CHAPTER XLVII

DISEASES OF BONES

JOHN CHARNLEY

ACUTE INFLAMMATION

TRAUMATIC PERIOSTITIS is a misnomer for the tender swelling which follows bruising of the periosteum and which is a subperiosteal extravasation of blood. Pressure dressings limit further extravasation. Repeated trauma may result in the formation of periosteal nodes of bone, as on the irregular shins of footballers. If the resistance of the patient is low, or if infective foci are present elsewhere, the subperiosteal hæmatoma, in common with hæmatomata in any part of the body, may become infected, since blood-clot is an excellent nidus for organisms circulating in the blood-stream. A subperiosteal abscess results, and unless the pus is evacuated without delay, necrosis of superficial bone may occur.

ACUTE PYOGENIC OSTEOMYELITIS

Predisposing causes of this condition are as follows :

(i) *Trauma.*—Before growth has finished, the weakest part of a long bone is at the diaphyseal side of the epiphyseal line. At this level (the metaphysis) loops of blood-vessels penetrate the epiphyseal cartilage, and any strain imposed on the bone may rupture one or more capillary loops with the formation of a hæmatoma.

(ii) *An Infective Focus.*—Such conditions as infected scratches, tonsillitis, or impetigo allow organisms to enter the blood-stream. A hæmatoma in any situation then forms an excellent culture medium, in which organisms rapidly multiply. Frequently the bone foci are multiple and mere incidents in a true septicæmia; these patients are, of course, much more ill than in the ordinary case which follows from a simple bacteræmia.

(iii) *Lowered General Resistance.*—In the past the disease was most frequent in industrial areas, where overcrowding and malnutrition were common.

Pathology.—The causative organism in the majority of cases is the *Staphylococcus aureus*, other organisms which are less frequently responsible being the *Streptococcus*, *Staphylococcus albus* and *pneumococcus*.

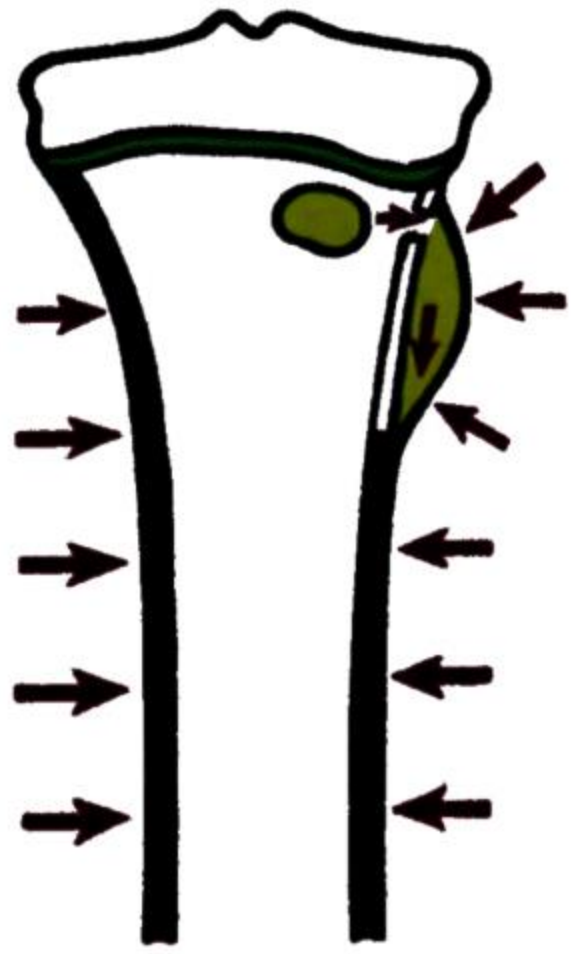


FIG. 1552.—Spread of pus in osteomyelitis.

