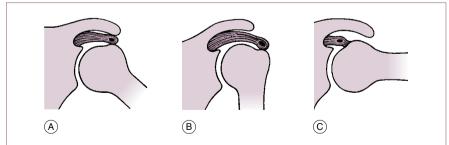


Fig. 14.14 Mechanical basis of the painful arc syndrome. The black spot represents any tender lesion near the supraspinatus insertion. (a) With the arm in mid-abduction the lesion is nipped between the humerus and the acromion. (b) With the arm dependent, the lesion is free from pressure. (c) At full elevation the lesion is again free from pressure.

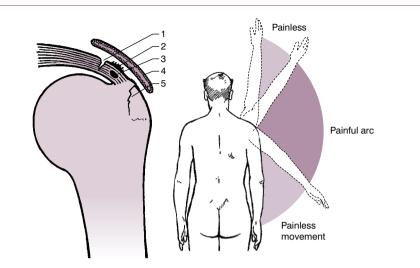


Fig. 14.15 (Left) Five causes of the painful arc syndrome. The clinical features are the same in each. 1. Incomplete tear of supraspinatus. 2. Supraspinatus tendinitis. 3. Calcified deposit in supraspinatus. 4. Subacromial bursitis. 5. Crack fracture of greater tuberosity.

Fig. 14.16 (Right) Painful arc syndrome. The middle arc of abduction is painful whereas the extremes are painless.

45° and persists through the arc of movement up to 160° (Fig. 14.16). Thereafter the pain lessens or disappears. In descent from full elevation pain is again experienced during the middle arc of the range: often the patient will twist or circum duct the arm grotesquely in an effort to get it down with the least pain. The severity of the pain varies from case to case. In cases of calcified deposit in the supraspinatus tendon the pain may be so intense that the patient is scarcely able to move the shoulder, or to sleep, and is driven to seek emergency treatment.

R ad iographic features. These vary with the underlying cause. Plain radiographs will reveal a fracture of the greater tuberosity or a calcified deposit (Fig. 14.17). A c a l c i f i e d deposit is d istin g u ish e d rad io lo gically from a n avulsed fragment of bone by the fact that it is hom ogeneous and does not th e trabeculation characteristic of bone. MR scanning dem on · mav strate som e of the other causes from degeneration and partial tears of the rotator cuff.

Diagnosis. Painful arc syndrome is som etim es confused with arthritis of the acromio-clavicular joint, which also causes pain during a certain phase of the abduction arc. But in acromio-clavicular arthritis the pain begins later in abduction (not below 90°) and increases rather than diminishes as full elevation is reached.

Differentiation between the five primary causes of the syndrome is aided by the history and by radiography. A history of injury suggests a strain of the



Fig. 14.17 Radiograph of shoulder showing calcification of the soft tissues above the greater tuberosity of the humerus (arrow). The calcified material usually lies within the supraspinatus tendon and is often associated with a painful tendinitis, but can be asymptomatic.

supraspinatus tendon or a lesion of the greater tuberosity, whereas a spontaneous onset suggests tendinitis, calcified deposit or subacrom ial bursitis. As noted, radiography will confirm or exclude a fracture or a calcified deposit (Fig. 14.17).

Treatment in the acute case. In mild cases treatment is often unnecessary, but when pain is more severe this may be required depending upon the primary cause of the syndrome.

Calcified deposit in supraspinatus tendon. If the pain is intense, as it som etim es is in these cases, relief can usually be gained by direct injection of hydrocortisone into the calcified deposit. If this fails the deposit of hydroxyapatite crystals may be dispersed with an aspiration needle follow ed by lavage of the subacrom ial space.

Contusion or crack fracture of greater tuberosity. Reliance should be placed on active use and mobilising exercises.

Strain of supraspinatus, supraspinatus tendinitis, and subacromial bursitis. Most of these cases respond gradually to physiotherapy in the form of ultrasound or interferential therapy, and mobilising exercises.

Treatment in the chronic case. In cases of painful arc syndrome in which severe symptoms persist despite a full trial of efficient conservative treatment, operation may be required. The procedure of acromioplasty excises the acromion process, or preferably its anterior third, together with the coraco-acromial ligament to prevent the possibility of further nipping of inflamed tissue between it and the upper end of the humerus. The operation can be carried out as either an open or closed arthroscopic procedure. The shoulder region

RUPTURE OF LONG TENDON OF BICEPS

The long tendon of the biceps is one of several tendons in the body that are prone to rupture without violent stress or injury. (O thers are the supraspinatus tendon and the tendon of extensor pollicis longus.)

Cause. The tendon will not rupture under ordinary stresses unless it is already weak. The predisposing factor is age-degeneration, probably accelerated by oft-repeated friction and angulation at the point where the tendon enters the bicipital groove of the hum erus.

Clinical features. The patient is usually a m an past m id dle age. W hile lifting or pulling with the arm he feels som ething give way in the region of the front of the shoulder. There is only moderate discomfort, and often the patient neglects to seek early advice. Later he may notice an unusual bulge of the muscle in front of the arm.

On examination soon after the rupture, there is slight tenderness over the bicipital groove of the humerus. When the patient contracts the biceps muscle, as in flexing the elbow or supinating the forearm against resistance, the belly of the long head is seen to bunch up into a short round mass like a ball. There is surprisingly little weakness of elbow flexion or of supination.

Treatm ent. The disability is usually so slight that operation is not required. W hen repair is considered necessary, it is sufficient to produce a tenodesis by fixing the distal stump of the tendon to the walls of the bicipital groove. The proxim al stump is ignored.

TENOSYNOVITIS OF LONG TENDON OF BICEPS (Biceps tendinitis)

This is an uncommon and rather minor affection characterised by pain and local tenderness in the region of the bicipital groove of the humerus and the long tendon of the biceps. It is generally ascribed to frictional irritation of the tendon within its groove, but it may be associated with degeneration of the tendons that form a cuff at the top of the shoulder.

Clinical features. The complaint is of pain in the front of the shoulder, worse on active use of the arm. Exam ination reveals local tenderness in the course of the long tendon of the biceps in the bicipital groove of the humerus. The pain can often be exacerbated by moving the shoulder while the tendon is made taut by forced supination of the forearm.

Treatment. Excessive use of the shoulder should be avoided. Physiotherapy by ultrasound, interferential therapy, or short-wave diathermy is worth a trial. Failing this, a local injection of hydrocortisone may be advised.

POLYMYALGIA RHEUMATICA

Polym yalgia rheum atica was described on page 166. It is worth mentioning again here because the soft tissues about the shoulders and the base of the neck are commonly the parts affected. The onset of this disorder of connective tissue is insidious, with aching pain and tenderness in the muscles of the shoulder girdle, neck, and spine, and severe 'stiffness' with substantial restriction of

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m obility of the shoulders, neck, and spine. There is also constitutional illness, with malaise, mild pyrexia, and night sweats, and elevation of the erythrocyte sed im entation rate. Early treatm ent by prednisolone in high doses should be ad vised if there is a suspicion of giant cell arteritis, pending confirm ation of the diagnosis by biopsy.

DISORDERS OF THE ACROMIO-CLAVICULAR JOINT

OSTEOARTHRITIS OF THE ACROMIO-CLAVICULAR JOINT

Degenerative arthritis (osteoarthritis) of the acromio-clavicular joint is seen m uch m ore often than is osteoarthritis of the gleno-hum eraljoint. Pathologically, there are degeneration and attrition of articular cartilage, and snurs of hone (osteophytes) are formed at the joint margins.

Clinical features. There is pain, localised accurately to the acromioclavicular joint and aggravated by strenuous use of the lim b - especially in overhead work. On examination irregular bony thickening of the joint margins due to osteophytes may be felt. There is no soft-tissue thickening and no increase of local skin temperature. The total range of shoulder movements is not appreciably decreased, but pain in the region of the acromioclavicular joint is exacerbated at the extrem es of movem ent, especially on elevation of the arm tow ards the vertical: the arc of movement below 90° is painless, but above 90° pain develops and persists throughout the rem ainder of the arc to full elevation (com pare painful arc syndrom e, p. 268).

Im aging. Radiographs show features that are typical of osteoarthritis with narrow ing of the cartilage space and marginal osteophytes. MR scans can provide more information on the extent of rotator cuff impingement in the subacromial space.

Treatment. Often treatment is not needed, other than modification of everyday activities. In severe cases operation is justified: it should take the form of excision of the lateral end of the clavicle with preservation of the conoid and trapezoid ligam ents

PERSISTENT ACROMIO-CLAVICULAR DISLOCATION **OR SUBLUXATION**

Persistent upward displacement of the lateral end of the clavicle is a common sequel to traum atic dislocation or subluxation of the acromio-clavicular joint. In most cases the displacement is slight and causes no symptoms, except perhaps for pain or discom fort during overhead work. Exceptionally there is pain, worse during full elevation of the arm. On examination the lateral end of the clavicle is unduly prominent, and a distinct step can be felt between it and the surface of the acrom ion.

Treatment. U sually treatment is unnecessary, but if disabling pain persists operation is advised. A simple and effective method to achieve pain relief is to excise the lateral end of the clavicle. How ever, in younger patients the resultant The

shoulder region

instability may be troublesome and it may be preferable to reconstruct the joint by coraco-acromial ligament transfer combined with internal fixation of the coraco-clavicular joint.

DISORDERS OF THE STERNO-CLAVICULAR JOINT

PERSISTENT OR RECURRENT DISLOCATION OF THE STERNO-CLAVICULAR JOINT

Forw ard dislocation of the medial end of the clavicle may be permanent, or it may recur on certain movements of the arm. Often, but not always, there is a history of precipitating injury. The symptoms are slight: there is a prominence in the region of the joint, with mild local pain. Recurrent displacement of the clavicle in and out of joint during movements of the arm may be an annoying disability. On examination the medial end of the clavicle, when displaced, is easily felt as a prominent forward projection. In recurrent dislocation the clavicle can be felt to click out of joint when the shoulders are braced back, and to go back into position when the shoulders are arched forwards.

Im aging. Radiographs reveal the displacement, when present. It is difficult to show the joint clearly on plane films and CT scanning may be necessary to provide fuller information.

Treatm ent. In many cases treatment is unnecessary, but operation is occasionally justified. The displacement is reduced and the clavicle is held in place by constructing a new retaining ligament from the tendon of the subclavius muscle or an autogenous semitendinosus tendon in a figure-of-eight configuration. W ire fixation must be avoided because of the risk of damage to the underlying major vessels.

EXTRINSIC DISORDERS SIMULATING SHOULDER DISEASE

Pain in the shoulder or arm often has no local cause, but is referred from an extrinsic lesion. Such a possibility must always be considered in differential diagnosis.

DISORDERS OF THE BRACHIAL PLEXUS OR ITS ROOTS

The pain caused by pressure upon the brachial plexus or its roots is commonly attributed erroneously to an affection of the shoulder. Such pain varies in its precise distribution according to the site and nature of the nerve lesion. Usually it radiates from the base of the neck, across the top of the shoulder, and down the front, side, or back of the arm; thence it extends into the forearm, and often into the hand and fingers. Thus in its typical form the pain from a nerve lesion in the neck differs from the pain of a shoulder lesion, which typically does not extend below the elbow. The conditions which can result in brachial plexus symptoms are described in Chapter 12.

CHAPTER 14

A ffections that may cause referred symptoms in the distribution of the brachial plexus include prolapsed cervical intervertebral disc, osteoarthritis of the cervical spine, cervical rib, herpes zoster, and tumours involving the spinal cord or the component nerves of the brachial plexus.

DISORDERS OF THE UPPER ARM

Shoulder pain typically radiates distally and is often felt near the insertion of the deltoid muscle. Pain arising locally at this site, for instance from a lesion in the shaft of the hum erus, may thus be confused with pain arising at the shoulder itself. Radiographs including the upper half of the hum erus will usually help to make the distinction.

DISORDERS WITHIN THE THORAX

Angina pectoris

In a sm all proportion of cases of angina pectoris the pain is felt predom inantly in the shoulder region (usually on the left side). O ther features are invariably present to suggest a cardiac origin, and the shoulder shows no clinical abnorm ality.

Pleurisy

Basal pleurisy is sometimes a cause of shoulder painwhich is explained by irritation of phrenic nerve endings, with referred pain in the distribution of the cutaneous branches of the same cervical roots (mainly C4).

Tumour

Pancoast's apical lung carcinom a is a well-known cause of radiating shoulder and upper limb pain, from involvement of the lower trunks of the brachial plexus. Chest radiography is diagnostic.

DISORDERS WITHIN THE ABDOMEN Cholecystitis

This is a cause of referred pain in the right shoulder, from irritation of the phrenic nerve endings under the diaphragm. The associated abdom inal symptoms and signs, and the lack of clinical abnormality in the shoulder, should prevent diagnostic errors.

Subphrenic abscess

This also is an occasional cause of referred shoulder pain. Constitutional sym ptom sand pyrexia, with norm al clinical findings in the shoulder, should indicate this possible cause.

15 The upper arm and elbow

A part from injury, disorders of the upper arm and elbow region are generally straightforward and present few special problems. They conform to the general descriptions of bone and joint diseases that were given in Part 2. Thus the humerus is subject to the ordinary infections of bone, and occasionally to bone tumours – especially metastatic tumours. The elbow is liable to every type of arthritis, none is particularly common though rheumatoid arthritis is commoner than osteoarthritis. A fter the knee, it is the joint most often affected by osteochondritis dissecans and loose body formation. The ulnar nerve lies in a vulnerable position at the back of the medial epicondyle, and the possibility of im pairment of nerve function complicating disease or injury of the joint should always be remembered. Replacement arthroplasty of the elbow is undertaken increasingly, but compared with those of hip and knee arthroplasty the results still leave much to be desired, especially from the point of view of the longevity of the new joint.

SPECIAL POINTS IN THE INVESTIGATION OF UPPER ARM AND ELBOW SYMPTOMS

History

The interrogation follows the usual lines suggested in Chapter 1. It is important to ascertain the exact site and distribution of the pain, and its nature. Pain arising locally in the humerus is easily confused with pain arising in the shoulder, which characteristically radiates to a point about half-way down the outer aspect of the upper arm. Elbow pain is localised fairly precisely to the joint, though a diffuse aching pain is often felt also in the forearm. When the ulnar nerve is interfered with behind the elbow the symptoms are mainly in the hand.

In the elbow, a history of previous injury, perhaps long ago in childhood, is often relevant. Injuries in this region are notoriously liable to have late effects in the form of impaired movement, deformity, arthritis, loose body formation, or interference with the ulnar nerve.

Exposure

The whole length of the upper limb must be uncovered. The opposite limb must be similarly exposed for comparison.

 Table 15.1
 Routine clinical examination in suspected disorders of the upper arm and elbow

1. LOCAL EXAMINATION OF THE ARM AND ELBOW	
Inspection Bone contours and alignment Soft-tissue contours Colour and texture of skin Scars or sinuses	Power Flexors Extensors Supinators Pronators
PalpationSkin temperatureBone contoursSoft-tissue contoursLocal tendernessMovements (active and passive)Humero-ulnar joint:FlexionExtensionRadio-ulnar joint:SupinationPronation? Pain on movement? Crepitation on movement	Stability Lateral ligament Medial ligament
	The median nerve Sensory function Motor function (opponens action) Sweating
	The radial nerve Sensory function Motor function (extension of wrist, thumb, and fingers)
	The ulnar nerve Sensory function Motor function Sweating

This is important if a satisfactory explanation for the symptoms is not found on local examination. The investigation should include:

1. the neck, with the brachial plexus

2. the shoulder

3. GENERAL EXAMINATION

General survey of other parts of the body. The local symptoms may be only one manifestation of a widespread disease

Steps in routine examination

A suggested plan for the routine clinical examination of the upper arm and elbow is summarised in Table 15.1.

Movements at the elbow

The elbow joint has two distinct components: the hinge joint between the humerus above and the ulna and radius below, allowing flexion-extension movement; and the pivot joint between the upper ends of the radius and ulna, allowing rotation of the forearm. It should be remembered that free rotation of the forearm is dependent not only upon an intact superior radio-ulnar joint: it demands also free mobility between the radius and ulna throughout their length, and distally at the inferior radio-ulnar joint. *Flexion-extension*: The normal range is from 0 to 155° (0 = anatomical position, with the arm straight). *Supination-pronation*: Rotation movements must be tested with the elbow flexed to a right angle, to eliminate rotation at the shoulder (Fig. 15.1A). The normal range is 90° of supination (palm up) and 90° of pronation (palm down) (Fig. 15.1B). If the range of rotation is restricted possible causes must be sought in the forearm and wrist as well as in the elbow.



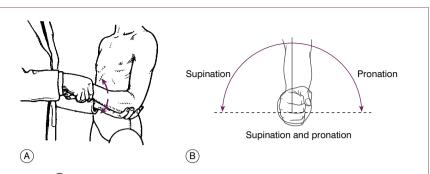


Fig. 15.1 (A) Examining rotation of the forearm. The elbow is flexed 90° to eliminate rotation at the shoulder. (B) Range of supination and pronation of the forearm.

The ulnar nerve

Because of the vulnerability of the ulnar nerve in its course behind the elbow, tests of ulnar nerve function should be carried out as part of the routine exam ination of the elbow. Exam ine for sensibility in the little finger and medial half of the ring finger, and test the ulnar-innervated small muscles of the hand for wasting or weakness: a simple test is to ask the patient to spread the fingers and to bring them together again forcibly, to prevent a card gripped between the middle and ring fingers from being withdrawn. N ote whether the skin in the territory of the ulnar nerve sweats equally with the rest of the hand.

The median and radial nerves

The integrity of the median and radial nerves should also be tested. Criteria of integrity of the median nerve are volar sensibility in the lateral three and a half digits, and active power of opposition of the thum b. Integrity of the radial nerve is demonstrated by ability to dorsiflex the wrist and to extend the digits at the metacarpo-phalangeal joints. A distal lesion, affecting the posterior interosseous division of the nerve, may leave wrist extension intact while impairing extension of the digits.

Imaging

Radiographic examination. Radiographs of the humerus must always include antero-posterior and lateral projections, and they should take in both the should er joint and the elbow.

Routine radiographs of the elbow comprise an antero-posterior projection with the elbow straight and a lateral projection with the joint sem iflexed. In special circum stances additional oblique or tangential projections may be helpful. A radiograph of the forearm bones and of the inferior radio-ulnar joint is also required when rotation of the forearm is impaired.

Other im aging techniques. Radioisotope scanning, CT scanning, and MR im aging may all be helpful in appropriate circum stances.

Extrinsic sources of pain in the upper arm

Pain in the upper arm is commonly referred from a lesion elsewhere particularly from the shoulder, and from the neck when the brachial plexus or its roots are involved. Shoulder pain usually radiates from the tip of the acromion process to about the middle of the outer aspect of the arm, but it does not extend below the elbow. In contrast, nerve pain from interference with the brachial plexus often extends throughout the length of the arm and forearm into the hand and fingers; and frequently there is accompanying paraesthesiae in the form of tingling, numbness, or 'pins and needles'.

DISORDERS OF THE UPPER ARM

ACUTE OSTEOMYELITIS (General description of acute osteomyelitis, p. 85)

O steom y elitis is less com m on in the upper lim b than in the low er. N evertheless the hum erus is a w ell-recognised site of haem atogenous infection – especially its upper m etaphysis.

Pathology. Except in time of war the humerus is seldom infected directly by organisms introduced from without, for compound fractures are rare. Infection is usually haem atogenous, from a focus elsew here in the body. This type of infection occurs mainly in children, and it usually begins in a metaphysis of the bone – more often the upper metaphysis than the low er. Since



Fig. 15.2 Acute osteomyelitis of upper end of humerus. Radiograph 4 weeks after onset showing marked rarefaction of the bone, with patchy areas of destruction and much subperiosteal new bone formation. both the upper and the lower metaphyses are partly enclosed within the capsule of the shoulder and of the elbow respectively, a metaphysial infection is liable to spread directly to the adjacent joint, causing pyogenic arthritis (see Fig. 7.2).

Clinical features. There is constitutional illness, with pyrexia. Locally, there is severe pain at the site of infection. On examination there is intense and welllocalised tenderness over the affected area – usually near one end of the bone. Later, there may be swelling and increased warmth, and a fluctuant abscess may form. The adjacent joint is commonly swollen from an effusion of fluid ('sym pathetic' effusion), even if the joint itself is not involved in the infection. In the absence of joint infection, how ever, movements are restricted only slightly, if at all

Im aging. Radiographs do not show any abnorm ality at first. A fter about two weeks there are often localised rarefaction and subperiosteal new bone form ation (Fig. 15.2), but these changes may be slight at first. Radioisotope scanning shows increased uptake in the affected area.

Investigations and treatment are the same as for acute osteom yelitis elsewhere (p. 89).

CHRONIC OSTEOMYELITIS (General description of chronic osteomyelitis, p. 90)

As in other bones, chronic pyogenic osteomyelitis of the humerus is nearly alw ays a sequel to acute osteom yelitis that has been neglected or has responded poorly to treatm ent. The bone is thickened, often throughout its whole length, and there may be a persistent or intermittent purulent discharge from a sinus, or recurrent flare-ups with local pain and induration. Radiographs show irregular thickening with patchy areas of sclerosis and cavitation, and som etimes a sequestrum

Treatmentwas described on page 91.

TUMOURS OF BONE

Benign tumours (General description of benign bone tumours, p. 106)

Osteochondroma, osteoid osteoma, and giant-cell tumour can all affect the hum erus but none are particularly com m on at this site.

Giant-cell tum our is uncommon in the humerus, but when it does occur the usual site is at the upper end, where it often extends close up to the articular surface. The tum our occurs chiefly in young adults, and its general characteristics are like those of giant-cell tum our of bone at other sites (p. 109).

Treatment. The high risk of recurrence after sim ple curettage and bone grafting has to be balanced against the likely disability after radical excision of the whole of the upper end of the humerus. Each case must be considered on its merits, but if the tumour is large there is much to be said for radical local excision of the affected part of the bone and replacement by a custom-made metal prosthesis.



Fig. 15.3 Metastatic tumour in the humerus from primary carcinoma of the lung. This is a common site for metastatic tumours, which often lead eventually to pathological fracture.

Malignant tumours (General description of malignant bone tumours, p. 112)

Primary malignant tumours

Prim ary malignant tum ours of bone are much less common in the upper limb than in the lower, and examples are seen only infrequently. However, osteosarcoma, chondrosarcoma, Ewing's tumour, and multiple myeloma should all be considered as possible causes of painful destructive bone lesions in the humerus.

Metastatic tumours

M etastatic tum ours, by comparison, are common, especially in the proximal part of the hum erus (Fig. 15.3). Carcinom atous deposits from tum ours of the lung, breast, prostate, kidney, and thyroid are common and usually occur near the upper end of the shaft, where there is much vascular marrow. Such metastases are a common cause of pathological fracture and may require internal fixation as well as adjuvant treatment with radiotherapy.

BONE CYST

Both simple bone cysts and aneurysm al bone cysts can occur in the humerus and were described on page 126. The humerus is the commonest site of simple bone cyst, which occurs especially in children or adolescents, and at the upper end of the bone. The cyst replaces the normal bone structure and may lead to pathological fracture as the presenting symptom in over 50% of cases. (Fig. 15.4 A). Sm all cysts may simply be kept under observation, since the majority heal spontaneously in adult life (Fig. 15.4 B). A large cyst which might lead to fracture, should first be aspirated and injected with corticosteroid solution or autogenous bone marrow. Most fractures through cysts heal with conservative treatment and internal fixation is rarely required in the humerus.

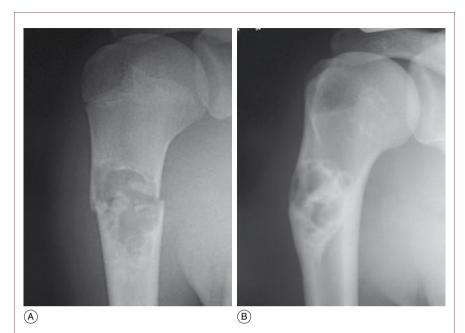


Fig. 15.4 (A) Radiograph showing a pathological fracture through a simple bone cyst in the shaft of the humerus in an adolescent patient. Cortical fragments have fallen into the multilocular cystic cavity. (B) Same patient nine months later showing the fracture has healed spontaneously and the cyst is showing evidence of infilling with dense sclerotic bone.

DISORDERS OF THE ELBOW

CUBITUS VALGUS

The normal elbow, when fully extended, is in a position of slight valgus – usually 10° in men and 15° in women. This is known as the carrying angle. If the angle is increased, so that the forearm is abducted excessively in relation to the upper arm, the deformity is known as cubitus valgus (Fig. 15.5).

Cause. Cubitus valgus is usually a consequence of previous disease or injury in the elbow region. The most frequent causes are:

- previous fracture of the low er end of the hum erus or of the capitulum, with m al-union
- 2. interference with epiphysial grow then the lateral side, from injury or infection.

Clinical features. A part from the visible deformity there are no symptoms unless secondary effects develop.

Secondary effects. The most important sequel of cubitus valgus is interference with the function of the ulnar nerve. When valgus deformity is marked, the nerve is angled sharply round the prominent medial part of the joint, and repeated friction may lead to fibrosis of the nerve trunk. Symptoms develop insidiously over a long period: there are tingling and blunting of sensibility

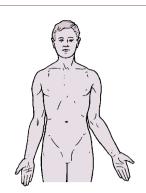


Fig. 15.5 Cubitus valgus (left elbow). The deformity predisposes to friction neuritis of the ulnar nerve.

in the ulnar distribution in the hand, with weakness and wasting of the ulnarinnervated small hand muscles (p. 291).

Treatm ent. Slight uncom plicated deform ity is best left alone. If angulation is severe, correction by osteotom y near the low er end of the hum erus is justified. If the function of the ulnar nerve is im paired the nerve should be transposed from its post-hum eral groove to a new bed at the front of the elbow.

CUBITUS VARUS

C ubitus varus is the opposite deform ity to cubitus valgus. The carrying angle, or norm al angle of valgus at the fully extended elbow, is decreased or reversed. Cause. The causes are sim ilar to those of cubitus valgus:

- previous fracture with mal-union (especially supracondylar fracture of the humerus)
- 2. interference with epiphysial grow thon the medial side.

Clinical features. There are usually no symptoms other than the visible deform ity, which may be embarrassing, especially to a child.

Treatm ent. M in or degrees of deform ity can safely be left uncorrected. If the angulation is severe it may be corrected by osteotomy through the low er end of the hum erus.

PYOGENIC ARTHRITIS OF THE ELBOW (General description of pyogenic arthritis, p. 96)

Pyogenic arthritis is usually an acute infection with suppuration, but it may occur in subacute or even in chronic form.

The causation, pathology, clinical features and treatment of the condition are sim ilar to other large joints and are described on page 97.

TUBERCULOUS ARTHRITIS OF THE ELBOW (General description of tuberculous arthritis, p. 98)

Tuberculous arthritis is much less common in the elbow than it is in the large weight-bearing joints such as the hip and knee. The pathological and clinical features of joint tuberculosis were described on page 98, and further description is not required here. Biopsy may be required to establish the diagnosis.

RHEUMATOID ARTHRITIS OF THE ELBOW (General description of rheumatoid arthritis, p. 134)

One or both elbows are commonly affected in rheumatoid arthritis, usually in conjunction with several other joints, and may result in considerable pain and functional disability.

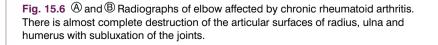
Pathology. The pathological changes are like those of rheum atoid arthritis elsew here. Beginning as a chronic inflam m atory thickening of the synovial m em brane, it tends later to involve the articular cartilage, which m ay eventually be alm ost totally destroyed. The subchondral bone m ay also be eroded by the synovial pannus form ation.

Clinical features. As in other joints, the main symptoms are pain, swelling from thickening of the synovial membrane, abnormal warm thof the overlying skin, and impairment of movement, particularly of rotation of the forearm. In the later stages there is commonly a fixed flexion deformity.

Im aging. Radiographic exam ination. A tfirst there are no changes. Later, there is diffuse rarefaction in the area of the joint. In long-established cases the cartilage space is lost and there m ay be considerable erosion of the bone ends (Fig. 15.6).

CT scanning may be useful in pre-operative planning to determine the amount of bone available for prosthetic support.

Treatment. Primary treatment is along the lines suggested for rheum atoid arthritis in general (p. 137).





Operative treatment. If extensive destruction of the articular cartilage leads to persistent disabling pain with bone destruction and deform ity, operation m ust be considered. If pain is largely at the lateral side of the joint the sim ple operation of excision of the head of the radius, with a limited synovectom y, often gives good relief. Replacement arthroplasty, by the fitting of a hinged prosthesis with long stems cemented into the humerus and ulna, has now been largely abandoned because of the risk of loosening and fracture. Im proved results have been obtained by non-linked replacements of the articular surfaces with metal and plastic liners. The long-term functional results are not as good as with hip and knee replacements, but offer satisfactory pain relief.

OSTEOARTHRITIS OF THE ELBOW (General description of osteoarthritis, p. 140)

O steoarthritis seldom occurs in an elbow that was previously normal. In nearly every case a predisposing factor has been present for several years. This is usually a damaged articular surface from previous fracture involving the joint, or from osteochondritis dissecans.

Clinical features. There is slow ly increasing pain in the elbow, worse on heavy use of the lim b. The patient may also notice that movement is impaired. In some cases there are attacks of sudden locking, suggesting the presence of a loose body in the joint. There is often a history of previous injury or disease involving the elbow – for instance, osteochondritis dissecans. On examination there is palpable thickening at the joint margins, from osteophytes. Flexion and extension are impaired but rotation is often full. There is coarse crepitation on movement.

Radiographs show narrowing of the cartilage space and pointed osteophytes at the joint margins (Fig. 15.7). Loose bodies (formed from detached osteophytes or from flakes of articular cartilage) may be present.

Treatm ent. Many patients with early arthritis, causing only intermittent pain and minimal loss of movement, can be managed by re-assurance and modification of activities. Others may require conservative treatment with analgesics and physiotherapy in the form of short-wave diathermy and mobilisation of the joint. Where pain becomes severe on a daily basis, or locking and joint stiffness limit function, surgery is usually indicated. Open or arthroscopic debridement to remove osteophytes and any loose bodies from the joint may be effective, but excision of the radial head may also be required to restore forearm rotation. In only a few cases is prosthetic joint techniques described for rheum atoid arthritis. It is im portant that the ulnar nerve is transposed anteriorly at the time of surgery to avoid the risk of later neuropraxia.

NEUROPATHIC ARTHRITIS OF THE ELBOW (General description of neuropathic arthritis, p. 147)

In neuropathic arthritis (Charcot's osteoarthropathy) of the elbow the joint becomes disorganised in consequence of a loss of sensibility to pain. It is a rare form of arthritis. The upper arm and elbow



Fig. 15.7 Osteoarthritis of the elbow. Note the narrowed cartilage space and pointed osteophytes at the joint margins. In this case osteoarthritis was secondary to osteochondritis dissecans occurring many years before.

Cause. The usual underlying cause of the disease in the elbow is syringom yelia, but any other affection that leads to loss of sensibility (e.g. diabetic neuropathy) m ay be responsible.

Pathology, clinical features and treatm ent are similar to other affected joints. Treatm ent is conservative with elbow bracing as operation is in appropriate.

HAEMOPHILIC ARTHRITIS OF THE ELBOW (General description of haemophilic arthritis, p. 145)

H aem ophilic arthritis affects the elbow more often than any other joint except the knee. As in other joints, the main feature is intra-articular haem orrhage, often recurrent, with consequent irritation and, later, degeneration of the joint.

The clue to the diagnosis is a history of previous bleeding or of a haemophilic tendency in the family. Haemarthrosis without major injury should always arouse suspicion of haemophilia. A prolonged blood clotting time is an important confirmatory finding.

Treatm ent (for fresh haem arthrosis). If antihaem ophilic factor is available it should be given in adequate dosage and the joint should be aspirated. The elbow is supported by crepe bandages and a removable light plaster or plastic splint. Gentle exercises are resum ed after 2 weeks. If antihaem ophilic factor is not available reliance must be placed on splintage, without aspiration. In this event, particularly after repeated haem arthrosis, perm anent dam age with fibrosis of the synovial mem brane and the form ation of intra-articular adhesions must be expected in the long term.

OSTEOCHONDRITIS DISSECANS OF THE ELBOW (General description of osteochondritis dissecans, p. 153)

A fter the knee, the elbow is the most frequent site of osteochondritis dissecans. The disorder is characterised by necrosis of part of the articular cartilage and of **Fig. 15.8** Osteochondritis dissecans. A fragment of the capitulum is separating. This is the typical site of osteochondritis dissecans in the elbow.

the underlying bone, with eventual separation of the fragment to form an intraarticular loose body (Fig. 15.8).

Cause. The precise cause is unknown. Impairment of blood supply to the affected segment of bone and cartilage by throm bosis of an end artery has been suggested. Injury probably plays a part.

Pathology. The part of the elbow affected is nearly always the capitulum of the humerus. The necrotic segment of articular surface varies in size; commonly its surface area is about a centimetre in diameter and its depth less than half a centimetre. A line of demarcation forms between the avascular segment and the surrounding normal bone and cartilage, and after an interval of months the avascular segment separates as a loose body (sometimes two or three), leaving a shallow cavity in the articular surface which is ultimately filled with fibrous tissue. The damage to the joint surface predisposes to the later development of osteoarthritis.

Clinical features. In the early stages, before the fragment has separated, the symptoms are those of mild mechanical irritation of the joint – namely, aching after use and intermittent swelling (from fluid effusion). On examination at this stage there is often an effusion of clear fluid into the joint, and there is slight limitation of flexion or extension.

When a loose body has separated, the main features are recurrent sudden painful locking of the elbow and subsequent effusion of fluid.

Im aging. Plain radiographs in the early stages show an area of irregularity on the affected subchondral bone, usually of the capitulum. Later a shallow cavity, whose margins are demarcated clearly from the bone within it, is seen (Fig. 15.8). Eventually the bony fragment separates from the cavity and lies free within the joint, usually in the lateral compartment. MR scanning in the earlier stages of the disease may be valuable in determining the possibility of operative treatment prior to separation of the bony fragment.

Treatment. If the fragment is small, operation is delayed until the fragment of bone and cartilage is ripe for separation or has actually separated. The fragment is then removed. If the fragment is large and is identified prior to separation it may be fixed in place with a fine screw or pin until fixation to the underlying bone occurs.

LOOSE BODIES IN THE ELBOW

Causes. There are four im portant causes of loose bodies in the elbow :

- 1. osteoch on dritis dissecans (1-3 bodies)
- 2. osteoarthritis (1-3 bodies)
- 3. fracture with separation of a fragment (1-3 bodies)
- 4. synovial chondrom atosis (50-500 bodies).

PATHOLOGY AND CLINICAL FEATURES

Osteochondritis dissecans was described on page 153 and osteoarthritis on page 140.

Loose body after fracture. A fragment may rarely be detached from the capitulum. Sometimes the medial epicondyle is detached and sucked into the joint, retaining its attachments to the flexor muscles. (Strictly this is not a loose body because it retains soft tissue attachments, but it behaves as one.)

Synovial chondrom atosis (osteochondrom atosis). This is a rare disease of synovial membrane in which numerous synovial villi become pedunculated and transformed into cartilage; eventually they are detached to form a large number of loose bodies, many of which become calcified (Fig. 15.9).

Clinical features. Many so-called loose bodies are 'silent' – that is, they do not cause symptoms. Often in such cases the fragment is not in fact loose, but has soft-tissue attachments that prevent its moving about the joint.

The characteristic symptom of a freely movable loose body is sudden locking of the elbow during movement, with sharp pain. The joint is usually unlocked after an interval, either spontaneously or by the patient's

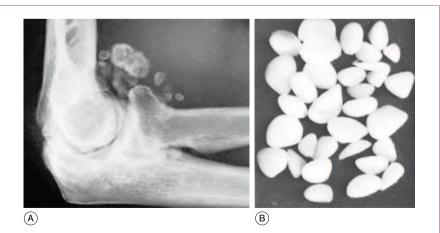


Fig. 15.9 B and B Multiple loose bodies in the elbow. A case of synovial chondromatosis.

m anoeuvres. Several hours later the joint swells because of effusion of fluid within it. The symptoms subside within a few days, but repeated attacks are to be expected.

Exam in ation in the stage of swelling shows the joint to be distended with fluid – a clear, pale, straw -coloured effusion. Between attacks a loose body may som etimes be felt. There is often a history or clinical evidence to suggest the cause of the loose body formation.

Radiographs show the loose body or bodies (Fig. 15.9A) and usually indicate the nature of the primary condition.

Treatment. Symptomless loose bodies may usually be safely left alone; but if a loose body causes locking it should be removed by operation. In cases of synovial chondromatosis, with numerous loose bodies, removal of the bodies should usually be supplemented by excision of as much of the synovial membrane as is easily accessible, to minimise the risk of recurrence.

TENNIS ELBOW (Lateral epicondylitis)

'Tennis elbow' is a common and well-defined clinical entity. It is an extra-articular affection characterised by pain and acute tenderness at the origin of the extensor muscles of the forearm from the lateral epicondyle. A similar but less common condition is 'golfer's elbow' at the origin of the muscles at the medial epicondyle.

Cause. It is believed to be caused by strain of the forearm extensor muscles, particularly the extensor carpiradialis brevis, at the point of their origin from the bone. A lthough it som etimes occurs after playing tennis or golf, other repetitive activities such as wheelchair use are just as likely to be responsible.

Pathology. It is assumed that there is incomplete rupture of aponeurotic fibres at the muscle origin, which is a region plentifully supplied by nerve endings. Histology shows no evidence of acute inflam mation, but an angiofibroblastic tendinosis is suggestive of repetitive micro injury with attempted healing. The elbow and radio-humeral joints are unaffected.

Clinical features. Patients are usually in the 30-50 age group presenting with pain at the lateral aspect of the elbow often radiating down the back of the forearm.

On examination there is tenderness precisely localised to the front of the lateral epicondyle of the hum erus (Fig. 15.10). Pain is aggravated by putting the extensor muscles on the stretch – for exam ple, by flexing the wrist and fingers with the forearm pronated. Movements of the elbow are full.

Im aging. Radiographs do not show any alteration from the norm al except for occasional calcification at the muscle origin in chronic cases. How ever, MRI scans may dem onstrate local oedem a and thickening in the extensor muscle origin.

Course. In about 80% of patients the symptoms eventually subside spontaneously after 1–2 years. In cases resistant to modification of activities more active treatment may be required.

Treatm ent. A large num ber of treatm ent methods, both conservative and surgical, have been applied to the condition but none have proved reliable in every case.

Сонservative treatment. Where rest and non-steroidal anti-inflammatory drugs have failed to provide relief, injection of the muscle origin with local anaesthetic and hydrocortisone is frequently employed. Repeat injections may be required on one of two occasions, but usually give relief for up to 6 weeks.

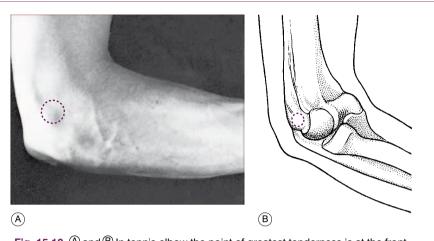


Fig. 15.10 (and (b) In tennis elbow the point of greatest tenderness is at the front of the lateral epicondyle, not over its greatest prominence. To be curative, injection must be made precisely at the point of greatest tenderness.

How ever, results from random ised trials with longer follow-up showed no greater im provem ent than achieved with other conservative measures. Orthotic devices, such as the proximal forearm band splint to reduce tension at the extensor origin are popular with those wishing to continue sporting activities, but their long-term benefit remains uncertain. O ther local treatment modalities such as sonic shock wave therapy and eccentric strengthening exercises provide equally uncertain long-term results.

Operative treatment. If severe disabling pain fails to respond to any of these conservative treatments, operation may have to be considered. The operation requires a small incision over the extensor origin which is stripped from its attachment to the lateral epicondyle, thereby detaching the pain-sensitive fibres from the bone while allowing natural healing to occur. With modern technology this procedure can now be carried out through an arthroscope without the need for open release. Long-term results have reported pain relief in over 80% of patients but som e local discom fort may persist.

OLECRANON BURSITIS

The bursa behind the olecranon process is liable to traum atic bursitis, septic bursitis, and gout.

Traum atic bursitis. In traum atic bursitis ('student's elbow ') the bursa is distended with clear fluid (Fig. 15.11). Treatm ent at first should be by aspiration, follow ed by the injection of hydrocortisone into the bursa. If the sw elling recurs the bursa should be excised.

Septic bursitis is treated by incision to secure adequate drainage. This should be conbined with an appropriate antibiotic to treat the underlying infecting organism.

Gouty bursitis. In gouty bursitis there is acute or subacute inflam mation, and whitish deposits of sodium biurate (tophi) may be visible through the walls of the bursa. If the symptoms are troublesome the bursa may be excised.



Fig. 15.11 Olecranon bursitis.

FRICTION NEURITIS OF THE ULNAR NERVE

The ulnar nerve is vulnerable where it lies in the groove behind the medial epicondyle of the humerus. Its function may be interfered with either by constriction or by recurrent friction while in tension. Constriction is usually secondary to osteoarthritis, with encroachment of osteophytes upon the ulnar groove. Friction under tension occurs especially when the carrying angle of the elbow is increased (cubitus valgus, p. 282). This latter type is often a late sequel of a supracondylar fracture of the humerus sustained in childhood ('tardy ulnar palsy'). In both cases the nerve undergoes fibrosis, and unless the mechanical fault is relieved without undue delay the changes may eventually become irreversible.

Clinical features. The patient com plains of num bness or tingling in the area of sensory distribution of the ulnar nerve, and often of clum siness in perform ing fine finger movem ents, as for instance in such activities as playing musical instrum ents.

On exam in ation in the fully developed condition the following signs are present: Sensory – There is blunting or loss of sensibility along the ulnar border of the hand and in the little finger and medial half of the ring finger. Motor – There are wasting and weakness of the ulnar-innervated small hand muscles. Sweating – The skin in the ulnar territory is drier than norm al because sweating is impaired. In doubtful cases nerve conduction studies may be carried out on the ulnar nerve, to detect any slowing of impulses at the elbow level.

Treatment. Whenever the ulnar nerve is interfered with by a lesion at the elbow operation should be undertaken. The operation will consist in decompression of the nerve by division of the overlying aponeurosis of the flexor carpiulnaris; or, if deform ity is present, by transposing the nerve to a new bed in front of the medial epicondyle of the elbow.

16 The forearm, wrist, and hand

So much in everyday life depends upon the efficient working of the hand, and so great is the practical and econom ic consequence of its disablement, that the care of the diseased or injured hand has become one of the most vital branches of orthopaedic surgery. It is also one of the most fascinating.

H and surgery is an art and a science in itself. Indeed it has already become a distinct speciality, dem anding a know ledge and experience not only of orthopaedic surgery but also of plastic surgery, microvascular surgery, and neurology.

In the treatm ent of hand disorders the primary emphasis should always be on restoration of function. Keen judgement is often called for in deciding between the claims of rest and of movement. It should be remembered that the hand tolerates immobilisation badly. Whereas the wrist may be immobilised for many weeks or even months with impunity, to immobilise injured or diseased fingers for a long time is to court disaster in the form of permanent joint stiffness. Although rest may be essential in the early days after a hand injury or in the acute stage of an infection, active finger exercises must be insisted upon as soon as that stage has passed. It is wise to accept it as a general rule that fingers should never be immobilised for longer than two, or at most three, weeks.

SPECIAL POINTS IN THE INVESTIGATION OF FOREARM, WRIST, AND HAND COMPLAINTS

History

It should be remembered that symptoms in the hand are often caused by disorders of the neck (with involvement of the brachial plexus or its roots) and sometimes by disorders at the elbow. Enquiry should always be made into any previous injury or other trouble with the neck or with the upper extremity as a whole.

Exposure

For the local exam ination the whole forearm should be uncovered to well above the elbow. The sound limb should be exposed likewise for comparison.

Steps in clinical examination

A suggested routine of clinical exam ination is sum marised in Table 16.1.

 Table 16.1
 Routine clinical examination in suspected disorders of the forearm, wrist, and hand

1. LOCAL EXAMINATION OF THE FOREARM, WRIST, AND HAND		
Inspection		
Bone contours	Metacarpo-phalangeal joints—	
Soft-tissue contours	Flexion-extension; adduction-	
Colour and texture of skin	abduction	
Scars and sinuses	Interphalangeal joints—Flexion–extension	
Palpation	Power	
Skin temperature	Power of each muscle group in control of:	
Bone contours	1. wrist movement;	
Soft-tissue contours	thumb and finger movement; and	
Local tenderness	3. gripping	
Movements (active and passive)	Stability	
At the wrist:	Tests for abnormal mobility	
Radio-carpal joint—Flexion–extension;	Nerve function	
adduction-abduction	Tests of sensory function, motor function,	
Inferior radio-ulnar joint—Supination and pronation	and sweating in distribution of median, ulnar,	
At the hand	and radial nerves	
Carpo-metacarpal joint of thumb—Flexion-	Circulation	
extension; adduction–abduction; opposition	Arterial pulses, warmth and colour, capillary	
	return, cutaneous sensibility	
2. EXAMINATION OF POSSIBLE EXTRINSIC SOURCES OF FOREARM AND HAND SYMPTOMS		
This is important if a satisfactory explanation for the symptoms is not found on local examination. The investigation should include:		
1. the neck and thoracic inlet, with special reference to the brachial plexus		
2. the upper arm		
3. the elbow		

3. GENERAL EXAMINATION

General survey of other parts of the body. The local symptoms may be only one manifestation of a more widespread disease

Movements at the wrist

Like the elbow, the wrist comprises two distinct components:

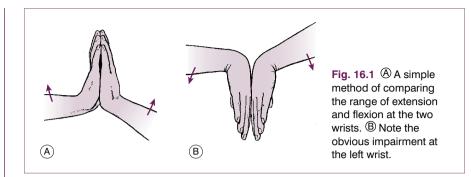
- the radio-carpal joint (including the intercarpal joints), allow ing flexion, extension, adduction, and abduction
- 2. the inferior radio-ulnar joint, allow ing supination and pronation.

The movem ents at each component must be examined independently.

The radio-carpal joint. The normal range of flexion (palmar flexion) is 80° and of extension (dorsiflexion) 90°. The range of adduction, or ulnar deviation, is about 35°, and of abduction, or radial deviation, about 25°. It is im practicable to measure the movements of the intercarpal joints individually, and it is sim plest to regard them as integral parts of the radio-carpal joint.

A rapid and reasonably accurate method of comparing the range of flexionextension movement on the two sides is as follows: To judge the range of extension: The patient places the palms and fingers of the two hands in contact in the vertical plane and lifts the elbows as far as he can while keeping the 'heels' of the hands together (Fig. 16.1). The angle between hand and forearm is easily compared on the two sides. To judge the range of flexion The forearm, wrist, and hand

ADAMS'S OUTLINE OF ORTHOPAEDICS



the manoeuvre is reversed. The patient places the backs of the hands together, with the fingers directed vertically downwards, and lowers the elbows as far as he can (Fig. 16.1). The angle between hand and forearm is compared on the two sides.

The inferior radio-ulnar joint. The norm al range is 90° of supination and 90° of pronation. To determ ine the range accurately the patient's elbows must be flexed to a right angle in order to eliminate rotation at the shoulder (see Fig. 15.1).

It must be emphasised that impaired rotation does not necessarily denote an abnormality of the wrist: it may equally well be caused by a disorder of the elbow or of the forearm.

Movements of the hand

M ovem ents of the hand occur m ainly at three groups of joints:

- 1. the carpo-metacarpal joint of the thum b
- 2. the metacarpo-phalangeal joints
- 3. the interphalangeal joints.

C arpo-m etacarpal joint of thum b. This joint allows movement in five directions: flexion, or movement of the thum b metacarpal medially in the plane of the palm; extension, or movement of the thum b metacarpal laterally in the plane of the palm; adduction, or movement of the metacarpal towards the palm in a plane at right angles to it; abduction, or movement of the metacarpal aw ay from the palm in a plane at right angles to it; and opposition, or rotation of the metacarpal to bring the thum b nail into a plane parallel with the palm (Fig. 16.2).

M etacarpo-phalangeal joints of thum b and fingers. These joints allow flexion-extension m ovem ent through 90° (the range is variable and often through as little as 30° in the thum b), and a sm all range of abduction from, and adduction to, the m id line of the m iddle finger.

Interphalangeal joints of thum b and fingers. These are true hinge joints, allow ing only flexion and extension. In the fingers, the range of flexion is 90° at the proxim al interphalangeal joints, and 45° at the distal interphalangeal joints. In the thum b, the range of movement at the interphalangeal joint is usually about 80°.

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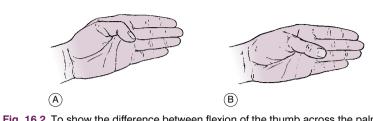


Fig. 16.2 To show the difference between flexion of the thumb across the palm A and true opposition B. In opposition the thumb metacarpal is rotated so that the thumb nail lies in a plane parallel with the palm.

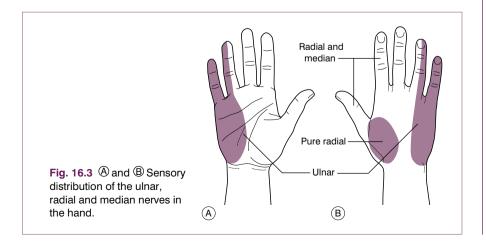
Power

Test the p o f each o v e m e n t i n tu rn Ιn t h in a tio n dem considerable patience, fo r ach m u indig u p u t h b it is vid u a llv . Thus i n t h u m n e cessarv t o t e t a b d t h adducu t o and brevis), th extensors (long fle 0 (long u s a n d vis), and t h Ιn t h test the flexors (profundus a n d superficialis), opponens. е fin gers th e tensor digito and in d ic is th e in teros lum bricals. Grip: Test th pow er of grip, which dem ands the com bined action • of the flexors and e rs of the wrist and the flexors of the fingers and thumb.

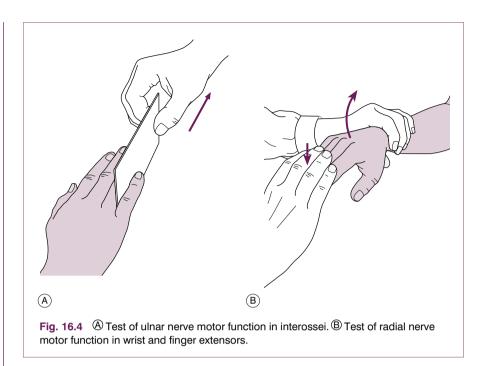
Nerve function

The state of the median, ulnar, and radial nerves is determined by tests of sensory function, motor function, and sweating. The ulnar nerve normally supplies sensation to the ulnar side of the hand together with the little finger and half the ring finger (Fig. 16.3).

largely The m ainder is innervated from th e m ed ian n e overlap on th e d o r s u m of the hand fro m th e radial nerv (F ig. 16.3) O n l v



The forearm, wrist, and hand



sm all skin area at the base of the thum b is purely supplied by the radial nerve. Intact function of the median nerve is indicated by ability to oppose the thum b to the little finger (see Fig. 16.2). Intact ulnar nerve function is shown by ability to spread the fingers apart and to bring them together again to grip a card between the middle and ring fingers (Fig. 16.4). An index of radial nerve function is the ability to extend the thum b and to extend the fingers at the metacarpo-phalangeal joints.

Circulation

The state of the circulation is assessed from the condition of the arterial pulses, the warm th and colour of the digits, the capillary return at the nail beds, and cutaneous sensibility. It should be remembered that sensibility to touch in the fingers is a most useful index of the adequacy of the circulation. Nerves require a blood supply to enable them to conduct impulses, and if the circulation is interrupted sensibility is quickly lost.

Extrinsic sources of forearm and hand symptoms

It is som etim es difficult to determ ine whether symptoms and signs in the forearm or hand are caused by a local disorder or whether they are referred from a more proxim al lesion. This difficulty arises mainly in neurological conditions. For instance, the symptoms of compression of the median nerve in the carpal tunnelmay be mimicked closely by a prolapsed cervical disc, and the symptoms of constriction of the ulnar nerve at the elbow may likewise be confused with those from a low cervical disc lesion or a cervical rib. When symptoms in the hand are not satisfactorily explained by the local condition a search must be made for a possible cause in the neck, upper arm, or elbow.

Imaging

Radiographic examination. Routine radiographs should include anteroposterior and lateral projections of the forearm, wrist, and hand. For detailed study of the carpal bones additional oblique projections are required.

If it is suspected that the symptoms may be referred from the neck or proximal part of the limb, radiographs of the appropriate part should be obtained.

DISORDERS OF THE FOREARM

ACUTE OSTEOMYELITIS (General description of acute osteomyelitis, p. 85)

A cute osteom yelitis is rather uncommon in the forearm bones. A s in other sites, the infection may be blood-borne (haematogenous) or it may be introduced from without, usually in consequence of a compound fracture. The haematogenous type occurs mainly in children. It affects the radius more often than the ulna, and the lowermetaphysis rather than the upper (see Fig. 7.3B).

The clinical features and treatment are like those of acute osteomyelitis elsewhere.

CHRONIC OSTEOMYELITIS (General description of chronic osteomyelitis, p. 90)

As in other bones, chronic osteom yelitis of the radius or ulna follows an acute infection.

Treatm ent. In most cases treatment should follow the usual lines, reliance being placed on rest and antibacterial drugs for non-suppurative flares of infection, and on thorough drainage operations and sequestrectomy for persistent purulent discharge.

BONE TUMOURS IN THE FOREARM AND HAND

Benign tumours (General description of benign tumours of bone, p. 106)

A ny type of benign tum our may occur in the bones of the forearm and hand. O nly chondrom a and giant-cell tum our require further mention here because of their more common occurrence at these anatomical sites.

Chondroma

Enchondrom a, which grows within the bone and expands it, is prone to occur in the metacarpals and phalanges of the hand presenting with deform ity or pathological fracture. The tum our may be solitary, but in the condition of multiple enchondrom atosis, or Ollier's disease, the tum ours may affect many bones in the hand causing ugly swelling and deform ity of the fingers (Fig. 16.5).

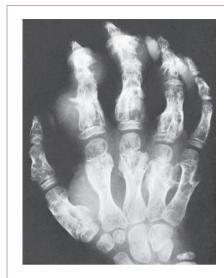


Fig. 16.5 Multiple enchondromata in the metacarpals and phalanges.

M alignant transform ation is hardly known in a solitary chondrom a of a bone of the hand, but it is a possibility in cases of multiple enchondrom atosis, leading to chondrosarcom a.

Treatment. If small, the tum our should be treated expectantly and fractures norm ally heal with simple splintage. Operation is required only if the tum our is found to be enlarging. Large tum ours should be excised and sent for routine histological examination, the bone substance being restored by cancellous bone grafts.

Enchondrom as of long bones are less common in the forearm, though these bones may be affected by multiple osteochondroma in the hereditary condition of diaphyseal aclasis (p.63). These tum ours may interfere with the normal grow th of the affected bone resulting in shortening and deform ity.

Enchondrom as occur chiefly in multiple form, in the condition known as dyschondroplasia, Ollier's disease, or multiple chondrom atosis. Their special significance in the forearm lies in the fact that the tum ours may interfere with the normal growth of the affected bone. If growth is retarded in one bone but proceeds norm ally in its partner marked curvature of the bones is to be expected, and it may cause ugly deformity, as seen commonly in dyschondroplasia.

Treatm ent. Severe deform ity from uneven grow th of the radius and ulna should be corrected by osteotom y, com bined when necessary with excision of the distal ulna, or som etim es the head of the radius.

Giant-cell tumour (osteoclastoma)

The lower end of the radius is one of the common sites in the upper limb for the development of a giant-cell tumour, which though classed as benign may show invasive tendencies. The lower end of the ulna is also susceptible. The tumour extends into the former epiphysial region close up to the articular surface (Fig. 16.6).



Fig. 16.6 (a) and (b) Radiographs of wrist showing a giant cell tumour in the distal radius. The lucent lesion has ill-defined proximal margins with a narrow zone of transition and lies in a typical subarticular position in the epiphysis.

Treatment. If the tum our is in the low erend of the radius radical excision and replacement by a suitable bone graft is to be recommended. A graft obtained from the upper part of the fibula is suitable because its shape matches that of the original bone. Ideally, the graft should be taken with the supplying artery and veins, which are anastom osed to suitable vessels in the recipient area by a microsurgical technique. If the low er end of the ulna is the part affected the bone should be excised up to a point well proximal to the tum our. The resulting disability is negligible.

Malignant tumours (General description of malignant tumours of bone, p. 112)

The radius and ulna are seldom affected by malignant bone tumours, whether primary or metastatic. When osteosarcoma does occur in the forearm the lower end of the radius is the usual site. Malignant change to chondrosarcoma is more common when there are multiple enchondromas present in the small bones of the hand.

VOLKMANN'S ISCHAEMIC CONTRACTURE¹

This is a flexion deform ity of the wrist and fingers from fixed contracture of the flexor muscles in the forearm.

¹Richard von Volkmann (1830–1889) German surgeon who was Professor in Halle, Saxony and also served as an army surgeon in the Franco-Prussian War. He described the ischaemic muscle paralysis and contracture in 1881.

Cause. It is caused by ischaemia of the flexor muscles, brought about by injury to, or obstruction of, the brachial artery near the elbow; or by tense oedema of the soft tissues of the forearm constrained within an unyielding fascial compartment.

Pathology. The effects of sudden occlusion of the brachial artery vary. In a few worst cases gangrene of the fingers will follow. Usually, how ever, the collateral circulation is sufficient to keep the hand alive, but not to nourish adequately the flexor muscles of the forearm or the main peripheral nerve trunks. The ischaemia that follows tense oedema in the anterior fascial compartment of the forearm, a consequence of severe injury in the region, has sim ilar effects. N ecrosis of muscle fibres of the forearm flexor group - especially the flexor digitorum profundus and flexor pollicis longus - with subsequent fibrosis and shortening, is the essential feature of Volkmann's contracture. It is often associated with tem porary or permanent ischaem ic paralysis of the peripheral nerves, especially the median nerve.

A ny m ajor fracture in the elbow region or upper forearm m ay lead to arterial occlusion. That m ost com m only responsible is a supracondylar fracture of the hum erus w ith displacem ent, the brachial artery being severed or contused by the sharp low er end of the m ain shaft fragm ent (Fig. 16.7). Contusion alone is sufficient to interrupt the flow of blood, because the artery goes into spasm and its lum en m ay be occluded by throm bosis.

Progressive oedema within the closed anterior fascial compartment of the forearm – for instance after fracture of the forearm bones – is commonly responsible for obstruction of the arterial flow (compartment syndrome).

In some cases the cause of the vascular obstruction is an over-tight plaster or bandage.

Clinical features. The condition is commonest in children. After sustaining a supracondylar fracture of the humerus or some other injury in the elbow region or forearm, the child complains of severe pain in the forearm.

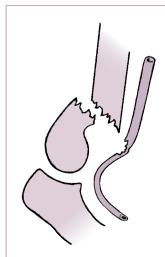


Fig. 16.7 To show how a supracondylar fracture of the humerus may damage the brachial artery, with risk of gangrene or ischaemic contracture. Over-tight plaster or dressings may have the same result.



Fig. 16.8 Typical appearance of the hand in established Volkmann's ischaemic contracture.

On examination in the incipient stage, the fingers are white or blue, and cold. The radial pulse is absent. Active finger movements are weak and painful. Passive extension of the fingers is especially painful and restricted. There may or may not be evidence of interruption of nerve conductivity namely, anaesthesia of the fingers and paralysis of the small muscles of the hand

In the established condition, which develops gradually within a few weeks of the injury, there is a striking flexion contracture of the w rist and fingers, from shortening of the fibrotic forearm flexor muscles (Fig. 16.8). Sensory and motor paralysis of the hand may persist as complicating factors, but they do not form an essential feature of Volkmann's contracture as such.

Diagnosis. In the incipient stage absence of the radial pulse, with marked unwillingness to extend the fingers because of pain, should alw ays arouse suspicion of Volkmann's contracture. If there are also anaesthesia and paralysis of the hand the diagnosis is practically certain. In the established condition the history and clinical features make the diagnosis clear.

Volkmann's ischaem ic contracture bears no real resem blance to Dupuytren's contracture (p. 321), for it affects the wrist as well as all the joints of the fingers, and there is no palpable thickening in the palm. Moreover the contracture is dem onstrably brought about by shortening of the flexor muscles, because if the wrist is flexed passively to relax the flexor tendons the range of extension at the finger joints is increased. Conversely, if the tendons are relaxed by flexing the fingers fully the range of wrist extension is increased (Fig. 16.9).

Treatment. In the incipient stage the problem is that of dealing with a sudden occlusion of the brachial artery or obstruction to the blood flow within a tightly congested fascial com partment. The case must be handled as an emergency, because the effects of occlusion becom e irreversible after about six hours. The follow ing action must be taken:

The forearm, wrist, and hand

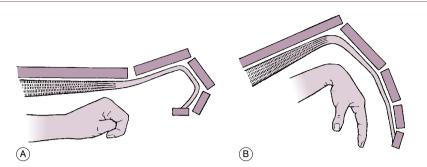


Fig. 16.9 In Volkmann's contracture the wrist can be partly extended if the fingers are flexed (a), and the fingers can be partly extended if the wrist is flexed (b): but the shortened fibrotic flexor muscles prevent extension of wrist and fingers together.

First step. A ll splints, plaster, and bandages that might be obstructing the circulation are removed. In the case of a fracture, gross displacement of the fragments is corrected as far as possible by gentle manipulation and a well-padded plaster splint is applied. Likewise if the elbow is dislocated it must be reduced without delay. Heat cradles or hot bottles are applied over the other three limbs and trunk to promote general vasodilation.

If these measures fail to bring about a return of adequate circulation within half an hour, the next step is taken:

Second step. At operation the anterior fascia of the forearm is exposed and split longitudinally throughout its length to open the fascial compartment, allowing the muscles to bulge through the gap. The brachial artery is then explored. If there is occlusion from kinking or spasm of the artery an attempt is made to relieve it by freeing the vessel and applying papaverine. If this fails, the artery may be distended by the injection of saline between clamps. In the last resort, the artery may have to be opened and damaged intim a removed; or the damaged length of artery may be excised and continuity restored by a vein graft. These procedures are best accom plished using magnification techniques, by a surgeon with wide experience of vascular surgery.

In the *established stage* restoration to norm al is im possible: reconstructive surgery at best can only im prove w hat function rem ains. The choice of treatment depends upon the circum stances of each case. In a mild case acceptable function may be restored by intensive exercises guided by a physiotherapist: such cases are how ever exceptional. In more severe cases the muscle shortening may be counteracted by shortening of the forearm bones, or by detachment and distal displacement of the flexor muscle origin (muscle slide operation).

In selected cases with severe muscle infarction, how ever, the best results are probably obtained by excision of the dead muscles and subsequent transfer of a healthy muscle (for exam ple, a wrist flexor or a wrist extensor) to the tendons of flexor digitorum profundus and of flexor pollicis longus to restore active flexion of the digits. These muscle transfers may be com bined, in appropriate cases, with arthrodesis of the wrist. When the median nerve is irreparably dam aged by ischaem ia nerve grafting is sometimes successful in restoring limited nerve function.

The forearm, wrist, and hand

ARTICULAR DISORDERS OF THE WRIST AND HAND

MADELUNG'S DEFORMITY¹ (Radio-ulnar dyschondrosteosis)

Madelung's deformity (radio-ulnar dyschondrosteosis) is a congenital subluxation or dislocation of the lower end of the ulna, from malformation of the bones. Although it is seemingly a localised disorder there may be minor generalised abnormalities of bone structure, often with short stature.

A similar wrist deformity is more often caused by disease or injury, such as a fracture of the lower end of the radius with proximal displacement of the lower fragment.

The deform ity varies in degree from a slight prominence of the low er end of the ulna at the back of the wrist, to complete dislocation of the inferior radioulnar joint with marked radial deviation of the hand (Fig. 16.10). The more severe types of deform ity may be associated with congenital absence or hypoplasia of the radius.

Treatm ent. If the disability justifies operation the lower end of the ulna should be excised. In a severe case, with m arked radial deviation of the hand, it m ay be necessary also to fuse the radius (or ulna, if the radius is absent) to the carpus in order to gain satisfactory correction.

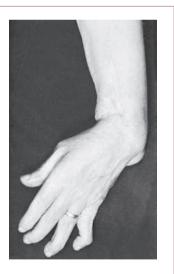


Fig. 16.10 Relative shortening of radius with subluxation of inferior radio-ulnar joint, radial deviation of the hand and prominent head of ulna (Madelung's deformity).

¹Otto Madelung (1846–1926) German general surgeon who was professor in Strasburg until after the First World War when the city was returned to France and he was forced to retire to Germany. He described the deformity in 1878.

PYOGENIC ARTHRITIS OF THE WRIST AND HAND (General description of pyogenic arthritis, p. 96)

Pyogenic arthritis of the wrist is uncommon. Infection may be haem atogenous, or it may be introduced through a penetrating wound. Spread from a focus of osteomyelitis is rare, partly because osteomyelitis itself is uncommon in the forearm bones, and partly because the lower metaphysis of the radius is entirely outside the capsule of the joint. (The lower metaphysis of the ulna is partly intracapsular (see Fig. 7.2).)

In the hand, any of the sm all joints m ay be infected by pyogenic organisms. The distal interphalangeal joints of the digits are prone to infection spreading from a suppurative lesion in the adjacent pulp space, or from a penetrating wound. These infections often cause permanent damage to the joint, with im pairment of movement or even rigid ankylosis. Radiographs in the late stage of infection may show diffuse rarefaction, loss of cartilage space and some bone destruction.

The clinical features and treatment of pyogenic arthritis are similar to those at other sites.

RHEUMATOID ARTHRITIS OF THE WRIST AND HAND (General description of rheumatoid arthritis, p. 134)

R heum atoid arthritis commonly affects the wrists and hands and is a major cause of serious loss of function and of ugly deform ity. Usually many or all of the joints of the hand are affected, though occasionally the disease may begin in a single joint. A ffected joints are swollen from synovial thickening, and movement is restricted. In the later stages articular cartilage and the underlying bone are eroded, and the fingers tend to deviate medially ('ulnar drift'), with dorsal prominence of the metacarpal heads and characteristic visible deform ity (Fig. 16.11A). At the wrist joint the disease commonly results in dorsal subluxation and dislocation of the ulnar head accompanied by subluxation of the carpus on the radius and radial deviation of the hand. R adiographs do not show any abnorm ality at first. Later, there is diffuse rarefaction of the bones. Later still, in progressive disease, destruction of cartilage leads to narrow ing of the joint space (Fig. 16.11B), and the subchondral bone may be eroded.

Im portant though these joint changes are in rheum atoid disease of the hand, equally serious disability may be caused by involvem ent of the soft tissues. These soft-tissue changes may take several forms, the most important of which are:

- 1. chronic tenosynovitis
- 2. rupture of tendons
- 3. contracture of intrinsic muscles
- 4. compression of the median nerve.

Chronic tenosynovitis. Masses of greatly thickened vascular synovial tissue envelop the flexor or the extensor tendons over the wrist or in the hand. Proliferation of the tenosynovium combined with nodular formation in the flexor tendon may produce symptoms of trigger finger.



Fig. 16.11 (A) Typical appearance of hand in long-established rheumatoid arthritis of wrist, metacarpo-phalangeal and interphalangeal joints. B Radiograph of the hand showing advanced erosive arthropathy due to rheumatoid arthritis. There is extensive destruction and subluxation of the radio-carpal, carpal, metacarpo-phalangeal, and interphalangeal joints with typical ulnar deviation of the fingers.

(B)

of tendons. Both the extensor and the flexor tendons are liable Run taneous rupture, from softening or fraying where they lie within novial sheaths. The extensor pollicis longus, extensor digitorum, extensor digitim inimiare the tendons that most commonly rupture.

Contracture of intrinsic muscles. Fixed contracture of the intrinsic muscles of the hand may follow fibrosis induced by the disease. It leads to inability to flex the interphalangeal joints fully when the metacarpo-phalangeal joint is held extended

Compression of the median nerve. A secondary effect of the synovial proliferation within the carpal tunnel is that the median nerve may be compressed by the transverse carpal ligam ent.

Treatment

(A)

Management of these complex disabilities of the hand is difficult and often unsatisfactory. The tendency of the disease to progress during months or years of activity means often that the hand becomes seriously crippled. Nevertheless much can be done with modern medical therapy to retard the progress of the and to prevent or correct deform ity, either by conservative treatm ent disease alone or by conservative treatment combined with operation.

Conservative treatment. The general plan of treatment is like that for rheumatoid arthritis as a whole (p. 137). It will usually include the administration of non-steroidal anti-inflam matory drugs, or in more resistant disease second-line drug therapy may be required with gold, penicillamine, or immuno-suppressive

agents. Cortisone and related steroids should be avoided if possible because of their undesirable side effects. Physiotherapy is of value: it should take the form of w arm w ater or w ax baths, w ith m obilising exercises and encouragement in active use of the hand. During an acute exacerbation the wrist joint m ay be im mobilised tem porarily in a moulded polythene splint or plaster of Paris back slab, but im mobilisation is never advised for the joints of the fingers other than with a dynam ic active splint.

Operative treatment. In carefully selected patients operation can be a valuable adjunct to conservative treatment, though it can never replace it. It should never be undertaken lightly, but only after careful deliberation and full discussion with the patient as well as the other members of the treatment team. Operations, particularly soft-tissue procedures, are often more rewarding when carried out in the fairly early stages of the disease, before deform ity from changes in the joints and soft tissues has become fixed and irreversible. Depending upon the nature of each individual case, operation may take one or more of the following forms.

Synovectomy. Excision of masses of thickened synovial tissue from tendon sheaths or from joints may slow down the destructive progress of the disease, and prevent tendon rupture and joint dislocation.

A rthroplasty. When the metacarpo-phalangeal or interphalangeal joints are badly disorganised arthroplasty by the insertion of a flexible silicone-rubber ('Silastic') prosthesis may sometimes be appropriate (Fig. 16.12). But the patient must be prepared to cooperate in a long programme of rehabilitation afterwards. The improvement gained is often cosmetic rather than functional. The benefit is not always lasting and deformity may recur because of breakage or loosening of the prosthesis.

A rthrodesis. For selected joints that are painful, stiff, deform ed, or unstable, arthrodesis in the position of most useful function is sometimes the best solution to the problem. When the wrist joint is badly destroyed, arthrodesis of the wrist in a neutral or slightly palm ar flexed position, will provide a stable basis for other reconstructive procedures in the hand. The metacarpo-phalangeal joint of the thum b may require fusion to restore deform ity and to provide the stability required for a pinch grip.

Tendon repair or replacement. Ruptured tendons may be repaired by suture or by grafting when practicable, or their lost function may be compensated by a tendon transfer operation (p. 44).

R elease of tight intrinsic muscles. Impaired finger movement and grasp from fixed contracture of the intrinsic muscles can be improved by partial division of the aponeurotic insertion of the muscles into the extensor expansion at the back of each finger.

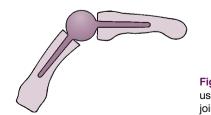


Fig. 16.12 Flexible silicone-rubber prosthesis used for arthroplasty of metacarpo-phalangeal joint.

Carpaltunnel decompression. Division of the transverse carpalligam ent and excision of the proliferative synovium will provide adequate decompression for the median nerve when neuropathy is present.

OSTEOARTHRITIS OF THE WRIST (General description of osteoarthritis, p. 140)

A lthough uncommon compared with osteoarthritis of the hip or knee, osteoarthritis of the wrist is a well-recognised sequel to certain injuries and diseases affecting the joint.

Cause. A lthough it is essentially a wear-and-tear process osteoarthritis seldom develops in a wrist that was previously normal. The wear and tear is nearly alw ays accelerated by previous injury to, or disease of, the joint surfaces. The commonest predisposing factors are comminuted fracture of the low erend of the radius with involvement of the articular surface, fracture of the scaphoid bone complicated by failure of union or avascular necrosis (osteonecrosis) of the distal fragment, dislocation of the lunate bone, Kienböck's disease of the lunate bone, and long-established ('burnt out') rheumatoid arthritis.

Pathology. The predom inant change is degeneration and wearing away of the articular cartilage lining the joint surfaces. The changes eventually involve all the carpal joints as well as the radio-carpal joint.

Clinical features. M on this or years after one of the predisposing conditions mentioned, the patient notices gradually increasing pain and stiffness of the wrist, worse on activity. On examination the wrist is slightly thickened from bony irregularity, but the swelling is not marked. The skin temperature is normal. Movements are markedly restricted, and painful if forced at the extremes.

R adiographic features. Radiographs show narrowing of the cartilage space and sharpening or spurring of the bone at the joint margins. The underlying causative condition (for exam ple, an ununited fracture of the scaphoid bone) is usually evident (Fig. 16.13).

Treatm ent. In mild cases the condition is best left alone, especially if the patient can avoid subjecting the wrist to heavy stress. When active treatment seems necessary, a choice must be made between conservative and operative methods. Conservative treatment can only diminish the symptoms; it can never remove them. Nevertheless it is usually worth a trial. The most useful method is to provide support for the wrist by a detachable splint made from moulded plastic (Fig. 16.14).

Operative treatment sometimes becomes necessary when the disability is severe. The only reliable method is by total arthrodesis of the wrist, with ablation of the radio-carpal and all the intercarpal joints. The inferior radio-ulnar joint and the triangular fibrocartilage are left undisturbed; so rotation of the forearm is preserved.

OSTEOARTHRITIS OF THE JOINTS OF THE HAND

The metacarpo-phalangeal joints and the interphalangeal joints of the hand are frequently the site of osteoarthritis in the elderly. Such manifestations are relatively unimportant and in most cases treatment is not required. Commonly involved are the carpo-metacarpal joint of the thumb (trapezio-metacarpal joint) (Fig. 16.15A) and the distal interphalangeal joints (Fig. 16.15B).



Fig. 16.13 Osteoarthritis of the wrist caused by an ununited fracture of the scaphoid bone. Note the diminished cartilage space, sclerosis, and spurring of bone at the joint margins, mainly at the radial side of the wrist.

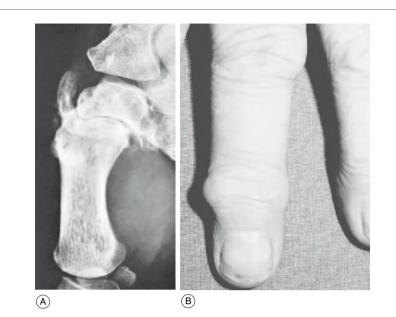


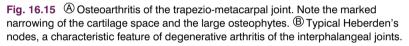
Fig. 16.14 Polythene wrist support. A splint such as this is sometimes used in the conservative treatment of osteoarthritis of the wrist.

Osteoarthritis of the trapezio-metacarpal joint

This is a common affection in women beyond middle age but it may also occur in younger persons, especially when there has been previous injury such as a fracture of the base of the first metacarpal bone involving the joint (Bennett's fracture-subluxation). The arthritis may seriously impair the function of the thumb because of pain.

Clinical features. There is pain, localised to the trapezio-metacarpaljoint, on using the thum b. The disability slow ly increases over the years until activities such as sewing or knitting – or indeed any active use of the thum b – become virtually impossible.





On examination the trapezio-metacarpal joint is prominent and slightly thickened. p a s s i v e movements of th e thum b cause Active o r m etacarpal pain. The range of movement at this joint varies widely in normal even individuals: so its m easurem ent is of little practical value, though com pariwith the opposite hand may be a guide to the extent to which movement s o n severe arthritis there may very little remaining i s impaired. In cases of b e mov

Radiographs show narrowing of the cartilage space and sharpening spurring of bone at the joint margins (Fig. 16.15A). In many cases the joint is su b l u x a t e d

Treatm ent. In the early stages, with only moderate pain, the condition is best left alone. Conservative treatment is generally disappointing, though sometimes the injection of hydrocortisone into the joint may give worthwhile temporary relief.

O perative treatment. If the symptoms become disabling operation is advisable. The choice lies between arthroplasty and arthrodesis. Arthroplasty is done sim ply by excising the trapezium, allowing the resulting gap to fill w ith fibrous tissue. It gives results that are very satisfactory for the usual elderly sufferer from this disorder and should usually be the method of choice. The use ofa prosthetic im plant is better avoided. If heavy use is to be dem anded of the hand in a young person (as in the case of a labourer, for exam ple), arthrodesis of the trapezio-metacarpal joint is sometimes preferred.

The forearm, wrist, and hand

Osteoarthritis of interphalangeal joints

This leads to pain and stiffness especially in the distal interphalangeal joints. Characteristically the form ation of osteophytes is a prom inent feature, with the appearance of ugly swellings known as Heberden's nodes (Fig. 16.15B). Active treatment is not required.

KIENBÖCK'S DISEASE¹ (Osteochondritis of the lunate bone)

K ienböck 's disease is an uncomm on affection of the lunate bone characterised by temporary softening, fragmentation, and liability to deformation. It tends to predispose to the later development of osteoarthritis of the wrist.

Cause. The precise cause is unknown. A disturbance of blood supply, possibly from throm bosis of a nutrient vessel, is believed to be the essential factor, but how it comes about is not clear. Repeated injury (for example, using the front of the wrist to drive a chisel in carpentry, or operating a pneum atic road drill) has sometimes been noted in the case history, but a causative connection is not fully established.

Pathology. In its behaviour the disease resembles osteochondritis of developing epiphysial centres in children (p. 130), such as Perthes' disease: in effect, it is a form of avascular necrosis (osteonecrosis). The bone becomes granular in texture, sm all dense fragments being interspersed with softened areas. In this state the bone eventually crumbles, and under the pressure imposed by muscle action and use of the wrist it gradually becomes compressed into a thin saucer-shaped mass. The overlying cartilage dies. After about two years the bone texture is restored to normal, but the bone remains deformed and lacks a smooth cartilaginous covering. The bone behaves like a piece of grit in a bearing and leads gradually to the development of osteoarthritis of the wrist.

Clinical features. There is pain in the wrist, most marked at the centre of the joint over the lunate area. The pain is worse during active use of the wrist. Because of the pain, the strength of grip is impaired.

On examination there is discomfort on pressure over the lunate bone. An important sign is that movements of the wrist are substantially restricted and cause pain if forced.

R a diographs are diagnostic. In the early stages the lunate bone appears slightly m ore dense than the surrounding bones, and if its depth is compared with that of the lunate bone of the sound wrist it is seen to be reduced, though only slightly at first (Fig. 16.16). Later, the bone has a fragmented appearance, small areas of increased density being scattered through it, and the flattening of the bone becomes obvious. Later still, signs of osteoarthritis of the wrist are evident.

Treatm ent. Treatm ent is often rather unsatisfactory. It m ust depend upon the duration of the symptoms and the degree of dam age to the wrist. In the earliest stage, when radiographic changes are only just perceptible, there is probably a place for protecting the wrist in plaster for two or three months in the hope that the condition will resolve through revascularisation of the bone. But once the

¹Dr Robert Kienböck (1871–1953) Austrian radiologist and Professor in Vienna who began using X-rays in 1897, only 2 years after their discovery by Röntgen.

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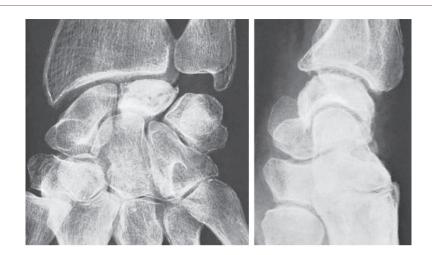


Fig. 16.16 Kienböck's disease of the lunate bone. Note the increased density, fragmentation and beginning compression of the bone.

disease is clearly established surgical treatm ent is recommended. If the is free from arthritis it is probably best to excise the lunate bone and replace it w ith a metal prosthesis. This probably gives better results than excision alone, without replacement, but the long-term results are nevertheless uncertain.

In late cases, if severe osteoarthritis is already present, excision of the lunate bone is of no avail. Treatment should then be the same as for osteoarthritis of the w rist (p. 307).

EXTRA-ARTICULAR DISORDERS ABOUT THE WRIST AND HAND

ACUTE INFECTIONS OF THE FASCIAL SPACES **OF THE HAND**

A cute infections of the hand account for a considerable proportion of the work casualty department or emergency room and are of great importance in industrial medicine. Unless they are treated efficiently they can lead to prolonged or even permanent disability, with impairment of working capacity.

Classification

If m inor superficial infections are excluded there are six types to be considered:

- 1. nail-fold infection (paronychia)
- 2. pulp-space infection (w hitlow, felon)
- 3. other subcutaneous infections
- 4. then ar space infection
- 5. mid-palmar space in fection
- 6. tend on sheath infection.

The forearm, wrist, and hand

Cause. All types are caused by infection with pyogenic bacteria. The usual causative organism is the *Staphylococcus aureus*, but the *Streptococcus* and occasionally other bacteria may be responsible. M inor injury such as a prick, abrasion, or blister usually provides the route by which infection can enter. M anual work in dirty conditions is clearly a factor that favours infection.

Pathology. The organisms reach the tissue planes by direct im plantation from outside, often as the result of a trivial injury such as a prick or abrasion. They set up an acute inflam matory reaction which in many cases goes on to suppuration. Without effective treatment, infection may spread to adjacent tissue planes; occasionally it may give rise to spreading lymphangitis or to septicaemia.

Clinical features. In general, the symptoms of acute hand infections are local pain (often with throbbing), swelling and loss of function. There is often some degree of constitutional disturbance, with pyrexia.

On examination there are obvious swelling, redness of the skin (except in deep infections), and marked local tenderness over the site of the infection. Special features of the individual lesions are described in the following pages.

Principles of treatm ent. Before suppuration has occurred, the aim of treatm ent is to abort the infection and avoid the need for operation. The essentials of this expectant treatm ent are rest for the hand, elevation of the lim b, and antibiotic drugs. In a m inor case it m ay be sufficient to support the hand in a sling, but in a severe case rest is best assured by a light plaster back-splint, and elevation m ay be m aintained by suspending the lim b in a roller tow el attached above the side of the bed. The question of antibiotics is difficult because the sensitivity of the organism is not at first know n. Flucloxacillin is usually given, often in conjunction w ith am picillin. Regrettably, patients are not often seen early enough to permit success from this expectant treatm ent.

When suppuration has already occurred, as indicated by severe throbbing pain, intense local tenderness, pyrexia, loss of function, and loss of sleep, the abscess should be drained surgically without further delay. Surgery must be done with adequate facilities, under regional nerve block or general anaesthesia and with tourniquet control. An adequate incision must be used to allow adequate abscess drainage but must not endanger important underlying structures. After adequate drainage has been secured the wound may be packed lightly open with vaselined gauze for two days. Thereafter, dry dressings are used and active finger exercises are encouraged.

W ithin the limits imposed by these principles there is often more than one way of performing the actual drainage operation. How ever, it should be stressed that a knowledge of the anatomy of the fascial spaces¹ of the hand is indispensable for the correct treatment of hand infections.

¹The term 'space' as used in this connection is a misnomer. It refers to the interval or plane between adjacent tissues, and in the normal hand it is only a potential space.

SPECIAL FEATURES OF INDIVIDUAL LESIONS Nail-fold infection (paronychia)

This is one of the commonest but least serious types of hand infection. The subcuticular plane beneath the nail fold is potentially continuous, at the base and sides of the nail, with the subungual space deep to the nail. Infection beginning in the nail fold may therefore easily spread under the nail (Fig. 16.17), and the resulting abscess cannot be drained effectively unless part of the nail is removed.

Clinical features. There are pain, redness, and swelling at one or both sides of the nail fold and at the base of the nail. There is local tenderness over the reddened area. If suppuration has extended deep to the nail there is marked tenderness on pressure upon the nail.

Complications: These are:

- 1. extension to the pulp space
- 2. chronic paronychia, follow ing inad equate treatment of the acute infection.

Treatm ent. In this type of infection conservative measures are often successful if begun within a few hours of the onset. When local suppuration has occurred the subcuticular abscess is drained by raising the cuticle from the nail or by raising it as a short flap after incising it vertically at one or both corners (Fig. 16.18A). If pus has extended under the nail the proximal third of the nail must also be removed.

Pulp-space infection (whitlow)

This is alm ost as common as nail-fold infection. The interval between the front of the distal phalanx and the skin is traversed by tough fibrous partitions, which subdivide the space into numerous fat-filled cells (like the cells of a honeycomb) disposed at right angles to the skin surface (Fig. 16.17). Infection occurring in this tough tissue is virtually within a closed compartment: tissue pressure rises rapidly and accounts for early throbbing pain.

Clinical features. The pulp is sw ollen, tense and tender. Severe throbbing pain, with exquisite localised tenderness, suggests that suppuration is present.

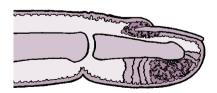


Fig. 16.17 Diagrammatic section showing the site of suppuration in nail-fold infection (paronychia) and in pulp-space infection (whitlow). In nail-fold infection the pus is beneath the cuticle and may extend under the nail, as shown. In pulp-space infection the pus lies in the tough fibro-fatty tissue immediately in front of the distal phalanx.

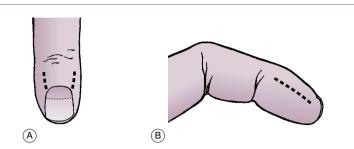


Fig. 16.18 Technique of drainage of paronychial abscess. For the mildest infections it is sufficient to raise the cuticle alone without incising it; but better drainage is secured by a vertical incision through the cuticle, on one or both sides. When pus has extended beneath the nail it is necessary also to remove the proximal third of the nail (shaded area). B Incision for drainage of pulp abscess. The incision is deepened across the pulp, in front of the phalanx, and the abscess cavity is cleared out under direct vision.

Complications: These are:

- osteom yelitis of the term in al phalanx, often leading to necrosis and sequestration of its distal half
- 2. pyogenic arthritis of the distal interphalangeal joint
- very rarely, spread of infection to the flexor tendon sheath (suppurative tenosynovitis).

Treatm ent. Conservative m easures are seldom successful except in the earliest stages. Surgical drainage is effected w ell by a lateral incision just in front of the plane of the term inal phalanx (Fig. 16.18B); it is deepened transversely across the pulp of the finger but should not extend proxim ally beyond a point half a centim etre distal to the term inal skin crease lest the flexor tendon sheath be inadvertently opened. An alternative m ethod is to incise directly into the pulp over the centre of the abscess, a technique that is to be preferred if the abscess is already threatening to point at the surface.

Subcutaneous infections (other than pulp-space infections)

These infections are common. Infectionmay occur in the subcutaneous plane at any point in the hand. Common sites are the middle or proximal segment of a finger, and the web spaces between the digits. Less common sites are the palm of the hand and the dorsum of the hand. These superficial spaces are clearly demarcated from the deep palmar spaces next to be described, and must not be confused with them.

Clinical features. The infection may arise in any part of the hand or fingers. There is localised swelling with redness and tenderness. In many cases the infection has spread through the skin from a subcuticular infection or blister.

Complications are:

- 1. sloughing of skin over the lesion
- 2. spread to the deep space or to the flexor tend on sheaths.

Treatm ent. Surgical drainage is by a short incision appropriately placed to reach the abscess without harm ing important structures or leaving an aw kw ard scar. In the case of a web-space infection the incision should not divide the skin fold of the web: a short transverse incision in the palm just proxim al to the skin fold is adequate (see Fig. 16.20B).

Thenar space infection

This is a well-defined entity but it is very uncommon. It may arise by extension subcutaneous lesion or a tend on sheath infection. The then ar space lies under the lateral (radial) half of the hollow of the palm. Ιt ofthe een the adductor pollicis muscle behind and the flexor tendon finger and the first and second lum brical muscles in front. Medially it is that extends deeply rated from the mid-palmar space by a fibrous septum fascia on the deep surface of the flexor tendons t o the fascia th e interossei and adductor pollicis muscle (Figs 16.19 and 16.20A). The th e space is prolonged forwards into the delicate sheath that surrounds the first lum brical muscle. It som etim es com municates also with the second lum brical canal. The lum brical canals thus provide a potential com munication between the subcutaneous web spaces and the thenar space: in practice, how ever, it is rare for infection to spread along this route

Clinical features. The radial half of the palm is ballooned out and the swelling extends to the dorsal aspect of the web between thum b and index finger. *Treatment*: Drainage is by an incision at the dorsal aspect of the first web space (Fig. 16.20B).

Mid-palmar space infection

This is also uncommon. It resembles the thenar space infection, but the swelling is confined to the ulnar half of the palm. It usually arises by extension from a subcutaneous lesion or a tendon sheath infection. The mid-palmar space

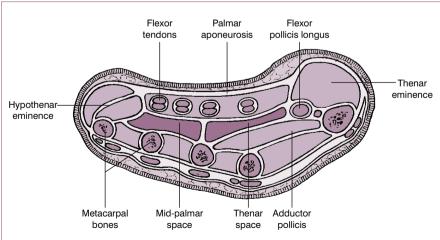


Fig. 16.19 The deep palmar spaces – the thenar space and the mid-palmar space – shown in diagrammatic transverse section.

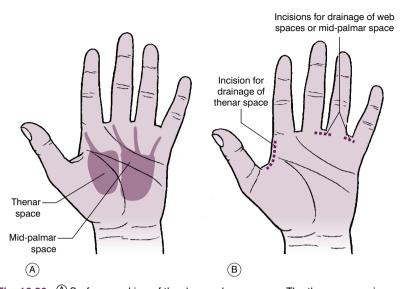


Fig. 16.20 (A) Surface marking of the deep palmar spaces. The thenar space is continuous with the first lumbrical canal and the mid-palmar space with the second, third, and fourth lumbrical canals. (B) Incisions for drainage through the web spaces.

lies under the medial (ulnar) half of the hollow of the palm. It is the interval ei and metacarpal bones behind and the flexor tendons (in h e the intero th e sheaths) of the m iddle, ring, and little fingers in front (Fig. 16.19). Laterally, the thenar space by the fibrous septum it is a rate d from alread v described. forwards into the sheaths of the The i s prolonged second. third, and space muscles (Fig. 16.20A). A gain, despite the potential commufourth lum brical space and the mid-palmar space along the lumbrical n ic a tio n between а w e b canals. ace infection very seldom spreads deeply to involve the palm.

Clinical features. The ulnar half of the palm is ballooned out. Movem ents of the fingers are restricted and painful.

Treatment. Drainage can be established through the web space between the middle and ring fingers or through that between the ring and little fingers (Fig. 16.20B).

Tendon sheath infection

This is rare, but important because prompt treatment is essential if the function of the finger is to be preserved. Distinction must be made b to u gh fibrous sheaths, which exist only in the digits, and the flim sy svnovial she aths, which line the fibrous sheaths and, in the case of the thum b and litexten d proximally into the palm . In acute in fection s tendon tle finger, ofthe sheaths (acute infective tenosynovitis) the pus is within the synovial sheath and it is confined only by the limits of the sheath. The flexor sheaths of the index, middle, and ring fingers end proximally at the level of the transverse palmar skin crease (Fig. 16.21A). The sheaths of the thumb and little finger extend

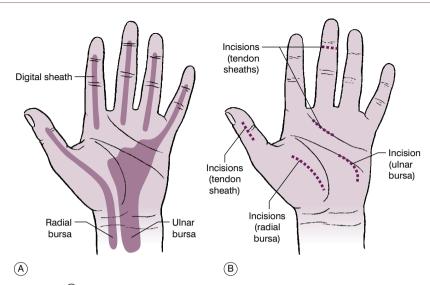


Fig. 16.21 ^(A) The synovial flexor sheaths. Whereas the sheaths for the index, middle, and ring fingers end proximally at the bases of the fingers those for the thumb and little finger extend upwards to become continuous with the radial bursa and the ulnar bursa respectively. ^(B) Incisions for drainage and irrigation of tendon sheaths and bursae.

proxim ally through the palm to end two or three centim etres above n rt of t h е sheath for the thum b т sheath for the little finger opens out proxim ally into the ulnar bursa. encloses the grouped tendons of flexor digitorum superficialis and flexor . 16.21A). d ig ito ru m profundus (Fig

Clinical features. The finger is swollen throughout its length, and acutely tender over the flexor tendon sheath. It is held sem iflexed and the patient is unw illing to extend it because of pain.

Complications: These are:

- necrosis of the tendons and adhesions between tendon and sheath, causing perm anent stiffness of the finger in sem i-flexion
- spread of infection to involve the radial bursa (from the flexor sheath of the thum b), or the ulnar bursa (from the sheath of the little finger).

Treatm ent. System ic antibiotic therapy is begun immediately. The sheath is opened at its proximal end in the palm and at its distal end (Fig. 16.21B), and irrigated with antibiotic solution through a fine tube passed along the sheath; the tube is withdrawn and the wounds are packed lightly open.

If the radial bursa or the ulnar bursa is infected it must be drained and irrigated through an additional incision in the palm (Fig. 16.21B).

CHRONIC INFECTIVE TENOSYNOVITIS (Including compound palmar ganglion)

Chronic inflammation of tendon sheaths in the lower forearm and hand may occur in response to low-grade infection, usually tuberculous. It is entirely distinct from acute tenosynovitis and is not preceded by it. It is now seen only rarely in Western countries except in some patients with chronic rheum atoid arth ritie

Pathology. The flexor tendon sheaths in the lower forearm and hand are those most commonly affected. The affected sheaths are greatly thickened and show the changes of chronic inflam mation. There may be histological evidence of tuberculosis in the thickened tissue. The sheaths often contain an excess of fluid and there may be collections of small fibrinous bodies. The tendons them selves are affected only slightly.

Clinical features. There is a gradual onset of swelling, with mild aching pain, in the region of the affected tendon sheaths - usually the flexor sheaths of the low erforearm and hand. The function of the fingers and thum b is impaired with moderate restriction of flexion and extension of the digits. The swelling is confined to the line of the tend on sheaths in the front of the forearm and the proxim al part of the palm (Fig. 16.22). In many cases fluctuation can be elicited between the forearm swelling and the swelling in the palm. This physical sign led to the use of the term compound palmar ganglion, though this is a misnomeras the common ganglia around the wrist joint arise from the synovial cavity of the joint and not the tend on sheath.

If an active tuberculous lesion is found elsew here in the body it is reasonable to infer that the tenosynovitis is also tuberculous.

Treatment. In mild cases in which the function of the fingers and thum b is not im paired conservative treatment is advised. In tuberculous cases a course of the appropriate antibacterial drugs is given (see p. 102).

In severe cases operation is recommended. It consists in excising thoroughly all the thickened and oedem atous synovial membrane. A fter operation finger movem ents are encouraged and practised daily under the supervision of a physiotherapist. A useful range of finger movement is usually restored, but permanent inability to flex the fingers fully into the palm may have to be accepted.



Fig. 16.22 Compound palmar ganglion. The swellings in the palm and at the front of the wrist are continuous deep to the flexor retinaculum, and fluctuation can be elicited between them.

The forearm, wrist, and hanc

SOFT-TISSUE TUMOURS IN THE HAND (General description of soft-tissue tumours, p. 157)

Soft-tissue tum ours are uncommon in the hand but special mention must be made of an unusual tum our that is the secondmost common cause of swelling in the hand after simple ganglion cyst. This is the giant-cell tum our of tendon sheath (localised nodular tenosynovitis).

Giant-cell tumours of tendon sheath

This is a benign tum our that is related to the more diffuse pigmented villonod ular synovitis in terms of its histological appearances. It presents in patients aged 30-50 years as a painless localised slow-growing mass on the volar aspect of the finger. It arises from the sheath of a tendon and, as it enlarges, it burrows between the tissue planes to eventually form a bulky mass which almost surrounds the finger like a collar. Histologically it is composed of cells of many forms, including round cells, giant cells of foreign-body type, xanthom a cells containing cholesterol, and fibroblasts. Treatment is by complete marginal excision of the mass, which may be difficult because of its proximity to the tendon and underlying bone.

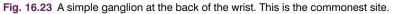
GANGLION (Simple ganglion)

A ganglion is the commonest cystic swelling at the back of the wrist.

Pathology. Conflicting views have been put forward on the origin of ganglia. Some believe that they represent a degenerative process. O thers claim that they are benign tum ours of tend on sheath or joint capsule. The cyst wall is of fibrous tissue and there is no true endothelial lining. It is connected at some point with a joint capsule or tend on sheath, but there is no communication between the joint cavity or tend on sheath and the interior of the cyst. The cyst is usually unilocular. The contained fluid is clear and viscous.