From its commencement as a small abscess on the metaphyseal side of the epiphyseal line, the pus immediately starts to extend to the surface of the bone, to appear under the periosteum ; it does not spread from the metaphysis directly along the medullary cavity of the diaphysis as might be expected (fig. 1552). The conditions associated with inflammation

of bone are unique in that the vessels in the unyielding bony canals become compressed by exudate, and thus the circulation is impeded, with risk of necrosis of adjacent bone. This death of bone by lack of blood supply is rendered even more certain by the presence of the toxins in the pus. As periosteum is stripped up by a subperiosteal abscess, this underlying bone is separated from its source of blood supply and immediately poisoned. In an untreated case the whole diaphysis may be killed by the pressure of pus stripping the periosteum over its whole surface and on all sides. Owing to the firm attachment of the periosteum to the epiphyseal cartilage and the resistance of the cartilage itself, subperiosteal pus is unlikely to invade the neighbouring joint, unless the epiphyseal line is intra-articular, as in the case of the head of the femur, upper end of humerus, external malleolus, and olecranon process. Pus finally bursts through the periosteum, and tracks under muscles or finds its way to the surface. If the patient survives, the necrosed bone forms a *sequestrum*, the surrounding periosteum becoming extensively thickened with the formation of new bone to form an *involucrum* (fig. 1553), which is perforated by *cloacæ* through which pus and spicules of dead bone escape from the cavity containing the sequestrum.

FIG. 1553.—Large sequestrum and involucrum. (*Sheffield University Museum.*)

Clinical Features.—The symptoms usually start abruptly, the child complaining of severe pain near the end of a bone, the pain being aggravated by movement. Shivering or rigors may occur, and the general symptoms of a severe infection are present.

The severity of the general signs of infection depends on the virulence of the organism and the resistance of the patient. In septicæmic cases the child may be comatose as a result of profound toxæmia; more usually elevation of the temperature by 2° to 3° F. (1° to 2° C.) with associated increase in pulse-rate indicates a more moderate degree of infection.

The local signs depend to some extent on the depth of the affected bone. If the bone is well covered by muscle, as in the case of the lower end of the femur, vaguely localised tenderness above the level of the knee joint associated with some swelling is discovered in the early stages. In the case of a subcutaneous bone, such as the tibia, redness and œdema of the skin, in addition to exquisite local tenderness, will be present in the early stages. In both cases movements of the limb are painful, and likely to be strongly resented. After two or three days local thickening is palpable, and sympathetic effusion occurs into the neighbouring joint. Unless efficient treatment is adopted, the local signs of pus become increasingly obvious; a painful brawny area appears which gradually softens, and finally an abscess bursts through the skin, the resulting sinus leading down to the bone.

Radiography is of little value in the early stages, as bony changes are not usually visible until the end of the second or third week. Leucocytosis is to be expected, and in severe cases a blood culture is likely to be positive.

Differential Diagnosis.—*Acute Suppurative Arthritis.*—This is an intra-articular condition, and therefore the slightest movement of the joint is painful. In the 'sympathetic' effusions associated with acute osteomyelitis, a considerable range of painless movement can usually be obtained if the patient is given time, and the maximum tenderness is near the end of the bone rather than over the joint. If doubt exists, some of the fluid should be aspirated for examination.

Acute rheumatic arthritis is usually polyarticular, and associated with characteristic acid sweats. In the past this differential diagnosis was very difficult and the therapeutic response of acute rheumatic joints to aspirin and salicylates used to be advised. To-day the response to penicillin is more useful than salicylates to establish the diagnosis of osteomyelitis directly.

Hæmarthrosis in children is mentioned on p. 88.

Scurvy.—Subperiosteal hæmatomata are sometimes very tender, and if near an epiphysis the condition may be confused with acute osteomyelitis.

Acute Exanthemata and Typhoid Fever.—These conditions may be suspected on account of the profoundly toxic and even comatose condition of the patient. Careful palpation of the iliac bones and the ends of the long bones is necessary, and if pressure over a localised area induces resentful movements or moaning, then the possibility of osteomyelitis should be considered.