Clinical features. G anglia are commonest at the back of the wrist, where they are often seen in adults of any age (Fig. 16.23). They also occur, less commonly, at the front of the wrist, or in the palm or fingers. Ordinarily there are no





sym ptom sother than the swelling itself and, som etimes, discom fort or slight pain. On exam ination the swelling may be soft and obviously cystic, but more often it is tense. It is often mistaken for a bony prominence – but careful tests will show that it is fluctuant.

Complications. A ganglion arising deeply in the wrist or palm may interfere mechanically with the ulnar or the median nerve or their branches. There will be motor and usually sensory impairment in the distribution of the particular branch affected.

Treatm ent. A ganglion is harm less and in the absence of pain or complications it may safely be left alone. Som etim es the ganglion can be dispersed subcutaneously by firm local pressure. This rather dramatic treatment is harm less and temporarily effective, but the ganglion may slow ly reappear. An alternative method of providing temporary relief is to aspirate the cyst with a widebore needle. Lasting cure can be ensured only by complete excision of the ganglion – not always an easy task because the thin-walled sac often tracks deeply between the tendons, where it may be torn and a fragment left behind, leading to recurrence. In children there is a tendency to spontaneous resolution; so the question of excision may be deferred.

A ganglion that is interfering with a peripheral nerve demands operative excision without delay.

CARPAL TUNNEL SYNDROME (Compression of median nerve in carpal tunnel)

Constriction of the median nerve as it passes beneath the flexor retinaculum is the commonest compression neuropathy in the arm, resulting in discomfort in the hand, especially in middle-aged or elderly women.

Cause. In the majority of cases no primary cause can be discovered, but any space-occupying lesion within the carpal tunnel may be responsible. Recognised causes are chronic inflam matory thickening of the tendon sheaths (as in rheumatoid arthritis), osteoarthritis of the wrist, deformity or malunion after fracture of the low er end of the radius, and myxoedema.

Pathology. The median nerve lies beneath the flexor retinaculum in company with the flexor tendons of the hand. If the available space within this strongwalled tunnelis reduced the nerve is compressed against the flexor retinaculum. When the retinaculum is divided in such a case the nerve may be found constricted and flattened where it lay behind it. The ulnar nerve does not pass behind the flexor retinaculum; so it is not liable to compression in this way.

Clinical features. The condition is commonest in women in or beyond middle life. The symptoms are sensory and motor. There is tingling, numbness, or discomfort usually in the radial three and a half digits (that is, in the normal distribution of the median nerve), and there is a feeling of clumsiness in carrying out fine movements such as those concerned in sewing. Distressing tingling is often prominent during the night and the patient may have to work the fingers or shake the hand to gain relief, making this an almost diagnostic symptom.

On exam ination the findings vary with the degree and duration of the compression. At first there are no objective clinical findings. Later there may be blunting of sensibility in the median nerve distribution. In a severe case there may eventually be evident wasting and weakness of the median-innervated small muscles of the hand, particularly abductor pollicis brevis. The Durkan test may be positive when direct compression of the median nerve at the carpal tunnel for 30 seconds reproduces num bness and tingling in one or more of the radial digits. Investigations. Electrophysiological nerve conduction testing may show decreased conduction velocity in the affected part of the median nerve. This is a reliable confirmatory test if the clinical diagnosis is in doubt.

Diagnosis. Care must be taken to exclude other causes of neurological disturbance in the hand, especially those arising in the neck from interference with the brachial plexus, and lesions of the median nerve elsewhere in its course.

Treatm ent. A trial may be made of conservative treatment by supporting the wrist at night for three weeks with a simple splint in a neutral position. When the symptoms arise in pregnancy, relief that lasts until after delivery (when the symptoms usually subside spontaneously) may be gained by the injection of hydrocortisone alongside the nerve at wrist level. This may be tried also in other cases and may cure the symptoms in 50% of patients. If it is unsuccessful full relief is assured by dividing the flexor retinaculum to decompress the nerve. This is a simple operation that may be done either through an open incision or (with slightly greater risk to the motor branch of the median nerve) by an endoscopic technique.

DUPUYTREN'S¹ CONTRACTURE (Contracture of the palmar aponeurosis; Dupuytren's disease)

This is an easily recognised condition characterised in the established phase by flexion contracture of one or more of the fingers from thickening and shortening of the palmar aponeurosis.

Cause. This is unknown. There is a hereditary predisposition. In a predisposed person injury possibly plays a part but its exact significance is uncertain. There is an increased incidence of the disorder among epileptics, but this is possibly related to the use of anticonvulsant drugs rather than to an underlying genetic association betw een the two diseases.

Pathology. The palm ar aponeurosis (palm ar fascia) is normally a thin but tough membrane whose fibres radiate from the term ination of the palmaris longus tendon at the front of the wrist to gain insertion into the proximal and middle phalanges of the fingers. It lies immediately beneath the skin. In D upuytren's contracture the aponeurosis, or part of it, becomes greatly thickened (often to half a centimetre or more), and it slow ly contracts, drawing the fingers into flexion at the metacarpo-phalangeal and proximal interphalangeal joints. The medial (ulnar) half of the aponeurosis is affected most, and serious flexion deformity is usually confined to the ring and little fingers, with only moderate deformity of the middle finger (Figs 16.24 and 16.25). The joints themselves are unaffected at first, but in long-established cases secondary capsular contractures occur. The flexor tendons in the palm are in no way affected.

The plantar aponeurosis in the foot is occasionally affected, but in the foot the lesion usually takes the form of a firm nodule under the instep rather than of a contracture involving the toes (Fig. 16.26). O ther parts that may be affected include the penis. Thus although the hands are primarily affected, the condition is sometimes much more widespread (Dupuytren's disease).

Clinical features. The affection is much more common in menthan in women. Often both hands are affected. The earliest sign is a small thick ened nodule in the

¹Baron Guillame Dupuytren (1777–1835) A French surgeon who rose from humble beginnings to become Surgeon-in-chief at the Hotel Dieu in Paris. He described many pathological conditions including the contracture in 1833.

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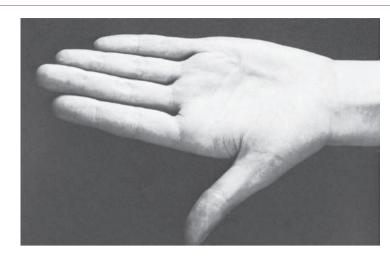


Fig. 16.24 Early Dupuytren's contracture. There is a nodule of thickened aponeurosis in the palm, opposite the base of the ring finger, with slight puckering of the skin; but so far there is no flexion contracture of the fingers.



Fig. 16.25 A typical example of Dupuytren's contracture of the palmar aponeurosis in which the ring finger has been drawn down into flexion. Note the tight band of thickened aponeurosis immediately under the skin. The band has sometimes been mistaken for a contracted flexor tendon.

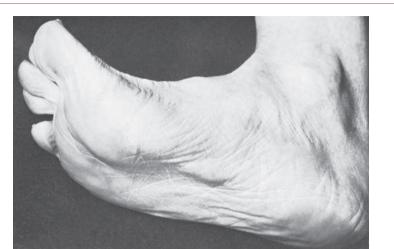


Fig. 16.26 Typical nodule in the sole of the foot in Dupuytren's disease.

m id - palm opposite the base of the ring finger (Fig. 16.24). The area of thickening gradually spreads from this point, giving rise eventually to firm cord-like bands that extend into the ring finger or little finger, or both, and prevent full extension of the metacarpo-phalangeal and proximal interphalangeal joints (Fig. 16.25). The skin is closely adherent to the fascial bands, and is often puckered. The flexion deform ity becomes progressively worse in the course of months or years.

In some cases these changes in the palm are accompanied by thickening over the dorsum of the interphalangeal joints (knuckle pads). The feet may also show nodules in the sole (Fig. 16.26). Occasionally the penis is distorted by thickened bands

Diagnosis. The thickened bands of palm ar aponeurosis must not be mistaken for contracted flexor tendons. It is easily confirm ed that the bands are distinct from tendons because they do not move when the fingers are flexed and extended.

Treatment. The only effective treatment is by operation, though a number of proteolytic drugs adm inistered by injection are under trial. How ever, operation is not necessary in every case: a contracture that is not progressing rapidly is often better left alone, especially in an elderly patient. Surgery is usually required if the flexion contractures exceed 30° at the metacarpophalangeal, or 15° at the interphalangeal joints. O peration entails excision of the thickened part of the palm ar aponeurosis by painstaking dissection to avoid dam age to digital nerves. Sim ple division of the taut contracted bands is less satisfactory because the contracture tends to recur. In selected cases multiple releases of metacarpo-phalangeal contractures through small separate incisions may give permanent improvement in over 50% of patients. In advanced cases the contractures may involve the overlying palmar skin and there may be a need to use skin grafting follow ing radical excision. A n alternative is to apply a splint to maintain the correction and allow the skin to heal by secondary intention.

The forearm, wrist, and hand

RUPTURE OR SEVERANCE OF TENDONS IN THE HAND

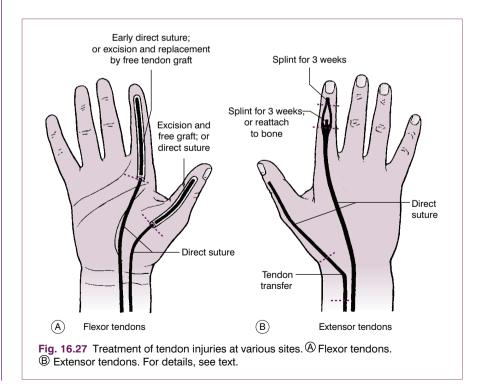
M ost tendon divisions in the hand are caused by cuts with sharp objects such as knives. Certain tendons are prone to rupture: thus the extensor tendon of easilv torn from its in sertion into the distal phalanx by sudden forced ion of the r: and extensor pollicis longus tendon is liable to rupture ntaneously r fractures of the low er end of the radius in consequence of its a fte es the roughened bone. In rheum atoid arthritis, becoming fraved he also, spontaneous ruptu especially of an extensor tend on _ is co

Clinical features and diagnosis. Loss of function of a tendon is obvious clinically. When the findings are correlated with the history the diagnosis is usually clear.

Treatm ent. This varies according to the tendon affected and the site of sevtu re (see below a n d Fig . 16.27). Sometime tre undesirable, but more o fte n o p e rativ e reconstruction i s to be advised: th e tendon is either sutured directly or replaced by a free tendon graft or by tendon transfer, according to circum stances (see pages 46 and 44 for the principles of these m ethods).

SPECIAL FEATURES OF INDIVIDUAL LESIONS Injuries of flexor tendons

Division within a fibrous flexor sheath of a finger. Severance at this site presents the most difficult problem of all tendon injuries. The prognosis is



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uncertain after operative repair or reconstruction because of the proclivity of the tendon to adhere to the sheath.

Treatment. If a flexor superficialis tendon alone is divided and the flexor profundus is intact treatment may not be required, for there is virtually no disability.

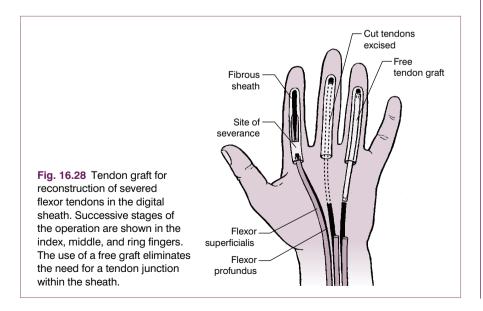
If a flexor profundus tendon alone is divided, the flexor superficialis being intact, the loss of active flexion at the distal interphalangeal joint can often be accepted. A ttem pted repair of the tendon is usually better avoided because of its uncertain results. A rthrodesis of the distal interphalangeal joint in slight flexion reduces the disability to a negligible level.

If both tendons are divided, operative repair or later reconstruction is advised. When the injury is recent (within one week) and the wound clean, and when good conditions and skilled staff are available, prim arv repair is the method of choice.

Technique. Direct suture of the severed ends dem ands high technical skill and long experience. Both the superficialis tendon and the profundus tendon should be repaired with loupe magnification, an atraumatic technique, and using sem i-absorbable fine 4-0 suture material.

For delaved repair because of late presentation, or where there is exten. sive damage or los o f tendon tissue, it may h e necessarv t o 11.5.6 free ten don graft. The standard method is to remove the flexor superficialis tendon en tirely (tom ake m ore room in the sheath) and to replace the w hole of the digital part of the flexor profundus tendon by tendon а free graft (from th e palm aris longus or from a to e extensor) sutured proxim ally to the profundus tendon in the palm or at wrist level, and inserted distally into a drill hole in the distal phalanx (Fig. 16.28). This method elim in a tes the need for tendon junction within the sheath, which carries the risk of adhesions that may cause d is a b ling stiffness

Division of flexor pollicis longus in the thum b. The problem is less difficult than that presented by division of both flexor tendons in a finger. Repair may



be m ade by direct suture, by advancem ent of the tendon, or by replacem ent of the digital part of the tendon by a free graft as described for the fingers.

Division of flexor tendons in the palm or wrist. Direct suture is advised. It may be done primarily if the wound is clean. The prognosis is good if a single tendon is affected but it is uncertain in cases of multiple tendon divisions at the front of the wrist, especially if the nerves are also injured.

Injuries of extensor tendons

Severance of extensor tendons at the back of the hand. This injury has a good prognosis. There is a tendency to spontaneous union with recovery of norm alfunction. *Treatment*: Prim ary suture should be undertaken if the injury is recent. If there has been delay, freshening and direct suture of the divided ends is advised. Repair of a spontaneously ruptured extensor tendon in rheum atoid arthritis has a less satisfactory prognosis because the tendon is of im paired quality. Nevertheless, operative repair should usually be attempted.

Rupture of extensor pollicis longus tendon may complicate fracture of the low er end of the radius. The tendon gives way after becoming frayed by repeated movement over the roughened low er end of the radius. Spontaneous rupture may also occur in drum mers. The extensive fraying makes direct suture unsatisfactory. *Treatment*: A clean rupture should be sutured end-to-end. If the tendon is frayed, as is usually the case, a tendon transfer operation is to be preferred. The tendon of extensor indicis is divided at the level of the neck of the second metacarpal bone, re-routed tow ards the thum b, and sutured to the freshened distal stum p of the extensor pollicis longus tendon (Fig. 16.29).

Rupture of middle slip of extensor expansion. This is caused by sudden forced flexion of the proximal interphalangeal joint, the middle slip of the

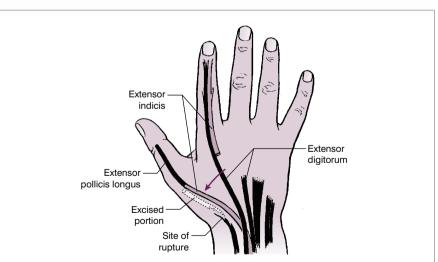
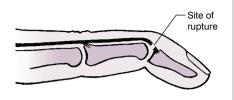


Fig. 16.29 Transfer of extensor indicis to replace a ruptured extensor pollicis longus. The tendon of extensor indicis is divided opposite the neck of the second metacarpal, re-routed towards the thumb, and sutured to the freshened distal stump of the extensor pollicis longus. This transfer is to be preferred to direct suture when the ends of the ruptured tendon are frayed.

Fig. 16.30 Mallet finger (baseball finger). The extensor tendon is avulsed from its insertion. The terminal joint cannot be extended fully.



extensor expansion being torn from its attachment to the middle phalanx. The patient is unable to extend the proxim al interphalangeal joint fully. The distal joint becomes hyperextended. Treatment: The choice lies between imm obilisation on a splint in the straight position for three weeks, or operative repair. In a fresh case sim ple splintage probably gives the better results, though restoration of full function is seld om achieved.

A vulsion of extensor tendon from distal phalanx of a finger. This is known as 'm allet' finger or 'baseball' finger. It is caused by sudden forced flexion of the distal interphalangeal joint - for instance, by a blow on the tip of the finger from a ball. In a few cases a small fragment of bone is avulsed with the tendon. The patient is unable fully to extend the distal interphalangeal joint (Fig. 16.30). Treatment: Immediate treatment is to splint the finger for three weeks with the distal interphalangeal joint fully extended. Splintage must be continuous and uninterrupted if a good result is to be achieved. The avulsed tendon alw ays unites back to the bone, but often with lengthening, in which case som e deform ity persists. How ever, the disability is usually insignificant and acceptable.

ACUTE FRICTIONAL TENOSYNOVITIS (Peritendinitis crepitans; paratendinitis crepitans; repetitive stress syndrome)

This is an easily recognised clinical condition common in young adults whose occupations dem and repetitive m ovem ents of the wrist and hand.

Cause. It is attributed to friction between the tendons and the surrounding paratenon, from over-use of the hand. It is entirely distinct from infective tenosynovitis.

Pathology. The tendons most often affected are those of the deep muscles at the back of the forearm, especially the extensors of the thum b and the radial extensors of the wrist. There is a mild inflam matory reaction about the tendon and its coverings, with local swelling and oedema.

Clinical features. A fter unusually active use of the wrist or hand over a period of days or weeks pain is felt at the back of the wrist and lower forearm. and swelling is noticed. The pain is aggravated by use of the hand.

On exam ination there is localised swelling in the line of the affected tendons usually the extensors of the thum b or wrist. If the examiner's hand is placed over the swelling while the patient flexes and extends the wrist and digits a characteristic fine crepitation is felt: it is caused by the fibrin-covered tendon gliding within the inflam ed paratenon. This typical crepitation is diagnostic of frictional tenosynovitis.

Treatm ent. Initially, a trial should be made of local injection of hydrocortisone. If this is unsuccessful, the wrist and forearm should be immobilised in plaster of Paris for three weeks, the fingers being left free. This affords sufficient rest to allow the inflammation to resolve. Excessive use of the fingers and thumb should be avoided for two months.

Comment. The condition described above is a distinct clinical entity with incontrovertible evidence of organic pathology. In recent years the label 'repetitive stress syndrom e' has been applied, too often, to a range of rather vague and purely subjective symptoms affecting the hand, or sometimes the whole arm, in persons occupied for long periods in repetitive tasks such as keyboard operation and computer work. In most such cases it is difficult to separate a genuine physical disability (if indeed it exists at all) from the psychological or 'functional' overlay that is often a prominent feature of such conditions.

DE QUERVAIN'S¹ STENOSING TENOVAGINITIS (Tenovaginitis of the abductor pollicis longus and extensor pollicis brevis)

This is a common and well-recognised condition characterised by pain over the styloid process of the radius and palpable thickening in the course of the abductor pollicis longus and extensor pollicis brevis tendons.

Cause. The precise cause is unknown. Excessive friction from overuse may be a factor, because the condition seems prone to follow repetitive actions such as wringing clothes, or in more recent times excessive typing or manipulations.

Pathology. The fibrous sheaths of the abductor pollicis longus and extensor pollicis brevis tendons are thickened where they cross the tip of the radial styloid process. The tendons them selves appear norm all as does the synovial lining of the sheath. The condition is possibly analogous to that other common form of tenovaginitis, 'trigger' finger (see below).

Clinical features. The condition is five times commoner in women than men, predominantly in middle age. The main symptom is pain on using the hand, especially when movement tenses the abductor pollicis longus and extensor pollicis brevis tendons (as in lifting a saucepan or a teapot). On examination there is local tenderness at the point where the tendons cross the radial styloid process (Fig. 16.31). The thickened fibrous sheaths are usually palpable as a firm nodule. Passive adduction of the wrist or thum b causes the patient to wince with pain.

Treatm ent. Conservative treatm ent with rest by splintage, or the injection of hydrocortisone and local anaesthetic into the tendon sheath, produces recovery in over 80 per cent of patients. Where pain and disability continue an operation to divide the thickened sheaths of the affected tendons provides a certain cure.

¹Fritz de Quervain (1868–1940) Swiss general surgeon who was Professor of Surgery in Berne. Described the chronic tenovaginitis which bears his name in 1895.

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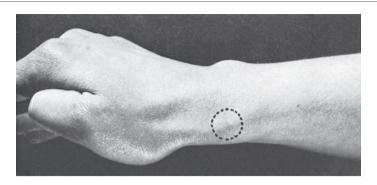


Fig. 16.31 Site of tenderness in de Quervain's tenovaginitis.

'TRIGGER' FINGER; SNAPPING FINGER (Digital tenovaginitis stenosans)

In this rather common condition thickening and constriction of the mouth of a fibrous digital sheath interfere with the free gliding of the contained flexor tendons.

Cause. This is unknown.

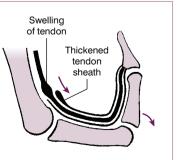
Pathology. The proxim alpart of the fibrous flexor sheath at the base of a finger or thum b is thickened and the mouth of the sheath is constricted. The contained tendons become 'w aisted' opposite the constriction, and sw ollen proxim al to it. The sw ollen segment enters the mouth of the sheath only with difficulty when an attempt is made to straighten the finger from the flexed position (Fig. 16.32).

Clinical features. The condition occurs:

- 1. in the fingers of the middle-aged (especially women)
- 2. in the thum b in infants or young children.

The adult type. There is complaint of tenderness at the base of the affected finger and of locking of the finger in full flexion (Fig. 16.33). The locking can be overcome either by a strong effort or by extending the finger passively with the other hand, when the flexion is released with a distinct snap. On examination

Fig. 16.32 Mechanism of trigger finger. The swollen part of the tendon is reluctant to enter the constricted mouth of the fibrous sheath when an attempt is made to extend the finger. When sufficient force is exerted it enters with a snap. The thickening forms a palpable nodule at the base of the finger.



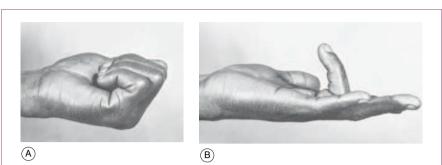


Fig. 16.33 Trigger finger. The fingers can be flexed without difficulty (A), but when the patient attempts to straighten them the affected finger sticks in the position shown (B).

there is a palpable nodule, usually slightly tender, at the base of the affected finger or thum b - that is, over the mouth of the fibrous flexor sheath. The snapping cannot be reproduced well on passive movem ents; it can be demonstrated only when the patient extends the finger fully with its own muscles or assists extension with the other hand.

The infantile type (contracted thum b of infants). The infant is unable to straighten the thum b, which is locked in flexion. On examination it may be possible to extend the thum b passively with a snap, but in many cases the flexed position of the joint cannot be corrected even by moderate force. A palpable nodule is present at the base of the thum b in the position of the mouth of the fibrous flexor sheath - that is, at the level of the head of the metacarpal bone. It should be noted that because the deform ity is often resistant to correction this condition in infants is often mistaken for a dislocated thum b or for a congenital deform ity.

Treatm ent. Conservative treatm ent by injection of local steroid at the site of the palpable nodule m ay som etim es achieve full relief. When this fails both the adult and the infantile type can be cured by the simple operation of incising the mouth of the fibrous flexor sheath longitudinally.

EXTRINSIC DISORDERS SIMULATING DISEASE OF THE FOREARM OR HAND

DISORDERS OF THE NECK

Certain disorders of the neck interfere with the brachial plexus or its roots, and thereby produce their predom inant sym ptoms - or even their only sym ptoms in the low er arm or hand. By far the commonest of such disorders are osteoarthritis of the cervical spine (cervical spondylosis) and prolapse of a cervical intervertebral disc. Less common as causes of peripheral symptoms are cervical rib, tumours of the spinal column or of the spinal cord, and soft-tissue tumours involving nerves. A m assat the thoracic inlet is an occasional cause of peripheral symptoms in the upper limb. The commonest cause is an apical tumour of the lung (Pancoast's tumour) involving the nerves of the brachial plexus.

DISORDERS OF THE UPPER ARM

Rarely, a disorder of the upper arm may produce its chief effects in the lower arm or hand, usually through the medium of the major nerve trunks. A wellknown example is crutch palsy, in which there is weakness or paralysis of the extensor muscles of the wrist, fingers, and thumb from repeated pressure of an axillary crutch upon the radial nerve in the axilla. These complications are avoided if elbow crutches can be used instead of axillary crutches.

DISORDERS OF THE ELBOW

A ffections of the elbow may be associated with vague referred pain in the forearm. A lm ost alw ays, how ever, the local symptoms in the elbow overshadow the referred symptoms; so mistakes in diagnosis are unlikely.

17 The hip region

D isorders of the hip are common both in children and in adults. Prominent among childhood affections are developmental (congenital) dislocation of the hip and Perthes' disease (osteochondritis) of the head of the femur. The hip is subject to all types of arthritis, but in adults osteoarthritis is overwhelmingly the most prominent affection.

Practically and econom ically, injuries and diseases of the hip are important because they so often cause prolonged suffering and serious disablement – even total incapacity. A cademically, the region is of interest for several reasons: the mechanics of the joint are complex; it is one of the most difficult joints to examine with accuracy; and – of special significance to students – cases of hip disease are often presented as tests of clinical acumen in the examinations in surgery. Time spent on learning how to examine the hip correctly will usually be well rewarded.

SPECIAL POINTS IN THE INVESTIGATION OF HIP COMPLAINTS

History

The characteristics of hip pain. Pain in the region of the hip is notoriously m isleading, for often it is referred from the spine or pelvis and has no connection with the hip joint itself. Therefore one must alw ays be cautious in attributing such pain to a hip lesion without first investigating the possibility of an extrinsic cause.

Pain arising in the hip is felt mainly in the groin and in the front or inner side of the thigh. Pain is often referred also to the knee; indeed pain in the knee is som etim es the predominant feature. In contrast, the 'hip' pain that is referred from the spine is felt mainly in the gluteal region, whence it often radiates down the back or outer side of the thigh.

True hip pain is made worse by walking, whereas gluteal pain referred from the spine is aggravated by activities such as stooping and lifting, and it is often eased by walking.

A ge incidence of hip disorders. Many of the important disorders of the hip occur in childhood, and often at a particular period of childhood. So true is this with some disorders that the age of the patient at the onset of symptom saffords some indication of the likely nature of the trouble, as shown in Table 17.1. (For ease of memorising, round figures have been given in the table but some latitude must be allowed.)

0	
diagnosis (years)	Disease
	Developmental (congenital) dislocation Tuberculous arthritis; transient synovitis
	Perthes' disease; transient synovitis
	Slipped upper femoral epiphysis
	Osteoarthritis (secondary to previous injury or disease) Osteoarthritis (primary)

 Table 17.1
 Usual age incidence of common hip disorders at time of diagnosis

Exposure

Age at time of c

0-2 2-5 5-10 10-20 20-50 50-100

For the proper exam ination of the hip the patient should be stripped except for a pelvic slip or underpants and, in women, a bra. The first part of the exam ination is conducted with the patient lying supine; afterwards the patient is examined standing and walking.

Steps in clinical examination

A suggested routine for clinical examination of the hip is summarised in Table 172

Setting the pelvis square

This is an important preliminary step. Determine from the position of the anterior superior iliac spines w hether or not the pelvis is lying square with the lim bs (Fig. 17.1). If it is not, an attempt is made to set it square. If this is impossible it means that there is incorrectable adduction or abduction at one or other hin (or rarely, a severe and rigid curvature of the spine): in that event the fact that the pelvis is tilted should be noted and borne in m ind during the subsequent steps of the exam ination.

Measuring the length of the limbs

Methods of measuring the lower limbs are often confusing to the uninitiated, but it is im portant that they should be properly understood. A ccuracy in measurement is of more than academic significance; it is of practical importance when corrective operations or adjustments to the shoes are contemplated. Limblength can be measured clinically within an error of one centimetre. If greater accuracy is needed, radiographic measurement (scanography) is recommended.

It is necessary to measure, first, the real or true length of each limb. Secondly, it is necessary to determ ine whether there is any 'apparent' or false discrepancy in the length of the limbs from fixed pelvic tilt (Fig. 17.2). Whereas it is always necessary to measure the true length, it is necessary to measure 'apparent' discrepancy only when there is an incorrectable tilt of the pelvis.

Measurement of true length. Ideally it would be desirable to measure from the normal axis of hip movement - that is, the centre of the femoral head but since there is no surface landmark at that point it is impracticable to do so clinically. The measurement is therefore taken from the nearest convenient landm ark - nam ely, the anterior superior spine of the ilium . D istally, m easurement is usually made to the medial malleolus.

The hip region

Table 17.2 Routine clinical examination in suspected disorders of the hip 1. LOCAL EXAMINATION OF THE HIP BEGION Examination for fixed deformity (Patient supine) Position of pelvis Including Thomas's manoeuvre for detection Determine the lie of the pelvis and set it and measurement of fixed flexion deformity square with the limbs if possible Movements (active and passive) Inspection Flexion Bone contours and alignment Abduction: abduction in flexion Soft-tissue contours Adduction Colour and texture of skin Medial (internal) rotation Scars or sinuses Lateral (external) rotation Palpation Power (tested against resistance of examiner) Skin temperature Estimate strength of each muscle group: flexors, extensors, abductors, adductors, Bone contours Soft-tissue contours rotators I ocal tenderness Examination for abnormal mobility Measurement of limb length Test for longitudinal (telescopic) movement Real or true length: Click test (in new-born) Measure from anterior superior iliac spine to (patient standing) medial malleolus Examination for postural stability (angle between pelvis and limbs to be equal Trendelenburg's test on each side) Gait If discrepancy found, determine site of shortening (or lengthening): (a) Above trochanter (Bryant's triangle; Nelaton's line; Schoemaker's line) (b) Below trochanter (measure each bone) 'Apparent' or false discrepancy: Measure from xiphisternum to medial malleolus. (Limbs to be parallel and in line with trunk) 2. EXAMINATION OF POTENTIAL EXTRINSIC SOURCES OF HIP SYMPTOMS This is important if a satisfactory explanation for the symptoms is not found on local examination. The investigation should include: 1. the spine and sacro-iliac joints 2. the abdomen and pelvis 3. the knee 4. the major blood vessels (arterial circulation)

3. GENERAL EXAMINATION

General survey of the other parts of the body. The local symptoms may be only one manifestation of a widespread or generalised disease

It should be noted that the anterior superior spine is well lateral to the axis of hip movement. This is of no consequence if the angle between limb and pelvis is the same on each side. But it will render the measurements fallacious if the angle between limb and pelvis is not the same on each side. This will be understood best by reference to Fig. 17.3A. It will be seen that abduction of a limb brings the medial malleolus nearer to the corresponding anterior superior spine, whereas adduction of the limb carries the medial malleolus away from the anterior superior spine. Thus if measurements are made while the patient lies with one hip adducted and the other abducted (a common posture in cases of hip disease) inaccurate readings will be obtained: the length will be exaggerated on the adducted side and underestimated on the abducted side.

The hip region



Fig. 17.1 First step in the clinical examination of the hip: determining the lie of the pelvis.

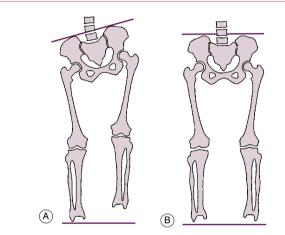


Fig. 17.2 'Apparent' or false discrepancy in limb length is caused entirely by incorrectable lateral tilting of the pelvis, which effectively abducts one hip and adducts the other hip (A). If the pelvis is square with the limbs there can be no 'apparent' discrepancy in limb length (B).

The rule is, therefore, that to obtain an accurate comparison of their true length by surface measurement the two limbs must be placed in comparable positions relative to the pelvis. Thus if one limb is adducted and cannot be brought out to the neutral position, the other limb must be adducted through a corresponding angle by crossing it over the first limb before the measurements are taken (Fig. 17.3B). Similarly, if one hip is in fixed abduction the other must be abducted through the same angle before the measurements of true length are made.

Fixing the tape measure at the anterior superior spine. A flat metal end (as found on the ordinary tailor's measure) is essential. The metal end is placed immediately distal to the anterior superior spine and is pushed up against it. The thum b is then pressed firmly backwards against the bone and the tape end together (Fig. 17.4). This gives rigid fixation of the tape measure against the bone and minimises any error in measurement.

Taking the reading at the medial malleolus. The tip of the index finger is placed immediately distal to the medial malleolus and pushed up against it. The thumb nail is brought down against the tip of the index finger so that the tape measure is pinched between them (Fig. 17.5). The point of measurement is indicated by the thumb nail.

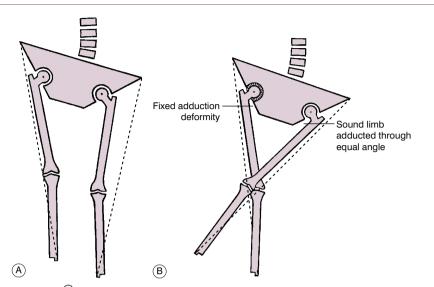


Fig. 17.3 A Since the anterior superior spine is lateral to the hip joint abduction approximates the foot to it and adduction carries the foot away from it. For this reason measurements of true length, taken from the anterior superior spine, are inaccurate if the angle of abduction or adduction is not equal on the two sides. B Correct way of measuring the true length when there is a fixed adduction deformity of one hip. The other hip must be adducted through an equal angle. (Position of tape measure shown by interrupted lines.)

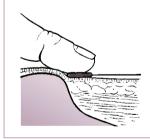


Fig. 17.4 Fixing the tape measure at the anterior superior spine.

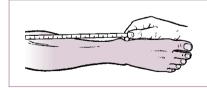


Fig. 17.5 Taking the measurement at the medial malleolus.

De ning If m eal real shortrm in in g t h of a lim b d e t e r m i n e hether the shortening is above ening i t w th e g n affection in or near the hip), or below the tro chanteric level (suggesting a disorder of the lim b bones).

The hip region

Shortening above the greater trochanter. Tests for shortening above the trochanteric level are: the measurement of Bryant's triangle, Nelaton's line, or Schoemaker's line.

In modern practice these tests are seldom used, since the information they provide can be supplied from simpler clinical observations or more accurately from radiographic measurements. They all depend on comparing the relative distance between the tip of the greater trochanters and the iliac crests. This can be quickly achieved with the patient supine, by using both hands with the thum bs placed on the greater trochanters and the tips of the index fingers on the anterior superior iliac spines. Any discrepancy between the two sides should then become apparent.

Shortening distal to the trochanter. True shortening is som etim es caused by an abnorm ality below the trochanteric level, such as a congenital defect of developm ent, im paired epiphysial grow th, or a previous fracture with overlapping of the fragm ents. To investigate this possibility individual measurements should be made of the femur (tip of greater trochanter to line of knee joint) and of the tibia (line of knee joint to medial malleolus) on each side and by flexing the knees to 90° and observing whether the shortening lies above the knee or below it (Gallenzi test).

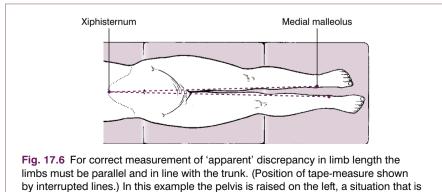
M easurem ent of 'apparent' discrepancy in lim b length. 'A pparent' or false discrepancy in lim b length is due entirely to incorrectable sidew ays tilting of the pelvis (Fig. 17.2A). The usual cause is a fixed adduction deform ity at one hip, giving an appearance of shortening on that side, or a fixed abduction deform ity, giving an appearance of lengthening. Exceptionally, fixed pelvic obliquity is caused by severe lum bar scoliosis.

To measure apparent discrepancy the limbs must be placed parallel to one another and in line with the trunk. Measurement is made from any fixed point in the midline of the trunk (for example, the xiphisternum) to each medial malleolus (Fig. 17.6).

If there is a discrepancy of true length it must be allowed for when 'apparent' discrepancy is determined. A salready noted above, there is no need to measure for apparent discrepancy if the pelvis lies square with the limbs, as determined from the position of the two iliac crests.

Examination for fixed deformity

Contracture of the joint capsule or of muscles may cause fixed deformity at the hip, preventing its being placed in a neutral position. Fixed flexion, fixed adduction, and fixed lateral rotation are common in some forms of arthritis.



commonly due to fixed adduction at the hip.

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338 ADAMS'S OUTLINE OF ORTHOPAEDICS

Fixed adduction deformity. This is detected by judging the relationship between pelvis and lim bs. It will already have been noted at an earlier stage of the exam ination. If fixed adduction is present the transverse axis of the pelvis (as indicated by a line joining the two anterior superior spines) cannot be set at right angles to the affected lim b, but lies at an acute angle with it.

Fixed abduction deform ity. The angle between the transverse axis of the pelvis and the lim b is greater than 90°.

Fixed flexion deformity. This is determined by a manoeuvre known as Thomas's test.

Principle of Thom as's test. If there is a fixed flexion deform ity at the hip the patient compensates for it, when lying on the back, by arching the spine and pelvis into exaggerated lordosis, as shown in Fig. 17.7 A. This allows the affected limb to lie flat on the couch. To measure the angle of fixed flexion deform ity it is necessary to correct the lumbo-pelvic lordosis. This is done by flexing the pelvis (and with it the lumbar spine) by means of the fully flexed sound limb (Fig. 17.7 B).

Technique of the manoeuvre. One hand is placed behind the lumbar spine (between it and the couch) to assess the degree of lumbar lordosis. If there is no lordosis when the affected limb lies flat on the couch there can be no fixed flexion deform ity and there is no need to proceed with the test. If there is excessive lordosis, as indicated by arching of the back (Fig. 17.7A), it is corrected in the following way: The sound hip is flexed to the limit of its range. The limb is then pushed further into flexion, thereby rotating the pelvis on a horizontal transverse axis until the arching of the spine is obliterated. During this manoeuvre the thigh of the disordered limb, if in fixed flexion, is autom atically raised from the couch as the lum bar lordosis is reduced (Fig. 17.7B). The angle through which the thigh is raised from the couch is the angle of fixed flexion deform ity.

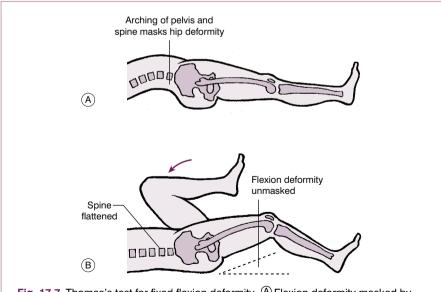


Fig. 17.7 Thomas's test for fixed flexion deformity. (A) Flexion deformity masked by arching of spine and pelvis. (B) Deformity revealed by flexing the sound hip and, by continuing the flexion force, correcting the arching of spine and pelvis.

CHAPTER 17

Fixed rotation deform ity. The most reliable index of the rotational position of the thigh is the patella, which norm ally points forwards when the hip is in the neutral position. If there is fixed lateral rotation or fixed medial rotation the lim b cannot be rotated to the neutral position, with the patella directed forwards. The angle by which it falls short of the neutral when rotated as far as possible is the angle of fixed rotation deform ity.

Movements

The accurate determination of hip movements demands much care, because restriction of hip movement is easily masked by movement of the pelvis. It is therefore essential to place one hand upon the pelvis to detect any movement there, while the other guides and supports the limb.

Flexion. The range of hip flexion is best demonstrated by flexing the hip and knee together; not by lifting the leg with the knee straight. Movement of the pelvis is best detected by grasping the crest of the ilium (Fig. 17.8). Only in this way is it possible to distinguish between true hip movement and the false flexion imparted by rotation of the pelvis. The normal range of true hip flexion is about 130°, but it varies according to the build of the patient.

Abduction. The limb to be tested is supported by one hand while the other hand bridges the pelvis from anterior superior spine to anterior superior spine (Fig. 17.9). In this way true abduction at the hip can be differentiated from the false abduction that is imparted by tilting of the pelvis. The normal range of true abduction at the hip is 30° to 35° (more in children).

Abduction in flexion. This is often the first movement to suffer restriction in arthritis of the hip. The patient flexes his hips and knees by drawing the heels towards the buttocks. He then allows the knees to fall away from one another towards the couch (see Fig. 17.11B). The normal range is about 70° (90° in young children).

Adduction. The limb to be examined is crossed over the other limb. Again care must be taken to differentiate between true adduction and the false movement imparted by tilting of the pelvis. The normal range of adduction is about 25-30°.

Lateral rotation and medial rotation. Judge the range by an imaginary pointer thrust axially into the patella, not by the position of the foot. The normal range both of medial and of lateral rotation is about 40°.

Extension. Contrary to what has often been written, the range of extension at the hip is nil. Extension of the hip joint beyond the neutral position is prevented by the strong anterior capsule and reinforcing Y-shaped ligament. Seeming backward movement of the thigh is in fact contributed entirely by rotation of the pelvis and extension of the spine, not by extension at the hip joint proper.

Examination for abnormal mobility

In cases of marked instability of the hip longitudinal movement or 'telescoping' can sometimes be demonstrated – especially in children with developmental (congenital) dislocation of the hip. To carry out the test the limb is grasped firmly in one hand and alternately pushed and pulled in its long axis, the trunk being steadied by the examiner's other hand upon the iliac crest.

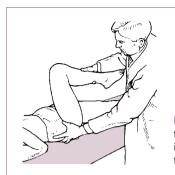


Fig. 17.8 Testing hip flexion. The right hand supports the limb while the left hand grips the ilium to detect incipient rotation of the pelvis. Hip and knee are flexed together.



Fig. 17.9 Testing abduction of the hip. The right hand supports the limb while the left, bridging the two anterior superior spines, is ready to detect tilting of the pelvis. Adduction is tested in the same way.

In infants it is important to examine for dislocation by the click tests of Ortolani and Barlow. These are described on page 344.

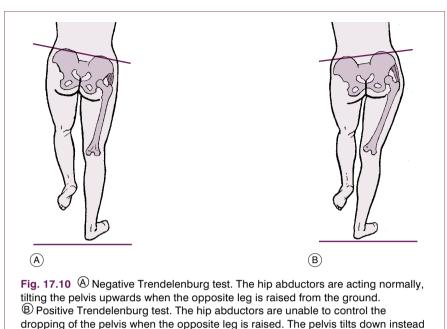
Examination for postural stability: the Trendelenburg test

The Trendelenburg manoeuvre is a test of the stability of the hip, and particularly of the ability of the hip abductors (gluteus medius and gluteus minimus) to stabilise the pelvis upon the femur when the subject is standing upon the one leg.

Principle of the test. Normally, when one leg is raised from the ground the pelvis tilts upwards on that side, through the action of the hip abductors of the standing limb (Fig. 17.10A). (This automatic mechanism allows the lifted leg to clear the ground in walking.) If the abductors are inefficient they are unable to sustain the pelvis against the body weight and it tilts downwards instead of rising up on the side of the lifted leg (Fig. 17.10B).

Technique. Stand behind the patient. Instruct him first to stand upon the sound lim b and to raise the other from the ground. Having thus got the idea of w hat he is required to do, he should now stand on the affected leg and lift the sound leg from the ground. By inspection, or by palpation with a hand upon the iliac crest, observe w hether the pelvis rises or falls on the lifted side. Rem em ber that the lim b upon w hich the patient stands is the one under test. If the pelvis rises on the opposite side (norm al) the test is negative (Fig. 17.10A). If it falls, the test is positive (Fig. 17.10B); in other words the abductor muscles are incapable of stabilising the pelvis upon the fem ur.

Causes of positive Trendelenburg test. There are three fundam ental causes:



- 1. paralysis of the abductor muscles (example poliomyelitis)
- 2. m arked approxim ation of the insertion of the abductor m uscles to their origin by upw ard displacement of the greater trochanter, so that the m uscles are slack (exam ples - severe coxa vara; developmental dislocation of the hip)
- absence of a stable fulcrum about which the abductor muscles can act (example - ununited fracture of the femoral neck).

Som etimes two of these factors may operate together: for instance, in a case of upward dislocation of the hip there may be an unstable fulcrum as well as approximation of the origin of the abductor muscles to their insertion.

Gait

W atch how the patient stands and observe his gait on walking. Note that a patient with an unstable or painful hip prefers to use a stick in the *opposite* hand, and tends to shorten the period of weight-bearing on the affected limb ('antalgic gait'). Characteristic gait patterns that are recognised include:

- 1. antalgic gait (weight-bearing minimised to reduce pain)
- 2. short-leg gait

of upwards.

 Trendelenburg gait (patient leans tow ards the opposite side to lift the sound leg clear of the ground).

The patient's ability to negotiate stairs must also be tested. A disability of the hip often precludes the normal rhythm of ascent and descent: on ascending,

the foot of the sound leg is advanced first, and that of the affected side is then brought up to it. On descent, the affected leg is put down first and the sound leg is brought down to it.

Extrinsic causes of pain in the hip region

If exam in ation of the hip itself fails to reveal abnorm alities sufficient to account for the patient's symptoms, possible causes outside the hipmust be investigated. A ttention should be directed particularly to the spine and sacro-iliac joints (including a neurological survey of the lower limbs), to the abdomen and pelvis (including rectal or bimanual examination if necessary), and to the vascular system (state of the peripheral pulses).

Imaging

Radiographic examination. *Plain radiographs* should include an anteroposterior projection showing the whole pelvis with both hips, and lateral films of each hip separately. It is recommended that the lateral films be obtained by slightly abducting the affected hip and directing the X-ray beam horizontally beneath the opposite flexed thigh. In special cases there is a place for *arthrography* (that is, radiography after the injection of radio-opaque fluid into the joint). When there is a possibility that the symptoms may be referred from the back radiographs of the spine and sacro-iliac joints must be obtained.

Radioisotope bone scanning. This is of value especially in the diagnosis of inflam matory lesions in or about the hip. It may also be helpful in the early detection of metastatic neoplastic deposits in the pelvis or upper end of the femur.

Computerised tomography (CT scanning) provides clear cross-sectional images of the pelvis or thigh and is useful in special circum stances. For instance, it can show accurately the orientation (degree of anteversion) of the acetabulum or of the neck of the femur. Or it may be used to outline bony or soft-tissue tum ours in or about the pelvis or hip (see Fig. 2.3, p. 15).

M agnetic resonance im aging (MRI) is of particular value in showing the extent of soft-tissue changes - for instance in the case of an invasive tum our. It may also allow early detection of bone necrosis in the fem oral head.

Ultrasound is now used increasingly in babies and young infants for the detection of developmental dysplasia before ossification of the femoral head allows radiological assessment.

Arthroscopy. Arthroscopic inspection of the interior of the hip is a useful supplementary method of investigation in adults, and it is now used increasingly in diagnosis and treatment.

DEVELOPMENTAL DYSPLASIA OF THE HIP

The term *developmental dysplasia* of the hip includes congenital dislocation of the hip, nearly alw ays diagnosed either within a few days of birth or within the first two years of life; and dysplasia of the hip in adults, characterised by shallow configuration of the acetabulum, defective congruity between the fem oral head and the socket, and a predisposition to osteoarthritis in middle or later life. Despite a trend tow ards re-naming congenital dislocation of the hip as developmental dysplasia of the hip, the title 'congenital dislocation' of the hip is so well established that it seem sunnecessary to discard it. That title is therefore retained here for dislocation diagnosed in infancy.

CONGENITAL DISLOCATION OF THE HIP

This is a spontaneous dislocation of the hip occurring either before or during birth or shortly afterwards. In Western races it is one of the commonest of the congenital skeletal deformities affecting 1 in 1000 neonates: it is also of special importance because neglect or inefficient treatment incurs the penalty to the patient of lifelong crippling.

Cause. Much remains to be learnt, but it now seems to be clear that a number of factors are concerned in the causation - some genetic and some environmental. One such abnormality acting alone may not always be sufficient in itself to bring about dislocation, and it may well be that a combination of factors is often at work.

- 1. Genetically determined joint laxity. Generalised ligamentous laxity is found in a proportion of the patients, and may also be present in a parent or relatives. It leads to lack of stability at the hip, so that dislocation may easily occur in certain positions of the joint.
- 2. Hormonal joint laxity. It is possible that in fem ales a ligam ent-relaxing hormone ('relaxin') may be secreted by the fetal uterus in response to oestrone and progesterone reaching the foetal circulation. This may cause instability in the same way as does genetically determined joint laxity. It is possible, also, that laxity of the hip ligaments from this cause might help to explain the greater incidence of dislocation in girls (the relaxing agent is not produced in boys). This factor requires further investigation.
- 3. Genetically determ ined dysplasia of the hip. There is little doubt that defective development of the acetabulum, and probably also of the fem oral head, can be inherited as a distinct entity. The defect appears alw ays to be bilateral, and is probably as common in boys as in girls. It predisposes to dislocation, which indeed may often occur before birth. If dislocation does not occur, the defect may show itself in adult life in the form of unduly shallow acetabula, with a tendency to subluxation and later osteoarthritis (acetabular dysplasia: see p. 352).
- 4. Breech malposition. The incidence of hip dislocation is slightly greater when the infant is delivered by the breech than with norm aldelivery. It is possible that the act of extending the hips during delivery may precipitate dislocation when there is already a predisposition to it from ligamentous laxity or acetabular dysplasia.
- 5. Post-natal positioning. The higher incidence of DDH in Inuit Eskim os who strapped their babies to a board with their hips adducted, compared to A frican tribes who carry their children on their backs with their hips abducted, indicates that the position that the hip is held in post-natally can have a major effect on acetabular development.