Complications.—Adequate and early treatment by penicillin, or other antibiotics if the infection proves resistant, renders serious complications much less common than formerly.

General.—(i) *Toxæmia.*—Some degree of toxæmia is inevitable.

(ii) *Septicæmia* should be suspected if shivering, rigors, or an intermittent temperature are present. Infection of the serous membranes is likely to occur, particularly of the pericardium.

(iii) *Pyæmia.*—In the past this condition was usually fatal. Infected emboli are carried to the lungs and plum-coloured, wedge-shaped infarcts occur, with a small quantity of blood-stained fibrinous fluid in the pleural cavity. Increased respiration, cyanosis, and patches of bronchial breathing are indicative of this complication.

In addition to these acute manifestations, chronic pyæmia can occur and give rise to abscesses in any part of the body. These abscesses reveal themselves at any time from the first few days of the disease until after the lapse of some months, and often appear like 'cold' abscesses with little or no local discomfort. When first detected these abscesses may contain a pint or more of pus.

Later complications are (*a*) chronic osteomyelitis and (*b*) amyloid disease from chronic suppuration.

Local Complications.

(i) *Joint.*—Acute suppurative arthritis may complicate acute osteomyelitis. In certain anatomical sites the epiphyseal line may be wholly or partly intra-articular, as in the case of the head of the femur, lower end of femur, olecranon process, inner side of the head of the humerus, and lower end of fibula.

(ii) *Spontaneous fracture* may occur, especially when a single weight-bearing bone such as the femur is extensively destroyed by an acute osteomyelitis without new bone formation, though in chronic osteomyelitis with sclerosis of bone it is most

unlikely. Spontaneous fracture is not very common in osteomyelitis and should make one review the diagnosis to exclude the possibility of bone sarcoma or secondary deposit.

(iii) *Deformity* sometimes follows from interference with the epiphyseal line, but it is a remarkable thing how very uncommon this is. Growth at the epiphysis directly affected may be diminished while growth in another at a distance, though reached by the hyperæmia, may be increased (fig. 1554).

FIG. 1554.—Manus valga, following osteomyelitis of the radius, and consequent diminution of its growth. Madelung's deformity.

(iv) *Brodie's Abscess.*—This is a chronic bone abscess which causes intermittent pain near the end of a long bone, with perhaps transitory effusion into the adjacent joint during an exacerbation. Examination may reveal thickening of the bone, and a radiograph is diagnostic. The amount of sclerosis is variable, ranging from dense sclerosis extending a considerable distance round the cavity to more commonly a single layer of sclerosis at the junction of the abscess with the cancellous bone (fig. 1555). If sclerosis is absent, the cavity may be suspicious of a tuberculous abscess. These chronic staphylococcal abscesses were first described by Brodie in connection with the head of the tibia. The abscess may be the sequel to a pyogenic septicæmia from which the patient has recovered some years previously and which has remained dormant in the interval. On the other hand, it may be found years later in a patient who is known to have had osteomyelitis affecting some bone other than the one in which the Brodie's abscess is discovered. Free exposure, curetting, and 'saucerisation' are necessary. Often the cavity is found to contain jelly-like granulation tissue rather than actual pus.