The relative importance of these various factors is not fully understood. Present evidence suggests, how ever, that there may be two distinct types of congenital dislocation of the hip. The first type is caused predom inantly by ligam entous laxity - whether genetically determ ined or horm onal - in which dislocation occurs as it were accidentally when some precipitating movement such as extension of the hips during delivery is the adjuvant cause, the dislocation in this type often being unilateral and readily correctable. The second type is due predominantly to genetically determined dysplasia of the acetabulum, which is always bilateral and often much more difficult to treat.

Pathology. The fem oral head: In a case of persistent dislocation the bony nucleus appears late and its development is retarded. The fem oral head is dislocated upwards and laterally from the acetabulum. The fem oral neck: In most cases the neck is anteverted (directed forwards) beyond the normal angle for infants of 25°. The acetabulum: The ossific centre for the roof of the acetabulum, like that for the fem oral head, is late in developing. The bone slopes upwards at a steep angle instead of forming a nearly horizontal roof for the acetabulum. The cartilaginous part of the roof is often well form ed at first, but if the dislocation is allowed to persist development does not proceed norm ally, and the socket assumes a shallow contour with steeply sloping roof. The fibro-cartilaginous labrum: The peripheral labrum which norm ally increases the depth of the developing acetabular socket is often folded into the cavity of the acetabulum to become a 'lim bus' and may im pede com plete reduction of the dislocation The capsule: This is gradually elongated as the fem oral head is displaced upwards.

Clinical features. Girls are affected six times as often as boys. In onethird of all cases both hips are affected. Unless it is specially looked for in infancy – as it always should be – abnormality may not be noticed until the child begins to walk. Walking is often delayed, and there is a limp or a waddling gait.

On exam in ation at that time, the main features in unilateral cases are asymmetry (notably of the buttock folds), shortening of the affected limb (Fig. 17.11A), and restricted abduction in flexion. In bilateral cases the striking features are widening of the perineum and marked lumbar lordosis. The range of joint movements is full except for abduction in flexion, which is characteristically slightly restricted (Fig. 17.11B). In most cases the affected limb is abnormally mobile in its long axis (telescopic movement).

Im aging. Plain radiographs show three important features (Fig. 17.12):

- The ossific centre for the head of the fem ur is late in appearing and its development is retarded
- 2. the bony acetabular roof has a pronounced upward slope
- 3. the femoral head (as judged from the position of the ossific centre) is displaced upwards and laterally from its normal position in the centre of the acetabulum.

These changes are not alw ays shown conclusively before the age of 4 m on ths. A rthrography (radiography after injection of opaque fluid into the joint) is

useful in showing the outline of the cartilaginous elements of the joint.

Ultrasound scanning allows the position of the fem oral head and acetabular socket to be determ ined in the new -born, when radiographic exam ination tends to be inconclusive.

D iagnosis. In the new -born. N early alw ays - though there are a few exceptions - dislocation or instability of the hip may be detected in the first few days of life by the diagnostic screening tests of Barlow or Ortolani (Fig. 17.13). In both tests the surgeon faces the child's perineum and grasps the upper part of each thigh between fingers behind and thum b in front, the child's knees being fully flexed and the hips flexed to a right angle (Fig. 17.14).

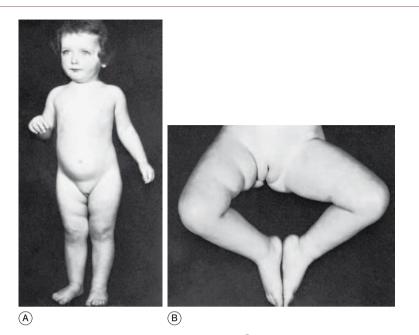
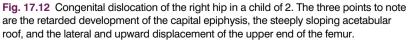


Fig. 17.11 Congenital dislocation of the right hip. (A) The right lower limb was slightly shorter than the left, as suggested here by the typical extra skin folds in the thigh. (B) shows the reduced range of abduction of the affected hip – another typical and important diagnostic feature.





The hip region

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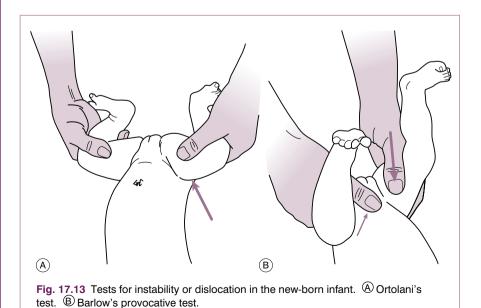
While each thigh in turn is steadily abducted towards the couch the middle finger applies forward pressure behind the greater trochanter (Ortolani), and alternately the thumb, placed anteriorly, applies backward pressure while the thighs are adducted (Barlow). One of two abnormal states may be detected:

- a dislocated fem oral head snaps back into the acetabulum with a palpable and audible jerk or jolt (Ortolani)
- backward pressure with the thum b dislocates a joint that is unstable (Barlow).

The manoeuvre must be combined with assessment of the range of abduction in flexion at each hip (Fig. 17.11B). If abduction is restricted it may indicate persistent or irreducible dislocation, and in such a case the absence of the characteristic jerk or jolt may mislead the observer into believing that all is well. In such a case, if unilateral, shortening may be observed when the knees are placed together, with the hips flexed.

In new born infants radiography may be inconclusive because the high proportion of radiolucent cartilage in the femoral head and acetabulum makes interpretation difficult. It becomes diagnostic after the age of about 4 months. As the necessary skill in the technique is more widely acquired, ultrasound scanning has become increasingly important in diagnosis in early infancy.

In older children. Delay in beginning to walk or abnormality of gait in early child hood should always arouse suspicion. The most important clinical sign in children 1 or 2 years old is a restricted range of abduction when the hip is flexed (Fig. 17.11B). If for any reason suspicion arises that all is not well with the hips, radiographic exam ination must be insisted upon. In these older children radiography is always conclusive.



The hip region



Fig. 17.14 Examining the hips of a new-born infant for instability. While the hip is abducted through the full range forward pressure is applied by the middle finger behind the greater trochanter. For details, see text.

Course and prognosis. The earlier the dislocation is reduced the better the prognosis. Even under the best conditions only about half or two-thirds of the patients treated after the first year of life can be expected to rem ain perm anently free from trouble. Gradual redislocation or subluxation is all too frequent, and pain from secondary degenerative changes often develops in middle adult life.

It is therefore important that, through careful examination of every new born infant, congenital dislocation be detected within the first week of life, when simple treatment can nearly always assure normal development of the hip.

Treatment

This varies according to the age of the patient when advice is sought. Four groups will be discussed:

- 1. neonatal cases (instability or dislocation)
- 2. age 6 m on ths 6 years
- 3. age 7 10 years
- 4. adolescents and adults.

Neonatal cases (within 6 months of birth). These are the ca neonatal screening, in stability o r d islo catio n is found o n eith er b v th e Ortolani-Barlow test or by ultrasound exam ination. In most of these cases the hip becomes stable spontaneously within 3 weeks. A ccordingly, there is much to be said for delaying a decision on definitive treatm ent until the time of reassessment three weeks after birth, when it will be found that a large proportion of the infants do not need treatm ent. In the interval between the first exam inaand the reassessment at 3 weeks the limbs are left free, though it seems sensible to advise the use of bulky double nappies to encourage abduction of the hips.

If at 3 weeks the hip is found to be stable, treatment is unnecessary, and the parents may be tentatively reassured. Nevertheless it is important that the child should be reviewed at the age of 5 or 6 months, when radiography gives conclusive findings, and again at 1 year of age.

If on the other hand the hip is still unstable at 3 weeks, splinting in the reduced position in moderate (not extrem e) abduction for 3 months is recommended. Splintage may be by plaster of Paris or more frequently using the Pavlic harness (Fig. 17.15), which is more flexible than the previously used Denis-Browne or V an Rosen splints. The dynamic Pavlic splint has an adjustable harness that can maintain the hips in flexion while limiting adduction. Splintage should be continued for a minimum of 6 weeks or for as long as instability persists, though this carries an increasing risk of the development of avascular necrosis of the fem oral head.

A ge 6 m on ths-6 years. This still form s a substantial group, but with more regular diagnosis in early infancy the proportion of patients treated as late as this should progressively decrease. There are three essential principles of treatment:

- 1. to secure concentric reduction
- 2. to provide conditions favourable to continued stability and norm al developm ent
- 3. to observe the hips regularly in order to detect any failure of norm al developm ent of the acetabulum and to apply appropriate treatment when necessary.

Reduction of dislocation. It is desirable whenever possible to obtain reduction by non-operative means, operation being used only when conservative methods fail. In practice, it is found that closed reduction is often possible in



Fig. 17.15 Pavlik harness used for the management of the unstable hip in the neonatal baby. It holds both hips in flexion and abduction allowing all movements except extension and is worn full-time. It permits spontaneous reduction without forcible manipulation.

babies up to 18 m on ths of age, but that thereafter the proportion that require operation progressively increases, so that operative reduction becomes almost routine after the age of 3 years.

Closed reduction. The standard practice is to apply weight traction to the lim bs with the child either on a frame or in gallows (Bryant's) suspension, and while traction is maintained, gradually to abduct the hips, a little more each day, until 80° of abduction is reached after 3-4 weeks. Cross traction by slings round the upper thighs may then be applied. In many cases reduction is obtained by this method alone. If, how ever, the hip is not reduced at 4 weeks an attempt is made to complete the reduction by gentle manipulation under anaesthesia. It is essential that reduction be complete, so that the fem oral head fits the socket concentrically. If necessary, arthrography, CT scanning, or magnetic resonance imaging may be employed to establish whether reduction is

If full reduction is secured, the lim bs are imm obilised for an initial period in plaster of Paris, usually in a position of moderate medial rotation and moderate abduction (Fig. 17.16): extreme positions must not be used. This has superseded the 'frog' position of right-angled flexion and abduction, form erly widely used, which has been found to prejudice the blood supply of the capital epiphysis of the femur, with risk of necrotic changes resembling those of Perthes' disease.

Operative reduction. If reduction is not obtained by traction and abduction, with or without manipulation, or when a soft-tissue obstruction to reduction has been demonstrated by arthrography, operation should be undertaken without delay. At operation, it will usually be found that full engagement of the fem oral head in the acetabulum is prevented by inturning of the acetabular labrum (lim bus), or occasionally by a volum inous ligament of the fem oral head or a tight psoas tendon. A ny such obstruction is removed or released to allow the fem oral head to be fully engaged. While the fem oral head is exposed to view, note should be made of the angle of anteversion of the fem oral neck. This

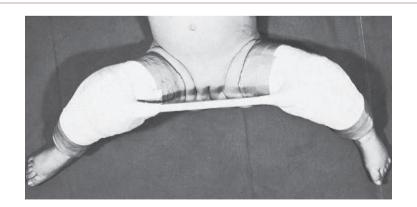


Fig. 17.16 A method of holding the hips in moderate abduction and medial rotation. Extreme positions of abduction or rotation are nowadays avoided because of the risk of damaging the blood supply to the capital epiphysis of the femur.

w ill often be found to be increased beyond the norm alangle of 25°. At the completion of the operation the lim bs are imm obilised in plaster in the same way as after closed reduction.

M aintenance of stability. A m ajor hazard to continued stability in a child whose hip dislocation has been concentrically reduced comes from excessive anteversion of the fem oral neck, which is a common if not a constant feature in children beyond 18 m onths of age. Excessive anteversion has its main adverse effect when the child assumes the erect posture for walking: with the hip extended excessive anteversion brings the fem oral head anteriorly, and radiographs may show it to lie eccentrically in the acetabulum. If uncorrected, this initial subluxation may progress eventually to redislocation.

The diagnosis of excessive anteversion is simple if operative reduction has been undertaken, for with the hip exposed the angle of anteversion can be measured under direct vision. When reduction has been by closed methods, how ever, diagnosis presents some difficulty – indeed to some extent it may be a matter of guesswork. Methods of radiographic measurement are available but they are not always easy to apply successfully in a small child and have been largely superseded. A more empirical method is often used: antero-posterior radiographs are taken with the hip first in the neutral position and then medially rotated. A more central position of the capital epiphysis in the acetabulum when the hip is medially rotated suggests that excessive anteversion is prejudicing stability. Definitive information on the angle of anteversion can best be gained from computerised tomography (CT scanning) or magnetic resonance imaging.

There are two methods of correcting excessive anteversion:

- 1. non-operative
- 2. operative (rotation osteotomy).

Non-operative management of anteversion. Long-continued harnessing of the hips in flexion and moderate abduction, a limited amount of walking being allow ed, has been found to favour spontaneous correction of anteversion. Correction may, how ever, take a year or more.

Rotation osteotomy. Excessive anteversion is easily corrected by rotating the femur through an osteotomy at its upper end. The femur is divided a little below the trochanteric level to allow the shaft fragment to be rotated laterally in relation to the upper end of the femur. The fragments are then fixed with a plate and screws. A fter operation immobilisation in plaster is maintained until union occurs – usually a matter of about 6 weeks. Thereafter all splintage is discarded.

Counteracting defective development of the acetabulum. In a proportion of cases – greater when treatment has been started late than when it has been begun in the first year of life – the acetabulum fails to develop norm ally from the stimulus of the femoral head within it, and remains unduly shallow. The femoral head is not well contained within it, being partly uncovered by the acetabular roof. If this deficiency is not corrected the femoral head may become slow ly displaced upwards, so that the joint is subluxated, the head no longer articulating congruously with the socket. The treatment of such acetabular deficiency is operative, and it should be carried out as soon as it is observed that this adverse situation has arisen. Mention will be made of four of the several operations that are available for improving the acetabulum :

- 1. osteotomy of the innominate bone (Salter's pelvic osteotomy)
- 2. pericapsular osteotomy of the ilium (Pemberton's pelvic osteotomy)
- shelf acetabuloplasty (W ainwright's shelf operation)
- 4. Chiari's displacement osteotomy of the ilium.

0 s innom inate bone (Salter). The iliac bone com · the etabulum, the cutem erging at the n o t c h pletely above greate ia tic alf of the bone, bearing the intact ac is then the low h ards, hinging at the sym physis pubis 17.17A) an d forw (Fig. at th femoral head is more fully covered by th e of the an d stability of the hip is correspondingly increased Τh operaoung children in whom th e acetab u la oralhea d congru

Per u la teotom v of ilium (Pemberton). This operatio providing increased cover for the fem oral h ead b v lar aim t h e d o s m a d e сu р w all from th e outer aspect of the ilium few m illim а of the capsule to the upper margin of the acetab u lu m The tends to the triradiate cartilage, hich form а flexible hinge w s roof of the acetabulum is deflected about which d o w n w a r d th e femoral head. The triangular osteotom y gap is held open by bone obtained

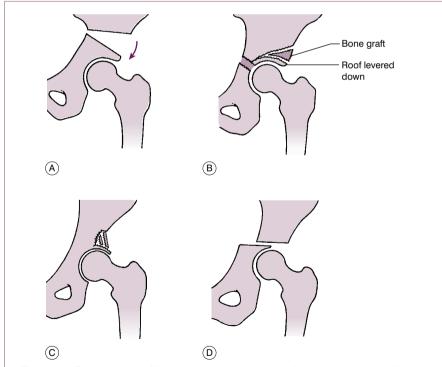


Fig. 17.17 Four methods of improving a poorly developed acetabulum to provide better cover for the femoral head. (A) Salter's osteotomy of the ilium. (B) Pemberton's pericapsular osteotomy of the ilium. C Wainwright's shelf acetabuloplasty. Chiari's pelvic displacement osteotomy. For details see text.

The hip region

locally from the ilium (Fig. 17.17B). This operation is most suitable for young children in whom the acetabular socket is relatively shallow compared to the shape of the fem oral head

Cortical turn-down acetabuloplasty (Wainwright). This so-called shelf operation also has the aim of increasing the surface area of the acetabular roof. A sizeable area of the outer table of the ilium is turned down as a flap into contact with the upper and outer aspect of the capsule of the hip joint (Fig. 17.17C). The flap, thus reflected, is held in place by strut grafts. This operation is suitable mainly for adolescents and young adults.

Chiari's velvic displacement osteotomy. The iliac bone is divided alm ost transversely im mediately above the acetabulum, and the lower fragment (bearing the acetabulum) is displaced medially (Fig. 17.17D). The cut surface of the upper fragment thus forms an extension of the acetabular roof, with capsule and new ly formed fibrous tissue intervening. The operation is suitable mainly for adolescents and young adults

Age 7-10 years. In these older children with untreated dislocations, the first point to be decided is whether or not treatment should be undertaken at all. In some of these children with well-developed false acetabula symmetrically placed on both sides, functional disability is slight, and appearance and gait may be acceptable. A ccordingly it may often be wise to advise against attem pted reduction of the dislocation. In contrast, there are others with highlying fem oral heads and poorly developed false sockets who can benefit greatly from operative reduction up to the age of 10 years or som etim es even later. This applies particularly when the dislocation is unilateral. Treatm ent in such cases entails open reduction of the dislocation, to accomplish which the femurmay have to be shortened in the subtrochanteric region. A ny excessive anteversion of the femoral neck is corrected at the same time by rotation at the site of bone resection . E ither at the sam e tim e , or preferably later, one of the operations m en tioned above for deepening the acetabulum (the Wainwright shelf operation or the Chiari operation) may be carried out. An obvious advantage of reducing the dislocation in these older children is that conditions are made suitable for replacem entarthroplasty should the need for it arise in later life, whereas this presents substantial difficulties if a high dislocation rem ains unreduced.

Age 11 years onwards. A fter the age of 10 years, and often in younger children, treatment of freshly diagnosed congenital dislocation of the hip is not advised unless secondary degenerative changes lead to severe pain. If increasing pain justifies operative treatment, the choice of method depends largely upon whether the dislocation affects one or both hips. If only one hip is affected total replacement arthroplasty may sometimes be practicable once adult life is reached; but if not, consideration should be given to the advisability of arthrodesis, which can offer a satisfactory solution. If both hips are affected (Fig. 17.18), if it is practicable, replacement arthroplasty is usually to be preferred.

DYSPLASIA OF THE HIP IN ADULTS

The gene that is responsible for many cases of congenital dislocation of the hip may also cause dysplasia, or failure of normal development of the joint, that may not become apparent in childhood.

Hipdvsplasia in adultsmay become symptomaticat any time from early ad ult life up till middle age, or later. The common presenting symptom is



Fig. 17.18 Bilateral untreated developmental hip dysplasia in an adult. The left hip is completely dislocated, with failure of normal acetabular development, and the right hip shows dysplastic changes.

pain, usually in one hip, but often occurring later, or in lesser degree, in the opposite hip as well. Exam ination shows good mobility of the hip, but often with complaint of pain at the extremes of the range, especially of flexion and abduction. On radiological exam ination the affected acetabulum is seen to be shallow, often with a steeply sloping roof (Fig. 17.19). The femoral head does not fit concentrically in the acetabulum : it may be shown to be displaced slightly upwards and outwards, so that Shenton's line - the norm ally smooth arch formed by the medial/inferior border of the femoral neck prolonged into the inferior border of the pubic ramus - is broken.

Dysplasia of the hip is important not only because it may cause pain and instability in its own right, but because it predisposes to the later development of degenerative arthritis, usually in middle life, with slowly increasing pain and difficulty in walking.

Treatment. Operative treatment is often appropriate, but it should be deferred until the disability becomes severe enough to demand it. The choice of operation is usually between osteotomy of the upper end of the femur to displace the femoral head and neck into more varus (Fig. 17.20), and pelvic osteotomy above the acetabulum to increase the coverage of the femoral head and improve stability of the hip (Fig. 17.17D). In patients with established arthritic changes total replacement arthroplasty of the hip may have to be recommended, even in patients who are relatively voung.

TRANSIENT SYNOVITIS OF THE HIP (Traumatic synovitis; transient arthritis; observation hip; irritable hip)

The so-called transient arthritis or synovitis of childhood is a short-lived affection of the hip of uncertain pathology, characterised clinically by pain, limp, and limitation of hip movements.



Fig. 17.19 Congenital dysplasia of the hip in a woman aged 42. Note that the acetabulum is very shallow. The femoral head is ill-formed and higher than normal. The cartilage space is greatly narrowed, indicating degenerative arthritis.

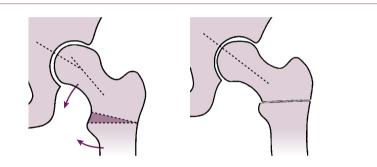


Fig. 17.20 Diagrams to show how adduction (varus) osteotomy of the femur improves the containment of the femoral head in the acetabulum. *Left* – Site of bone wedge to be removed. *Right* – Gap closed after removal of wedge, so that femoral neck is turned down into varus. The osteotomy has the effect that the upper part (head and neck) of the femur is abducted in the socket, while the femoral shaft remains in the neutral position.

Cause. This is unknown. Injury is possibly a factor but the evidence in support of it is slender.

Pathology. This is unknown. Possibly there is a mild inflam mation of the synovial membrane, initiated by minor injury; or perhaps a viral infection.

under 10, Clin condition c o n fin Th i s virtu allv e d i l d complains of pain in the he is especially boys The c h i l d groin an d thig h an d noticed to limp, sparing the affected leg. On examination the only physical sign is limitation of hip movements. *Radiographs* do not show any alteration from the normal.

The hip region

D iagnosis. Transient arthritis of the hip is important only because it resembles clinically the earliest stages of pyogenic arthritis, tuberculous arthritis or of Perthes' disease, before the characteristic radiographic features of those conditions have become apparent. Transient arthritis should be diagnosed only after the hip has recovered – never while the symptoms and signs are present. While the symptoms and signs last, the case should be regarded as one of suspected infective arthritis or Perthes' disease and the child investigated fully to exclude these diagnoses. Ultrasound scanning may be indicated to identify any joint effusion which would require aspiration. Full recovery within a few weeks excludes more serious disease and justifies a retrospective diagnosis of transient synovitis.

Course. Full recovery, with return of a normal range of hip movements, invariably occurs within three to 6 weeks.

Treatment. Rest in bed until the pain has settled and movements have been restored is the only treatment required.

PYOGENIC ARTHRITIS OF THE HIP (General description of pyogenic arthritis, p. 96)

Pyogenic arthritis of the hip is uncommon. It occurs mostly in children, in whom it is often secondary to osteomyelitis of the upper end of the femur. Its features resemble those of pyogenic arthritis elsewhere; but in infants there are particular characteristics that require special description.

Pathology. Organisms (usually staphylococci or streptococci) may reach the joint directly through the blood stream, or the infection may spread from an adjacent focus of osteom yelitis of the femur. Rarely, a penetrating wound is responsible. In new -born babies the infection may enter through the um bilicus. There is an acute inflam matory reaction in the joint tissues, with an effusion of turbid fluid or pus. In favourable cases healing with restoration to norm al can occur, but often the joint is perm anently destroyed or dam aged, and in older children and adults bony ankylosis may occur.

In infants bony ankylosis does not occur because the fem oral head and the acetabulum are composed alm ost entirely of cartilage rather than of bone, but there may be total destruction of the developing fem oral head, with secondary dislocation of the hip (pathological dislocation) (Tom Smith's disease¹). The fem ur may remain short, from destruction of the upper fem oral grow th cartilage. A dditional shortening will occur if the dislocation is allowed to persist and the fem ur to slide upwards on the ilium; so the discrepancy in length may be substantial by the time adolescence is reached.

Clinical features. The clinical features differ so much in infants and in older patients that separate descriptions are required.

Pyogenic arthritis of infants. The onset is within the first year of life. Often there has been a known septic lesion som ewhere on the body (for example, um bilical sepsis), but it may have caused little anxiety. Then the child becomes unw ell and pyrexial.

¹Sir Thomas Smith (1833–1909) Surgeon at St.Thomas's and Great Ormond Street Children's Hospitals in London described acute arthritis of infants in 1874.

On examination it is not alw ays apparent at first that the hip is the seat of the trouble. But careful examination will show thickening in the hip area, and movements of the joint are restricted, and disturb the child. Sometimes an abscess points at the skin surface in the buttock or thigh.

Im aging. In the early stages there is no alteration in the plain radiographs, but ultrasound scanning may show the hip joint to be distended with fluid (Fig. 7.13, p. 99). If the infection progresses to the stage of destroying the capital epiphysis of the femur, the ossific nucleus fails to appear as it should before the age of one year. In such a case subsequent radiographs may show gradual dislocation of the hip. This 'pathological' dislocation is distinguished from congenital dislocation by the facts that the acetabular roof is of norm al shape and that the capital epiphysis is perm anently absent (Fig. 17.21). Radioisotope scanning reveals increased uptake in the region of the hip.

Pyogenic arthritis in older children and adults. The onset is acute or subacute, with pain in the hip m ade worse by attem pted weight-bearing, reluctance to walk, and severe lim p. There is constitutional illness with pyrexia. On examination there may be some fullness about the hip region from swelling of the joint. All movements of the hip are markedly restricted, and painful if forced.

Im aging. There may be no change on plain radiographs in the early stages, but ultrasound will demonstrate the presence of an effusion (Fig. 7.13, p. 99). There may be evidence of osteom yelitis in the upper metaphysis of the femur. Later, if the infection persists, there is rarefaction of bone about the hip, and the cartilage space is narrowed, indicating destruction of articular cartilage. Finally, there may be bony ankylosis of the joint (Fig. 17.22).

Radioisotope bone scanning shows increased uptake in the region of the hip.

Investigations in both the infantile and childhood forms of suspected septic arthritis are similar. There is a polymorphonuclear leucocytosis and the erythrocyte sedimentation rate and C-reactive protein level are raised. Blood cultures are taken and if ultrasound shows a joint effusion, aspiration of the



Fig. 17.21 Old pyogenic arthritis of left hip in an infant (Tom Smith's disease). The epiphysis of the head of the femur has been destroyed and the hip is dislocated. Note the almost normal appearance of the acetabular roof, which helps to distinguish this from a congenital dislocation. The normal hip is shown for comparison.



Fig. 17.22 Bony ankylosis of the hip caused by pyogenic arthritis. The infection spread to the hip from a focus of osteomyelitis in the upper metaphysis of the femur. This is a common outcome of pyogenic arthritis in older children and adults.

joint is urgent yielding pus or turbid fluid from which the causative organism and its antibiotic sensitivities may be identified.

Treatm ent. Treatm ent is by appropriate antibiotic therapy, initially intravenously with a broad-spectrum cephalosporin, which can be changed later depending upon the nature of the infecting organism. Arthrotomy to perm it open drainage and saline irrigation of the joint is preferred to daily aspiration in preventing the form ation of adhesions and residual infection. Rest for the joint and relief of muscle spasm are best ensured initially by weight traction through adhesive skin strapping applied to the leg. When the infection has been overcom e active movements are encouraged.

Pathological dislocation complicating pyogenic arthritis of infants, with total destruction of the upper fem oral epiphysis. Definitive treatment of this rare but crippling condition must aw ait adolescence. In childhood the aim of treatment is to prevent progressive upward displacement of the fem ur and thereby to minim ise shortening. Provided the infection has settled, operation should be undertaken to deepen the acetabulum, to place the upper end of the fem ur within it and, if necessary, to lever down a 'shelf' of ilium over it, on the lines of the Pem berton osteotom y illustrated in Figure 17.17B. In adolescence, when the bones are nearing full development, arthrodesis may be recommended if the hip is painful. If the hip has fused spontaneously (Fig. 17.22) the situation is best accepted, provided that fusion has occurred in a good functional position.

TUBERCULOUS ARTHRITIS OF THE HIP (General description of tuberculous arthritis, p. 98)

The hip is one of the joints most frequently affected by tuberculosis. In Western countries, how ever, its incidence has declined so sharply that it is now seldom seen, and it is mainly confined to poorer countries or to immigrants from such countries.

Clinical features. The patient is usually a child – often 2 to 5 years old – or a young adult, often with a history of contact with a person with active pulmonary tuberculosis. The symptoms are pain and limp. The general health is usually impaired. On examination a thickening is often palpable in the region of the hip. All movements of the hip are limited, often markedly, and attempts to force movement provoke pain and muscle spasm. The gluteal and thigh muscles are wasted. A 'cold' abscess is sometimes palpable in the upper thigh or buttock. A tuberculous lesion may be apparent elsewhere in the body.

Im aging. Radiographic features. At first the changes are slight, but later there are fuzziness of the joint m argins and narrow ing of the cartilage space, indicating erosion of the articular cartilage (Fig. 17.23).

M R I scanning can show signs of oedema in bone and soft tissues and will demonstrate the effusion and cold abscess. *Radioisotope bone scanning* shows increased uptake in the region of the hip.

D iagnosis. This is mainly from transient synovitis, Perthes' disease (osteochondritis), low -grade pyogenic arthritis, and rheum atoid arthritis. Im portant features supporting a diagnosis of tuberculosis are: the presence of a tuberculous lesion elsew here; a positive M antoux reaction in children; a 'cold' abscess; a high erythrocyte sedim entation rate; and the typical histological appearance on biopsy of the synovial mem brane.

Course and prognosis. In a reasonable proportion of cases, especially in children, the infection is aborted by treatm ent and a sound joint is preserved, provided there has been no destruction of cartilage or bone w hen treatm ent is begun.

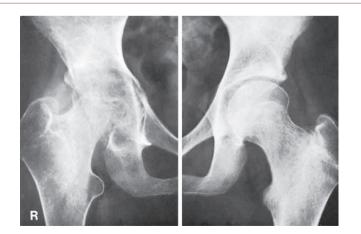


Fig. 17.23 Tuberculous arthritis of right hip in a more advanced stage. The cartilage has been destroyed and the articular surfaces of the acetabulum and femoral head have lost their sharp definition. The joint is permanently destroyed. The normal hip is shown for comparison.

Treatm ent. Essentially, treatm ent is the same as that for other tuberculous joints. The mainstay of treatm ent is a prolonged course of antibacterial agents, as described on page 102.

Local treatment is initially by rest for the hip, either in traction or in plaster. The subsequent treatment depends upon the progress made. If radiographs show no destruction of cartilage or bone, and if there is no evidence of deterioration full activity is gradually resumed.

On the other hand, if at the end of 3 or 6 m onths' treatment radiographs show marked destruction of cartilage or bone (Fig. 17.23), there is no possibility of preserving the joint intact. The choice then lies between total replacement arthroplasty and arthrodesis. Arthroplasty should only be undertaken when the disease is quiescent, and will require the reintroduction of antibacterial drugs to cover the period of operation. In children such operations should be deferred until adolescence.

RHEUMATOID ARTHRITIS OF THE HIP (General description of rheumatoid arthritis, p. 134)

The hip joints often escape in cases of rheum atoid arthritis; but when they are affected the consequent disability is severe. The main features of the disease are like those of rheum atoid arthritis in general, as described on page 134.

Clinical features. The changes may affect one or both hips, in common with several other joints. The main symptoms are pain and limitation of movement, aggravated by activity.

On examination swelling is not obvious because the joint is so deeply situated; for the same reason the temperature of the overlying skin is not increased as it is in rheum atoid affection of the more superficial joints. The range of all hip movements is impaired and movement is painful if forced. Fixed flexion deformity or adduction deformity may develop. The gluteal and thigh muscles are wasted.

Im aging. Radiographic features. In the earliest stages there are no radiographic changes. Later, there is diffuse bone rarefaction in the area of the joint. Later still, destruction of articular cartilage leads to narrow ing of the cartilage space between femur and acetabulum, often with inward protrusion of the softened medial wall of the acetabulum (Fig. 17.24).

Investigations. The erythrocyte sedimentation rate is increased during the active stage. The latex fixation test and the Rose-W aaler test may be positive.

Course. The disease becomes inactive after months or years, but the hip is seldom restored to normal. In long-established cases degenerative changes are superimposed upon the original inflammatory condition, giving rise to secondary osteoarthritis (Fig. 17.24A).

Treatm ent. M edical treatm ent is the same as that for rheum atoid arthritis in general (p. 137). Local treatm ent for the hip joints depends upon the activity and severity of the inflamm atory reaction. When the reaction is moderate or mild, exercises under physiotherapy supervision and active use within the limits of pain are encouraged. Intra-articular injections of hydrocortisone have som etimes given relief, but they cannot safely be repeated.

Operative treatment is justified when pain is severe and walking is limited to a few yards. Replacement arthroplasty (see Fig. 17.27A, p. 363) is the method of choice and can be expected to give as good results as in patients with osteo arthritis, though involvement of other joints in the lower limb may continue to impair mobility.





A

Fig. 17.24 (A) Long-established rheumatoid arthritis of the hip, with destruction of the cartilage space. The marginal osteophytes indicate that osteoarthritis is becoming superimposed upon the old rheumatoid disease. (B) The left hip of another patient, showing marked protrusion of the femoral head into the softened acetabulum (protrusio acetabuli).

OSTEOARTHRITIS OF THE HIP (General description of osteoarthritis, p. 140)

O steoarthritis of the hip is a common cause of severe disablement, especially in the elderly. It is not uncommon even in younger patients, when it is usually secondary to previous injury or disease. Indeed operations for the relief of osteoarthritis of the hip nowmake up a substantial part of the work of an orthopaedic department.

Cause. It is sometimes regarded as a wear-and-tear process; but in fact it reflects an inability of articular cartilage fully to repair itself. Any injury or disease that damages the joint surfaces initiates or accelerates the process of degeneration. Common examples of such predisposing causes are fracture of the acetabulum, Perthes' osteochondritis, slipped upper femoral epiphysis, and ischaemic necrosis (osteonecrosis) of part of the femoral head from any cause. In another group degeneration of the joint is secondary to a developmental imperfection (dysplasia) or congenital subluxation. In many cases there is no evidence of an underlying cause, and for want of any other explanation such cases are regarded as primary or idiopathic.

Pathology. The articular cartilage is worn away, especially where weight is transmitted. The underlying bone becomes hard and eburnated with subarticular cyst formation. Hypertrophy of bone at the joint margins leads to the formation of osteophytes.

Clinical features. The patient is usually elderly; but when osteoarthritis is secondary to previous hip disease or to injury it often arises in middle life or even earlier. There is pain in the groin and front of the thigh; often also in the knee. The pain is made worse by walking and eased by rest. Later, there may

The hip region

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be complaint of stiffness, which manifests itself in every day life by inability to reach the foot to tie the shoe laces or cut the toe nails. The symptoms tend to increase progressively month by month and year by year until they eventually cause severe painful limp and incapacity for normal activities.

On examination all hip movements are impaired. Limitation of abduction, adduction, and rotation is marked, but a good range of flexion is often preserved. Forced movements are painful. Fixed deformity (flexion, adduction, or lateral rotation, or a combination of these) is common (see Fig. 17.26).

Radiographic features. The changes are characteristic. There is diminution of the cartilage space, with a tendency to sclerosis of the subchondral bone and cyst form ation (Figs 17.25 and 17.26). Hypertrophic spurring of bone (osteophyte form ation) is usually seen at the joint margins.

Treatm ent. The treatm ent required depends upon the severity of the disability. M ild osteoarthritis is best left untreated. In cases of moderate severity conservative treatm ent may suffice, but in severe cases operation is often advisable.

Conservative treatment. Clearly no form of conservative treatment can possibly influence the distorted anatomy of the joint. A tbest such treatment is only palliative; it may alleviate but cannot abolish the pain. Four methods will be mentioned:

- 1. 'R elative' rest. By this is m eant a m odification of the patient's m ode of life by change of occupation or adjustm ent of duties so that the w ork throw n upon the hip is reduced. The use of a stick (cane) or w alking aid and the correction of shortening by a shoe raise also com e into this category, and they often afford considerable relief.
- 2. Drugs. M ild analgesic medication is often helpful, especially when the pain disturbs sleep, though non-steroidal inflam matory drugs are not as effective as in rheum atoid arthritis.
- 3. *Physiotherapy*. Local deep heat by short-wave diathermy, with exercises to strengthen the muscles and to preserve mobility, often provides temporary relief.

Fig. 17.25 Radiograph of idiopathic osteoarthritis of the hip. There is narrowing of the joint space, a subchondral cyst is seen in the medial femoral head, and large osteophytes are evident at the lateral margin of the acetabulum and on the lateral side of the femoral head.





Fig. 17.26 Advanced osteoarthritis of right hip. Note the adduction deformity – a common feature that causes apparent shortening of the limb from tilting of the pelvis. As in Figure 17.25, the characteristic features are narrowing of the joint space, subchondral bone sclerosis, and marginal osteophytes.

4. Injections into the joint. The injection into the joint of hydrocortisone, with or without a local anaesthetic solution, has been tried, and in a few cases tem porary relief has been claimed. How ever, repeated injections may accelerate joint destruction and are not to be recommended.

Operative treatment. Operation may be required if pain is severe – especially if it hinders sleep and interferes seriously with the patient's capacity for walking or work. Three types of operation must be considered:

- 1. arthroplasty (Fig. 17.27)
- 2. upperfemoral osteotomy (Fig. 17.28A)
- 3. arthrodesis

though the last two are now seldom used.

A rthroplasty. The method most commonly used in primary management is total replacement arthroplasty (Figs 17.27A and 17.29A). Excision arthroplasty (Fig. 17.28B) is now only used as a salvage operation after other methods of treatment have failed, particularly when replacement arthroplasty has failed on account of infection.

In total replacement arthroplasty both the femoral and acetabular articular surfaces are replaced by artificial materials. The introduction of this technique in the 1960s resulted from two important innovations: the development of new metal and polymer biomaterials which could provide low friction articulations while remaining inert in the body, and the use of an acrylic filling compound, or polymethylmethacrylate cement, to fix the implants to the bone. One of the earliest, and still most successful designs was that of Charnley, which replaced the femoral head with a much smaller stainless steel head on a stem fixed into the femoral shaft with acrylic cement. This articulated with a thick hemispherical socket or cup of high-density polyethylene, which was also fixed to the bone of the

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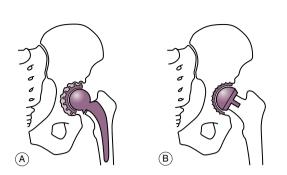
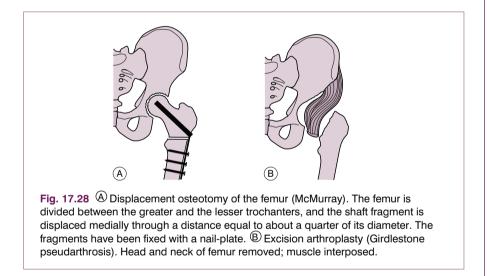


Fig. 17.27 (A) Total replacement arthroplasty. The femoral head is of metal, the socket of plastic. (B) Resurfacing (double cup) arthroplasty. Matching metal shells are used to resurface the femoral head and acetabular socket with cemented or cementless fixation.



cem ent (Fig. 17.29A). now tio n g t h e q o f life Н a l p e d m ost feared s. In th th e o f The th is in fe rate o f plica reduced to around 1 b v t h use of routine prophylactic an tibio tic com bined with sterile o p e r a t i n g environm ents utilising clean a i r la m flo w ventilation. A more challenging long-term problem is the progressive aseptic

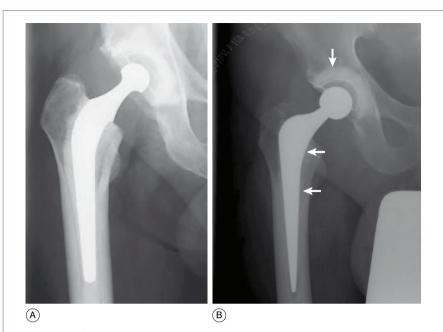


Fig. 17.29 (A) Total replacement arthroplasty of hip. The hemispherical socket, of polyethylene, is not seen, but its mouth is indicated by the wire marker. (B) AP radiograph of hip in patient 10 years after total hip replacement. There is a dark lucent line (arrowed) between the cemented cup and the bone of the acetabulum. The femoral shaft also shows endosteal bone resorption around the proximal and mid portion of the stem. This is indicative of loosening of both prostheses.

loosening of the prosthetic components which may occur (Fig. 17.29B) in some patients and results in a cumulative failure rate of 1% each year. This is associated with bone destruction around the implants which was thought to result from a granulomatous tissue reaction to the wear particles liberated from the weight-bearing surfaces.

In the intervening years, there have been m any attempts to improve on this basic design to provide longer implant survival, particularly when the technique is used in younger patients. These have included attempts at 'cementless' mechanical fixation of implants using prostheses with porous metal surfaces to encourage bone ingrow th, and the development of new biomaterials such as ceramics or better polyethylenes with improved wear characteristics.

A nother concept that has been reintroduced is the resurfacing or 'double cup' arthroplasty (Figs 17.27B and 17.30). This uses matching shells to resurface the fem oral head and reline the ream ed acetabular socket. Earlier attempts with this technique in the 1970s, using conventional metal and polyethylene components, had resulted in early failure because of rapid wear of the thin acetabular component. This problem has now been overcome by the use of improved metal-on-metal shells. The operation is only indicated in younger more active patients under the age of 60 where preservation of bone stock is required for

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Fig. 17.30 Metal-on-metal 'double cup' hip resurfacing prosthesis.

potential later revision. Short-term results are now as good as with conventional replacement arthroplasty, but the operation, which is more technically demanding, should only be used for selected patients by those skilled in its use until results from longer follow-up become available.

Upper femoral osteotomy (McMurray displacement osteotomy). This operwas a standard method of treatment before total replacement arthroplasty was developed, but it is now little used. It may still be useful in patients under 55 with moderately early osteoarthritis where pain is a major problem but there is still an adequate range of functional movement, including 90° of flexion. The fem ur is divided between the greater trochanter and the lesser trochanter, and the lower (shaft) fragment is displaced medially through about a quarter of its diameter (Fig. 17.28A). Internal fixation of the fragments by nail-plate and screws is usually employed. Relief of pain is often satisfactory in over 70% of patients and preoperative joint movement is retained. The quesof why an upper fem oral osteotomy should relieve the pain of an osteoarthritic hip has not been answered satisfactorily. It is possible that in some way the remodelling of bone trabeculae necessitated by the displacement stim ulates repair processes in the dam aged articular cartilage; or it m ay alter the vascularity of the fem oral head . Certainly in a favourable case the cartilage thickens appreciably in the first two or three years after operation, as shown radiologically. The other advantage of the operation is that it can still be converted to a hip replacement arthroplasty later, should the result prove disappointing in the long term.

A rthrodesis. The joint is fused in a position of $15-20^\circ$ of flexion but without any abduction, adduction, or rotation. There is complete relief of pain, and good function is possible so long as the other hip, the knees and the spine are norm al. It is only applicable in younger patients under 40 with distorted hip anatom y and is inappropriate for patients in countries where squatting is the norm al habit. In excision arthroplasty (Girdlestone pseudarthrosis) a false joint is created by excising the head and neck of the fem ur and the upper half of the wall of the acetabulum, and suturing a mass of soft tissue (such as the gluteus medius muscle) in the gap thus created, to act as a cushion between the bones (Fig. 17.28B). This is essentially a salvage operation, originally designed for chronic infections, and should only be used when alternatives have failed or are inappropriate.

It usually provides pain relief, but at the expense of substantial shortening and instability, necessitating the permanent use of a stick for walking and a considerable shoe raise.

PERTHES' DISEASE (Legg–Perthes' disease; coxa plana; pseudocoxalgia; osteochondritis of the femoral capital epiphysis)

Perthes' disease is osteochondritis of the epiphysis of the fem oral head. The general features of osteochondritis were described in Chapter 8 (p. 130). Like most examples of osteochondritis, Perthes' disease is an affection of childhood. The fem oral head is tem porarily softened and may become deformed. The main importance of the condition is that it may lead to the development of osteoarthritis of the hip in later life.

Cause. A temporary, and possibly repeated, local disturbance of blood supply is believed to be the major factor, but the precise cause of the vascular disturbance is unknow n.

Pathology. The bony nucleus of the epiphysis of the fem oral head undergoes necrosis either in whole or in part, presum ably from ischaemia. This sets up a sequence of changes which occupies two to three years. The first stage is that of ingrow th of new blood vessels and removal of dead bone by osteoclasts. In the second stage, which is not distinct but overlaps the first stage so that both processes are going on together, new bone is laid down on the dead trabeculae, gradually reconstituting the bony nucleus. The third stage is that of remodelling: this may continue for several years. This sequence of necrosis and replacement of bone is patchy rather than uniform, so that the nucleus has an appearance of fragmentation as seen in the radiographs. During this period structural rigidity is lost, and deformation of the epiphysis may occur from pressure across the joint.

In the early phases of the cycle of changes grow th of the bony element of the epiphysis is tem porarily arrested, but the cartilage surrounding the bony nucleus, which form s a considerable proportion of the fem oral head, continues to grow and so is disproportionately thick (Fig. 17.31), though sometimes revascularisation and healing will restore a relatively norm al fem oral head Fig. 17.32). Nevertheless it may sometimes follow the bone in suffering deformation, so that the fem oral head as a whole may become much flattened (Fig. 17.33). At the same time there is often some enlargement of the fem oral head, as the acetabulum grows, it tends to follow the contours of the fem oral head, so that it may end up abnorm ally large and shallow (Fig. 17.34).

¹George Clemens Perthes (1869–1927), German surgeon and early pioneer of radiotherapy and the pneumatic tourniquet, identified the radiological appearance of the disease in 1898.

The hip region



Fig. 17.31 Perthes' disease of the left hip. Note the shrunken appearance of the bony nucleus of the femoral epiphysis, the corresponding increase in depth of the cartilage space, the patchy changes of density, and the suggestion of fragmentation.



Fig. 17.32 Same patient as in Figure 17.31 two years after the onset of symptoms. The shape of the head is virtually normal, and the femoral neck is of normal length. There is little risk of osteoarthritis.

Fig. 17.33 In this patient, despite prolonged relief from weight-bearing, the femoral head is markedly flattened and the femoral neck is short. The deformity of the femoral head predisposes to osteoarthritis in later life.

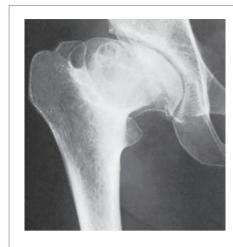


Fig. 17.34 Old untreated Perthes' disease. The femoral head is markedly flattened and the femoral neck is short. There is already some narrowing of the cartilage space, suggesting early osteoarthritis.

In consequence of interrupted grow that the epiphysial plate the femoral neck – and the limbas a whole – may be shorter than on the normal side, though the discrepancy is not great.

Clinical features. The disease occurs mainly in children of 5 to 10 years. It usually affects only one hip. The child complains of pain in the groin or thigh, and is noticed to limp. There is no disturbance of general health. On examination the only striking sign is moderate limitation of all hip movements, with pain and spasm if movement is forced.

Im aging. Radiographic features. The earliest radiographic changes are usually, though not alw ays, present by the time advice is sought. There is a slight decrease in the depth of the ossific nucleus of the fem oral head, whereas the clear cartilage space is often increased in depth: in other words the bony nucleus seems to have shrunk within its surrounding bed of cartilage (Fig. 17.31). The nucleus becomes denser than that of the norm al side, though the density is patchy rather than uniform, so that there is an appearance of fragmentation. In severe cases the nucleus becomes progressively more flattened. Eventually the texture of the bone returns to norm al (Fig. 17.32), but if flattening has occurred the fem oral head is permanently deformed (Figs 17.33 and 17.34). Radioisotope scanning shows failure of up take of the isotope in the region corresponding to the bony nucleus of the fem oral head, but the changes are better dem onstrated even at a very early stage by *M R I scanning*.

Diagnosis. Perthes' disease is distinguished from tuberculous arthritis, which it may resemble clinically, mainly by the radiographs. A normal erythrocyte sedimentation rate and blood count, and good general health, are other distinguishing features.

Prognosis. The disease has no direct adverse effect upon the general health. The main risk is to the future function of the affected hip joint, because if the fem oral head suffers permanent deformation there is a risk of secondary osteoarthritis in later life, often in the fifth or sixth decade (Fig. 17.34).

The outcome depends largely upon whether the whole of the epiphysis is affected or whether part of it escapes, as it often does. In the latter case the prognosis is favourable (Fig. 17.32), whereas if the whole epiphysis is affected marked flattening of the fem oral head may occur despite the most careful treatment (Fig. 17.33). The state of the cartilaginous part of the head, as determined from arthrography or from comparison of MRI scanning of both hips, is also important in prognosis. If head height is well preserved, the outlook is favourable, whereas if there has been early collapse of cartilage permanent deform ation of the head is to be expected. In general, the outlook is more favourable in younger children than in older children.

Treatm ent. It has to be admitted that the treatment of Perthes' disease is often disappointing: no universally satisfactory method has yet been evolved. Indeed it has sometimes been questioned whether treatment has any effect on the final state of the hip.

The former method of preventing weight-bearing pressure upon the softened femoral head by prolonged recumbency (often for 2 years or more) has long been abandoned because the results were not commensurate with the severe disruption of home life that this treatment entailed. O ther methods of trying to prevent pressure upon the head while still allowing the child to be up and about, such as slings or ischial-bearing calipers, have also fallen into disfavour because they are seldom effective and because they may embarrass the child psychologically.

The present trend is to grade the cases according to the likely outcome, so far as the shape of the fem oral head is concerned, as judged from the radiographic features in the early stages and to regulate the treatment accordingly. In the 'favourable' category are placed those with only half the head affected (as seen in the lateral radiographs) and with no sign of lateral extrusion of part of the fem oral head from under the roof of the acetabulum. In the 'unfavourable' grade are placed those with the whole head affected or with some lateral extrusion of the head beyond the roof of the acetabulum. In general, patients with a favourable prognosis do not require treatment other than by rest for a few weeks to allow the pain to subside though it is essential that they attend periodically for radiological review . In contrast, those with an unfavourable prognosis, with the fem oral head in danger of becom ing badly deform ed, are advised to have surgical treatment to prevent this.

Present thought is that treatment, when needed, should be by 'containment' of the fem oral head within the acetabulum. This means that the fem oral head must be centred within the acetabulum so that the two are co-axial, and thus the whole circum ference of the fem oral head is embraced by the socket. The socket then acts as a mould, to keep the head hem ispherical while it is in the softened state.

In practice, ensuring maximal containment of the femoral head demands that the femoral head and neck (or the whole limb) must be abducted in relation to the acetabulum, to make them co-axial. This has sometimes been achieved by splinting the limbs in 20° or 30° of abduction, but the child is thus greatly handicapped in walking. Most surgeons therefore prefer to realign the femoral head and neck by dividing the femur below the greater trochanter and deflecting the neck downwards to coincide with the central axis of the acetabulum (see Fig. 17.20). A lternatively, the acetabulum itself may be redirected after osteotomy of the innom inate bone (see Fig. 17.17D, p. 351).

OSTEONECROSIS (Non-traumatic avascular necrosis) OF THE FEMORAL HEAD

N ecrosis of the bone of the fem oral head m ay be a complication of traum a, particularly fracture of the fem oral neck, but m ay also occur without a history of injury. This non-traum atic or idiopathic osteonecrosis is thought to be the result of an ischaem ic episode affecting the bone and m arrow tissue, and m ay cause progressive collapse of the fem oral head in young adults.

Cause. The actiology of this uncom mon condition is still unclear, though several factors have been proposed as the mechanism of ischaemia, including intraosseous hypertension, fatem bolism, and intravascular coagulation. There is often a history of steroid therapy or alcohol addiction, and the condition may also develop in patients receiving immuno-suppression therapy following organ transplantation. It may also be associated with inherited haem oglobinopathies, such as sickle cell disease; and it may occur as a complication of Gaucher's disease (p. 72).

Pathology. The bone necrosis does not involve the entire fem oral head, but com monly occupies a wedge-shaped segment beneath the superior weightbearing surface. This may result in a subchondral fracture with subsequent collapse of the articular surface and a progression to secondary osteoarthritis. Surrounding the segment of bone necrosis there is a dense margin showing histological changes of an inflam matory response, with vascular granulation tissue suggesting a repair mechanism.

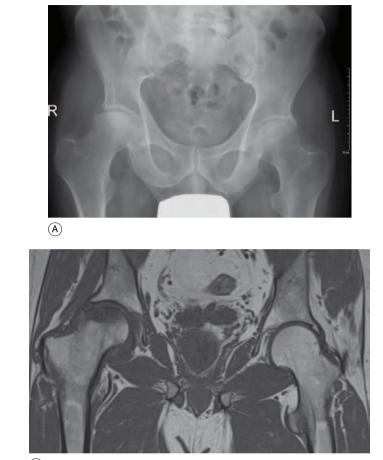
Clinical features. The patient, usually young or middle-aged, will present with increasing pain, which is frequently bilateral, in the hip or thigh during standing or walking. There is often a history of steroid therapy, excessive alcohol intake, or one of the other medical risk factors. Initially the range of hip movement is maintained, though painful at its extremes. Later, when bony collapse has occurred, there may be marked restriction of hip movement, with secondary contractures and lim b shortening.

Investigation. In the early stage of the disease plain radiography may be norm al (Fig. 17.35A), though magnetic resonance imaging (MRI) may show a low -intensity focus in the affected fem oral head (Fig. 17.35B). Bone scintigraphy using a technetium -labelled isotopemay reveal an area of increased or decreased uptake in the fem oral head at the site of developing necrosis, but is less sensitive than an MRI scan.

A full haem atological and biochem ical screen should be undertaken to identify any associated disease.

R ad iographic features. One of the earliest radiographic signs of developing osteonecrosis may be narrowing of the joint space, with flattening of the weight-bearing surface of the head and an underlying area of sclerosis in the bone. Progression to subchondral fracture results in a crescent sign of lucency beneath the superior articular surface with a dense segment in the underlying fem oral head (Fig. 17.36). In the advanced stages of the disease there may be secondary arthritic changes, with progressive collapse of the fem oral head.

Treatm ent. Treatm ent is usually surgical and is determ ined by the stage and extent of the disease. If diagnosed early, prior to fem oral head collapse, an attem pt can be m ade to encourage revascularisation by drilling the affected segm ent through a trans-trochanteric approach, with the possible addition of bone grafting to provide both an osteogenic stim ulus and m echanical support. In m ore advanced disease, where som e bony collapse has occurred, an osteotomy of the fem oral neck m ay allow better containm ent of the fem oral head and restoration of an intact articular w eight-bearing surface. Once secondary



B

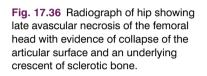
Fig. 17.35 A Radiograph of pelvis showing flattening of the femoral head with sclerosis in the right hip indicative of avascular necrosis. Compare with normal appearance on the left. Coronal T1 weighted MR scan of the pelvis showing a dense segment in the superior part of the right femoral head. This abnormal appearance is indicative of avascular necrosis, which the MR scan will detect long before there are changes seen on plain radiographs.

osteoarthritis is established, rem oval of the fem oral head and total replacem ent arthroplasty of the hip is the only surgical option.

SLIPPED UPPER FEMORAL EPIPHYSIS (Adolescent coxa vara; epiphysial coxa vara)

This is an affection of late childhood in which the upper femoral epiphysis is displaced from its normal position upon the femoral neck. The displacement occurs at the grow th plate (epiphysial line), and it is common for it to occur on both sides (though seldom simultaneously).





Cause. This is unknown. The condition is often associated with overweight from endocrine dysfunction or from other causes, but in other cases the patient is of norm albuild.

Pathology. The junction between the capital epiphysis and the neck of the fem urloosens. W ith the downward pressure of weight-bearing and the upward pull of muscles on the fem ur the epiphysis is displaced from its normal position. D isplacement is always backwards and downwards, so that the epiphysis comes to lie at the back of the fem oral neck (Fig. 17.37).

The displacement usually occurs gradually, but occasionally a sudden displacement is caused by injury, such as a fall. Left undisturbed, the epiphysis fuses to the femoral neck in the abnormal position. The consequent deformity of the articular surface then predisposes to the later development of secondary osteoarthritis.

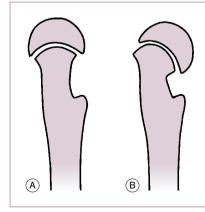


Fig. 17.37 Upper end of child's femur seen from the side. A Normal position of epiphysis. B Slipped epiphysis. The displacement is always backwards and downwards.

The hip region

C linical features. The patient is between 10 and 20 years of age. In about half the cases there is evidence of an endocrine disturbance leading to marked overweight. In a little less than half the cases both hips are affected, though seldom simultaneously. Typically, there is a gradual onset of pain in the hip, with limp. Sometimes the pain is felt mainly in the knee, which may confuse the diagnosis. Rarely, these symptoms develop acutely after an injury, such as a fall.

On examination the physical signs are characteristic, for there is selective limitation of certain hipm ovem ents, the otherm ovem ents being full or even increased. The movem ents that are restricted are flexion, abduction, and medial rotation. Lateral rotation and adduction are often increased, and the limb tends to lie in lateral rotation. Forcing movem ent in the restricted range exacerbates the pain.

R adiographic exam ination. Even a slight displacement of the epiphysis is recognisable, provided good *lateral* radiographs are obtained. It must be stressed that a slight displacement is easily overlooked if antero-posterior films alone are examined (Fig. 17.38). Lateral radiographs are essential. In the lateral film the epiphysis is seen to be tilted over tow ards the back of the fem oral neck (Fig. 17.39),¹ the posterior 'horn' being low er than the anterior, whereas in the norm al hip they are level.



Fig. 17.38 AP radiograph of the pelvis in a child with an early slipped femoral epiphysis of the left hip. The epiphysis has slipped medially and backwards. This subtle abnormality is identified by drawing a line along the superior margin of the femoral neck. On the normal right side a small portion of the epiphysis is seen to extend above the line. On the abnormal left side, when the line is drawn there is no part of the epiphysis lying above it.

¹Students often have difficulty in determining in lateral radiographs of the upper end of the femur which is the back and which is the front of the bone. The key is the bony projection formed by the trochanters: this is always posterior.

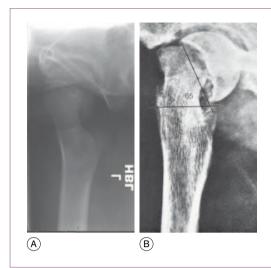


Fig. 17.39 (A) Lateral radiograph of the left hip in the same child confirms that the epiphysis has slipped backwards on the femoral neck. (B) Another patient. Slipped epiphysis of severe degree.

D iagnosis. Slipped upper fem or alepiphysis should be suspected in every patient of 10-20 years of age who complains of pain in the hip or knee. The characteristic clinical features, together with the radiographic evidence of epiphysial displacement, are conclusive. The condition is nevertheless often missed, partly because pain may be predominantly in the knee, the hip therefore being not examined; or because lateral radiographs are not obtained (Fig. 17.38).

Complications. These include avascular necrosis of the epiphysis of the femo oral head, cartilage necrosis, and late osteoarthritis.

A vascular necrosis (osteonecrosis) and consequent collapse of the epiphysis m ay occur if its blood supply is dam aged. This com plication is usually a consequence of attem pted reduction of the slip by manipulation or of operation, but it m ay occur spontaneously, especially after a sudden acute slip.

Cartilage necrosis is a rare and unexplained thinning of the articular cartilage, with marked restriction of joint movement. It is commonest after operative treatment and may possibly represent an auto-immune reaction.

If severe displacement is allowed to remain uncorrected osteoarthritis is likely to develop in later life (Fig. 17.40).

It is necessary to emphasise that a careful watch must always be kept for slipping of the opposite femoral epiphysis, which may occur in up to 50% of patients and may justify prophylactic fixation in those thought to be at greater risk.

Treatment. The treatment depends upon the degree of displacement. This may be graded as *slight* or *severe*.

Slight displacement. When displacement is slight (less than 40° as measured on the lateral radiograph) (Fig. 17.39A) the position may be accepted and all that is necessary is to prevent further displacement. This is achieved by driving threaded wires or slender screws¹ along the neck of the femur into the

¹A three-flanged nail, formerly sometimes used for fixation instead of threaded wires, is not recommended because it does not easily penetrate the hard epiphysis and may damage its blood supply.

The hip region



Fig. 17.40 Osteoarthritis developing twenty years after uncorrected slipped epiphysis.

epiphysis (Fig. 17.41). It should be remembered that even though the position that has been accepted may be imperfect, improvement can occur spontaneously in the succeeding years, through a process of remodelling.

Severe displacement. When displacement is severe (Fig. 17.39B) the position cannot easily be accepted because of the virtual certainty that painful osteoarthritis will develop in adult life. The position should therefore be improved. Three methods are available: manipulation, operative replacement of the epiphysis at the site of slipping, and compensatory osteotomy at a low er level.



Fig. 17.41 Slipped epiphysis with only slight displacement. Threaded wires have been inserted to prevent further slipping.

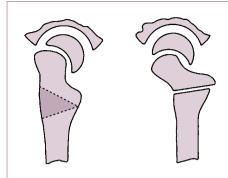


Fig. 17.42 Subtrochanteric osteotomy for slipped femoral epiphysis of severe degree. By removal of an appropriate wedge of bone (shown outlined in the left-hand diagram), the epiphysis is restored to its proper relationship with the acetabulum. The operation has the advantage that the blood supply of the epiphysis is not endangered.

M anipulation, with or without prelim inary weight traction, is seldom successful; it is worth trying only in the rare cases of recent sudden displacement, especially if caused by injury. M anipulation – predom inantly by medial rotation – should be carried out very gently lest the blood supply to the epiphysis be further dam aged. A fter successful manipulative reduction further slipping should be prevented by inserting threaded wires or screws, as described above.

Operative replacement of the epiphysis, with fixation by wires or a screw, has som etim es been practised when symptoms have been present for less than 3 months, provided the growth plate is still open. At its best it can restore the hip virtually to normal. Nevertheless the operation has the serious hazard that it may destroy the blood supply to the fem oral head, leading to avascular necrosis (osteonecrosis) of the fem oral head and precipitating the onset of disabling osteoarthritis. In the opinion of many surgeons this major hazard negates any indication for the operation.

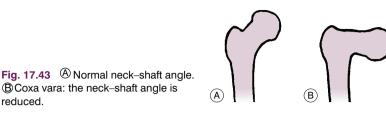
C om pensatory osteotom y is an alternative m ethod that is preferred by m ost surgeons. The osteotom y is done just below the trochanteric level (Fig. 17.42). An anteriorly based wedge of bone is removed so that the shaft of the fem ur is angled into flexion relative to the upper fragment. The operation thus compensates for the backward tilting of the epiphysis; correction should be sufficient to bring the epiphysis once more into the weight-transmitting segment of the acetabulum. The operation entails no risk of dam age to the blood supply of the fem oral head, so there is no risk of disastrous avascular necrosis (osteonecrosis); but it leaves the articular surface of the upper end of the fem ur deform ed, and therefore does not altogether rem ove the risk of secondary osteoarthritis in later years.

EXTRA-ARTICULAR DISORDERS IN THE REGION OF THE HIP

COXA VARA

The general term *coxa vara* includes any condition in which the neck-shaft angle of the femur is less than the normal of about 125° (Fig. 17.43). The angle is sometimes reduced to 90° or less. The deformity is caused mechanically by the stress of body weight acting upon a femur that is defective or abnorm ally soft.

The hip region



B Coxa vara: the neck-shaft angle is reduced

Causes. The most important causes of coxa yara are:

- 1. Congenital. Part of the fem oral neck rem ains as unossified cartilage, which gradually bends during childhood (congenital coxa vara; infantile coxa vara). This type is uncommon.
- 2. Slipped upper femoral epiphysis (epiphysial coxavara). This was described on page 371.
- 3. Fracture. Coxa vara is comm on after fractures in the trochanteric region with mal-union, and in ununited fractures of the neck of the femur.
- 4. Softening of bone, in general affections such as rickets, osteom alacia, or Paget's disease.

Effects. Coxa vara leads to true shortening of the limb. Approximation of the greater trochanter to the ilium slackens the abductor muscles of the hip and thus impairs their efficiency, leading in severe cases to a Trendelenburg 'dip', with consequent lim p (p. 341).

Treatment. The treatment is mainly that of the underlying condition. Often am ild deform ity is best accepted. In appropriate cases the neck-shaft angle can be corrected by osteotomy just below the greater trochanter.

SNAPPING HIP

Snapping hip is a harm less condition in which a distinct snap is heard and felt on certain movements of the joint. It does not denote any underlying injury or disease and it is seldom of practical significance. The snap is attributed to slipping of a tendinous thickening in the aponeurosis of the gluteus maximus over the bony prominence of the greater trochanter. It is heard easily when the patient flexes the hip actively, but it is not reproduced by passive movement with the muscles relaxed. Treatment is required only exceptionally, when disability is severe. The offending ridge of aponeurosis is simply divided transverselv from its under surface.

EXTRINSIC DISORDERS SIMULATING DISEASE **OF THE HIP**

A shas already been mentioned, it frequently happens that a patient complains of symptoms in the region of the hip or thigh when in fact they arise at a distance. The conditions that may confuse the diagnosis in this way fall into three main groups:

1. disorders of the spine or sacro-iliac joints

- 2. disorders of the abdomen or pelvis
- 3. occlusive vascular disease.

DISORDERS OF THE SPINE AND SACRO-ILIAC JOINTS

Prolapsed intervertebral disc

The pain of a prolapsed lumbar intervertebral disc is often referred to the gluteal region or lateral aspect of the thigh: indeed this is the commonest clinical feature in cases of intervertebral disc degeneration of slight or moderate degree. On examination other evidence of a spinal disorder will usually be found, whereas the hip itself is normal clinically and radiographically.

Sacro-iliac arthritis

The pain caused by arthritis of a sacro-iliac joint – whether it be tuberculous, pyogenic, or the early stages of ankylosing spondylitis – spreads diffusely over the gluteal area and may simulate an affection of the hip. Mistakes should be prevented by careful clinical examination and by routine radiography of the whole pelvis in cases of alleged hip complaints.

DISORDERS OF THE ABDOMEN AND PELVIS Pelvic or lower abdominal inflammation

In flam m ation involving the side w all of the pelvis m ay m im ic a hip lesion very closely; indeed even experienced surgeons have been deceived. The condition responsible is usually a subacute suppurative lesion such as a deep peri-appendicular abscess or a pyosalpinx. The hip symptoms arise partly from irritation of the obturator nerve, causing referred pain in the thigh, and partly from irritative spasm of the hip muscles that have their origin within the abdomen or pelvis - namely the psoas, iliacus, pyriform is, and obturator internus. The muscle spasm may cause marked restriction of hip movements, with pain if movement is forced. Differentiation from an intrinsic lesion of the hip depends upon a careful history and a complete physical examination, including an investigation of the abdomen and pelvis.

OCCLUSIVE VASCULAR DISEASE

Thrombosis of lower aorta or main branches

Ischaem ic pain in the muscles of the buttock or thigh, from occlusion of the low er abdom inal aorta or its main branches, may occasionally simulate disease of the hip. Distinction should not be difficult: in occlusive vascular disease the pain is brought on by activity and is quickly relieved by rest; the fem oral, popliteal and pedal pulses will be weak or absent and the hip will show a full range of painless movement.

18 The thigh and knee

The knee depends for its stability upon its four main ligaments and upon the quadriceps muscle. The importance of the quadriceps cannot be overemphasised. So efficiently can a powerful quadriceps control the knee that it can maintain stability despite considerable laxity of the ligaments. In many injuries and diseases of the knee the quadriceps wastes strikingly, and to some extent the condition of the muscle is an index of the state of the knee: if it is wasted it is probable that there is a significant abnormality within the joint.

A part from its vulnerability to injury, the knee is also particularly prone to alm ost every kind of arthritis. Moreover, it is the joint most commonly affected by osteochondritis dissecans and intra-articular loose body formation.

The region of the knee is the zone of m ost active bone grow th in the low er lim b (contrast the upper lim b, where m ost grow th occurs tow ards the should er and the wrist rather than tow ards the elbow). Perhaps partly for this reason the m etaphyses near the knee are common sites of osteom yelitis and of primary m alignant bone tumours.

The knee is, in fact, a region where nearly every kind of orthop aed ic disorder may be represented.

In the diagnosis of knee complaints arthroscopy has secured for itself a role in investigation for any suspected intra-articular lesion although M R I has usurped this position. A rthroscopic techniques of surgery have become routine for such common disorders as meniscal tears and intra-articular loose bodies. A rthroscopic surgery has the advantages that form al opening of the knee is avoided and that recovery and convalescence are greatly accelerated. Stay in hospital is reduced, or increasingly the operation is performed as a 'day case procedure' without the need for admission.

In recent years total replacement arthroplasty of the knee has become established as the routine operation for the relief of disabling arthritis, whether rheumatoid or degenerative. The newer operation of unicompartmental arthroplasty is now producing results that allow it to be considered as an alternative to tibial osteotomy for the treatment of arthritis confined to a single tibio-femoral compartment.

SPECIAL POINTS IN THE INVESTIGATION OF THIGH AND KNEE COMPLAINTS

History

The history is of particular importance in the diagnosis of disorders of the knee. In a case of torn meniscus, for instance, the history is often the most important factor in the clinical diagnosis. When there has been a previous injury to the knee, the exact sequence of events at the time of the injury and afterwards must be ascertained. Enquiry is made into the mechanism of the injury; what the patient was doing at the time; whether he was able to carry on afterwards. Was heable to finish the game? If not, was he carried from the field or was heable to walk? How soon after the injury did the knee swell? Was heable to straighten the knee fully? If not, how did he eventually get it straight? Was heable to bend it? These and many other details must be elicited by careful questioning because they are so important in building up a picture of what exactly happened to the knee. Caution is necessary in accepting the patient's story of 'locking' at its face value. Many patients speak of 'locking' when the knee simply feels stiff and painful, or when it causes momentary jabs of pain on movement. Locking from a torn meniscus means simply that the knee cannot be straightened fully; it can usually be flexed freely. In locking from a loose body within the joint the knee may be jammed so that it will neither flex nor extend, but this is rather uncommon and the knee usually unlocks itself after an interval, or can be freed by judicious manoeuvring.

Exposure

For proper exam ination the whole length of the limb must be uncovered. It is im possible to exam ine a knee adequately when the thigh is half covered by tightly rolled trousers or underpants. The sound knee must also be exposed for comparison. For proper exam ination of the knee the patient must always be recumbent upon a couch.

Steps in clinical examination

A suggested routine for clinical examination of the thigh and knee is summarised in Table 18.1.

Determining the cause of a diffuse joint swelling

The knee exem plifies better than any other joint the different types of diffuse articular swelling. That the joint is in fact swollen should be obvious from inspection: com parison of the two knees will show that the concavities present at each side of the patella have been filled out on the affected side.

A diffuse swelling of the knee can arise only from three fundamental causes:

- 1. thickening of bone
- 2. fluid within the joint
- 3. thickening of the synovial membrane (in practice it is found that this is the only soft tissue about the knee that swells appreciably).

Determ ination of the particular cause or com bination of causes in a given case depends entirely on careful palpation, as follow s:

Thickening of bone. Thickening of bone is detected without difficulty by deep palpation if the affected side is compared with the normal. There may be a general enlargement, caused perhaps by a bone infection or by an expanding tum our or cyst; or there may be simply a local prominence, caused usually by osteophytes at the joint margin or by an exostosis.

Fluid within the joint. A fluid effusion is best detected by the fluctuation test. The palm of one hand is placed upon the thigh immediately above the patella - that is, over the suprapatellar pouch. The other hand is placed over the front of the joint, with the thumb and index finger just beyond the margins of the patella (Fig. 18.1A). Pressure of the upper hand upon the
 Table 18.1
 Routine clinical examination in suspected disorders of the thigh and knee

1. LOCAL EXAMINATION OF THE THIGH AND KNEE

Inspection

Soft-tissue contours Colour and texture of skin Scars or sinuses

Palpation

Skin temperature Bone contours Soft-tissue contours Local tenderness

Measurements of thigh girth

Comparative measurements at precisely the same level in each limb give an indication of the relative bulk of the thigh muscles, and in particular of the quadriceps

Movements (active and passive, against normal knee for comparison) Flexion Extension **Power** (tested against resistance of bone contours and alignment examiner) Flexion Extension

Stability

Medial ligament Lateral ligament Anterior cruciate ligament: anterior draw test; Lachman test; pivot shift test Posterior cruciate ligament

Rotation tests (McMurray) (Of value mainly when a torn meniscus is suspected)

Stance and gait

2. EXAMINATION OF POTENTIAL EXTRINSIC SOURCES OF THIGH OR KNEE SYMPTOMS

This is important if a satisfactory explanation for the symptoms is not found on local examination. The investigation should include especially:

1. the spine

2. the hip

3. GENERAL EXAMINATION

? Pain on movement? Crepitation on movement

General survey of other parts of the body. The local symptoms may be only one manifestation of a widespread disease

suprapatellar pouch drives fluid from the pouch into the main joint cavity, where it bulges the capsule at each side of the patella and imparts an easily detectable hydraulic impulse to the finger and thumb of the lower hand (Fig. 18.1B). Conversely, by pressure of this finger and thumb the fluid can be driven back into the suprapatellar pouch, the hydraulic impulse being clearly received by the upper hand. In this way an unmistakable sense of fluctuation can be elicited between the two hands. W ith practice it is easy to detect even a small effusion in this way. The 'patellar tap' test (Fig. 18.1C), in which the patella is tapped backwards sharply so that it strikes the fem ur and rebounds, though still used, is less reliable. The test is negative in the presence of fluid in two circum stances: first, when there is insufficient fluid to raise the patella away from the fem ur; and secondly, when there is a tense effusion. If used at all, the 'patellar tap' test should be used only as a supplementary method.

D istinction between effusions of blood, serous fluid, and pus is made partly from the history, partly from the clinical examination. An effusion of blood (haemarthrosis) appears within an hour or two of an injury and rapidly becomes tense and therefore painful. An effusion of clear fluid develops slow ly (12-24 hours) and is never as tense as an effusion of blood (haemarthrosis). An effusion of pus is associated with general illness and pyrexia.

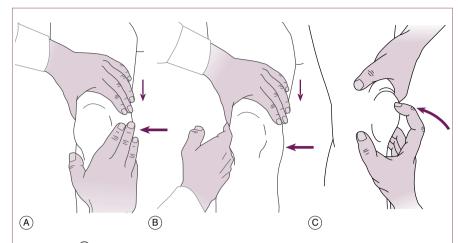


Fig.18.1 (A) Fluctuation test for fluid in the knee joint. One hand compresses the suprapatellar pouch, (B) while the thumb and finger of the other hand detects the fluid impulse on either side of the patella. (C) In the patellar tap test the finger pushes the patella onto the front of the femoral condyle through the fluid resistance.

Thickening of synovial membrane. A thickened synovial membrane is alw ays a prominent feature of chronic inflammatory arthritis. The thickening is often most obvious above the patella, where the reduplicated membrane forms the suprapatellar pouch. It has a characteristic boggy feel on palpation, rather as if a sheet of warm sponge-rubber had been placed between the skin and the underlying bone. It is worth emphasising that since it is highly vascular, a thickened synovial membrane is alw ays associated with increased warm th of the overlying skin.

Movements

A ccurate assessment of the range of movement is particularly important in the knee, because even a slight impairment of movement is significant. It is important to note also whether movement is painful and whether it is accompanied by crepitation.

Flexion. The norm alrange varies with the build of the patient. Thin patients can flex more than fat patients – usually enough to bring the heel in contact with the buttock. The range of the sound knee should always be taken as the norm al for the individual.

Extension. There is a fairly wide variation in the normal range of extension: it is wrong to accept 0° as the starting-point of movement (0° = the anatom ical position, with the knee straight). Many normal women can hyperextend their knees whereas some normal men cannot extend quite to the straight position. Variations are only of small magnitude but they may be significant. It is important to detect even a slight impairment of knee extension: therefore the range on the sound side must be taken as the yardstick of normal extension and a very careful comparison must be made between the two sides.

The thigh and knee

Tests for stability

The integrity of each of the four major ligaments is tested in turn.

Testing the medial and lateral ligaments. For this test the joint must be in a position just short of full extension, so that the posterior part of the joint capis relaxed: with the knee fully extended even marked laxity of the collateral ligam ents can be masked by the intact posterior capsule, held taut. It must be rem em bered, how ever, that with the knee slightly flexed the medial and lateral ents are normally som ewhat slack and allow a little side-to-side wobble. ligam Technique: Support the limb by a hand gripping the ankle region and by the other hand behind the knee, flexing it slightly. Instruct the patient to relax the m uscles. Using the more proxim al hand as a fulcrum on the appropriate side of the knee, apply first an abduction force to test the medial ligament (Fig. 18.2A) and then an adduction force to test the lateral ligam ent. If the ligam ent is torn, the joint will open out more than in the norm alknee when stress is applied.

th e anterior and posterior cruciate ligaments. The anterior Testing cruciate ligam ent prevents anterior glide of the tibia on the fem ur; the posterior cruciate ligam ent prevents posterior glide. First the ligam ents are tested with the knee flexed 90°. Technique: The patient's knee being flexed to a right angle and the foot placed firm ly on the couch, sit lightly on the foot to prevent it from sliding (Fig. 18.2B). With the interlocked fingers of the two hands form a sling behind the upper end of the tibia, and clasp the sides of the leg between the then are minences. Place the tins of the thum hs one upon each fem oral condule Ensure that the patient has relaxed the thigh muscles. A lternately pulland push upper end of the tibia to determ ine the amount of antero-posterior movement. Normally there is an antero-posterior glide of up to half a centimetre; but since the norm al is variable it is wise to use the patient's sound lim b for com parison. Excessive glide in one or other direction indicates dam age to the corresponding cruciate ligam ent.

second test the ligaments are examined with the knee flexed or 20° (Lachman test). One hand supports the thigh just above the ping the fem oral condyles, while the other hand grasps the upper of the tibia (Fig. 18.3). While the patient relaxes the muscles the extent of any anterior or posterior glide of the tibial condyles upon the femuris determined by pushand-pull movem ents of the tibia

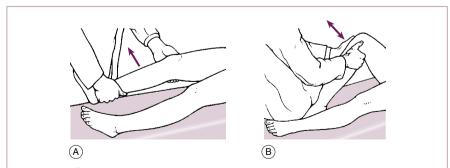


Fig. 18.2 (A) Testing the medial ligament. The knee is held slightly flexed (see text). B Testing the cruciate ligaments. The patient's foot is steadied by sitting upon it. Pulling the tibia forwards tenses the anterior ligament; pushing it backwards tenses the posterior ligament.

The thigh and knee



Fig. 18.3 In the Lachman test the amount of anterior or posterior glide of the tibia upon the femur is assessed with the knee flexed only about 20°.

Lateral pivot shift. The test for lateral pivot shift is supplementary to the tests described above for deficiency of the anterior cruciate ligament: it may be positive when the foregoing test is equivocal. The test depends on the fact that when the anterior cruciate ligament and the lateral ligament are deficient or lax the pivot between the lateral condyle of the femur and that of the tibia may be unstable. In that event the lateral tibial condylar surface may be displaced forwards in relation to the fem oral condyle when the tibia is rotated medially with the knee straight. When the knee is then flexed the subluxation is spontaneously reduced with a visible or palpable 'jerk'. The test is thus an indication of antero-lateral instability.

Technique. The leg on the affected side is lifted by the examiner's corresponding hand (the right foot is lifted by the right hand; the left leg by the left hand) so that the knee drops into full extension with the muscles relaxed. The lim b is supported under the arm, and with the other hand the examiner then presses against the outer aspect of the lim b just below the knee, im parting a valgus strain (Fig. 18.4). At the same time the tibia is rotated medially upon the fem ur. The knee is now flexed slow ly from the straight position. If the test is positive the lateral tibial condyle becomes spontaneously relocated on the fem oral condyle when the knee reaches 30° or 35° of flexion. The relocation is evidenced by a visible or palpable jerk (hence the term 'jerk test' sometimes used for the manoeuvre).

Rotation test for pedunculated tag of meniscus

The object of this test, often known as McMurray's test and used only for suspected tears of the menisci, is to demonstrate a pedunculated tag of meniscus by causing it to be momentarily jammed between the joint surfaces: when the knee is then straightened a loud click may be heard and felt as the tag is disengaged.



Fig. 18.4 Test for lateral pivot shift. The test depends upon first rotating the tibia medially to provoke subluxation of the lateral condyle of the tibia upon the lateral femoral condyle, and then correcting the subluxation by flexing the knee (see text).

The manoeuvre is carried out by repeatedly:

- 1. flexing the knee, first fully but in succeeding tests progressively less fully, then
- 2. rotating the tibia upon the fem ur, first laterally but in further tests medially, and finally
- 3. extending the knee while the rotation of the tibia is still maintained.

A loud click, distinct from the norm alpatellar click and usually associated with pain, suggests a tag tear (not a 'bucket-handle' tear) of a meniscus. Caution: Loud clicks can often be produced in norm alknees. Most of them arise from movements of the patella, and they are not accompanied by pain. Discretion must be used in interpreting a click as an abnorm alfinding.

Extrinsic causes of pain in the thigh and knee

In most cases symptoms felt in the knee have their origin locally in ornear the joint; but there are exceptions that may trap the unwary. Most importantly, pain in the knee may be the predominant feature of a disorder of the hip, such as arthritis or slipped upper femoral epiphysis. Less commonly sciatic pain, perhaps from a prolapsed intervertebral disc, has its greatest intensity at the level of the knee. In the investigation of pain in the knee we must therefore recognise the possibility that it may be referred from the spine or hip, and extend the exam ination to those regions if a satisfactory explanation for the trouble is not found on local exam ination.

Imaging

Radiographic examination. In a straightforw ard case antero-posterior and lateral films are sufficient. They should alw ays include a reasonable length of the fem ur and of the tibia and fibula. Tangential projections of the fem oral condyles with the knee flexed are som etimes helpful, especially when osteochondritis dissecans is suspected. Tangential ('sky-line') views of the patella may also be required.

When it is suspected that the knee symptoms might be referred from a lesion of the hip or spine appropriate radiographs of those regions should be obtained.

Radioisotope bone scanning. O ccasionally this may be useful in the diagnosis of inflam matory or neoplastic lesions.

M agnetic resonance im aging. When adequate inform ation cannot be obtained from plain radiography, magnetic resonance im aging may be helpful as a noninvasive alternative to arthroscopy.

Arthroscopy

A rthroscopy can be a useful adjunct to clinical and radiographic exam ination in the diagnosis of knee com plaints (Fig. 18.5). Its use for diagnostic purposes has been largely replaced by MRI, but it is a well-established method of treating a num ber of intra-articular disorders by minimally invasive operation.

A rthroscopy is usually carried out with the patient anaesthetised, the joint cavity is filled with saline through a hollow needle, and a cannula and telescope are entered at the appropriate site – usually antero-laterally or antero-medially, depending upon whether the surgeon is concerned to inspect mainly the medial or the lateral compartment. By correctly manoeuvring and rotating the arthroscope, and if necessary by the use of alternative sites of entry, alm ost the whole extent of the interior of the joint can be brought into view with the possible

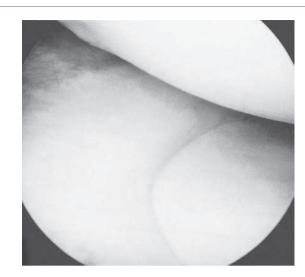


Fig. 18.5 Arthroscopic photograph showing normal appearance of medial meniscus. The medial femoral condyle is seen above, and the upper surface of the tibia is at the lower right. The concave edge of the meniscus is seen clearly lying upon the tibia.

exception of the postero-lateral recess. The information gained can be enhanced by probing the menisci and other intra-articular structures with an instrument introduced at a site away from the arthroscope.

DISORDERS OF THE THIGH

ACUTE OSTEOMYELITIS (General description of acute osteomyelitis, p. 85)

The femur is one of the bones most commonly affected by pyogenic osteomyelitis. The infection is carried to the femur either through the blood stream (haematogenous osteomyelitis), when it usually affects the lower metaphysis; or it is introduced through an external wound, especially in cases of compound fracture. The clinical features and treatment are the same as those of osteomyelitis elsewhere (p.89).

CHRONIC OSTEOMYELITIS (General description of chronic osteomyelitis, p. 90)

Chronic pyogenic osteom yelitis is nearly always a sequel to acute infection that has been neglected or has responded poorly to treatment. As with the acute disease, the lower end of the femuris affected more often than the upper; but in many cases the infection spreads to involve a large part of the femoral shaft. Clinical features and treatment are like those of chronic osteom yelitis elsewhere (p.91). The femur is one of the commonest sites of the important bone tumours.

Benign tumours (General description of benign bone tumours, p. 106)

Of the four main types of benign bone tumour - osteoid osteoma, chondroma, osteochondroma, and giant-cell tumour - only the giant-cell tumour requires further consideration here, because of the special treatment requirements when it occurs close to the knee.

Giant-cell tumour (osteoclastoma)

The low er end of the femur is a particularly frequent site for this uncommon tumour. The upper end of the femur is affected much less often. The tumour usually arises in young adults. It begins in what was the metaphysial region, but since the epiphysis is fused there is no obstacle to its spread into the articular end of the bone (see Fig. 8.10A & B). The bone is gradually expanded, the cortex becoming very thin and pathological fracture may sometimes occur.

Though classed with the benign tum ours, a giant-cell tum our tends to recur after inadequate rem oval and in rare cases it has the character of a sarcom a, m etastasising through the blood stream.

Treatm ent. Thorough curettage of the tum our and filling of the resultant cavity with bone grafts or acrylic bone cem ent has been widely used but it is attended by a high incidence of recurrence. It may still be appropriate for small tum ours but careful monitoring afterwards is essential so that any recurrence may be detected early. If the tum our is large many surgeons now prefer to excise the tum our-bearing low er end of the femur and to fit a custom -made metal prosthesis to replace the low er end of the femurand the knee joint.

Malignant tumours (General description of malignant bone tumours, p. 112)

The femur is a common site for all of the main types of malignant bone tumour occurring in younger patients. Three require mention – namely osteosarcoma, Ewing's sarcoma, and chondrosarcoma, though others such as lymphoma, malignant fibrous histiocytoma, and myeloma should be considered in the differential diagnosis of destructive femoral bone lesions. How ever, it should be remembered that metastatic tumours are much more common than any of the primary malignant tumours, particularly in patients over the age of 50.

Osteosarcoma (osteogenic sarcoma)

This is usually a tum our of childhood or early adult life: when it occurs in patients beyond middle age it is usually a complication of Paget's disease. Typically it arises in the metaphysis of a long bone, and the lower metaphysis of the femur is the favourite site. The tum our is highly malignant, with a mortality still in the region of 40% or more despite recent advances in treatment. Treatment is discussed on page 117.

Ewing's tumour

This also occurs mainly in children or adolescents. Unlike most bone tumours, it usually affects the shaft of the bone, which it expands in a fusiform manner. Over it, layer upon layer of new bone is laid down, giving a typical 'onion-peel' appearance as seen in the radiographs. A lthough the tum our responds dram atically to chem otherapy, usually in com bination with radiotherapy or surgical excision, the prognosis rem ains poor, with a mortality in the region of 50 percent from blood-borne metastases. Treatment is discussed on page 121.

Chondrosarcoma

This tum our occurs more commonly in middle age and elderly patients suggesting that it represents a malignant change in a pre-existing chondroma. Clinically it presents with local pain and swelling and may reach a large size because of slow growth. Imaging shows an expanding lytic lesion with characteristic patchy calcification and cortical destruction. Treatment is entirely surgical since no chemotherapy is effective on the relatively avascular tum our.

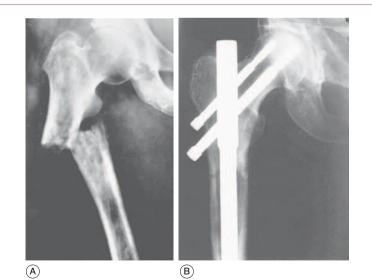
Metastatic (secondary) tumours

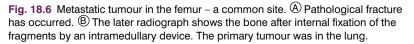
The femur is commonly invaded by metastatic tumours, especially in its proximal half (Fig. 18.6).

Pathology. The tum ours that metastasise most readily to bone are carcinomas of the lung, breast, prostate, kidney, and thyroid. The bone structure is usually destroyed by the tum our and pathological fracture is common (Fig. 18.6A).

Clinical features. Pain is the predominant symptom, but sometimes the tum our causes little disturbance until a pathological fracture occurs.

Treatm ent. The principles of treatm ent of m etastatic tum ours in bone were described on page 126. M ost pathological fractures of the fem ur lend themselves well to internal fixation with a long m odified intram edullary nail, though som etim es this requires the addition of acrylic bone cem ent to achieve stability (Fig. 18.6B). W here massive bone destruction has occurred in the proximal





or distal femur, it may be necessary to replace this with a custom prosthesis. This facilitates nursing and greatly increases the quality of life because external splintage can be dispensed with and the patient mobilised.

ARTICULAR DISORDERS OF THE KNEE

PYOGENIC ARTHRITIS OF THE KNEE (General description of pyogenic arthritis, p. 96)

Pyogenic arthritis is commoner in the knee than in most other joints, partly because the knee is so exposed to injury and partly because of the close relationship of the joint cavity to the low erm etaphysis of the femur, which is one of the commonest sites of acute osteomyelitis. The onset is acute or subacute, with pain, swelling, and loss of function. Radiographs do not show any abnormality in the early stages.

Treatment. A ppropriate antibiotic therapy must be started immediately (see p.98). Local treatment: The joint is rested in a plaster splint in a position of 20° of flexion. The purulent effusion is removed daily by aspiration so long as it re-forms or by arthrotomy. Rest is continued until the infection has been overcome; thereafter active movements are encouraged.

TUBERCULOUS ARTHRITIS OF THE KNEE (General description of tuberculous arthritis, p. 98)

A fter the hip, the knee is the lim b joint most often affected by tuberculosis, usually in children or young adults. It is now an uncommon disease in Britain and other W estern countries, though seen more often in developing countries and occasionally in immigrants to Britain. The knee is painful, diffusely sw ollen from thickening of the synovial membrane, and warm. Movements are restricted, the thigh muscles are wasted, and an abscess or sinus is sometimes apparent.

Radiographic features. The earliest change is diffuse rarefaction throughout the area of the knee (Fig. 18.7). Later, unless the disease is arrested, there is narrow ing of the cartilage space and erosion of the underlying bone.

Treatm ent. Constitutional treatm ent, by antituberculous drugs, is the sam e as that for other tuberculous joints (p. 102). Local treatm ent is at first by rest in a splint or plaster, generally for two to three m on ths in the first instance, depending on severity and progress. Subsequent m anagem ent depends upon the response to treatm ent and the state of the joint at the end of this period of im m obilisation. If the articular cartilage and bone are still intact, if the general health is good and the local signs have subsided, and if the erythrocyte sed im entation rate has steadily im proved, it is likely that the disease has been aborted. In that event active joint m ovem ents are encouraged and w alking is gradually resum ed.

On the other hand, if the review at the end of the initial period of imm obilisation shows that the disease is still active and that articular cartilage or bone has been destroyed, sound bony fusion should usually be the ultimate aim, though arthroplasty may sometimes be considered. Imm obilisation is therefore continued until the disease becomes quiescent. Arthrodesis may then be undertaken, provided the grow the piphyses have closed. In children still growing it is better to defer arthrodesis lest grow th be disturbed, and in the meantime to protect the knee in a walking caliper or splint.

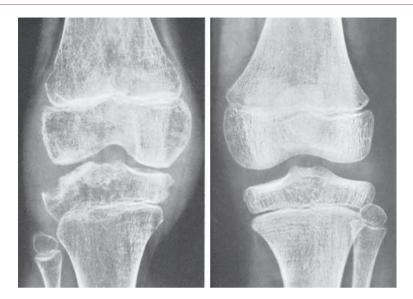


Fig. 18.7 Tuberculous arthritis of right knee in a child. The normal left knee is shown for comparison. Note the rarefaction, the diminution of cartilage space, and the small area of erosion near the lateral margin of the tibial joint surface. Destruction is only moderate, and a reasonably good result may be achieved with conservative treatment.

RHEUMATOID ARTHRITIS OF THE KNEE (General description of rheumatoid arthritis, p. 134)

The knees are among the joints most frequently affected by rheum atoid arthritis, and they often suffer severe permanent disability. Both knees are often affected simultaneously with several other joints.

The knees are painful, swollen from synovial thickening, and warm to the touch. Bow-leg, knock-knee, or flexion deformity may occur. Movement is impaired, and painful if forced.

Im aging. Radiographs do not show any abnormality at first. Later there is diffuse rarefaction of the bone in the area of the joint. In long-established cases destruction of articular cartilage leads to narrow ing of the joint space (Fig. 18.8), and there may be clear-cut erosions of bone, characteristically at the articular margins. Radioisotope bone scanning shows increased uptake of isotope in the region of the joint.

Course and prognosis. The inflam mation dies down after months or years, but the knee is seldom restored to normal. The joint surfaces are usually dam aged and wear out sooner than those of a normal joint. Thus in the late stages osteoarthritis is liable to be superimposed upon the original rheum atoid condition.

Treatm ent. In the active stage the treatm ent is that for rheum atoid arthritis in general and requires coordinated care by a multi-disciplinary team (p. 137). Local treatm ent for the knees depends upon the severity of the inflam matory reaction. If it is severe, rest in bed or even temporary immobilisation with moulded plaster or polythene splints is advisable. When it is moderate or slight,

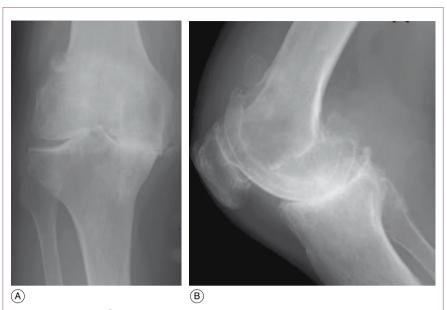


Fig. 18.8 (A) and (B) AP and lateral radiographs showing rheumatoid arthritis of the knee. The bone is porotic and there is complete loss of the medial joint space with irregularity of the articular surface indicating an underlying erosive process.

activity within the limits of pain is encouraged. Physical treatment is worth a trial. The most effective methods are exercises to preserve muscle power and joint movement, and local heat in the form of short-wave diathermy. Injections of hydrocortisone into the joint have som etim es given relief, but repeated injections are inadvisable because they may accelerate the destructive process.

O perative treatment. Three types of operation may be employed in treating m ore advanced stages of joint disease:

- 1. synovectom y
- 2. replacementarthroplasty
- 3. arthrodesis.

In deciding between them each case must be considered on its merits, and no hard-and-fast rules can be laid dow n.

Synovectomy. When there is persistent boggy thickening of the synovial membrane, but the articular cartilage is well preserved, the operation of synovectomy (excision of the synovial membrane) is worth considering. Comfort may be much improved and the advance of the disease is possibly slowed by the removal of the tissue producing the proinflamm atory cytokines and enzymes responsible for cartilage destruction. This operation alone has no place in the later stages of the disease and is now used less frequently since the introduction of better drugs for the medical control of inflam matory disease.

Replacement arthroplasty. Replacement arthroplasty of the knee now good results as have been achieved at the hip. Excellent and durable resu The thigh and knee

being achieved in over 90 per cent of patients after ten years. In a favournow a h le pain is well relieved and good function is restored, with perhaps 90° of flexion movement. Replacement arthroplasty of the knee is particularly valuable for patients with severe disorganisation of the joint, and especially for elderly patients with involvement of several other joints.

eral techniques of knee arthroplasty are available: all of them rely upon em ent of the articular surfaces by a metal or plastic (polyethylene) prosreplac thesis. Most of the earlier devices took the form of a hinge, but such devices seldom used because they do not mimic normal knee movement, and consequently there may be early implant loosening with bone destruction.

present trend is to provide gliding articular surfaces rather than a The pivoted hinge. Thus the fem oral condyles may be replaced by a metal prosthesis cemented in place, and the tibial condyles by a matching polyethylene proswith a metal backing (total condylar replacement, Fig. 18.9A). sis usually th e When badly damaged, the patella may also be resurfaced with a m atching polyethylene bearing. In unicom partmental arthritis, the medial or the lateral f.e.m oral condyle may be replaced alone (Fig. 18.9B). How ever, this is only suitfor osteoarthritis and in most cases of inflammatory arthritis, bicondylar a h l e lacement is preferred (Fig. 18.10). Many different types of total knee prosthesis are now available, including designs that incorporate artificial menisci, results show no obvious advantages over the excellent results butmedium-term obtained with the original condylar replacem ents.