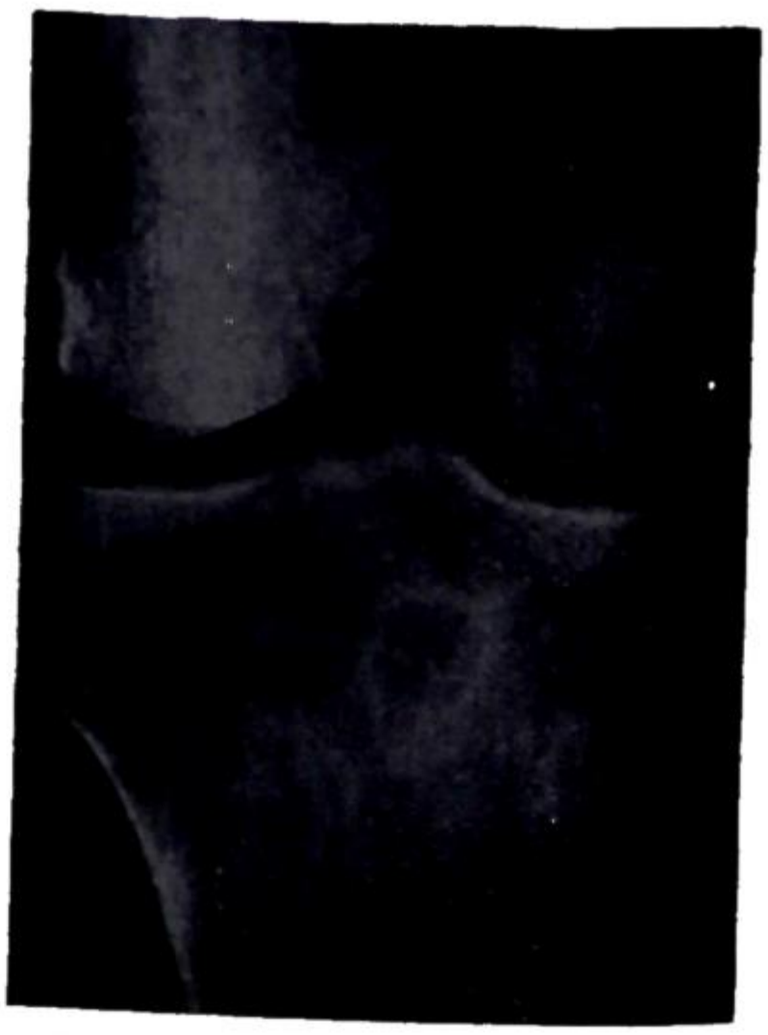


FIG. 1555.—Brodie's abscess in metaphyseal region of upper end of tibia.

It must be emphasised that nowadays all these complications are, with perhaps the exception of Brodie's abscess, rarely encountered since the use of antibiotics which have completely changed the problem of acute osteomyelitis.

Treatment.—Penicillin is administered immediately the diagnosis is a probability and this procedure has reduced the mortality of the disease from 25 per cent. to under 3 per cent. In cases treated within two or three days of onset complete resolution is to be expected within a further three or four days, before radiological evidence of disease is present, if the organism is sensitive to the antibiotic. At least 500,000 units of penicillin are

Sir Benjamin Brodie, 1783–1862. Surgeon, St. George's Hospital, London.

administered daily for a period of three weeks. Persistent local tenderness indicates the possibility of abscess formation. It is important to immobilise in a splint which permits access for the testing of tenderness. An abscess will keep up the patient's temperature if it is not evacuated, and may erroneously suggest that the organism is not susceptible to the antibiotic. Owing to the widespread (and often unnecessary) use of penicillin, resistant strains of staphylococci are increasing in numbers. Therefore, if response to penicillin after three or four days is disappointing, other antibiotics must be tried, and this choice will be helped by sensitivity tests if the organism can be grown from the blood or obtained locally from the site of the disease.

OPERATION is indicated in order to evacuate a subperiosteal abscess, or, in the later stages, to remove a sequestrum. If a subperiosteal abscess is present as indicated by clinical signs, and especially if the toxæmia is not responding to antibiotics, it is unwise to delay surgery lest unnecessary necrosis of bone is produced and the duration of the illness thereby protracted.

(i) *Abscess Formation.*—Aspiration is inadequate. A small incision should be made so that all the pus can be evacuated. The wound is then dusted with penicillin, and sutured. If constitutional disturbance is severe,

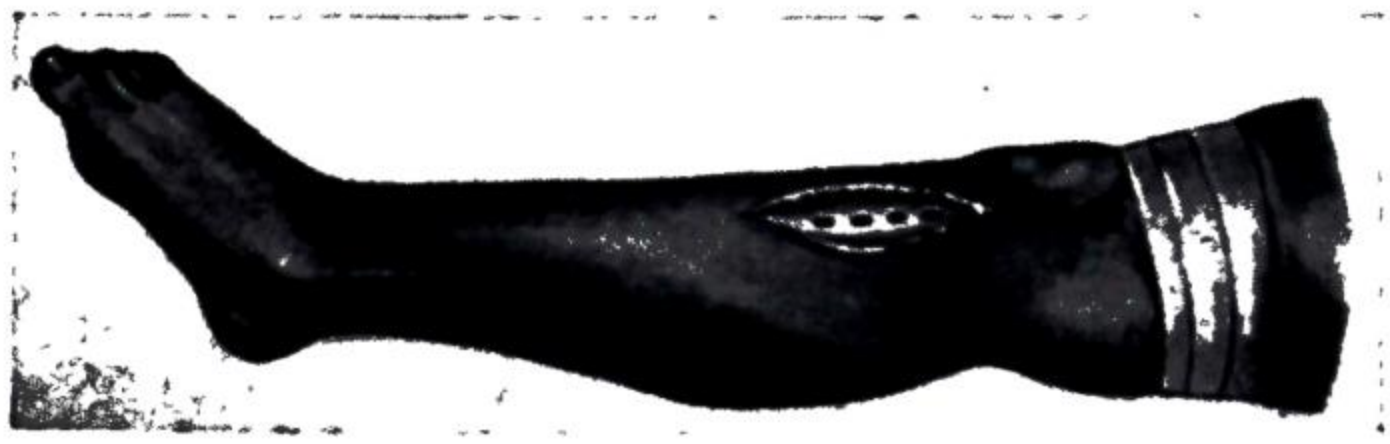


FIG. 1556.—Drilling of the tibia in a case of acute osteomyelitis. An Esmarch's tourniquet has been applied to control hæmorrhage.

or if deep-seated pain suggests intramedullary infection, drilling of the bone is advisable (fig. 1556), and the wound is then closed.

(ii) *Sequestrum Formation.*—Sequestra usually occur because treatment began too late. The sequestrum is produced by death of bone under the combined effects of local toxins and lack of blood supply caused by the obstruction to capillary circulation by the pressure of pus under the periosteum.

It is to be noted that under antibiotic treatment the significance of the X-ray as an indicator of sequestration has slightly to be modified. It is not uncommon to see the X-ray appearances apparently getting worse between the third and fourth weeks in a child who has responded well to penicillin, and who throughout this time has been afebrile, eating well, and without local evidence of inflammation. This merely means that the original local toxæmia killed a certain amount of bone which the penicillin then sterilised, and with the passage of time the process of demarcation of the living bone from the dead goes on as a late aseptic process only when the patient has passed the dangerous phase. In these cases the 'sequestrum' will be reincorporated if there is no discharging sinus.

Friedrich von Esmarch, 1823–1908. Professor of Surgery, Kiel.

ACUTE TRAUMATIC OSTEOMYELITIS

This condition arises as a result of infected wounds, e.g. compound fractures, operations on bones, following amputations, etc. The constitutional disturbances are less severe than in cases of infective osteomyelitis, as the causative wound provides some measure of drainage. More extensive opening of the wound, removal of dead bone, or even amputation may be necessary.

CHRONIC INFLAMMATION

CHRONIC PYOGENIC OSTEOMYELITIS

In addition to Brodie's abscess (p. 1218), which is a hæmatogenous chronic infection where the acute onset has either been absent or rendered insignificant by other more serious events occurring at the time, acute osteomyelitis may persist as a chronic inflammation of the bone and may become a lifelong disability. The risk of this condition developing is now greatly minimised by the modern treatment of the acute infection, but many cases still remain as a legacy of the pre-penicillin era, and more will probably occur if staphylococci become penicillin resistant.