Arthrodesis. This is a reliable operation for the total abolition of pain and good stability, but it is appropriate only if the other joints of the low er lim bs are healthy – a condition that is seldom met in rheum atoid disease. The joint is usually fused in about 20° or 25° of flexion, a position that is m ore convenient than the fully straight position, though a stiff knee is, of course, an aw kw ard handicap.

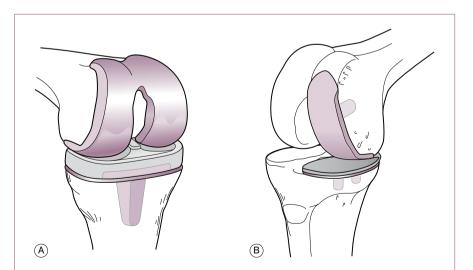


Fig. 18.9 A Condylar total knee replacement arthroplasty. A biconvex metal prosthesis is used to resurface both femoral condyles and articulates with a flatter biconcave metalbacked polyethylene tibial component.
B Unicondylar knee arthroplasty to replace a single tibio-femoral compartment. The curved femoral resurfacing prosthesis articulates with either a fixed, or mobile, polyethylene tibial component.

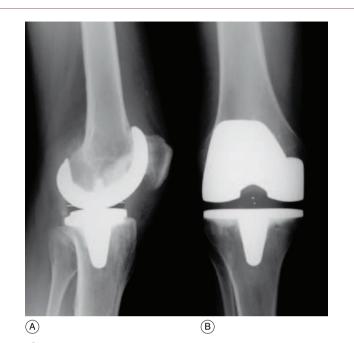


Fig. 18.10 (A) and (B) AP and lateral radiographs showing a total replacement arthroplasty of the knee. The metal prosthesis resurfacing both femoral condyles articulates with a polyethylene tibial prosthesis, which is not visible, but is supported by the metallic tibial stemmed implant.

OSTEOARTHRITIS OF THE KNEE (General description of osteoarthritis, p. 140)

The knee is affected by osteoarthritis more often than any other joint. The condition is particularly common in elderly, obese women.

Cause. It is caused by a degeneration of the articular cartilage of uncertain aetiology; but nearly alw ays som e factor is present that has caused the joint to wear out sooner than usual. O besity is the commonest factor: for some reason it seems to impose a harm fulstress upon the knee whereas it does not adversely affect the hip or ankle. O ther important predisposing factors are: previous fracture causing irregularity of the joint surfaces; previous disease with damage to articular cartilage (especially old rheumatoid arthritis or infective arthritis); previous intra-articular mechanical damage, as from a torn meniscus or from osteochondritis dissecans; and mal-alignment of the tibia on the femur (as in long-established bow-leg or knock-knee deform ity from any cause).

Pathology. The articular cartilage is worn away and the underlying bone becomes thickened and eburnated. There is hypertrophy of bone at the joint margins, with the formation of marginal osteophytes. The changes may affect predominantly the medial compartment of the femoro-tibial joint, or the patello-femoral joint; but usually the whole joint is affected. The thigh and knee

Clinical features. The patient is commonly an elderly, heavy woman, in whom both knees may be affected. In another group, mostly in men, there is a history of previous mechanical derangement from a sports injury. There is slow ly increasing aching pain in the joint, worse after unusual activity, and 'grating' may be felt or heard on movement. The symptoms are often exacerbated by a slight strain or twist. There is usually evidence of one of the predisposing factors mentioned above.

On exam ination the knee is slightly thickened from hypertrophy of bone at the joint margins, where a rim of osteophytes may be palpable. Effusion of fluid into the joint is unusual, except after much activity. Movement is moderately restricted and is accompanied by coarse crepitation. The quadriceps muscle is wasted. In severe cases there is a tendency to varus (bow-leg) deformity, less often a valgus (knock-knee) deformity, often with inability to straighten the knee fully.

R adiographic features. N arrowing of the cartilage space, which is the first sign of osteoarthritis in most joints, is often not discernible until a later stage in the case of the knee. An earlier sign in many cases is sharpening or 'spiking' of the joint margins, especially of the patella (Fig. 18.11) and tibia. Later, narrowing of the cartilage space is obvious, osteophytes form at the joint margins, and the subchondral bone may become sclerotic (Fig. 18.12). O pacities that appear to be loose bodies are often seen; most are not in fact loose but are attached to the synovial membrane.

Treatment. In the usual case of moderate severity, conservative treatment is often successful in relieving the symptoms, although the structural changes in the joint are clearly irreversible. The most effective method is by physiotherapy. Intensive active exercises are carried out to strengthen the wasted quadriceps muscle. Local heat therapy is often also given, but it is less important than the exercises. The knee is largely dependent upon the quadriceps for its stability, and if a powerful muscle can be developed symptoms may remain in abeyance despite a substantial degree of arthritis.

Intra-articular injections of hydrocortisone have been tried for pain relief, but the results are uncertain and any improvement is usually temporary. In general, steroid injections are not recommended because they have sometimes led to acceleration of the degenerative process. More recently injection of hyaluronan preparations has become popular, to provide viscosupplementation by increasing the viscosity of the synovial fluid, but the results have proved inconclusive.

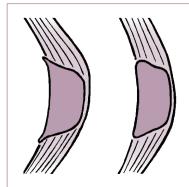


Fig. 18.11 Spiking of the articular margins of the patella, as seen in the lateral radiograph, is an early sign of osteoarthritis. The normal state (right) is shown for comparison.

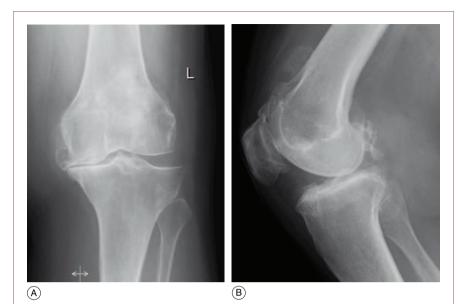


Fig. 18.12 (A) and (B) Radiographs of a knee with advanced osteoarthritis. There is marked narrowing of the medial joint space and the patello-femoral joint. However the bony cortex of tibia and femur remain clearly defined with subchondral sclerosis and numerous marginal osteophytes, some of which may have become loose bodies posteriorly.

Operative treatment. In advanced arthritis, with severe persistent pain, especially when associated with deformity and stiffness, operation may be advisable. Its nature will depend upon the circum stances of each case. The follow ing are the operations most used:

- 1. arthroscopic w ashout
- 2. rem oval of loose bodies
- 3. upper tibial osteotom y
- 4. excision of patella
- 5. arthroplasty
- 6. arthrodesis.

Arthroscopic washout. Washout of the joint, often coupled with an arthroscopic debridem ent, has been used to treat early osteoarthritis in younger patients. How ever, its use in random ised controlled trials has indicated that its benefit may be doubtful and shortlasting

Removal of loose bodies. When loose bodies cause recurrent locking of the joint they should be removed. This is a simple operation, usually carried out by an arthroscopic technique, that gives good results. Any evident irregularities or excrescences of the articular surfaces may be trimmed at the same time.

Upper tibial osteotomy. Tibial osteotomy aims to relieve pain and to correct deform ity. It is especially valuable when wear of articular cartilage and bone has affected one half of the tibio-fem oral joint more than the other. Commonly

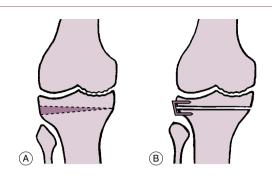


Fig. 18.13 (A) Bow-leg deformity from uneven destruction of articular cartilage, that of the medial compartment being much thinner than that of the lateral. Body weight is now transmitted mainly through the diseased medial half of the joint. Interrupted line shows wedge of bone to be removed for correction of deformity. (B) After corrective osteotomy and fixation with staples the line of weight transmission is shifted towards the more healthy lateral compartment.

the medial half of the joint is markedly narrowed whereas the lateral compartment remains relatively healthy. There will be obvious bow-leg deformity and pain is likely to be prominent in the degenerate medial compartment, which is forced by the mal-alignment to take most of the weight (Fig. 18.13 A). Correction of the mal-alignment by removal of a wedge of bone based laterally (Fig. 18.1.3 B) transfers the weight-bearing thrust towards the more healthy lateral compartment and is often effective in relieving pain. Likewise if the lateral compartment is worn more than the medial, with consequent genu valgum, a medially based wedge may be excised. The osteotomy is done about 1.5 cm below the upper articular surface of the tibia, and to permit early walking the fragments are usually fixed together at operation by metal staples (Fig. 18.13 B).

Excision of patella. This is only appropriate in the unusual situation when the arthritic process is largely confined to the patello-femoral joint, the femorotibial joint being relatively healthy. With the introduction of successful techniques for patello-femoral arthroplasty this operation is now seldom performed.

A rthroplasty (see Fig. 18.10). This has now become established as the surgical treatm ent of choice for advanced osteoarthritis of the knee. It will correct deformity, relieve pain, and restore mobility in over 90% of patients, with results extending out for 10-15 years. Methods of replacement arthroplasty were outlined for the treatment of rheum atoid arthritis on page 392. Most commonly the same techniques of total replacement arthroplasty of both the tibio-fem oral and patello-fem oral joints are used in osteoarthritis. How ever, unicompartmental tibio-fem oral arthroplasty is now being increasingly used as an alternative to upper tibial osteotomy in younger active patients to restore more more movement when the arthritis is at an early stage and confined to one compartment. A curved metal prosthetic replacement is fixed to the affected fem oral condyle and articulates with a polyethylene tibial component, either directly, or through a gliding polyethylene meniscal bearing to provide more physiological movement (Fig. 18.14). The results in appropriately selected cases are as good

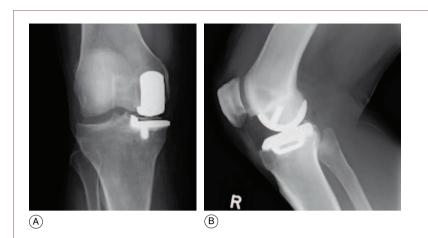


Fig. 18.14 (A) and (B) Radiographs of unicompartmental tibio-femoral arthroplasty with a metal resurfacing of one femoral condyle articulating with a polyethylene tibial prosthesis supported by a metal backing fixed to the bone.

as those from total joint replacement and still allow later revision to the full procedure if required at a later stage.

Arthrodesis. This is now seldom undertaken, but it may occasionally be appropriate in a severe case, or as a salvage procedure when other operations have failed and where the other knee and the hips are norm al.

HAEMOPHILIC ARTHRITIS OF THE KNEE (General description of haemophilic arthritis, p. 145)

Haem ophilic arthritis affects the knee more often than any other joint. It is uncom mon because haem ophilia itself is encountered only rather rarely.

Pathology. Initially there is simply a haemorrhage into the joint (haemarthrosis). With rest, this is slowly absorbed into the hypertrophic synovial membrane. But further bleeding usually occurs, and this leads eventually to degenerative changes in the articular cartilage and to fibrous thickening and contractures of the synovial membrane.

Clinical features. The findings on exam ination vary according to the phase and duration of the disease. A fter each fresh episode of bleeding the knee is sw ollen, partly from contained blood and partly from synovial thickening caused by interstitial extravasation of blood. The overlying skin is abnorm ally w arm. Joint movem ents are restricted, and painful if forced.

In a quiescent phase between episodes of haem arthrosis there is som e thickening of the joint from synovial fibrosis, movem ents are slightly or moderately impaired, and often there is moderate flexion deformity.

Investigations. The clotting time of the blood is increased.

Diagnosis. Because of the synovial thickening, increased warm thof the skin and restriction of knee movements, haemophilic arthritis is easily mistaken for chronic inflammatory arthritis. A history of previous bleeding incidents The thigh and knee

and the increased clotting time of the blood are the important distinguishing features. Biopsy should be avoided because it may cause further bleeding. A history of haem ophilia in other male family members also provides a clue.

Treatment. In centres where the necessary haematological facilities are available the ideal treatment for acute haemarthrosis is to aspirate the knee under the tem porary cover of antihaem ophilic factor (factor VIII) as if it were an ordinary traum atic haem arthrosis. The leg should be elevated and ice packs should be applied to the knee, which should be rested in a polythene or plaster splint until the acute sym ptom s subside. With the increasing availability of recom binant factor VIII, many haem ophilic patients retain their own supply at hom e and are able to initiate treatm ent by intravenous injection at the onset of symptoms of bleeding. This can be repeated for several days to manage the acute episode and reduce the need for hospital admission and delay the development of chronic joint changes. If antihaem ophilic factor is not available the outlook for the future of the knee is much less favourable. A spiration should usually be avoided. Instead, the knee should be bandaged and imm obilised on a Thomas's splint or in a plaster backslab. A fter 2-4 weeks the residual blood is absorbed and cautious activity may be resumed under physiotherapy supervision

The chronic degenerative arthritis that results from multiple repeated haem arthroses may have to be controlled by the permanent use of a polythene knee splint. Operative treatment to reduce this risk – such as arthroscopic synovectomy – is practicable, but only under the cover of adequate doses of antihaem ophilic factor. When joint contractures or deformities develop, they may require tend on release or lengthening, or even corrective osteotomies. A dvanced haem ophiliac arthropathy (see Fig. 9.7, p. 147) may necessitate replacement arthroplasty of the joint to restore mobility. This is now possible under factor V III cover, which needs to be continued for 2-3 weeks after surgery. The majority of patients get good results, but there is a greater risk of complications, particularly infection as many patients have acquired H IV from contaminated blood transfusions.

NEUROPATHIC ARTHRITIS OF THE KNEE (General description of neuropathic arthritis, p. 147)

N europathic arthritis (Charcot's osteoarthropathy) of the knee is now seen very seldom in Britain because of the rarity of tabes dorsalis, formerly the most prevalent underlying cause. O ther occasional causes include denervation of the joint from a lesion of the cauda equina or from other neurological disease.

The pathological changes may be regarded as a much exaggerated form of osteoarthritis. The articular cartilage and parts of the underlying bone are worn away, but at the same time there is often considerable hypertrophy of bone at the joint margins. The ligaments become lax and the joint is unstable.

Clinically there is marked lateral laxity, often allowing severe bow-leg deformity. Pain is slight or absent.

Radiographs show marked destructive changes, usually with some new bone formation at the joint margins.

Treatm ent m ay be required if there is m arked deform ity or gross instability dem and ing som e form of protective appliance (orthosis), such as a moulded plastic splint or a caliper. A rthrodesis is practicable but because of the absence of severe pain operation should usually be avoided.

ANTERIOR KNEE PAIN (Including chondromalacia of the patella)

A nterior knee pain is a generic term that alm ost certainly includes more than a single clinical entity. The non-specific nature of the label im plies, correctly, that the pathogenesis of the pain is not always well understood. The clinical syndrom e characteristically occurs in adolescents, especially girls, though it also affects athletes, particularly runners. The description that follows relates to one well-recognised type of lesion, namely chondrom alacia of the patella. Sim ilar symptoms may occur in the absence of demonstrable patellar changes, and their causation is often conjectural. Chondrom alacia may represent part of a spectrum of conditions associated with patellar instability or malalignment. These also include the more severe disorders of recurrent or habitual dislocation (see p. 409).

Chondromalacia of the patella

In chondrom alacia of the patella the cartilage of the articular surface of the patella - particularly the medial facet - is roughened and fibrillated for reasons that are unknow n. It is surm ised that friction between the damaged area and the corresponding femoral condyle is responsible for the pain. The condition is distinct from osteoarthritis but osteoarthritis may be superimposed upon it in later years.

Clinical features. The patient is often a girl aged 15-18 years. There is aching pain deep in the knee, behind the patella. Pain is exacerbated by climbing or descending stairs. There is often an effusion of fluid, and tenderness may be found on palpating the deep surface of the patella after displacing it to one side. There may also be a point of marked tenderness over the front of the medial fem oral condyle. M ovem ents may be accompanied by fine crepitation transmitted to the exam iner's hand upon the patella, especially when the patient does a 'knees bend' exercise from the standing position.

Investigations. Radiographs are normal, though axial views are required to exclude lateral patellar tilt or subluxation. M R I scans may sometimes reveal defects or fissures in the articular cartilage of the patella, but this is not as reliable as direct visualisation by arthroscopy which will also demonstrate any associated synovial bands, if present.

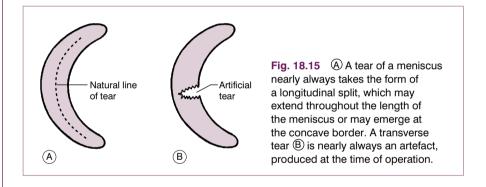
Treatment. This should nearly alw ays be non-operative. A n elasticated bandage is applied and strenuous activities are curtailed. These precautions will usually reduce the symptoms to an acceptable level. Physiotherapy consisting of strapping the patella medially and strengthening the vastus medialis muscle can be of benefit. Operative treatment should be avoided unless significant patello-fem oral malalignment is present, for although a variety of procedures has been devised the results are alm ost universally disappointing.

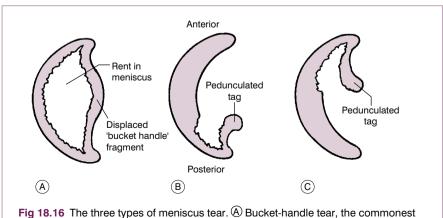
TEARS OF THE MENISCI

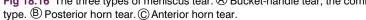
Injuries of the menisci (sem ilunar cartilages) are common in men under the age of 45. A tear is usually caused by a twisting force with the knee sem iflexed or flexed. It is usually a football injury, but it is also common among men who work in a squatting position. Thus it was common among coal miners excavating shallow seams, before the advent of mechanisation. The medial meniscus is torn much more often than the lateral.

Pathology. In patients of ath letic age there are three types of meniscus tear, but all begin as a longitudinal split (Fig. 18.15A) which must be distinguished fro m the jatrogenic transverse tear resulting from operative trau m (F 18.15B) If the split extends throughout the length of the meniscus it becomes a buckethan d le tear, in which the fragm ents remain attached at both ends (Fig. 18,16A). This is much the commonest type. The 'bucket handle' (that is, the central fragdisplaced towards the middle of the joint, so that the condule of the m an t) is ur rolls upon the tibia through the rent in the meniscus (Fig. 18.16A). Since f.e.m fem oral condyle is so shaped that it requires most space when the knee is th e straight, the chief effect of a displaced 'bucket-handle' fragm ent is that it lim its full extension (= 'locking').

If the initial longitudinal tear emerges at the concave border of the menispedunculated tag is form ed. In posterior horn tear the fragm entremains at its posterior horn (Fig. 18.16B); in ched an terior i t rem ains ched at its anterior horn (Fig. 18.16C). The peripheral meniscus a t t n art of th e i e ascular and tears in the peripheral third can sometimes be sutured as they capacity for healing. The inner part is avascular and does not heal, ha esom tears in the inner third therefore need to be excised.







As the inner parts of the meniscus are alm ost avascular, when they are torn there is not an effusion of blood into the joint. Instead there is an effusion of clear synovial fluid, secreted in response to the injury.

Clinical features of torn m edial m eniscus. The patient is usually m ale and 18-45 years old. The history is characteristic, especially with 'bucket-handle' tears. In consequence of a twisting injury the patient falls and has pain at the antero-m edial aspect of the joint. He is unable to continue w hat he w as doing, or does so only with difficulty. He is unable to straighten the knee fully. The next day he notices sw elling of the w hole knee. He rests the knee. A fter about 2 weeks the sw elling lessens, the knee seems to go straight, and he resum es his activities. W ithin weeks or months the knee suddenly gives way again during a twisting m ovem ent; there are pain and subsequent sw elling as before. Sim ilar incidents occur repeatedly.

Locking. By 'locking' is meant in ability to extend the knee fully. It is not a true jamming of the joint because there is a free range of flexion. Locking is a common feature of torn medial meniscus, but the limitation of extension is often so slight that it is not noticed by the patient. Persistent locking can occur only in 'bucket-handle' tears: tag tears cause momentary catching but not true locking in the accepted sense.

On examination in the recent stage the typical features are effusion of fluid, w asting of the quadriceps muscle, local tenderness at the level of the joint anteromedially, and (characteristically in 'bucket-handle' tears) limitation of the *last few degrees* of extension by a springy resistance, with sharp antero-medial pain if passive extension is forced.

In the 'silent' phase between attacks there are often no signs other than wasting of the quadriceps.

Clinical features of torn lateral meniscus. The features are broadly similar, but the clinical picture is often less clearly defined. The history may be vague. Pain is at the lateral rather than the medial side of the joint, Instead it is often poorly localised.

Im aging. Plain radiographs are usually normal, whether the tear be of the medial or of the lateral meniscus, but in untreated cases of long duration signs of early degenerative arthritis may be noted in the affected compartment. Arthrography will often demonstrate meniscal tears, but it is now seldom undertaken because MRI is even more reliable in demonstrating the various types of tear and is non-invasive (Fig. 18.17).

Arthroscopy. On arthroscopic examination a meniscal tear can be seen w hatever its site, except som etim es at the posterior end of the lateral meniscus (Fig. 18.18).

D iagnosis. In the 'silent' phase clinical diagnosis often depends largely upon the history. The surgeon should be very cautious in diagnosing a torn m eniscus unless there is a clear history of injury and unless there have been recurrent incidents, each followed by synovial effusion. If one is relying on clinical diagnosis alone a period of observation may be required before the diagnosis becom es reasonably certain. M R I, or arthroscopy if this is not available, should establish the nature of the lesion conclusively.

Late effects. Long-continued internal derangement from a torn meniscus predisposes to the later development of degenerative arthritis. Arthritis is also liable to developmany years after a meniscus has been removed.

Treatment. Once the diagnosis is established the standard treatment is to excise either the whole meniscus or, more appropriately in most cases, the

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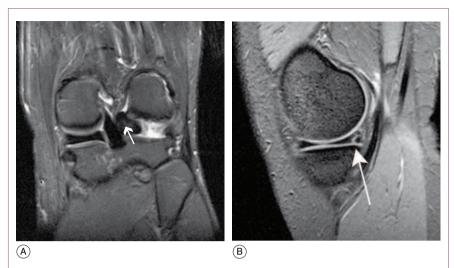


Fig. 18.17 (A) Coronal MR scan of knee showing that the lateral meniscus has a bucket handle tear with a large meniscal fragment displaced centrally into the joint (arrow). (B) Sagittal T2 weighted MR scan of the knee with a vertical tear of the posterior horn of the medial meniscus (arrow).

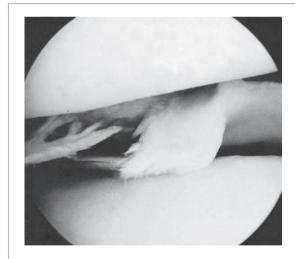


Fig. 18.18 Arthroscopic photograph showing tear of medial meniscus.

dis d ίh μ et-handle' fragm ent alone. This operation is u su a llv car. rie t h arth ro scopic technique without form al opening o f t h io in t th o rse the joint may be opened by incision if difficulty arise ø h C O 11 s d u r i n g th e arthroscopic surgery. In selected cases of peripheral tear, repair by o f suture is som etim es undertaken using a sem i-closed arthroscopic technique.

HORIZONTAL TEAR OF DEGENERATE MEDIAL MENISCUS

The meniscal tears described above are uncommon in patients over the age of 50, when the menisci begin to show degenerative changes. But a degenerate meniscus is liable to suffer a different type of lesion. The medial meniscus in particular may split horizontally at a point often near the middle of its convexity (Fig. 18.19). Such a split is usually of small dimensions, and since there is no separation of the fragments natural healing can occur.

C linically there is troublesom e and persistent pain at the medial aspect of the knee at the joint level. The pain may be noticed after a minor injury, but often an injury has not been remembered. In the early stages there is usually a small effusion of fluid into the joint.

Treatment should be expectant at first, by bandaging and quadriceps exercises. In most cases the symptoms resolve in the course of several months. In the occasional case in which they fail to do so, excision of the torn meniscal fragment by arthroscopic surgery should be advised.

CYSTS OF THE MENISCI

A cyst of a meniscus (semilunar cartilage) forms a tense, alm ost solid swelling at the level of the joint, usually on the lateral side.

Cause. Cysts arise spontaneously, but there is often a previous history of direct injury at the site of the cyst.

Pathology. The swelling is formed by a proliferation of fibrous tissue, which is honeycombed with small cystic cavities containing small quantities of clear gelatinous fluid.

Clinical features. The lateral meniscus is affected much more often than the medial. There is visible swelling, most obvious when the knee is held slightly flexed, at the level of the joint and usually anterior to the lateral (or medial) ligament (Fig. 18.20). The swelling tends to be painful at night and it is usually tender on firm pressure. The swelling is so tense that fluctuation can seldom be elicited – indeed it is sometimes mistaken for bone.

Im aging. Radiographs may show an indentation of the side of the tibial condyle where the cyst has been in contact with it. MRI scanning will confirm the origin of the cyst from the meniscus (Fig. 18.21) and exclude more serious soft-tissue tumours.

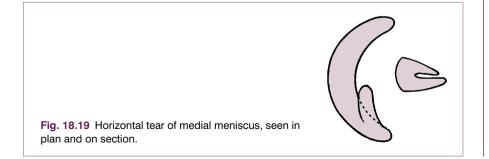




Fig. 18.20 Cyst of lateral meniscus.



Fig. 18.21 Sagittal T2 weighted MR scan of knee. There is a cyst lying adjacent to the anterior horn of the lateral meniscus. The adjacent meniscus has a horizontal tear. Meniscal cysts are always associated with a meniscal tear.

CHAPTER 18

Treatment. If the disability justifies operation the cyst should be excised together with the meniscus from which it arises. Very occasionally, it may be practicable to excise the cyst arthroscopically while leaving the meniscus intact.

DISCOID LATERAL MENISCUS

Rarely the lateralm eniscus (sem ilunar cartilage) fails to assum e its norm al crescentic form during developm ent, but persists in its em bryonic form as a thick disc-like mass interposed between the lateral condyles of the femur and tibia.

A discoid meniscus may cause recurrent discomfort in the knee, with a tendency to giving way. Usually a loud 'clonk' can be demonstrated on flexion-extension movements. These symptoms often become prominent during childhood or adolescence. If the disability becomes troublesome the meniscus should be removed. There is a risk of the development of degenerative arthritis in later life.

OSTEOCHONDRITIS DISSECANS OF THE KNEE (General description of osteochondritis dissecans, p. 153)

O steoch ond ritis dissecans is characterised by local ischaem ic necrosis of a segm ent of the articular surface of a bone and of the overlying articular cartilage, w ith eventual separation of the fragm ent to form an intra-articular loose body. The knee is affected m uch m ore often than any other joint.

Cause. This is unknow n. Impairment of the blood supply to the affected segment of bone by throm bosis of an end artery has been suggested. Injury is possibly a predisposing factor. There is also a constitutional predisposition to the disease, because it may affect several members of a family or several joints in the same patient.

Pathology. The lesion nearly alw ays affects the articular surface of the medial condyle of the femur (Fig. 18.22). The size of the affected segment varies – it is often about 2 cm in diameter. Within the area of the lesion the subchondral bone is avascular and the overlying cartilage softens. A clear line of demarcation

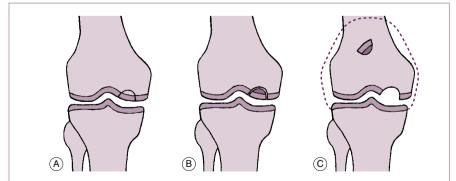


Fig. 18.22 The evolution of osteochondritis dissecans. A A segment of the articular surface dies. (B) A line of demarcation forms around it. (C) The fragment breaks away and lies loose in the joint, leaving a cavity in the femoral condyle.

form s between the avascular segment and the surrounding normal bone and cartilage (Fig. 18.22A). A fter many months the fragment separates as a loose body (som etim es two or three), leaving a shallow cavity in the articular surface which is ultimately filled with fibrocartilage (Fig. 18.22B&C). The damage to the joint surface predisposes to the later development of osteoarthritis, especially when the fragm ent is large.

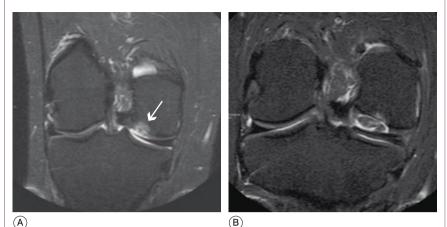
Clinical features. The patient is an adolescent or a young adult, who complains of discom fort or pain in the knee after exercise, a feeling of insecurity, and intermittent swelling. The condition is commoner in males and may affect both knees in 15-20% of patients. When a loose body has already separated within the joint the predom inant symptom is recurrent sudden locking. On examination there is a fluid effusion. The quadriceps muscle is wasted. Movem ents are not usually impaired.

Im aging. Radiographs show a clear-cut defect of the bone at the articular surface of the medial femoral condyle (Fig. 18.23). At first the cavity is occupied by the separating fragment of bone; but later the cavity may be empty, and a loose body will then be seen elsew here in the joint. The lesion is show n best in tangential postero-anterior projections with the knee sem iflexed (Fig. 18.23B). The advent of M RIhas provided m ore valuable inform ation on the state of the overlying articular cartilage and whether this is healing or liable to separate (Fig. 18.24).

Arthroscopy. The osteochondritic lesion in the medial femoral condyle will be clearly evident in the later stages. Initially, how ever, the defect is concealed by articular cartilage that looks norm al, though if it is probed an area of softening may be apparent.



Fig. 18.23 Osteochondritis dissecans. (A) Routine antero-posterior radiograph. B Tangential postero-anterior projection with knee semiflexed – the so-called intercondylar view. This shows clearly the large crescentic cavity in the medial femoral condyle, with the separating fragment in situ. Inset shows the loose fragment after removal.



Q

Fig. 18.24 (A) Coronal MR scan of knee showing early osteochondritis dissecans. The arrow points to a defect of the cortex of the medial femoral condyle, which is the commonest site for this condition. (B) Coronal MR scan of knee. In this case the area of osteochondritis has become separated from the underlying bone and can potentially become displaced forming an intra-articular loose body.

Treatment. In the developing stage treatment should be expectant: the knee is supported with a crepe bandage and strenuous activities are curtailed. Sometimes in these early cases the lesion will heal spontaneously, especially in young adolescents, and can be monitored by repeat MRI.

When the lesion shows a clear line of demarcation between the separating fragment and the surrounding normal bone – the loose piece should usually be removed, especially if it is small. This may be done arthroscopically. A shallow cavity is left in the femoral condyle, but this gradually fills with fibrocartilage and adequate function is usually restored.

Because of the risk of the later development of osteoarthritis if a large part of the fem oral condyle has been excavated, som e surgeons recommend that the loose fragment be replaced in position and fixed with a pin or pins. It has been shown that the fragment may unite again with its bed, but it is by nomeans certain yet that the incidence of late osteoarthritis will be reduced by this method of treatment. A ttempts are now being made to use chondrocyte or osteochondral grafting of the defect for cases in which the separated fragment is large, but as yet the long-term results are uncertain.

LOOSE BODIES IN THE KNEE

The knee is the joint most commonly affected by the formation of loose bodies. There are four main causes:

- 1. osteochondritis dissecans (1-3 loose bodies)
- 2. osteoarthritis (1-10 loose bodies)
- 3. hip fracture of a joint surface (1-3 loose bodies)
- $4\;.\;\;synovial\ chondrom\; atosis\;(up\ to\ 500\ loose\ bodies).$

Pathology. Osteochondritis dissecans was described on page 153. A loose body may be formed by spontaneous separation of a fragment of bone and cartilage from the articular surface of the medial femoral condyle. The loose body lies free in the joint, and a shallow cavity remains in the condyle.

O steoarthritis was described on page 393. Som e of the loose bodies that may be found in osteoarthritis are probably form ed by detachment of marginal osteophytes. Most separated osteophytes, how ever, retain a synovial attachment and do not cause trouble: although they appear loose in radiographs they should not be regarded as such unless symptoms of locking indicate that they are moving freely within the joint. True loose bodies may possibly form from flakes of articular cartilage shed into the joint that gradually enlarge, nourished by synovial fluid.

Chip fracture of joint surface (osteochondral fracture) is an infrequent cause of intra-articular loose bodies. There is a clear history of the causative injury. A flake of bone with overlying articular cartilage is detached, alw ays from a convex surface.

Synovial chondrom atosis (osteochondrom atosis) is a rare disease of the synovial m em brane (p. 152). It is characterised by the form ation of num erous sm all villous processes, which becom e pedunculated. Later their bulbous extrem ities becom e cartilaginous and they are detached to lie free in the joint. Finally, som e or all of the num erous loose bodies becom e calcified.

W hatever the cause of a loose body, its repeated jam m ing between the joint surfaces will predispose to osteoarthritis after a long latent period, or will aggravate existing osteoarthritis.

Clinical features. The characteristic sym ptom of a loose body in the knee is recurrent locking of the joint from interposition of the loose piece between the joint surfaces. Suddenly, without warning, the knee becomes jammed during movement. Locking is accompanied by severe pain. A fter a variable interval the patient is usually able, by manoeuvring the limb, to disengage the loose body and free the joint. The next day the knee is found to be swollen with fluid. In many cases the patient is able to feel the mobile body through the soft tissues when it lies in a superficial part of the joint. It is common for such a body to lodge in the suprapatellar pouch.

On examination the findings are often slight, for a patient is seldom seen when the knee is locked. If he is seen soon afterwards a fluid effusion is present. Between attacks there may be no objective signs other than perhaps slight wasting of the quadriceps. Som etimes the loose body can be palpated, especially if it has migrated to the suprapatellar pouch. The features of an underlying condition such as osteoarthritis may be present.

R adiographic features. W ith few exceptions, loose bodies are shown radiographically. They often lie in the suprapatellar pouch (Fig. 18.25A). C are should be taken not to m istake the fabella (a seasm oid bone in the lateral head of the gastrocnem ius) (Fig. 18.25B) for a loose body. The position of the fabella is constant: it lies slightly above the level of the joint well behind the fem ur and tow ards the lateral side, and it is alw ays oval in shape with its long axis vertical.

Treatm ent. In general the treatm ent for an intra-articular loose body is to rem ove it, when possible by an arthroscopic technique. Rem oval should alw ays be advised if the loose body is causing recurrent locking. If there are no symptoms of locking operation is not essential. In such cases the fragment, though appearing loose in the radiographs, is often attached to the synovial mem brane and is kept out of harm 's way. This applies particularly to detached osteophytes in cases of osteoarthritis.

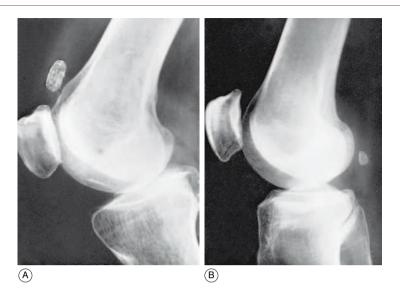


Fig. 18.25 (A) Loose body in the knee. As in this case, loose bodies often lie in the suprapatellar pouch. (B) The fabella, a sesamoid bone in the lateral head of the gastrocnemius, is present in many normal persons. It is sometimes mistaken for a loose body in the joint.

RECURRENT DISLOCATION OF THE PATELLA

The patello-fem oral joint is one of the three joints that are most liable to recurrent displacement, the others being the shoulder and the ankle. In the case of the patello-femoral joint, unlike the other two, the instability is often caused by congenital factors rather than by an initial violent injury.

Pathological anatom y. In dislocations of the patella the displacement is alw ays lateral, the patella slipping over the lateral condyle of the femur while the knee is flexed. Four factors, all of which may be inborn, predispose to recurrent dislocation:

- general ligam entous laxity ('double-jointedness'), which may be an inherited defect of soft tissues
- 2. under-developm ent of the lateral fem or al condyle, with a shallow intercondylar groove
- 3. an abnormally high position of the patella (patella alta), which consequently does not lie so deeply as usual in the intercondylar groove and is often smaller than normal
- 4. genu valgum, which causes the line of pull of the quadriceps to lie too far to the lateral side.

This last factor is seld om an important one.

Clinical features. Recurrent dislocation of the patella is more common in girls than in boys. Often both knees are affected. Trouble usually begins during adolescence. Dislocation occurs while the patient is engaged in some activity The thigh and knee

that entails flexing the knees – not necessarily a violent exertion. Suddenly, w hile the knee is flexed or sem iflexed, there is severe pain in the front of the knee, and the patient is unable to straighten it. Often the displacement of the patella is recognised and reduced on the spot, either by the patient herself or by an onlooker.

On exam ination in the dislocated state the knee is swollen, and the patella is seen and felt up on the lateral side of the lateral fem oral condyle. A fter reduction the main signs are an effusion of fluid (usually blood-stained), and tenderness over the medial part of the quadriceps expansion, which is usually strained ortorn. One of the minor anatom ical anom alies mentioned abovem ay be observed. In particular, generalised ligamentous laxity is often found, as evidenced by the patient's ability to hyperextend the knee (genu recurvatum) or other joints such as the wrists or the joints of the fingers and thum b; this double-jointedness may be present also in parents or other relatives. The patella is often found to lie higher than normal, and it may be unduly small.

Im aging. Radiographs are seldom obtained in the state of dislocation. A fter reduction the kneem ay appear norm al radiographically, but commonly the patella is small and is seen at a slightly higher level than usual, often in both knees ('patella alta').

M R I scans may be more informative and may demonstrate damage to the articular surface of the patella and any defects or tears in the medial soft-tissue structures (Fig. 18.26).



Fig. 18.26 Axial MR scan of knee in a patient following a recent acute dislocation of the patella. The large arrow indicates bone oedema where the patella has struck the condyle at the moment of dislocation. The star indicates the reciprocal bone oedema seen within the medial patellar facet. The small arrow indicates disruption of the medial patello-femoral ligament.

Course. Dislocation of the patella does not always become recurrent: some patients have no further trouble after an initial dislocation. But in most cases dislocations recur with ever-increasing ease and frequency, so that the patient may become seriously handicapped. Oft-repeated dislocations predispose to the later development of osteoarthritis.

Treatm ent. Treatm ent should be expectant at first. A fter a dislocation the patient should receive a course of physiotherapy designed to strengthen the quadriceps m uscle, and especially the vastus medialis.

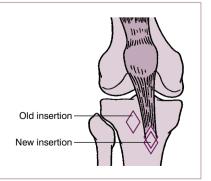
If the dislocations recur with such frequency that the patient is seriously disabled, operation should be advised. The method often recommended is to detach the bony insertion of the patellar tend on and transpose it to a new bed in the tibia, medial and distal to the original insertion (Fig. 18.27). In this way the patella is drawn lower into the deeper part of the intercondylar groove of the femur, and the line of pull of the quadriceps mechanism is transferred more to the medial side. This operation is often criticised on the grounds that it may be followed, after an interval of many years, by the development of degenerative arthritis. But such arthritis is an in-built complication of recurrent dislocation of the patella and cannot be ascribed solely to the operation. O ther operations include release of tight soft tissues at the lateral side of the joint, reefing of the quadriceps expansion, and repair of the soft tissues on the medial side.

Habitual dislocation

It is im portant to distinguish between recurrent dislocation of the patella and habitual dislocation. Whereas in recurrent dislocation the knee may seem normal for weeks or months between dislocations, in habitual dislocation the patella dislocates laterally each time the knee is flexed beyond a certain range. This condition becomes apparent at an earlier age than recurrent dislocation - usually in early childhood. The underlying pathology is also distinct: there is an abnorm ality of the quadriceps muscle and in particular of the vastus lateralis, which may show a fibrous contracture; or there may be an abnorm al fibrous band tethering the vastus lateralis to the ilio-tibial tract. It is this shortened vastus lateralis that pulls the patella laterally every time the knee is markedly flexed. In the absence of treatment the patella may eventually become permanently dislocated.

Treatment is by division of the tight muscle or band, by arthroscopy or open operation, so far as is necessary to allow full flexion of the knee without displacement of the patella.

Fig. 18.27 Transposition of the insertion of the patellar tendon downwards and medially re-aligns the pull of the quadriceps and draws the patella down to lie in the intercondylar groove of the femur.



EXTRA-ARTICULAR DISORDERS IN THE REGION OF THE KNEE

GENU VARUM AND GENU VALGUM

Genu varum (bow leg) and genu valgum (knock knee) occur commonly in childhood. In the vast majority of instances there is no underlying disease, and the deformity need not cause anxiety because it is gradually corrected spontaneously as the child grows.

Genu varum or genu valgum may also occur, either in children or in adults, as a consequence of injury or disease. The commonest causes are:

- fracture of the low er part of the fem ur or of the upper part of the tibia with m al-union (for exam ple, depressed fracture of the lateral tibial condyle causing genu valgum)
- 2. rheum atoid arthritis or osteoarthritis
- 3. rarefying diseases of the bones, such as rickets or osteom alacia
- 4. other bone-softening diseases such as Paget's disease (osteitis deform ans) (see Fig. 6.5, p. 67)
- in children, uneven grow the of the epiphysial plates, such as may occur after injury or osteom yelitis or in dyschondroplasia (p. 65).

In assessing a case of genu varum or genu valgum the surgeon must alw ays be careful to exclude such underlying organic disorders by full clinical examination, and if necessary by radiography, before diagnosing the benign childhood affections described in the following sections.

Benign genu varum of toddlers

The knee and leg are bowed outwards (Fig. 18.28A). A mild degree of this deform ity is so common as to be alm ost normal in children aged 1 to 3 years. It does not require treatment unless it persists into later childhood. Care should be taken to exclude the possibility of rickets or other underlying bone disease.

Benign genu valgum of childhood

The knee is angled inwards, the tibia being abducted in relation to the femur. W ith the knees straight, the medial malleoli cannot be brought into contact (Fig. 18.28B). The 'knock-knee' deformity is common in children aged 3 to 5 years. In the absence of underlying bone disease it usually corrects itself spontaneously in the course of years.

Treatm ent. In early childhood treatm ent is unnecessary, but it is common practice (albeit of doubtful relevance) to fit a wedge, base medially and 3-5 m illim etres deep, to the heel of the shoe. In theory this tends to shift the line of weight-bearing medially, which in turn favours correction of the deform ity (see Fig. 19.20).

Severe genu valgum persisting after the age of 10 requires active treatment. In grow ing children two methods of correction are available. One is to retard the grow that the medial side of the epiphysial cartilage of the femur or tibia by bridging the epiphysis to the diaphysis with metal staples (epiphysiodesis). The other and more certain method is by supracondylar osteotomy of the

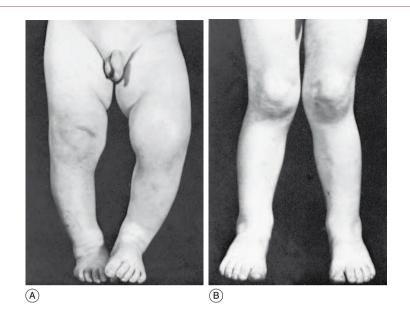


Fig. 18.28 (A) Typical genu varum in a toddler. Slight bowing is common in infants but it is usually corrected spontaneously as the child grows. B Genu valgum. Deformity of this degree in young children is usually corrected spontaneously during growth.

or of the upper end of the tibia if the fault lies there - with excision of a suitable wedge from the medial side. A fter the cessation of epiphysial grow th genu valgum can be corrected only by osteotomy.

RUPTURE OF THE QUADRICEPS APPARATUS

The quadriceps muscle gains insertion into the tibia through the medium of the patella (enclosed with in the quadriceps expansion) and the patellar tendon. Complete rupture may occur at three points (Fig. 18.29):

- 1. at the point of attachment of the quadriceps tend on to the upper pole of the patella
- 2. through the patella and the surrounding quadriceps expansion (fractured patella)
- 3. at the attachment of the patellar tend on to the tibial tubercle.

In all cases the injury is caused by an unexpected flexion force, resisted automatically by a sudden contraction of the quadriceps.

Avulsion from patella

A vulsion of the quadriceps tend on from the upper pole of the patella occurs mainly in elderly men, in whom the quadriceps tendon is often degenerate. It is not a common injury. The clinical diagnosis is seldom in doubt, but can be confirmed by ultrasound or MR scanning (Fig. 18.30). The tendon should be re-attached to the bone by strong non-absorbable sutures passed through drill holes near the upper border of the patella.

The thigh and knee

ADAMS'S OUTLINE OF ORTHOPAEDICS

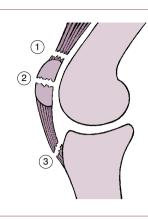


Fig. 18.29 The three points at which the quadriceps apparatus may rupture. 1. At insertion of quadriceps into patella. 2. Through the patella. 3. At insertion of patellar tendon into tibial tubercle.



Fig. 18.30 Sagittal T2 weighted MR scan of knee showing a degenerate tear of the quadriceps tendon (arrow).

Disruption through patella

This is the usual site of rup ture, and it forms a common variety of fractured patella ра e 11a The in iu rv 0 11 m ainly i n adults of middle ag Ιf t h е together i s cleanly h r o k e n in to tw o pieces the fragments should be fixed with reinforcing sutures through the torn b v c 1 a wiring, ues on either side of the patella. If there are multiple patellar fragthese should be excised and the quadriceps expansion repaired by m su tu res

Avulsion at tibial tubercle

This is the least common injury, occurring mainly in children or young adults. A fragment of bonemay be pulled off with the tendon. The torn tendon should be re-attached by sutures.

APOPHYSITIS OF THE TIBIAL TUBERCLE (Osgood–Schlatter's disease¹)

A pophysitis of the tibial tubercle is a childhood affection in which the tibial tubercle becomes enlarged and temporarily painful. Often known as Osgood-Schlatter's disease, it was formerly regarded as an example of osteochondritis juvenilis (p. 130), but it is now generally agreed that it is nothing more than a strain of the developing tibial tubercle, from the pull of the patellar tendon.

C linical and radiographic features. The patient is a child or adolescent aged 10 to 16 years, usually a boy, and often active in athletic pursuits. The com plaint is of pain in front of and below the knee, worse on strenuous activity. On examination the tibial tubercle is unduly prominent, and tender on palpation. Pain is increased when the quadriceps is tensed, as in raising the leg against resistance with the knee held straight. The sym ptom s and signs are confined to the region of the tibial tubercle, and the knee joint itself is norm al.

Radiographs show enlargement and sometimes fragmentation of the tibial tubercle (Fig. 18.31).

Course. The disorder is usually self-lim iting, and norm al function is alm ost alw ays restored by the time the apophysis of the tibial tubercle is fused to the m ain body of the bone.

Treatm ent. In m ost cases treatm ent is not required. If local pain and tenderness are severe and the symptoms persist into late adolescence, it may be necessary to rest the knee for a few weeks in an extension brace.

PREPATELLAR BURSITIS

The bursa that lies in front of the low er half of the patella and the upper part of the patellar tendon is prone to inflam mation.

Types. There are two types of prepatellar bursitis:

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    irritative
    infective or suppurative.
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Irritative prepatellar bursitis

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This is caused by repeated friction; it occurs especially in those who do much kneeling ('housemaid's knee'). There is fibrous thickening of the wall of the bursa, which is distended with fluid.
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¹Robert Osgood (1873–1956) was a famous American orthopaedic surgeon, but was working as a radiologist in Boston Children's Hospital when he described the condition in 1903. He worked with Robert Jones in England during the First World War and helped him found the British Orthopaedic Association.

Carl Schlatter (1864–1934) was a Swiss general surgeon who also reported the condition in 1903, he later became Professor of Surgery in Zurich in 1924.



Fig. 18.31 Lateral radiograph of knee. The tibial tuberosity is fragmented. The normal appearance of the tibial tuberosity in adolescents is very variable. Diagnosis of Osgood-Schlatter's syndrome is principally clinical based on localised pain and tenderness. Many patients with radiographs similar to this are asymptomatic.

Clinical features. There is a softly fluctuant swelling in front of the lower part of the patella, which is clearly dem arcated. It is manifestly confined to a plane in front of the joint, and the joint itself is unaffected.

Treatment. A trialmay be made of aspiration under local anaesthesia, but the effusion tends to recur unless further friction can be avoided. The risk of recurrence may possibly be reduced if hydrocortisone is injected into the emptied sac. O perative excision of the bursa affords a more certain permanent cure.

Suppurative prepatellar bursitis

This is caused by infection of the bursa with pyogenic organisms, which reach bursa directly through a puncture wound, or through the lym phatics from th e an infected lesion on the leg. The wall of the bursa is acutely inflam ed and the sac is distended with pus.

Clinical features. There are pain and swelling in front of the knee. There may be mild constitutional disturbance, with pyrexia. The swelling is confined to the site of the prepatellar bursa. It is acutely tender on palpation, and overlying skin is hot and reddened. The inguinal lymphatic glands are th e often enlarged and tender. The knee joint itself is unaffected, but the patient is unw illing to bend it fully because flexion increases the pain by tensing the skin over the hursa

POPLITEAL CYSTS

Cystic sw ellings are not infrequently found in the popliteal fossa. Most are exam ples of irritative bursitis, usually of the sem im embranosus bursa. A few are caused by herniation of the synovial cavity of the knee (Baker's cyst). Care must be taken to distinguish popliteal cysts from other, more serious sw ellings in this region, such as aneurysm of the popliteal artery and synovial sarcoma. This can be achieved by appropriate imaging using ultrasound or MRI scans.

Semimembranosus bursitis

The sem im em branosus bursa lies between the medial head of the gastrocnemius and the sem im em branosus. The bursa may become distended with fluid to form an elongated sac that bulges backwards between the muscle planes. Clinically, there is a soft cystic swelling at the back of the knee, close to the medial condyle of the femur.

Treatm ent is not alw ays required. In children particularly, operation may usually be avoided because the cystm ay disappearspontaneously. Nevertheless if the sw elling becomes uncom fortably large, especially in an adult, the sac should be excised and then sent for routine histological exam ination to confirm the diagnosis.

Baker's cyst¹

A Baker's cyst is simply a herniation of the synovial cavity of the knee, with the formation of a fluid-filled sac extending backwards and downwards (Fig. 18.32A). It is not a primary condition but is always secondary to a disorder of the knee with persistent synovial effusion, such as rheumatoid arthritis or osteoarthritis. In long-standing cases the hernial sac is much elongated, and may extend a considerable distance down the calf. Occasionally this may rupture and the resultant pain and local tenderness may be mistaken for a deep vein throm bosis.

C linically there is a soft cystic bulge near the midline behind the knee or in the upper calf. The underlying abnorm ality of the knee, with synovial effusion, will usually be obvious.

Im aging. Where there is any uncertainty as to the diagnosis, it may be necessary to use ultrasound or MRI scanning to establish the nature and extent of the lesion (Fig. 18.32B).

Treatment. In most cases treatment should be directed towards the underlying condition of the knee rather than to the cyst itself. Nevertheless if the cyst is extensive it is sometimes advisable to excise it, with routine histological examination of the removed sac to confirm the diagnosis.

¹William Morrant Baker (1839–1896) was a surgeon at St. Bartholomew's Hospital, London and first described synovial cysts connected to joints in 1877. He also invented the rubber tracheostomy tube.

The thigh and knee

The thigh and knee

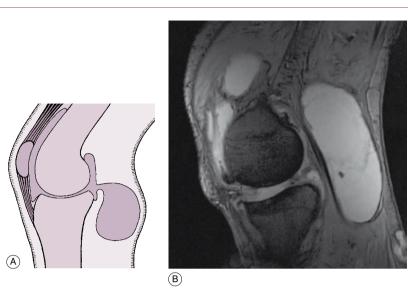


Fig. 18.32 (A) To show how a Baker's cyst is formed as a herniation of the synovial membrane. (B) Sagittal T2 weighted MR scan of knee showing the typical appearance of a large popliteal or Baker's cyst. The large high-signal lesion in the popliteal fossa is often associated with extensive degenerative changes in the knee joint, as seen here.

PELLEGRINI-STIEDA'S DISEASE¹

Pellegrini-Stieda's disease is the name som etimes used to describe ossification in the subligamentous haematoma after partial avulsion of the medial ligament from the medial condyle of the femur. Clinically there is persistent discomfort at the medial side of the knee after an injury to the medial ligament. There are thickening and slight tenderness over the site of attachment of the ligament to the medial femoral condyle. Radiographs show a thin plaque of new bone close to the medial condyle.

Treatment is by active mobilising and muscle-strengthening exercises.

Calcified deposit in medial ligament

It is probable that some supposed cases of Pellegrini-Stieda's disease are in fact exam ples of calcified deposit within the medial ligament. A similar deposit may occur in the lateral ligament. These lesions are homologous with the calcified deposit that occurs more commonly in the supraspinatus tendon at the shoulder (p. 269). If the symptoms are acute the calcified material should be removed by aspiration or by operation. A steroid injection may also be of benefit in some patients.

¹Augusto Pellegrini (1877–1958), who was Professor of Surgery in Florence and later Perugia, described post-traumatic ossification of knee ligaments in 1905. He was also a pioneer in the development of powered prostheses for the upper limb.

Alfred Stieda (1869–1945) was a German surgeon and Professor in Konigsberg who also reported the condition in 1905.

EXTRINSIC DISORDERS WITH REFERRED SYMPTOMS IN THE KNEE

From time to time patients are seen whose main complaint is of pain in the knee, but local examination reveals no satisfactory explanation for it. In such cases the possibility that the pain is referred from a disorder distant from the knee should always be considered. The commonest source of such referred pain is a disorder of the hip, particularly a slipped capital femoral epiphysis in children or osteoarthritis in the adult. Much less often a disorder of the spine is responsible, though referred pain to the leg from pressure of prolapsed disc material on lum bo-sacral nerve roots may sometimes cause confusion.

19 The leg, ankle, and foot

In the orthopaedic out-patient clinic disorders of the foot are second in frequency only to disorders of the back. Their prevalence m ay have several causes. *Hereditary factors*: The foot is probably in a state of relatively rapid evolution consequent upon m an's assumption of the upright posture, and perhaps for that reason it is prone to variations in structure and form which may impair its efficiency. *Postural stresses*: Overweight throws an increased burden on the feet, and they may be unable to withstand the stress without ill-effect, especially if the intrinsic muscles are poorly developed. *Footwear*: The wearing of shoes is a potent cause of foot disorders. Many types of shoe interfere seriously with the mechanics of the

SPECIAL POINTS IN THE INVESTIGATION OF LEG, ANKLE, AND FOOT COMPLAINTS

In nearly all cases symptoms in the leg, ankle, or foot can be explained by a local abnormality. Only rarely are they referred from a distant lesion. In this respect the low er limb differs markedly from the upper, for in many cases symptoms in the hand have no local cause but are referred from a proximal lesion.

History

The precise distribution of pain should be ascertained. The occupation and habits of the patient, including sporting activities, may be significant, as may also be a history of previous injury. Specific enquiry should be made into the effect upon the symptoms of standing and walking.

Exposure

It is essential that socks or stockings be removed and that the whole leg be exposed up to the knee. Both lim bs must always be exam ined so that the two may be compared. The first part of the exam ination is conducted with the patient lying upon a couch. Later, the foot is exam ined while the patient stands.

Steps in clinical examination

A suggested plan for the routine clinical exam ination of the leg, ankle, and foot is sum marised in Table 19.1.

Assessing the state of the peripheral circulation

An essential part of the exam ination of the foot that is often forgotten is to study the efficiency of the arterial circulation. A reasonably accurate assessment may

Table 19.1 Routine clinical examination in suspected disorders of the leg, ankle, and foot

1. LOCAL EXAMINATION OF THE LEG, ANKLE, AND FOOT	
Inspection Bone contours and alignment Soft-tissue contours Colour and texture of skin Scars or sinuses Palpation Skin temperature Bone contours Soft-tissue contours Local tenderness State of peripheral circulation Dorsalis pedis pulse Posterior tibial pulse Posterior tibial pulse Popliteal pulse Popliteal pulse Popliteal pulse Popliteal pulse Popliteal pulse Popliteal pulse Popliteal pulse Popliteal pulse Papliteal pulse Papliteal pulse Popliteal pulse Popliteal pulse Papliteal pulse Popliteal pulse Posterior tibial pulse Papliteal pulse Popliteal pulse Popliteal pulse Papliteal pulse Popliteal pulse Popliteal pulse Popliteal pulse Posterior tibial pulse Posterior alpulse Posterior alpu	At the toes: Flexion Extension Power (tested against resistance of examiner) Each muscle group to be tested in turn. (Power of calf muscles is best tested with the patient recumbent and then standing) (Compare with other side) Stability Integrity of ligaments—particularly the lateral ligament of the ankle Appearance of foot on standing Colour Shape of longitudinal arch Shape of longitudinal arch Shape of forefoot Efficiency of toes Efficiency of toes Efficiency of calf muscles (? ability to raise heel from ground while standing on affected leg alone) Gait Condition of footwear Sites of greatest wear. (Compare with other side)
2. GENERAL EXAMINATION General survey of other parts of the body. The	local symptoms may be only one

manifestation of a widespread disease

be made on clinical evidence alone, but if surgical treatment is contemplated and vascular insufficiency is suspected it is necessary to have more precise information which can be provided only by certain special investigations.

Clinical assessment. This is based on a study of the texture of the skin and nails, colour changes, skin tem perature, the arterial pulses, auscultation, and exercise to lerance. Texture of skin and nails: The skin of an ischaem ic foot loses its hair and becomes thin and inelastic. The nails are coarse, thickened and irregular. Ulceration of the tips of the toes may be noted. Colour changes. A brick-red rubor or cyanosis occurring when the foot is made dependent after a period of elevation (Buerger's test) denotes serious im pairm ent of the arterial circulation. Temperature: A foot with impaired arterial supply is colder than normal, but little reliance can be placed on this test as applied clinically at the bedside. A rterial pulses: The pulses to be felt for are the dorsalis pedis, the posterior tibial, the popliteal and the fem oral. The popliteal pulse is often difficult to feel even in norm al individuals. Palpation should be made with the fingertips of both hands supporting the slightly flexed knee. Pulsation of the dorsalis pedis artery is best felt at the dorsum of the foot between the bases of the first and second metatarsals. The posterior tibial artery is felt about 2 cm behind and below the tip of the medial malleolus. A bsence or impairment of arterial pulsation is an important sign of defective circulation. It should be remembered, how ever, that a normal pulse is easily

The leg, ankle, and foot

m asked by thickening or oedem a of the soft tissues. Capillary return: In lim b ischaem ia capillary return is slow ed after blanching of a digital pulp or nail by pressure. Auscultation: A bruit over one of the major limb vessels, caused by turbulence of blood flow , m ay denote partial obstruction or an arterio-venous com m unication .

Special investigations. These may be indicated when the clinical examination shows evidence of vascular im pairment. They include ankle blood pressure recordings, Doppler ultrasound probe analysis, com bined probe analysis and ultrasonography, pulse volum e recording (plethysm ography), and digital arteriography. For more detail on these and the treatment of limb ischaemia readers should consult a textbook of vascular surgery.

Movements at the ankle and tarsal joints

Since the joints are close together, movement at the tarsal joints is easily mistaken for m ovem entat the ankle, and vice versa. C arefulexam ination is required to determ ine the range at each individual joint.

Ankle movement. The ankle is strictly a hinge joint. The only movements are extension (dorsiflexion) and plantarflexion. The range should be judged from the excursion of the hindfoot rather than the forefoot, so that any contribution from the tarsal joints is disregarded. Sim ilarly, in testing the passive range, the foot should be controlled from the heel (Fig. 19.1). The norm al range of ankle movem entvaries in different subjects; so the norm al ankle m ust be used as a control. A n average range is about 25° of extension (dorsiflexion) and 35° of plantarflexion.

Subtalar and midtarsal movement. In normal use the subtalar and midtarsal joints work together as a single unit. The movem ents permitted are:

- 1. combined inversion and adduction (supination)
- 2. combined eversion and abduction (pronation).

In clinical examination the range of movement contributed by each component can be determ ined separately. To test subtalar movement support the low er leg by a hand gripping the ankle. With the other hand lightly grasp the calcaneus from below (Fig. 19.2). Instruct the patient alternately to invert and evert the foot, observing the range through which the heel rocks from side to side. Compare with the sound foot. The norm alrange is about 20° on each side of the neutral position.

To test midtarsal movement grasp the calcaneus firm ly so that subtalar movement is eliminated. With the other hand lightly grasp the midfoot near the bases of the metatarsals (Fig. 19.3). Instruct the patient alternately to twist

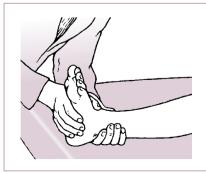


Fig. 19.1 Examining ankle movement. The examining hand grips the hindfoot rather than the forefoot, so that movements of the subtalar and midtarsal joints are eliminated.



Fig. 19.2 Examining subtalar movement. The calcaneus is gripped by the examining hand and moved upon the talus.

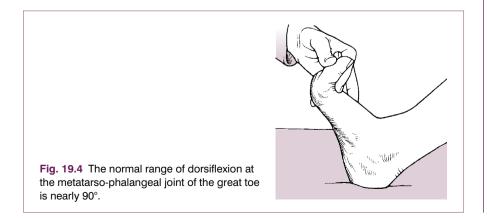
Fig. 19.3 Examining midtarsal movement. The heel is gripped in the steadying hand to eliminate subtalar movement.

the foot inwards and outwards into inversion and eversion, and compare the range with that on the sound side. The normal is a rotation of about 15° on each side of the neutral position.

Determine the active and passive at the m etatarso phala geal and interphalangeal joints. It should b e r e m ber e d t h the norof dorsiflexion of the great toe at the m e ta r s o - p hala ngeal joint is 90° (Fig. 19.4). The range varies, but lim itation to less than nearlv 60° of dorsifle x is certainly abnorm al. The range of dow nw ard fle x ion is about 15° but varies between individuals. Movement at the lesser toes is variable: there i + should be not less than 30° of flexion at the metatarso-phalangeal joints and at the interphalangeal joints.

Examination of the feet under weight-bearing stress

Instruct the patient to stand evenly on both feet. Observe the general shape of the ankle, foot, and toes. Study the shape of the longitud inal arch. Is it of norm al



shape? Is it flattened so that the navicular region is in contact with the ground (pesplanus or valgus)? Or is it higher than norm al (pescavus)? It is im portant to view the heel from the back, so that any inward (varus) or outward (valgus) deviation may be noted. Next study the forefoot. Is it splayed and broader than norm al? Assess the function of the toes. Norm ally they can be pressed upon the ground by the action of the intrinsic muscles so that the metatarsal heads are lifted up and relieved of weight-bearing pressure. Finally, exam ine the efficiency of the calf muscles. The crucial test is to ask the patient to stand on the affected leg and to raise the heel from the ground (see Fig. 19.5).

Examination of spine

Certain deform ities of the foot - especially pescavus with clawing of the toes m ay be caused by a neurological abnorm ality in the thoraco-lum bar or lum bar region of the spine, associated with spina bifida or other developm ental anom aly (see p.171). Exam ination should therefore be made for a tell-tale dimple, pigm ented area, or tuft of hair on the overlying skin.

Gait

Look especially for abnorm al posture of the feet such as turning in (intoeing) or turning out, or drop foot (inability to dorsiflex the foot, necessitating high stepping gait). O bserve whether weight is borne correctly on the sole of the foot or whether it is taken toom uch on the medial or lateral border. Observe alsowhether the heel is raised normally from the ground at the beginning of each step.

For a more refined analysis of gait special force plates may be incorporated in a walkway to record the pressure beneath each component part of the foot in all phases of the step. It is thus possible objectively to com pare the pattern of

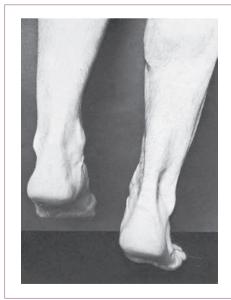


Fig. 19.5 The crucial test of intact calf function is to raise the heel from the ground while standing only on the affected leg. Inability to do this after an injury to the calcaneal tendon is diagnostic of complete rupture.

gait in a defective foot with the norm alpattern; or to compare the gait pattern of a foot before and after operation. The patient's ability to negotiate stairs with norm alrhythm should also be assessed.

Footwear

The exam ination of the foot is not complete until the patient's shoes have been inspected and compared on the two sides. Note the position of greatest wear. When the foot is norm al the greatest wear in the sole occurs beneath the ball of the foot and slightly to the medial side. In the heel it is at the posterior border slightly to the lateral side. The state of the uppers is also important: excessive bulging on the medial side suggests a valgus foot and excessive bulging on the lateral side an inverted foot.

Radiographic examination

The ankle. Routine radiographs of the ankle comprise an antero-posterior and a lateral projection centred at the level of the joint. The films should include a reasonable length of the shafts of the tibia and fibula, and the whole of the talus.

When laxity of the lateral ligament is suspected a special inversion film is required. This is an antero-posterior projection taken while the heel is held in fullest inversion by an assistant. If the lateral ligament is torn or lax the talus will then be shown tilted in the ankle mortise (see Fig. 19.10, p. 433).

In cases of suspected ligamentous injury antero-posterior stability should also be tested. Rupture of the anterior talo-fibular component of the lateral ligament allows anterior subluxation of the talus in the mortise as shown in a lateral radiograph taken while the foot is pushed forward upon the tibia.

The foot. Routine radiographs should comprise an antero-posterior (strictly a supero-inferior) projection and a lateral projection, preferably taken while weight is borne on the feet. An oblique projection (non-weight-bearing) is used to show the mid-foot. Special techniques are available to show the calcaneus (axial view).

DISORDERS OF THE LEG

RUPTURE OF THE CALCANEAL TENDON

Surprising as it m ay seem, a ruptured calcaneal tendon (tendo Achillis) is often overlooked, the symptoms being wrongly ascribed to a strain or to a ruptured plantaris tendon.

Pathology. The rupture is nearly alw ays complete. It occurs about 5 cm above the insertion of the tendon. If it is left untreated the tendon unites spontaneously, but with lengthening and loss of function.

Clinical features. While running or jum ping, the patient feels a sudden agonising pain at the back of the ankle. He may believe that something has struck him. He is able to walk, but only with a bad lim p. On examination of the back of the heel there is tenderness at the site of rupture. There is general thickening from effusion of blood and from oedem a of the paratenon, but a gap can usually be felt in the course of the tendon. The power of plantarflexion at the ankle is greatly weakened, though some power remains through the action of the tibialis

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posterior, the peronei, and the toe flexors. A useful test, to be carried out with the patient prone, is to squeeze the bulk of the calf muscles from side to side. N orm ally this causes a slight plantarflexion movem ent of the foot, but not if the tendon is ruptured.

D iagnosis. The retention of some power of plantarflexion m ay deflect the unwary from the correct diagnosis. The crucial test is to ask the patient to lift the heel from the ground while standing only upon the affected leg (Fig. 19.5). This is impossible if the tendon is ruptured. In cases of doubt the gap in the tendon may be well demonstrated by ultrasound or M R I scanning (Fig. 19.6).

Treatment. Non-operative treatment may be used in selected cases, usually older and more sedentary patients who make less demands on their ankle function. The method is only applicable where passive ankle flexion can bring the torn ends of the tendon into apposition. The ankle is then immobilised in a below-knee plaster for 5 weeks, with the foot in slight equinus to relax the tendon and thus help to prevent lengthening.

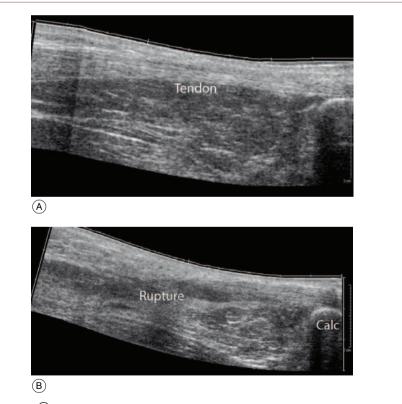


Fig. 19.6 (A) Ultrasound of normal Achilles tendon. Patient's foot on right. Normal appearance of tendon seen above the word 'Tendon'. (B) Compare with this ultrasound of a ruptured tendon.

In the majority of younger patients, particularly those who wish to continue athletic pursuits after healing, operative treatment is preferable. It entails repair of the tendon, using non-absorbable sutures of synthetic material, tension on the suture line being relaxed by immobilising the limb with rightangled knee flexion and moderate ankle plantarflexion for 2 weeks. For the next four weeks a below-knee plaster with the ankle at 90° is worn. Certain protocols allow earlier mobilisation of the ankle under close supervision of a physiotherapist.

W hether treatment is by plaster alone or by operation, it must be completed after removal of the plaster by increasingly vigorous exercises for the calf muscles, practised under the supervision of a physiotherapist until full strength is restored.

ACUTE OSTEOMYELITIS (General description of acute osteomyelitis, p. 85)

The tibia is one of the commonest sites of haematogenous osteomy elitis. Because of its liability to open (compound) fracture it is also the commonest site of osteomy elitis from direct contamination. The fibula is less often affected.

The pathological and clinical features and treatment conform to the general description on page 89.

CHRONIC OSTEOMYELITIS (General description of chronic osteomyelitis, p. 90)

Chronic osteom yelitis in the low er leg, as elsew here, is nearly alw ays a sequel of acute osteom yelitis. It m ay follow either the haem atogenous type of infection or an infected open fracture.

Brodie's abscess. This rather uncommon lesion was described on page 92. It is a special form of chronic osteomyelitis which arises insidiously, without a recognised acute infection preceding it. The tibia is the commonest site (see Fig. 7.7, p. 93).

SYPHILITIC INFECTION OF THE TIBIA (General description of syphilitic osteitis, p. 95)

A lthough skeletal syphilis is now rare in W estern countries, it still occurs in other parts of the world, and when it does occur the tibia is often the bone affected. The infection may take the form of a localised gumma or of diffuse osteoperiostitis (see Fig. 7.11A & B, p. 96). There is a gradually enlarging swelling, with moderate pain. It is important to bear the possibility of syphilis in mind, because the swelling is easily mistaken for a tumour.

TUMOURS OF BONE

Benign tumours (General description of benign bone tumours, p. 106)

Of the four main types of benign tumours of bone - osteoid osteoma, chondroma, osteochondroma, and giant-cell tumour require further mention here.

Chondroma

In the tibia or fibula this is seldom found except in multiple form in the condition of dyschondroplasia (p. 65). The individual tumours in this condition resemble enchondromata. They arise from the growing epiphysial cartilage plate, and they interfere with the normal growth of the bone. An important effect is that the growth of the tibia and fibula may be unequal, with the consequence that the bones may become curved or the plane of the ankle joint may be tilted away from the horizontal (see Fig. 6.4A, p. 65).

Giant-cell tumour (osteoclastoma)

The upper end of the tibia or fibula, like the low er end of the fem ur, is a favourite site for this tum our. It usually arises in a young adult, expanding the bone and extending to within a short distance of the articular surface.

Treatm ent. If the tum our is in the fibula the whole of the affected end of the bone should be excised together with an adequate margin of healthy bone. If the tum our is in the upper end of the tibia, the problem of treatment is much more difficult. Curettage and packing with bone graft or acrylic cement is usually attempted unless the articular surface is already compromised. If this fails, or is impractical, as in the femuritmay be necessary to excise the upper end of the tibia to ensure full eradication of the tum our. Function and continuity may be restored after excision by the use of a custom -made prosthesis to replace the knee joint and the upper half of the tibia, or the knee may be arthrodesed where this is not possible.

Malignant tumours (General description of malignant bone tumours, p. 112)

The tibia, like the femur, is a comm on site for primary malignant bone tumours, especially osteosarcoma and Ewing's tumour.

Osteosarcoma (osteogenic sarcoma)

This tum our usually affects the uppermetaphysis of the tibia: the lower end of the tibia and the fibula are affected much less often. The tum our metastasises rapidly through the blood stream, especially to the lungs. Treatment was described on p.117.

Ewing's tumour

This usually affects the shaft of a long bone, again in childhood or early adult life. The tibia is one of the commonest sites. Treatment was described on page 121.

INTERMITTENT CLAUDICATION

In term ittent claudication is a symptom of arterial insufficiency in the lower limb. In its typical form it is characterised by cramp-like pain in the calf, induced by walking and relieved by rest.

Cause. The usual underlying cause is arteriosclerosis with consequent partial or total obstruction of the m ain lim b vessel. Throm bo-angiitis obliterans and arterial em bolism are less common causes. Tobacco smoking is a major contributory factor. **Pathology**. The basic disturbance is ischaem ia of muscle, in consequence of which metabolites cannot be removed speedily enough when the muscle is exercised. The accumulation of metabolites is believed to be responsible for the pain, which subsides within a few minutes when the muscle is rested. The muscles usually affected are those of the calf, but in some instances other muscle groups are involved, according to the site of the arterial obstruction. The vascular lesion is usually a complete occlusion of the fem oral or the popliteal artery. In claudication affecting the buttock the aortic bifurcation or the iliac artery may be occluded.

Clinical features. Intermittent claudication is much more common in men than in women. In the usual arteriosclerotic type the patient is past middle life, but in cases due to thrombo-angiitis obliterans or embolism the symptoms may develop in early adult life. The patient is usually a regular smoker.

W ith gradual arterial occlusion the onset is insidious and the symptoms are slowly progressive; but in cases precipitated by thrombosis or embolism the onset may be sudden. In a typical case the patient complains that after walking a certain distance - perhaps a hundred metres or so - he is forced to stop by severe cramp-like pain in the calf, or occasionally in another muscle group, such as the buttock. After a few minutes' rest the pain disappears and he is able to walk on again for a similar distance.

On examination there is objective evidence of impaired arterial circulation in the low er lim b (p. 421). The posterior tibial, dorsalis pedis, and popliteal pulses are absent. There may be ischaemic changes in the skin of the foot. Evidence of widespread arterial or cardiac disease is nearly always found on general examination.

For further details on the **investigation**, **diagnosis** and **treatment** of this condition readers should refer to a textbook of vascular surgery.

DISORDERS OF THE ANKLE

PYOGENIC ARTHRITIS OF THE ANKLE (General description of pyogenic arthritis, p. 96)

Pyogenic arthritis of the ankle is uncommon. The organisms reach the joint through the blood stream or through a penetrating wound; local spread from a focus of osteomyelitis of the tibia or fibula is rare because the bonymetaphyses are entirely extra-capsular (see Fig. 7.2, p. 87).

TUBERCULOUS ARTHRITIS OF THE ANKLE (General description of tuberculous arthritis, p. 98)

Tuberculosis is much less common in the ankle than it is in the hip and knee. In Britain it is now seen very seldom. When it is seen, it is often in an immigrant from a developing country.

The clinical features correspond to those of tuberculous arthritis of other superficial joints, with pain, sw elling, increased warm th of the overlying skin, restriction of movement, and limp.

Treatm ent. Early conservative treatm ent (p. 102) m ay restore a m obile ankle, but if in a resistant case articular cartilage is badly eroded or destroyed arthrodesis m ay have to be undertaken.

RHEUMATOID ARTHRITIS OF THE ANKLE (General description of rheumatoid arthritis, p. 134)

One or both ankles are often affected by rheum atoid arthritis in common with other joints in the lower limb, particularly the foot. There may be marked destruction of the articular cartilage and subchondral bone with pain, stiffness, and deformity (Fig. 19.7).

Treatm ent. Medical treatm ent is along the lines suggested for the disease as a whole (p. 137). Local treatm ent: In the active phase rest in a plaster is som etim es required, but in most cases the patient should be encouraged to remain active as far as possible, with such help as may be gained from local support by a moulded polypropylene splint. Operation is advised mainly when destruction of articular cartilage has led to intractable pain with marked im pairm ent of capacity for walking. A rthrodesis and replacement arthroplasty are the methods available. A rthrodesis is usually the operation of choice because it gives perm anentrelief of pain with good function. If the subtalar and midtarsal joints are also severely affected they should be included in the fusion. Replacement arthroplasty of the ankle is appropriate in som e patients (Fig. 19.8). The operation is technically dem anding because of the lim ited surgical access to the joint, while the long-term results are much less satisfactory than with the hip or knee because poor bone support may lead to early im plant loosening.

OSTEOARTHRITIS OF THE ANKLE (General description of osteoarthritis, p. 140)

Degenerative destruction of the articular cartilage is less common in the ankle than in the knee or hip. There is nearly always a known predispos-



Fig. 19.7 Radiographs of the ankle with advanced rheumatoid arthritis showing loss of joint space and erosion of the articular surfaces of the tibia and talus.

The leg, ankle, and foot



Fig. 19.8 (A) and (B) Radiographs of a Scandinavian total ankle replacement arthroplasty inserted for the treatment of advanced rheumatoid arthritis. Metal prostheses have been used to resurface the dome of the talus and the distal tibia and both articulate with a mobile polyethylene meniscal prosthesis placed between them (position shown by wire marker).

ing factor which causes the joint to wear out prematurely. The commonest is irregularity or mal-alignment of the joint surfaces after a fracture. Sometimes articular disease such as previous rheumatoid arthritis or osteochondromatosis is the primary factor.

Clinical features. The symptoms are pain which slowly increases over months and years, and limp. *On exam ination* the joint is a little thickened from hypertrophy of bone (osteophyte form ation) at the joint margins. Movements are restricted slightly or severely according to the degree of arthritis.

Radiographs show the typical features of osteoarthritis – narrowing of the cartilage space, a tendency to sclerosis of the bone adjacent to the joint, and osteophyte formation at the joint margins (Fig. 19.9).

Treatm ent. In m ild cases treatm ent is often unnecessary, because the patient m ay be willing to accept the disability when the nature of the trouble has been explained. When treatm ent is called for, conservative measures should be tried first if the disability is only moderate. Physiotherapy by short-wave diathermy, and active exercises are usually advised. Som etimes local splintage by a moulded polypropylene support will provide relief while allowing the patient to continue to walk. Such treatment, how ever, is only palliative, and if



Fig. 19.9 Osteoarthritis of the ankle complicating fracture-subluxation 10 years before. Note the marked narrowing of the cartilage space and the prominent osteophytes.

the disability increases to the extent of becoming a serious handicap operation should be undertaken.

Surgical treatment should usually be by arthrodesis, which provides a painless stable joint for many years. A number of different methods are available to produce reliable bony fusion and with the introduction of arthroscopic techniques to remove the degenerate cartilage, combined with rigid internal fixation across the opposed bone surfaces, the post-operative rehabilitation is rapid. Unfortunately, after 10-15 years more than 50% of these patients develop further disability from hindfoot pain because of the accelerated onset of arthritis in the adjacent sub-talar and talo-navicular joints. In an attempt to overcom e this problem in younger patients, replacement arthroplasty with resurfacing prostheses has been explored as a possible alternative (see Fig. 19.8). A s with arthroplasty for rheum atoid arthritis, the long-term results are still uncertain because of bone resorption and implant loosening and it is not yet widely recommended.

NEUROPATHIC ARTHRITIS OF THE ANKLE (General description of neuropathic arthritis, p. 147)

Neuropathic arthritis is uncommon but nevertheless well recognised in the ankle. The underlying neurological disease is diabetic neuropathy, syringomyelia, cauda equina lesion, tabes dorsalis, or, where it is prevalent, leprosy.

Treatm ent. In m any cases protection by a firm surgical boot, reinforced if necessary by a below -knee brace, is all that is required. O ccasionally arthrodesis

of the ankle may have to be considered. A ppropriate treatment must be given for the underlying neurological disorder.

RECURRENT SUBLUXATION OF THE ANKLE

When the lateral ligament of the ankle is torn and fails to heal there may be persistent instability with recurrent attacks of giving way in which the talus tilts medially in the ankle mortise. A nterior displacement relative to the tibial articular surface may also occur. The causative injury is always a severe inversion force.

Clinical features. The patient com plains that the ankle 'goes over' at frequent in tervals, often causing him to fall. Each incident is accompanied by pain at the lateral side of the ankle. There is alw ays a history of previous severe injury, followed by much swelling and extensive bruising at the lateral side of the joint.

On exam ination there is often some oedem a about the ankle. There is tenderness over the site of the lateral ligam ent. The norm al ankle movem ents dorsiflexion and plantarflexion - are unchanged, but abnorm alm obility is present as shown by the fact that the heel can be inverted passively beyond the norm alrange perm itted at the subtalar joint. Moreover, when the heel is fully inverted a dim ple or depression of the skinm ay be visible in front of the lateral malleolus, where the soft tissues have been 'sucked' into the gap created between tibia and talus.

Radiographic features. Routine radiographs do not show any abnormality. A ntero-posterior film s must be taken while the heel is held fully inverted. If the lateral ligament is torn or lax the talus will then be shown tilted away from the tibio-fibular mortise at the lateral side through 20 or 30° or more (Fig. 19.10). A nterior displacement of the talus relative to the tibial articular surface may sometimes also be demonstrated in lateral radiographs taken while the foot is pushed forwards.

Diagnosis. Chronic strain of the lateral ligament may cause similar symptoms, but in that condition radiographs will not show the talus tilted significantly on forced inversion. (It should be noted that the talus may tilt up to



Fig. 19.10 Tilting of the talus in the ankle mortise under adduction stress; an indication of torn lateral ligament.

10° or even 15° in a norm al ankle. Tilting beyond that am ount is dem onstrated only when the ligam ent is torn.)

Treatm ent. If the disability is slight it may be sufficient to strengthen the evertor muscles (mainly the peronei) by exercises, to enable them to control the ankle more efficiently. Stability may also be enhanced by broadening and 'floating out' the heel of the shoe. If the disability is severe operation is required. A new lateral ligament may be constructed either from the peroneus brevis tend on or from the peroneus tertius. Trials are also proceeding with the use of artificial ligaments, either as substitutes or as a means of promoting the grow th of new ligamentous tissue.

DISORDERS OF THE FOOT

CONGENITAL CLUB FOOT (Talipes equino-varus)

The rather vague term 'club foot' has come to be synonymous in the minds of most surgeons with the commonest and most important congenital deformity of the foot-talipes equino-varus (Fig. 19.11). The less common, and usually less serious, form of club foot, talipes calcaneo-valgus, will be considered later under that title.

Cause. This is still under debate. In most cases a defect of fetal development is responsible, with im balance between the invertor-plantarflexor muscles and the evertor-dorsiflexor muscles. A neuromuscular defect is possibly relevant. M inor degrees of the deformity may possibly be explained by prolonged mal-position of the foetal foot in the uterus, but this cannot be accepted as the usual cause.

Pathology. The crucial component of the deformity is subluxation of the talo-navicular joint, so that the navicular bone lies partly on the medial aspect of the head of the talus instead of on its distal aspect (Fig. 19.12). The soft tissues at the medial side of the foot are under-developed and shorter than



Fig. 19.11 Bilateral club foot (talipes equino-varus) in an infant boy. Note the poor development of the calf muscles.

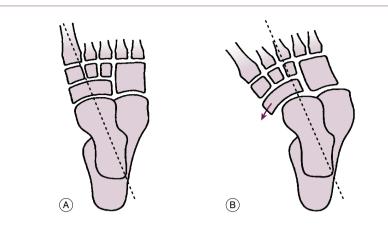


Fig. 19.12 (A) Normal alignment of the forefoot upon the long axis of the talus. (B) Subluxation of the navicular bone medially on the head of the talus – the crucial component in the pathology of talipes equino-varus. Interrupted line shows forward projection of the long axis of the talus passing lateral to the first metatarsal – a useful radiological sign. In the normal state the line passes through or medial to the first metatarsal (A).

norm al. The foot is adducted and inverted at the subtalar, midtarsal, and anterior tarsal joints, and is held in equinus (plantarflexion) at the ankle. In most cases under-development of the calf and peroneal muscles is a striking feature. Thus if only one foot is affected there is a marked discrepancy in the girth of the calf between the two sides.

In the absence of early effective treatm ent the developing tarsal bones assum e an abnorm al shape as grow th occurs, perpetuating the deform ity.

Clinical features. The deform ity is much commoner in boys than in girls. (Contrast developmental dysplasia (congenital dislocation) of the hip, which is much commoner in girls.) One or both feet may be affected. When the infant is born it is noticed that the foot is turned inwards so that the sole is directed medially (Fig. 19.11). The deformity, to be more precise, consists of three elements:

- 1. inversion (twisting inwards) of the foot
- 2. adduction (inward deviation) of the forefoot relative to the hindfoot
- 3. equinus (plantarflexion).

The foot cannot be pushed passively through the norm al range of eversion and dorsiflexion. There may be obvious under-developm ent of the muscles of the low er leg, especially noticeable when only one foot is affected.

Diagnosis. New -born infants should be exam ined routinely for evidence of club foot. It is not sufficient, for purposes of diagnosis, that the foot be found to rest in the position described, for often the feet of norm al infants tend to lie naturally in a som ew hat inverted position. The criterion for the diagnosis of club foot is that the deform ity cannot readily be corrected and over-corrected to bring the foot into eversion and dorsiflexion. It should be rem em bered that in norm al infants under 1 year old it is possible to evert and dorsiflex the foot far enough to bring the little toe into contact with the shin.

Radiographic features. In the antero-posterior radiograph of a norm al foot a line projecting the long axis of the talus forwards passes medial to the first metatarsal bone or coincides with it (Fig. 19.12A). In uncorrected or incompletely corrected club foot the line passes lateral to the metatarsal (Fig. 19.12B).

Prognosis. The prognosis depends largely upon the age at which primary treatment is begun, and upon the efficiency with which it is carried out. The longer the delay before treatment, the smaller is the prospect of complete cure. Yet even with prompt treatment the outcome is uncertain. In a proportion of cases, despite the greatest care from the time of birth, there is a tendency to relapse when treatment is discontinued. These are usually the cases that show marked hypoplasia of the muscles of the low er leg, especially of the peroneal group. Even in the most severe cases, how ever, it should always be possible to ensure a plantigrade foot, if not a norm al foot, by operative means.

Treatm ent in a fresh case. A lthough it is seem ingly a simple deform ity, talipes equino-varus presents difficult problems in treatm ent. The most widely accepted practice is to rely upon conservative treatm ent by correction and splin-tage during the first year of life (often using the so-called Ponseti technique¹) and often well beyond that; if casting and splintage fail to correct the position then operative correction is carried out.

Primary conservative treatment. Ideally treatment should be begun immediately after birth - certainly not more than 1 week later. The principles of treatment are:

- to correct and over-correct the deform ity by firm m anual pressure, repeated at appropriate intervals (usually weekly at first)
- to hold the foot in the over-corrected position to counteract the natural tendency for the deform ity to recur.



Fig. 19.13 Correcting a club-foot deformity by manual pressure without anaesthesia. Note that pressure is applied under the midfoot, not under the forefoot.

¹Ignacio Ponseti (1914–) Spanish born orthopaedic surgeon emigrated to Iowa in USA in 1941 and developed his innovative conservative treatment for clubfoot, which he still teaches and is widely used throughout the world.

CHAPTER 19

Correction of deform ity. The deform ity is corrected by firm manual pressure without an aesthesia (Fig. 19.13). The Ponseti technique involves first correcting the cavus deform ity, then the adduction and heel varus, and finally the equinus deform ity. Depending on the severity of the deform ity, it may be possible to correct it fully by two or three manipulations, or as many as five or six manipulations at weekly intervals may be required.

Maintenance of correction. Three methods are available for holding the foot in the corrected position between manipulations:

- 1. a plaster of Paris cast
- 2. metal splints as advocated by Denis Browne
- 3. adhesive strapping.

Retention in a plaster is much to be preferred, because it holds the foot in the over-corrected position more efficiently and for a longer period than do metal splints or strapping – even though the technique of applying a plaster correctly is not easy to learn. The plaster must extend to the upper thigh, with the knee flexed 90° (Fig. 19.14); otherw ise the infant is able to draw the foot up inside the plaster, with consequent loss of correction. The plaster must be changed every week at first, but the interval may be extended to two and then three weeks as the child grow s larger.

Operative treatment. Opinions vary on the correct duration of conservative treatment and on the tim ing of corrective operations in infants. If treatment by manipulation and retention fails, operation should usually be undertaken before the age of 9 months: some would say much earlier. If at the end of three or four months the feet are not norm al clinically and radiologically, operation should be advised. The idea behind early operation is to set the tarsal bones in norm al relationship to one another and to remove deforming forces, thus allowing the bones to develop in their norm al shape from an early age. All taut ligaments at the medial side of the ankle and foot are divided and any tendon that is too tight to allow full correction is lengthened – including the calcaneal tendon. Finally the tarsal bones, thus released, are restored to their norm al

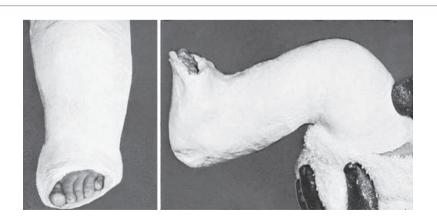


Fig. 19.14 Plaster for maintaining correction in congenital club foot. It is essential to include the thigh, with the knee flexed to a right angle.

relationships, particular attention being paid to the talus and the navicular bone. A fter operation a plaster is worn for 2 or 3 m on ths.

Treatment in neglected or relapsed cases. Repeated manipulation and retention in plaster can produce worthwhile improvement in children of up to two years of age. If sign ificant deform ity is still present after the age of two, operative treatm ent is required. It should be appreciated that in these late cases no method of treatment - whether conservative or operative - is capable of restoring the foot to norm al. The most that can be done is to restore a plantigrade foot.¹

Types of operation. In children aged 2 to 12 years there is the option to employ any of seven operations, depending upon the circum stances of each case:

- 1. division of the short soft tissues at the medial side of the foot, the foot thereafter being forced into a plantigrade position and imm obilised in plaster for three months
- 2. transfer of the tend on of the tibialis anterior to the outer side of the foot
- 3. transfer of the tibialis posterior tend on through the interosseous membrane to the outer side of the foot, to supplement the action of the evertor muscles
- 4. lengthening of a short calcaneal tend on
- 5. arthrodesis of the calcaneo-cuboid joint, with excision of a wafer of bone to shorten the lateral border of the foot
- 6. when inversion of the heel is a prominent feature, D wyer osteotomy of the calcaneus with insertion of a bone wedge in the medial side to correct the line of w eight-bearing
- 7. application of a circular (Ilizarov) external fixation frame which allows gradual correction of the deform ity.

In children over the age of 12 resort must be had to operation upon the bones: a wedge of bone of appropriate size (with base dorso-laterally) is removed from the tarsus so that when the resulting gap is closed the foot is plantigrade. This operation is not recommended for children under 12 because the active bone grow th of the foot is likely to be impaired.

CONGENITAL TALIPES CALCANEO-VALGUS

This is the opposite deform ity to talipes equino-varus. The foot is everted and d orsiflexed . It is usually a less serious deform ity than talipes equino-varus and with few exceptions, in which there is displacement at the talo-navicular joint (see congenital vertical talus, below), it responds readily to treatm ent.

Cause. The cause is unknow n. In some cases it may simply be a postural deformity, from folding of the foot against the shin for a long time in intra-uterine life.

Clinical features. One foot or both feet may be affected. The foot rests in a position of eversion and dorsiflexion, so that its dorsum lies alm ost in contact with the shin (Fig. 19.15). Tightness of the dorso-lateral soft tissues prevents the foot from being brought down easily into inversion and equinus, though with steady pressure a fair degree of correction can usually be obtained.

Treatment. In most cases the deformity will respond to repeated manual stretching by the parents, who should be carefully instructed how to coax the foot into the over-corrected position of inversion and equinus by steady

¹Plantigrade = sole walking: with the sole on the ground.



Fig. 19.15 Congenital talipes calcaneo-valgus. The typical deformity.

pressure upon the dorsum of the foot. The manipulations should be begun immediately after birth and should be carried out several times a day.

If calcaneo-valgus deform ity still persists when the child is a month old more intensive supervision is required. The surgeon should gently over-correct the deform ity as far as possible by manipulation without anaesthesia, thereafter applying a plaster with the foot in the over-corrected position. The plaster is changed weekly until a full range of inversion and equinus is gained. At that stage the plaster may be discarded without fear of relapse.

Congenital vertical talus

In a sm all proportion of cases of talipes calcaneo-valgus there is an underlying skeletal deform ity at the talo-navicular joint. The navicular bone is displaced onto the dorsal aspect of the head of the talus, which is thus pushed downwards so that the long axis of the talus becomes alm ost vertical. The condition may som etimes be associated with muscular imbalance consequent upon neurological deficit, as for instance in spina bifida. In most of these cases operative correction will be required.

ACCESSORY BONES IN THE FOOT

M any accessory bones have been described in the foot, but m ost are of little or no practical im portance. The com m onest is the **os trigonum**, w hich lies im m ediately behind the talus, on the upper surface of the tuberosity of the calcaneus (Fig. 19.16). It does not cause sym ptom s. It m ay be confused w ith a fracture of the talus.

The only tarsal accessory bone that is frequently responsible for symptoms is the **os tibiale externum**¹ (accessory navicular bone) (Fig. 19.17). This lies medial to the navicular bone, and forms a well-marked prominence at the inner border of the foot which may become painful and tender from the pressure of the shoe. If the symptoms justify operation the accessory bone should be removed.

¹The term os tibiale externum may seem confusing in so far as the ossicle is on the inner side of the foot. The title however relates to the embryonic position of the foot, in which the ossicle forms on the outer side.

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Fig. 19.17 Os tibiale externum.

PES CAVUS

In pescavus or 'hollow foot' the longitud in al arch of the foot is accentuated.

Cause. In many cases the deform ity has a congenital basis. It is sometimes fam ilial. In other cases there is an underlying neurological disorder causing muscle imbalance. For instance, it is often associated with a minor degree of spinal dysraphism (p. 171), or it may follow poliom yelitis.

Pathology. The metatarsal heads are lowered in relation to the hind part of the foot, with consequent exaggeration of the longitudinal arch. The soft tissues in the sole are abnorm ally short, and eventually the bones them selves alter shape, perpetuating the deform ity. There is alw ays associated claw ing of the toes, which are hyperextended at the metatarso-phalangeal joints and flexed at the proxim al and distal interphalangeal joints (Fig. 19.18). This claw ing seem s to result from defective action of the intrinsic muscles - lum bricals and interossei. The effect is that the toes are alm ost functionless, and unable to take their norm al share in weight-bearing. Consequently excessive weight falls upon the metatarsal heads on walking or standing, and hard callosities form in the underlying skin. The mal-alignment of the tarsal joints predisposes to the later developm ent of osteoarthritis.

Clinical features. The deform ity often becomes evident in childhood. It may affect one foot or both feet. In some cases the symptoms are negligible. When symptoms do arise they may take three forms:

- 1. painful callosities beneath the metatarsal heads
- 2. tenderness over the deform ed toes from pressure against the shoe
- 3. pain in the tarsal region from osteoarthritis of the tarsal joints.

On examination the deform ity is characteristic and easily recognised (Fig. 19.18). The longitudinal arch is high; the forefoot is thick and splayed; the toes are clawed; the metatarsal heads are prominent in the sole. Callosities beneath

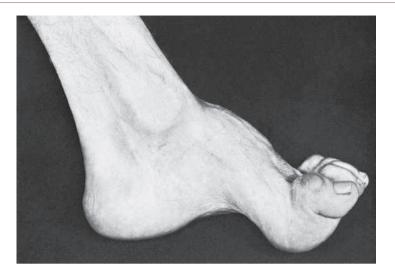


Fig. 19.18 Pes cavus. Typical deformity with high arch, clawed toes, and prominence of the metatarsal heads in the sole. In such a case the spine should always be examined for evidence of dysraphism.

etatarsal heads indicate that they take excessive weight. The toes cannot be straightened at will by the patient, nor can they be pressed firm ly upon the ground to take a share in weight-bearing. There may also be tender callosities re the tops of the toes have rubbed against the shoes.

base of the spine should be examined for a congenital anom aly such The as spina bifida, which may be suggested by the presence of a dimple, a tuft of hair, or an area of pigmentation. If suspicion of spinal dysraphismexists radiographs of the spine should be obtained.

Treatment. In many cases treatment is not required. Mild symptoms can often be relieved by regular chiropody and by the provision of a resilient pad beneath the metatarsal heads to distribute the weight more widely. It is often helpful to prescribe surgical shoes, made to fit the altered shape of the feet.

If the symptoms are severe operation may be required. The nature of the operation should depend upon the cause of the main symptoms.

Operations on the toes. When local pressure upon the toes or beneath the metatarsal heads is the main complaint, adequate relief can often be afforded simply by straightening the clawed toes. This may be done by arthrodesing all the interphalangeal joints or, if the toes are still mobile, by transplanting the long flexor tend on into the extensor expansion to supplement the action of the intrinsic muscles.

Operations on the soft tissues of the sole. In appropriate cases arthrodesis of the toes may be supplemented by the Steindler muscle-slide operation, in which the taut ligam entous tissues in the sole of the foot are detached from the calcaneus and allowed to slide forwards as the height of the arch is reduced by strong manual force. A fter operation the correction is maintained by immobilising the foot in plaster for 2 m on ths.

The leg, ankle, and foot

Operations on the tarsal joints. When osteoarthritis of the tarsal joints is the main cause of the symptoms arthrodesis of the affected joints - usually the subtalar, calcaneo-cuboid, and talo-navicular joints (the so-called triple arthrodesis) - is required. At the same time the deformity is corrected by excising a wedge of bone, base upwards, from the metatarsus. When necessary, this operation may be combined with operations to straighten the toes.

PES PLANUS (Flat foot; valgus foot)

In this common condition the longitudinal arch of the foot is reduced so that. on standing, its medial border is close to, or in contact with, the ground (Fig. 19.19). It is usually associated with some degree of twisting outwards of the foot on its longitudinal axis (eversion or valgus deform ity).

Cause. In many cases it probably has a congenital basis, but it may be caused by selective m uscle w eakness or paralysis.

Pathology. All infants have flat feet for a year or two after they begin to stand. When the deform ity persists into adult life it becomes a permanent structural defect, the tarsal bones being so shaped that when articulated they tend to form a straight line rather than an arch.

Clinical features. In children, flat feet are usually symptom less, but the parents commonly complain that the uppers of the shoes persistently bulge inwards and that the heels wear down quickly at the inner sides.

In adults, too, flat feet are often free from symptoms, but they are more liable than are norm al feet to suffer foot strain (p.444), and when pain is com plained of it is usually from that cause.

In later life pain may also arise from osteoarthritis of the tarsal joints consequent upon their mal-alignment.

Treatment. In children under 3 years old treatment is not required. In children over 3 the accepted method of treatment is to tilt the shoe slightly to the



Fig. 19.19 Pes planus. Marked flattening of the longitudinal arch, with valgus deformity seen well from behind (inset).

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Fig. 19.20 Shoes drawn from behind, to illustrate medial heel wedges.

lateral side by inserting a wedge, base medially, between the layers of the heel (not the sole) (Fig. 19.20). This may help to overcome the valgus twist and to reduce the bulging-over of the uppers at the medial side, but it must be accepted that in most cases it is little more than a placebo. In older children it is better to insert a valgus insole (arch support) into the shoe, and this may be supplemented by a course of supervised exercises to strengthen the intrinsic muscles of the foot.

In cases of severe valgus deform ity – w hich is usually the consequence of selective m uscle im balance, as after poliom yelitis – operation to restore the correct relationship betw een talus and calcaneus, and to fuse the two bones together (talocalcaneal arthrodesis), m ay be considered. In children this operation m ay be done by placing bone grafts extra-articularly in the sinus tarsi, from the lateral side.

In adults treatment is not needed unless symptoms are present, when the advisability of fitting an arch support should be considered. Supports are seldom of benefit when the foot is completely flat, but they often afford relief when the longitudinal arch is diminished but not lost.

If the symptoms in a case of long-established flat foot are ascribed to superimposed osteoarthritis of the tarsaljoints, treatment should be directed against the arthritis (see below).

Peroneal spastic flat foot (spasmodic painful flat foot) and tarsal coalition

Whereas in most cases flat foot is painless, in a small number the flattening may be associated with pain and intermittent spasm of the peroneal muscles, provoked by weight-bearing. Peroneal spastic flat foot is important because it is often associated with congenital tarsal coalitions which, if not treated by early surgical excision, may lead to secondary arthritic changes in the tarsal joints.

Pathology. Tarsal coalitions represent an inherited failure of bony development and are present in 1-2% of the population. The characteristic feature is the existence of a cartilaginous or bony bar bridging two adjacent tarsal bones. The two commonest types are:

- 1. calcaneo-navicular coalition
- 2. talo-calcaneal coalition.

Clinical features. Symptoms usually begin in early adolescence, when the patient presents with a painful, rigid, valgus hindfoot. The symptoms are aggravated by prolonged standing or walking. Examination shows marked restriction of subtalar movement. Attempted eversion of the heel passively often provokes spasm of the peroneal muscles.

Diagnosis. Special oblique or axial radiographs may be required to show the abnorm albony bar, though this can be demonstrated more clearly on a CT scan. Later, secondary osteoarthritic changes may be seen in the tarsal joints. **Treatm ent**. If coalition is diagnosed early, excision of the abnorm albarm ay relieve pain and restore som e m obility. In the later stages, if degenerative arthritis causes severe disability arthrodesis of the affected joints m ay be required.

FOOT STRAIN

The term 'foot strain' implies a subacute or chronic strain of the tarsal ligaments, not an acute injury from sudden violence.

It may be caused in a norm al foot by excessive standing or walking by a person unaccustomed to it: but it occurs mostly in those with a long-established foot deformity such as pes planus (flat foot) or pes cavus, when the ligaments of the foot may be inadequately protected by muscles.

The main symptoms are prolonged aching in the feet, worse on standing or walking, often with aching also in the calves.

lt is im portant to elim inate other causes of foot problem s such as ischaem ia, neurological deficit and, in boys, particularly m uscular dystrophy.

Treatment should be by reducing the time spent in standing and walking, by the fitting of an arch support if indicated, by supervised foot and toe exercises, and sometimes by electrical stimulation to strengthen the muscles of the leg and foot.

OSTEOARTHRITIS OF THE TARSAL JOINTS

O steoarthritis m ay affect any of the tarsal joints, but in practice it is seen most often in the subtalar and mid tarsal joints. It seldom arises primarily: there is nearly alw ays a predisposing cause such as previous fracture or disease involving the joint surfaces (especially fractures of the calcaneus), or mal-alignment of the tarsal bones (as in severe flat foot or severe pes cavus).

Clinical features. The main symptom is pain, which gradually increases over months or years and finally leads to a limp and impaired capacity for walking. Pain is localised fairly accurately to the particular joint or joints affected. A history will usually be obtained of previous injury, disease, or deform ity of the foot. *On exam ination* movem ent of the affected joint is impaired, and painful if forced.

Radiographs confirm the diagnosis and may give an indication of the primary underlying cause.

Treatm ent. In m ild cases treatm ent is not required, especially if the patient's activities can be curtailed. When the disability is troublesome more active measures are needed. Conservative treatm ent is only palliative, but it is usually worth a trial. It should take the form of short-wave diathermy, muscle exercises, and support from an elastic bandage or moulded polypropylene heel seat. A trial may also be made of local injection of hydrocortisone into the affected ioint: but repeated injections are not advised.

If conservative treatment fails to give adequate relief operationmust be considered. The only effective method is by arthrodesis of the affected joint or joints.

OTHER FORMS OF ARTHRITIS OF THE TARSAL JOINTS

Like all true synovial joints, the tarsal joints are liable to any of the recognised form s of arthritis, including pyogenic arthritis, rheum atoid arthritis, tuberculous arthritis, gouty arthritis, and neuropathic arthritis. Of these, the only one that is at all com m on is rheum atoid arthritis, w hich affects particularly thesubtalar joint. The general subject of osteochondritis was discussed in Chapter 8 (p. 130). The growing navicular bone is one of its best-recognised sites. The developing nucleus of the bone is temporarily softened and usually becomes compressed by the mechanical forces entailed in walking. A disturbance of blood supply is possibly a causative factor, but the pathogenesis is not fully understood.

Pathology. The pathology is believed to be like that of osteochondritis of other growing bony nuclei (see Table 8.2, p. 131). The bone, presum ably necrotic from ischaemia, loses its norm all trabecular structure and may become fragmented as it is gradually absorbed and replaced by new living bone. A fter about two years the norm all bone structure is restored and the bone may regain alm ost its norm all size and shape. If slight deform ation of the bone does rem ain, the growing foot seems to adapt itself to the altered shape and little or nod isability persists.

Clinical features. Köhler's disease is confined to children aged about 3 to 5 years. The child com plains of pain in the m id tarsal part of the foot and is noticed to lim p. *On exam ination* there m ay be slight sw elling in the m id tarsal region, with tenderness on firm palpation over the navicular bone and som etimes a slight increase in w arm th. There m ay be som e restriction of m id tarsal m ovem ents with pain on forcing, but these signs are slight and som etimes absent.

Radiographic features. Radiographs are diagnostic. The ossifying nucleus of the navicular bone appears squashed antero-posteriorly (Fig. 19.21A); it is

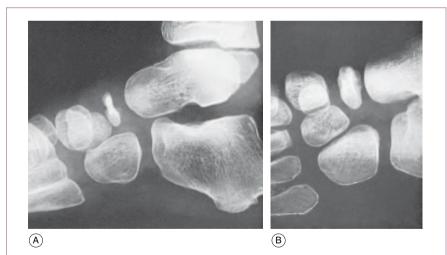


Fig. 19.21 Köhler's osteochondritis of the navicular bone. (A) Early stage. Bony nucleus dense and flattened antero-posteriorly. (B) Two years later. Bone texture restored; slight residual flattening.

¹Alban Köhler (1874–1947) German pioneer in radiology worked in Wiesbaden and described the condition in 1908.

denser than norm al, and may have a fragm ented appearance. Serial radiographs during the 2-year span of the disease show the gradual evolution of the bone changes. A fter a stage of maximal density and deformation a few months after the onset there is gradual im provem ent until norm al bone texture is restored (Fig. 19.21B).

Treatment. Despite the slow evolution of the bone changes prolonged treatment is not required. Good results follow symptomatic treatment. Usually all that is necessary is to rest the foot for 6-8 weeks in a walking plaster.

PAINFUL HEEL

The causes of painful heel are conveniently classified according to the site of the pain (Fig. 19.22).

Pain within the heel Disease of the calcaneus (osteomyelitis; tumour: Paget's disease) Arthritis of the subtalar joint

Pain beneath the heel Tender heel pad Plantar fasciitis

Pain behind the heel Rupture of the calcaneal tendon (p. 425) Calcaneal paratendinitis Post-calcaneal bursitis Calcaneal apophysitis

DISEASE OF THE CALCANEUS

The calcaneus is subject, although rarely, to all types of infection of bone, the com monest being pyogenic infection (osteom yelitis). O ccasionally it is the seat of a benign or malignant tum our. It may also be affected by other disorders of bone, such as Paget's disease.

Arthritis of the subtalar joint

The commonest type of arthritis in the subtalar joint is osteoarthritis secondary to fracture of the calcaneus (p.444). The joint is occasionally subject to other forms of arthritis, such as pyogenic arthritis, rheum atoid arthritis, tuberculous arthritis, and gout.

Calcaneal paratendinitis (calcaneal tenosynovitis)

The calcaneal tendon is surrounded by loose connective tissue, or paratenon, which allows gliding movements. Rarely, this becomes inflamed from excessive friction. The condition should be termed paratendinitis rather than tenosynovitis, because there is no true synovial sheath.

Clinical features. The patient is usually an active athletic young adult. There is pain in the region of the calcaneal tendon, made worse by activities such as running or dancing. On examination there is tenderness on palpation between finger and thum b deep to the tendon (Fig. 19.22), and there is slight local thickening in this region. The tendon itself is of norm al size and consistency.



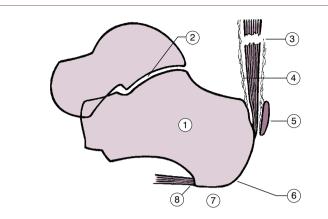


Fig. 19.22 Eight causes of painful heel, with site of pain. 1. Disease of the calcaneus. 2. Arthritis of the subtalar joint. 3. Ruptured calcaneal tendon. 4. Calcaneal paratendinitis. 5. Post-calcaneal bursitis. 6. Calcaneal apophysitis. 7. Tender heel pad. 8. Plantar fasciitis.

Treatm ent. Local physiotherapy may be helpful, particularly by the application of ultrasound therapy to the affected area, or from eccentric calf muscle training. In many cases relief is afforded by local injection of hydrocortisone deep to the tendon. (The tendon itself must not on any account be injected lest it be weakened, with serious risk of rupture.) In a resistant case operation may be required: it consists in excising the loose connective tissue surrounding and deep to the tendon.

Post-calcaneal bursitis

This is the commonest cause of pain behind the heel. It is often a cause of troublesome disability in young women.

Pathology. An adventitious bursa form s at the back of the heel, between the tuberosity of the calcaneus and the skin. Repeated friction against the back of the shoe leads to chronic inflam mation and thickening of the walls of the bursa, and the sac may be distended with fluid. Prominence of the underlying bone aggravates the bursitis.

Clinical features. There is troublesome tenderness where the swelling is in contact with the shoe (Fig. 19.22). The symptoms are aggravated by walking, and they tend to be worse in winter than in summer; hence the term 'winter heel'. On examination there is an obvious gristly prominence at the back of the heel; the overlying skin is thickened and may be red.

Treatm ent. In mild or recent cases the symptoms can be controlled by protecting the back of the heel with a double layer of elastic adhesive strapping and by wearing shoes with soft backs. If these measures fail the bursa should be excised: its recurrence must be prevented by excising the prominent upper posterior corner of the calcaneal tuberosity, im mediately above the attachment of the calcaneal tendon.

Calcaneal apophysitis (Sever's disease¹)

This harm less condition occurs only in children, during the period of active grow th of the calcaneal apophysis. It was form erly believed to be an example of osteochondritis (p. 130), but it is now generally agreed that it is nothing more than a chronic strain at the attachment of the posterior apophysis of the calcaneus to the main body of the bone, possibly from the pull of the calcaneal tendon. It may thus be regarded as analogous to Osgood-Schlatter's disease of the tibial tubercle (p. 415), and totally unrelated to osteochondritis.

Clinical features. The child, usually between 8 and 13 years old, complains of pain behind the heel, and a slight lim p m ay be noticed. On examination there is tenderness over the low erposterior part of the tuberosity of the calcaneus (Fig. 19.22). Radiographs usually fail to show any alteration from the normal. Importance has sometimes been attached to an appearance of fragmentation of the calcaneal apophysis, but this is a normal state, often seen in children without pain in the heel.

Treatm ent. In most cases treatment is not required, because the symptoms will gradually subside spontaneously. If the pain is troublesome, rest for a few weeks in a below-knee walking plaster will afford adequate relief.

Tender heel pad

This is a distinct clinical condition characterised by pain beneath the hind part of the heel on standing or walking.

Pathology. The site of the tenderness is the tough fibro-fatty tissue beneath the prominent weight-bearing part of the calcaneus. In some cases the lesion is probably no more than a simple contusion; but in most cases injury seems to play no part and it must be assumed that there is mild inflam mation, of uncertain origin.

Clinical features. Pain beneath the heel on standing or walking is the only symptom. *On examination* there is well-marked local tenderness on firm palpation over the heel pad (Fig. 19.22).

Treatm ent. There is a tendency to slow spontaneous improvement. Recovery may be hastened by the injection of hydrocortisone locally at the site of greatest tenderness, and by providing a sponge-rubber heel cushion on an insole. Ultrasound therapy to the tender area is also worth a trial if pain persists. A ntiinflammatorymedication should also be prescribed.

Plantar fasciitis

In this condition, which is believed to be inflam matory, there is pain beneath the anterior part of the calcaneus. It may be part of a more widespread inflam matory condition such as Reiter's disease.

Pathology. The lesion affects the soft tissues at the site of attachm ent of the plantar aponeurosis to the inferior aspect of the tuberosity of the calcaneus (Fig. 19.22).

Clinical features. The complaint is of pain beneath the heel on standing or walking; the pain extends medially and into the sole. The disability is sometimes severe. When the condition is part of a widespread inflammatory disorder both heels may be affected. *On examination* there is marked

¹James Sever (1878–1964) American orthopaedic surgeon who was Chief at Boston Children's Hospital for 40 years and described the condition in 1912. He also wrote articles on neonatal brachial plexus injuries.

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tenderness over the site of attachment of the plantar fascia to the calcaneus. The site of tenderness is further forward than it is in tender heelpad, just described. *Radiographs* usually do not show any abnormality. A sharp spur projecting forwards from the tuberosity of the calcaneus is sometimes found, but its significance is doubtful because such spurs may be present in patients without heel symptoms.

Treatment. Conservative treatment usually suffices if pursued energetically, though recovery may be slow. A course of non-steroid al anti-inflammatory drugs is usually prescribed. The heel should be protected by a resilient cushion on an insole. If these measures fail, local injection of hydrocortisone into the tender area may be tried. If the fasciitis is part of a widespread inflammatory disorder (notably Reiter's syndrome) treatment appropriate to the underlying condition should be instituted.

PAIN IN THE FOREFOOT (METATARSALGIA)

Pain in the forefoot is one of the commonest orthop aed ic complaints. There are three main causes, of which the first is the most frequent:

- 1. anterior flat foot (dropped transverse arch)
- 2. stress fracture of a metatarsal bone (march fracture)
- 3. plantar digital neuritis (Morton's metatarsalgia).

Anterior flat foot (dropped transverse arch)

Perm anent flattening of the transverse arch of the foot, with excessive weightbearing pressure beneath the metatarsal heads, is the commonest cause of metatarsalgia. In most cases the primary cause is inefficiency of the intrinsic muscles of the foot.

P athology. Even in norm al feet the transverse arch is only a potential arch, not a constant one. But in the norm al state the m etatarsal heads can be raised from the ground at will by the action of the toes, held straight at the interphalangeal joints by the intrinsic m uscles and flexed strongly at the m etatarsophalangeal joints by the intrinsic m uscles in conjunction with the long and short flexors (Fig. 19.23A). Thus the weight is shared between the metatarsal heads and the toes. If the intrinsic m uscles are inefficient the toes are unable to fulfil their im portant weight-sharing function and all the pressure falls upon the metatarsal heads (Fig. 19.23B). The excessive pressure leads to the form ation of callosities.

Clinical features. The main complaint is of pain beneath the forefoot. There may be secondary symptoms from pressure of the shoes upon deformed toes. *On examination* the forefoot is often splayed, appearing broader than normal. There are callosities beneath some or all of the metatarsal heads. The toes are often curled. The patient is unable to raise the metatarsal heads from the ground by pressing downwards with the toes – an indication that the intrinsic muscles are inefficient.

Treatm ent. In patients under 50 worthwhile improvement can usually be gained by a prolonged course of physiotherapy, designed to strengthen the intrinsic muscles by special exercises. In older patients this treatment is seldom effective, and instead a trial may be made of soft moulded orthotic insoles to

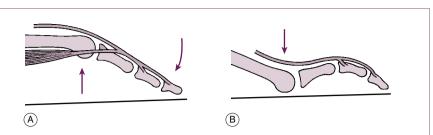


Fig. 19.23 (A) Diagram to show the normal action of the toes in raising the metatarsal heads from the ground, whereby they share the weight with the metatarsal heads. This action is controlled mainly by the intrinsic muscles, which, by producing flexion at the metatarso-phalangeal joints and extension at the interphalangeal joints, cause the toes to press upon the ground, lifting the metatarsal heads. (B) If the intrinsic muscles are inefficient all the weight must be borne by the metatarsal heads.

distribute the weight-bearing pressure over a wide area of the metatarsus. If there is a prominent callosity it may be pared away, with temporary relief. If disability is severe, pain from local prominence of an individual metatarsal head in the sole may be relieved by osteotomy of the neck of the metatarsal and dorsal displacement of the head.

Stress fracture of a metatarsal bone (march fracture; fatigue fracture)

Stress or fatigue fractures are unusual in that there is no history of violence. The possibility of fracture may therefore be overlooked. A stress fracture of a metatarsal is not a common cause of pain in the forefoot but the possibility of its occurrence should be remembered.

Cause. The fracture is ascribed to long-continued or oft-repeated stress, hence the name as it is common in new military recruits subjected to excessive route marching; it has been likened to the fatigue fractures that som etimes occur in metals.

Pathology. The fracture usually affects the shaft of the second or third metatarsal bone, near its neck. It is no more than a hair-line crack, and there is no displacement of the fragments. In the process of healing a large mass of callus may form around the bone at the site of fracture. (This has occasionally been mistaken for a tumour.)

Clinical features. The complaint is of severe pain in the forefoot on walking. The onset is rapid but the patient is usually unable to ascribe it to an obvious cause. Enquiry may reveal, how ever, that he has recently done an unusual amount of walking or marching before the onset. On examination there is swelling at the dorsum of the forefoot, with marked and well-localised tenderness over the affected metatarsal bone.

R adiographs at first show only a faint hair-line crack which is easily overlooked (Fig. 19.24A), but after two or three weeks the callus surrounding the fracture is clearly visible and usually abundant (Fig. 19.24B).

Treatm ent. The fracture heals spontaneously; so treatment is purely symptomatic. Indeed in some cases treatment is not needed; but if pain is severe immobilisation in a below-knee walking plaster for three or four weeks is advised.

The leg, ankle, and foot





Fig. 19.24 Stress fracture of second metatarsal. (A) shows the initial radiograph, taken a week after the onset of pain. The fracture is seen as a fine crack across the bone. (B) shows the condition three weeks later, in the stage of healing. Abundant callus has formed about the site of fracture.

Plantar digital neuritis (Morton's metatarsalgia1; interdigital neuroma)

This condition, which is primarily an affection of a digital nerve, is characterised typically by metatarsal pain combined with a radiating pain in the third and fourth toes.

Pathology. The underlying lesion is a fibrous thickening or 'neurom a' of the digital nerve of the 3-4 cleft just proxim alto its point of division into term inal branches. It takes the form of a fusiform swelling, usually about a centimetre long, surround ing the nerve as it lies in the space between the heads of the third and fourth metatarsals (Fig. 19.25). Occasionally the nerve to the 2-3 cleft is the one affected. The cause of the fibrous thickening is uncertain.

Clinical features. The patient is often a woman of middle age. She complains of pain in the forefoot on standing or walking. A characteristic feature is that the pain, arising in the metatarsal region, radiates forwards into the contiguous sides of the third and fourth toes, or to the fourth toe alone. Rarely, the cleft between the second and third toes is affected. The pain, like nerve pain in general, is piercing and disabling. Patients often state that they can relieve the pain by taking the shoe off and squeezing or manipulating the forefoot.

¹Thomas Morton (1835–1903) American Civil War surgeon and founder of Philadelphia Orthopedic Hospital described the condition in 1876.

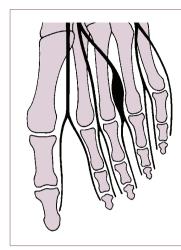


Fig. 19.25 Fibrous thickening of an interdigital nerve, a characteristic feature of plantar digital neuritis (Morton's metatarsalgia). The 'neuroma' is usually in the 3–4 cleft.

On examination the forefoot is often splayed, as in an terior flat foot. Som etim es a painful click can be elicited by compressing the metatarsal heads together from side to side, and upward pressure on the sole between the third and fourth metatarsal heads is painful.

Im aging. Plain radiographs are norm al, but the abnorm ality of the nerve can be visualised with ultrasound or MRI scanning (Fig. 19.26) confirm ing the diagnosis.

Treatm ent. The patient should try first the effect of w earing a sponge-rubber m etatarsal pad to support the anterior arch. If this fails to relieve the symptom s operative excision of the thickened segm ent of the nerve is recommended, though the patient must be w arned that this leaves some residual numbness in the toe.

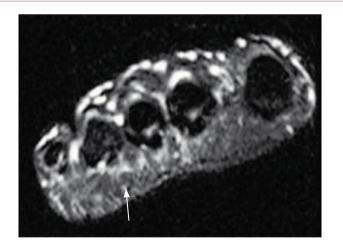


Fig. 19.26 Morton's neuroma shown on an axial T1 weighted MR scan of forefoot. The great toe is on the right of the image and the arrow indicates the small soft-tissue nodule in the interspace between the 3rd and 4th metatarsal heads.

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PLANTAR WART (Verruca pedis; verruca plantaris)

Plantar warts may occur in any part of the sole of the foot, including the under surface of the heel. They are like warts elsewhere, except that they do not project beyond the skin surface. They are distinct from plantar callosities, which are simply localised thickenings of the skin at points of excessive pressure.

Cause. A virus infection is responsible.

Pathology. A wart is a simple papillom a, growing outwards from the basal layers of the skin. It is prevented by the pressure of weight-bearing from projecting much beyond the skin surface, but the surrounding skin is thickened, so the wart may have a total depth of up to half a centimetre. It slow ly enlarges, but seldom reaches a diameter of as much as a centimetre.

Clinical features. The chief com plaint is of severe localised pain on walking. *On exam ination* the skin surrounding the wart is thickened and therefore raised. The wart, a little darker in colour and with a mosaic surface, is seen in the centre of the raised area (Fig. 19.27). Its edge is clearly dem arcated from the surrounding skin: this can be discerned easily if the skin is stretched away from the wart, when a tiny cleft becomes apparent between wart and skin. There is always marked local tenderness on pressure over the wart.

D iagnosis. The main difficulty is to distinguish warts from callosities. Warts occur anywhere on the sole, callosities only over points of pressure. Warts are also much more tender than callosities. But the most reliable distinguishing feature is that a wart has a mosaic surface and a clearly defined margin with a potential cleft between it and the skin (Fig. 19.28A), whereas a callosity blends imperceptibly with the surrounding normal skin (Fig. 19.28B).

Treatm ent. The local application of appropriate caustics is often successful. If this treatm ent fails the wart should be curetted out and the base lightly cauterised.



Fig. 19.27 Plantar wart. Note the clearly circumscribed outline and the slight cleft when the skin is stretched away from the wart.

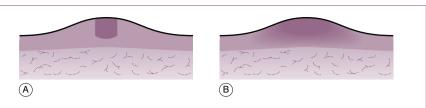


Fig. 19.28 (A) Diagrammatic section of a plantar wart. It is clearly demarcated from the surrounding skin. (B) Diagrammatic section of a callosity. It blends imperceptibly with the surrounding normal skin.

CALLOSITIES

A callosity is simply a localised thickening of the skin in response to abnorm al pressure. It is nearly alw ays secondary to a pre-existing disorder of the foot.

Plantar callosities are callosities on the sole of the foot. They occur under a prominent bone. They are commonest beneath the metatarsal heads when deficient intrinsic muscles prevent the toes from taking their proper share in weight-bearing (anterior flat foot, p. 449). They are also common beneath the base of the fifth metatarsal in patients who for any reason walk with the foot inverted.

Callosities on the toes often take the form of localised thickenings, when they are term ed *corns*. They are caused by pressure against the shoe, and they are especially common when the dorsum of a toe is made unduly prominent by a fixed flexion deform ity, as in hammer toe (see Fig. 19.33A, p. 459).

Treatment. The treatment is mainly that of the underlying condition. Palliative measures include paring of excess epidermis (preferably by a chiropodist, though simple instruments are available for use by the patient), and sponge-rubber padding to distribute the weight-bearing pressure over a wider area.

GANGLION

G anglia are common on the dorsum of the foot and around the ankle. They are similar in all respects to the ganglia that occur at the back of the wrist and hand. They consist of thin-walled sacs filled with glairy viscous fluid, and the fibrous wall is usually connected deeply with a ligament, tendon sheath, or joint capsule. Clinically, a ganglion appears as a fluctuant subcutaneous swelling, which may be either soft or tense. If it causes trouble it should be excised.

DISORDERS OF THE TOES

HALLUX VALGUS

In hallux valgus the great toe is deviated laterally at the metatarso-phalangeal joint. It is common in women past middle age, and is not infrequent even in young women.

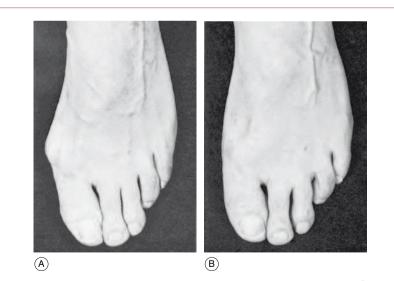
CHAPTER 19

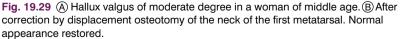
Cause. In some cases, particularly in children and adolescents, hereditary factors are responsible. But in most the deform ity is caused by the toes being persistently forced laterally by enclosure in narrow pointed shoes. The wearing of high heels favours the development of hallux valgus because the forefoot is forced into the narrow pointed part of the shoe.

Pathology. Outward deviation of the great toe is the most obvious feature of the deform ity, but a further, alm ost constant feature is that the first metatarsal is deviated medially, so that the gap between the heads of the first and second metatarsals is unduly wide (metatarsus primus varus). Indeed this may often be the primary defect. A fter several years two secondary changes occur. One is the formation of a thick-walled bursa (bunion) over the medial prominence of the metatarsal head; this may become inflamed, occasionally with suppuration. The second, a later development, is osteoarthritis of the metatarso-phalangeal joint consequent upon its mal-alignment (see Fig. 19.30B).

C linical features. The patient is nearly alw ays a woman, who is often at or past m id dle age when she seeks advice but may sometimes be a young woman or even an adolescent girl. The early symptoms arise from tenderness over the bunion from pressure against the shoe. There is also difficulty in getting comfortable footwear. Later, additional symptoms arise from osteoarthritis of the metatarso-phalangeal joint, and from flattening of the transverse arch (anterior flat foot, p. 449), which is a common associated deformity.

On examination the deformity is obvious at a glance (Figs 19.29A and 19.30A). The skin over the prominent joint is hard, reddened, and tender. Often a thick-walled bursa can be felt, and occasionally it is distended with fluid (Fig. 19.30B). In relatively early cases metatarso-phalangeal joint movements are free and painless, but in severe cases of many years'





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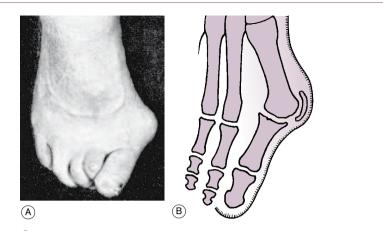


Fig. 19.30 (A) Severe hallux valgus. The great toe is over-riding the deformed second toe. (B) Diagram showing the prominent metatarsal head with overlying bunion, and osteoarthritis from long-standing mal-alignment of the joint.

duration the secondary osteoarthritis makes movement limited and painful. In late cases the forefoot is often flat and splayed, and the toes may be severely curled (Fig. 19.30A).

Treatment. In mild cases treatment is not required, but footwear must be selected with care to obtain adequate width. It may also be worthwhile to protect the bunion with pads of felt, and to wear a wedge of plastic foam between the great toe and the second toe to reduce the deformity.

If disability is troublesome operation is advisable. There is much variation of opinion among different surgeons on the choice of treatment. Mention will be made here of only four of the many methods that are available.

Trimming of 'exostosis'. When the deviation of the toe is slight, but troublesome symptoms arise from localised prominence or 'exostosis' of the first metatarsal head at the medial side of the foot, it may sometimes be sufficient simply to excise the bursa and chisel away the medial prominence of the metatarsal head without disturbing the joint itself. There is, how ever, a tendency for the symptoms to recurafter this operation, and in general the results are so disappointing that the operation is now seldom recommended.

D is placement osteotomy of the neck of the first metatarsal bone. This is illustrated in Fig. 19.31. A fter division of the neck of the metatarsal the head fragment is displaced markedly laterally (Fig. 19.31B). The outward shift of the metatarsal head eliminates the prominence of the 'exostosis' without the need for its removal. The soft tissues between the heads of the first and second metatarsals are also relaxed, allowing permanent reduction of the subluxation at the first metatarso-phalangeal joint. A fter operation the toe may be immobilised in plaster for 6 weeks or fixed with a screw to ensure union at the site of osteotomy without loss of position.

By a process of rem odelling, the alignm ent of the first m etatarsal is gradually altered after operation so that it lies closer to the second m etatarsal (Fig. 19.31B).

In this operation the joint itself is left undisturbed, indeed unopened. The operation gives good results in patients with relatively slight deform ity (Fig. 19.29B): it does not shorten the toe appreciably or impair active movement,

he leg, ankle, and foot

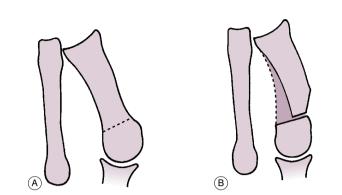


Fig. 19.31 Displacement osteotomy of the neck of the first metatarsal. (A) Before operation. Note the wide gap between the first and second metatarsals. (B) After division of the first metatarsal through its neck the head fragment is displaced markedly laterally, so that its medial prominence (the 'exostosis') disappears. The metatarso-phalangeal subluxation is automatically reduced. Remodelling (interrupted line) alters the shape of the metatarsal and the intermetatarsal gap is narrowed.

and it is therefore particularly suitable for young patients who wish to lead an energetic life.

Excision arthroplasty of the first metatarso-phalangeal joint by Keller's¹ method is widely used in elderly patients. The object is to create a flail, freely movable false joint between the first metatarsal and the proximal phalanx, with correction of the mal-alignment. This is done by excising the proximal half of the proximal phalanx so that a gap is left between the two bones: at the same time the bursa is excised and the medial prominence of the metatarsal head is smoothed off with a chisel (Fig. 19.32A).

The space created by excision of the base of the phalanx fills with rubbery fibrous tissue, and a false joint form s which allows a reasonable range of movement (Fig. 19.32B).

This operation leaves the great toe markedly shorter than normal and rather floppy, with poor active control over toe movements. The patient should be warned about this in advance. Nevertheless the main symptoms are relieved and the result is usually satisfactory in elderly patients who do not wish to walk long distances or to indulge in athletic pursuits.

A rthrodesis of the metatarso-phalangeal joint of the hallux in a position of slight extension allows full and permanent correction of the valgus deformity, even if it is very severe – but at the cost of loss of mobility.

When severe hallux valgus in an elderly patient is associated with flattening of the transverse arch and marked clawing of the toes (see Fig. 19.30A), operation of any type may be disappointing and it may be wiser to rely upon wellmade surgical shoes.

¹William Keller (1874–1959) Distinguished American Army surgeon who served as a general surgeon throughout his long military career, while developing his operation for bunions in 1904.

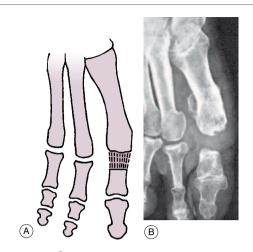


Fig. 19.32 Hallux valgus. A Excision arthroplasty (Keller's operation): removal of the proximal half of the proximal phalanx. The resulting gap fills with flexible fibrous tissue. The bursa and the underlying prominence of the metatarsal head have also been removed. B Radiograph 10 years after Keller's operation for hallux valgus.

HAMMER TOE

The term hammer to e denotes a fixed flexion deformity of an interphalangeal joint.

Cause. Presum ably an im balance of the delicate arrangement of flexor and extensor tendons is responsible; but the precise explanation of its occurrence is unknow n. H ammer deformity, especially of the second toe, is often associated with severe hallux valgus (see Fig. 19.30A).

Pathology. The proximal interphalangeal joint of the second toe is that most commonly affected. The affected joint is sharply angled into flexion. Secondary contracture of the plantar aspect of the joint capsule fixes the deformity, and a callosity usually forms over the dorsum of the flexed joint, from pressure against the shoe (Fig. 19.33A).

Clinical features. Typically the deform ity affects only one toe - usually the second. In the characteristic deform ity the proxim al interphalangeal joint is in fixed flexion, and the distal interphalangeal joint, though still mobile, rests in compensatory hyperextension (Fig. 19.33 A). The symptom s, if any, are caused by the overlying callosity or 'corn' or pain from bearing weight on the end of the toenail.

Treatment. If symptoms are slight the deformity may be accepted, or conservative treatment by protective felt pads may be sufficient. In severe cases operation gives gratifying results. The joint surfaces are excised and the joint is arthrodesed or pseudarthrosed in the corrected position (Fig. 19.33B).

UNDER-RIDING TOE (Congenital curled toe)

Children are often brought for advice because one of the smaller toes, often the fourth, is curled inwards and lies beneath the adjacent toe. The condition does

CHAPTER 19

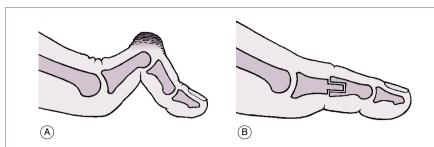


Fig. 19.33 (A) Hammer toe: the typical deformity, with callosity over the prominent proximal joint. (B) Peg arthrodesis, for correction of hammer toe.

not cause any symptoms during childhood, and it should be left alone until adolescence or early adult life, when the toe can easily be straightened if it begins to cause symptoms. Similar principles apply to the management of over-riding toe.

RHEUMATOID ARTHRITIS OF THE TOE JOINTS

D eform ity of the forefoot is a common cause of pain and disability in rheum atoid arthritis, but may be underdiagnosed because of the more visible problems in the patient's other low er limb joints. Characteristically the metatarso-phalangeal joints are most affected, with destruction of articular cartilage, dorsal subluxation of the phalanges and clawing of the toes. Painful skin callosities then develop on the sole beneath the prominent metatarsal heads and on the dorsum of the flexed toes from the pressure of footwear.

In the early stages *radiographs* show only joint narrowing and marginal erosions. In the later stages there may be subluxation or dislocation of the metatarso-phalangeal joints with marked destruction of bone (Fig. 19.34).

Treatment. M inor deform ity may be managed by the provision of moulded insoles and broad-fitting shoes with soft uppers. In advanced disease with fixed painful deform ities forefoot reconstruction is advisable and should norm ally precede surgery for the hindfoot or knee joints to reduce the risk of ulceration and infection. There are a number of different operative procedures to restore the forefoot alignment by excision of the bases of the proxim al phalanges and trimming of the metatarsal heads (excision arthroplasty). Following wound healing, patients may require the provision of orthotic insoles and surgical shoes to allow them to walk in comfort.

OSTEOARTHRITIS OF THE TOE JOINTS

In practice, osteo arthritis in the toes is seen commonly only in the metatarso-phalangeal joint of the great toe. This has been termed *hallux rigidus*. Occasionally the metatarso-phalangeal joint of one of the smaller toes is affected, usually as a late result of Freiberg's disease of a metatarsal head (p. 462).

Hallux rigidus

This is osteoarthritis of the metatarso-phalangeal joint of the great toe. Like osteoarthritis elsew here, it is caused by wear and tear, but previous injury or disease of the joint is an important predisposing factor.



Fig. 19.34 Severe toe deformities from long-established rheumatoid arthritis. Note the subluxation of the metatarso-phalangeal joint of the great toe, and dislocation of several of the lesser toes at the metatarso-phalangeal joints. Some of the metatarsal heads show erosion of bone.

Pathology. The changes are like those of osteoarthritis in other joints. The articular cartilage is gradually worn aw ay from both surfaces of the joint until eventually the subchondral bone is exposed. The exposed bone becomes hard and glossy (eburnation). The marginal bone hypertrophies to form osteophytes, which often cause obvious thickening, especially at the dorsum of the toe.

Clinical features. The complaint is of pain in the base of the great toe on walking. On examination the metatarso-phalangeal joint is palpably thickened from osteophyte formation. If an osteophyte is especially prominent on the dorsal or medial aspect of the joint a thick-walled bursa (bunion) may form over it; occasionally the bursa is distended with fluid. Flexion and extension of the toe at the metatarso-phalangeal joint are restricted – usually markedly so by the time the patient seeks advice (Fig. 19.35A). Forced dorsiflexion of the painful joint on walking is the main source of the disability. (It should be remembered that the normal range of dorsiflexion at the metatarso-phalangeal joint of the great toe is nearly 90°.)

Radiographs confirm the presence of osteoarthritis. The cartilage space is narrow ed, the subchondral bone tends to be sclerotic, and there is osteophytic spurring of the joint margins (Fig. 19.35B).

Treatment. In mild cases treatment is not required. When treatment is called for, conservative measures are usually worth a trial first. A meta-tarsal bar should be fitted beneath the sole of the shoe at the metatarsophalangeal level. This acts as a rocker in walking, and so reduces the dorsiflexion required of the toes when weight is brought onto the forefoot from the heel.

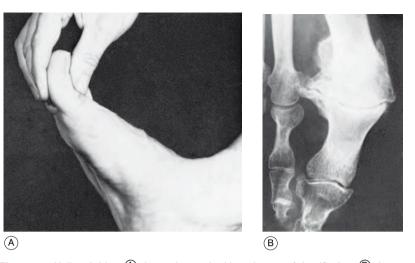


Fig. 19.35 Hallux rigidus. A shows the marked impairment of dorsiflexion. B shows the radiographic changes typical of osteoarthritis, namely narrowing of the cartilage space, subchondral sclerosis, and the formation of osteophytes.

W hen the disability is severe operation should be advised. One method is to create a flail joint by excision of the base of the proxim al phalanx (Keller's arthroplasty), as for hallux valgus. M any surgeons find, how ever, that arthrodesis of the metatarso-phalangeal joint (see Fig. 4.1B) in a position of slight extension gives better results, with complete relief of pain.

Osteoarthritis of other toe joints

Osteoarthritis of the other metatarso-phalangeal joints is uncommon except as a sequel to Freiberg's disease of a metatarsal head (see below).

GOUTY ARTHRITIS OF THE GREAT TOE JOINTS (General description of gouty arthritis, p. 143)

The joints of the great toe are those most often affected in gout, especially in the first attack.

Clinical features. The patient is usually over 40, and more commonly a man than a woman. There is a sudden onset of severe pain in the great toe, often during the night.

On examination the toe is swollen, red, and extremely tender. Joint movements are impossible because of pain. There is sometimes slight pyrexia. The patient will usually recall previous similar attacks lasting a few days, with freedom from pain in the intervals. Radiographs are normal in the early stages. Investigations: There is sometimes a mild leucocytosis. The plasma urate level is usually raised. *Chronic gout*. In this form deposits of sodium biurate in and around the joints of the great toe lead to persistent nodular thickening. *Radiographs* show rounded areas of transradiance in the bone ends; these represent deposits of sodium biurate (which is transradiant) in the subchondral bone.

D iagnosis. A cute gout is easily m istaken for acute infective arthritis. Features suggestive of gout are: a raised plasm a urate level; a history of previous attacks, w ith sym ptom -free intervals; and the presence of tophi in the ears or elsew here.

Course. Gout usually occurs in recurrent attacks. In the early years, an acute attack subsides within a few days, leaving the joint clinically norm al. In chronic gout the joint is gradually disorganised, causing perm anent disability.

Treatm ent. A cute attacks respond to selected non-steroidal anti-inflam matory drugs such as indom etacin or naproxen, begun in high dosage which is reduced after two or three days, or to colchicine. M eanw hile the foot should be rested, and the toe should be protected from pressure by a bulky w ooldressing. The treatm ent of recurrent and chronic gout was detailed on page 145.

FREIBERG'S DISEASE OF A METATARSAL HEAD¹ (Metatarsal osteochondritis)

Freiberg's disease of a m etatarsal head is regarded by some as an example of osteochondritis juvenilis (p. 130) and by others as osteochondritis dissecans (p. 153). It may therefore be advisable to use the non-committal eponymous title for the present. The essential feature of Freiberg's disease is partial necrosis and fragmentation of a metatarsal head, which may become deformed under the pressure of weight-bearing. It is an uncommon condition.

Pathology. The epiphysis of one of the m etatarsal heads – nearly alw ays the second or third – is the part affected. The bony nucleus becomes necrotic and granular. Part of the articular surface separates, usually remaining attached only by a hinge of articular cartilage. W hile it is in this crumbly state the m etatarsal head is crushed by the pressure against it of the base of the proximal phalanx of the toe. The articular surface of the metatarsal head thus loses its norm al dome-shaped contour and becomes flat (Fig. 19.36). A fter about 2 years the texture of the bone returns to norm al, but flattening of the articular to osteo arthritis.

Clinical features. At the time of onset the patient is 14 to 17 years old. There is pain in the affected metatarso-phalangeal joint, worse on standing or walking. On examination there is slight thickening in the region of the head of the metatarsal, which is tender on pressure. Movements of the metatarso-phalangeal joint are slightly restricted and painful. *Radiographs* reveal the nature of the trouble, though at first the changes are very slight and may be overlooked. Later the head of the metatarsal appears fragmented, with patches of increased density. Finally, the articular surface is flattened, so that the end of the bone appears square-cut instead of round (Fig. 19.36).

¹Albert H. Freiberg (1868–1940) American orthopaedic surgeon worked throughout his career in Cincinnati, Ohio. He described the condition, which he described as an infarction from local trauma, in 1914.



Fig. 19.36 Radiograph of forefoot showing the typical appearance of Freiberg's disease in the second metatarsal. There is an abnormal appearance of the metatarsal head, which is flattened and sclerotic due to osteochondritis.

Treatm ent. When the diagnosis can be made in the early stage - before marked radiographic changes are apparent - operation offers a hope of preventing permanent distortion of the joint surface. Through a window cut in the dorsal surface of the metatarsal neck the necrotic bone of the head is curetted out and replaced by cancellous chip bone grafts, packed firm ly enough to restore the norm aldom e-shaped contour of the articular surface. Thereafter the toe is supported in a plaster cuff for 6 weeks.

When deform ity of the metatarsal head is already well established at the time of diagnosis attempted restoration of the articular surface is of no avail. Expectant treatment is then recommended. If pain is troublesome rest in a walking plaster for 2 months may afford relief; but if disabling osteoarthritis develops later the head of the metatarsal should be excised.

INGROWING TOE NAIL (Embedded toe nail)

Ingrowing to enail is common only in the great to e.

Cause. Some persons have toes that are prone to develop ingrowing toe nail. But the main causative factors are incorrect cutting of the nail, pressure on the nail-wall (lateral skin fold) by the shoe or by the adjacent second toe, and accumulation of dirt and sweat.

When the nail is cut its sides should be left long enough to project beyond the term inal pulp (Fig. 19.37A): if it is cut too short a sharp corner of nail lies in contact with the lateral skin fold (Fig. 19.37B), and this corner may tend to embed itself in the skin, especially if there is local pressure at the side of the toe. In the presence of dirt and sweat, infection is then liable to arise.

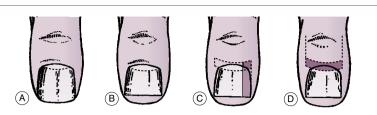


Fig. 19.37 (A) Nail cut correctly. (B) Nail cut too short: corners dig into pulp. (C) Operation for ingrowing toe nail. A strip of nail is avulsed and its re-growth is prevented by excision of a segment of the germinal matrix. (D) Operation for permanent ablation of the whole nail. After avulsion of the nail, only the germinal matrix need be excised to prevent re-growth. The raw area is covered by advancing the proximal skin flap.

Clinical features. The lesion may be at the medial or (more commonly) the lateral border of the nail, or both. There is pain at the affected anterior corner of the nail. On examination the skin fold is inflamed, and there may be local suppuration where the corner of the nail digs into the skin.

Treatm ent. In mild cases conservative treatm ent may suffice. Pledgets of gauze soaked in alcohol (surgical spirit) are tucked beneath the corner of the nail tw ice a day, and the nail is allowed to grow until its edges project beyond the skin folds (Fig. 19.37A).

In long-standing cases operation is advisable. If only one side of the nail is involved it is sufficient to avulse a strip of nail at the affected side and then to prevent re-grow th of this part. Since the nail is form ed only from the germ inal matrix - the proximal curved segment of the nail bed that corresponds to the lunula - and not from the nail bed as a whole, it is necessary to rem ove only an appropriate piece of the germ inal matrix to prevent regrow th (Fig. 19.37C).

In the worst cases, with infection at both sides of the nail, permanent ablation of the entire nail by excision of the whole of the germ inal matrix is more satisfactory (Fig. 19.37D). The small raw area that remains can be covered simply by advancing a dorsal skin flap, based proximally and with its free edge at the nail fold.

SUBUNGUAL EXOSTOSIS

A subungual exostosis is a bony outgrow th from the dorsal surface of the distal phalanx of a toe - usually the great toe. It projects upwards and forwards between the tip of the nail and the term in al pulp. The nail is raised and deformed, and the skin of the pulp overlying the outgrow this thickened and hard. There is sharp pain when pressure is applied over the nail or term in al pulp. *Radiographs* show the exostosis, which is seen best in the lateral projection.

Treatm ent. The exostosis should be excised through a term inal incision just beyond the tip of the nail.

Translated from the Greek, this means 'hooked nail'. The term is descriptive. The nail – usually of the great toe – is enorm ously thickened, discoloured and curved, eventually resem bling a miniature ox-horn (Fig. 19.38). The condition is due to a chronic fungal infection of the nail.

Treatment. Simple removal of the nail is an adequate temporary measure; but the new nail will become similarly deformed. The chance of this is reduced with appropriate oral antifungal therapy. For permanent cure the nail bed must be ablated by excision of the germinal matrix, as described in the section on ingrowing to enail (p. 464).



Fig. 19.38 Onychogryposis.

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