Chronic osteomyelitis may remain quiescent for months or years, but from time to time acute or subacute exacerbations recur, especially if the patient's resistance is undermined by worry, overwork, or other debilitating conditions.

An exacerbation is ushered in with constitutional disturbances and local evidence of inflammation, which may culminate in discharge of pus from a pre-existing sinus. An X-ray sometimes reveals a sequestrum which has separated from the surface of the bone or which lies in a cavity (fig. 1557).

FIG. 1557.—Chronic osteomyelitis of the femur with a cavity containing a sequestrum.

The chronicity of chronic osteomyelitis is the result of the physical characteristics of bone, in that the abscess cavity can never close by the falling in of the walls as happens in the soft parts. Moreover, the effect of inflammation is to kill the hard, bony walls of the abscess, thereby causing sclerosis, and so preventing the antiseptic action of the blood getting to the contents of the cavity. The contents of the cavity thus continue to decompose very much in the same way as would animal matter in a warm, moist test-tube.

TREATMENT consists in immobilisation of the limb and the administration of antibiotics, under which régime many cases subside for a variable period. Surgical intervention has to be considered if an X-ray indicates the presence of a sequestrum or cavitation. If a sinus is present, a sequestrum may be detected with a probe which grates on the loose fragment of dead bone. Penicillin is administered

for some days prior to the operation, and access to the bone is usually gained through a previous scar. The soft tissues are stripped from the bone with a raspatory, and the involucrum is removed as necessary in order to gain access to the sequestrum. If a cavity is present, the overhanging walls are removed with an osteotome, until it is efficiently 'saucerised.' The wound is dusted with penicillin powder and closed.

It is to be noted that so difficult is it to guarantee that an operation will clear up a sinus of many years' duration, that operative intervention is not to be considered lightly unless a sequestrum is known to be present. If a sequestrum is present and is removed, the sinus will probably close. Clinically a sequestrum is often suggested by the presence of pouting granulation tissue at the mouth of the sinus.

If only a cavity is present in the bone without a sequestrum, the attempt to 'saucerise' may fail and still leave a small sinus. There are many cases where, if the discharge is slight and easily controlled by a dressing, it is preferable to retain the sinus and dressing permanently. Amyloid disease need be feared only when a copious discharge of pus has persisted for some years.

Amputation is advisable if exacerbations are frequent or prolonged in order to rid the patient of recurring periods of painful disability, and to forestall the onset of amyloid disease.

SYPHILITIC DISEASES

Congenital.—(i) *Osteochondritis* of the nasal septum is the first manifestation. Necrosis of cartilage occurs at the age of about four weeks, and the resulting discharge causes 'snuffles.' Characteristic depression of the bridge of the nose follows destruction of its support (fig. 31).

(ii) *Craniotabes* of the vault of the skull occurs during the first six months as a result of absorption of bone. This condition is likely to occur in any debilitating disease at this age, and is often due to concomitant rickets (see p. 1229).

(iii) *Parrot's nodes* may appear on the skull during the early years. They consist of patches of periostitis, and if the parietal bones alone are affected, a 'natiform' head results; if the frontal bones are also involved, so that there are four bosses, the term 'hot-cross bun' is applied. Similar patches of periostitis may affect the long bones.

(iv) *Epiphysitis* occurs towards the end of the first year, the epiphyseal line being broader than usual and yellowish in colour. Separation may occur, resulting in so-called 'pseudo-paralysis.' Periostitis extends from the epiphysis along the shaft of the bone and forms a fusiform swelling, unlike the abrupt expansion of rickets.

(v) *Dactylitis* is a rare manifestation which occasionally occurs in severe cases. The osteitis commences centrally, and a marked periosteal reaction occurs.

(vi) *Overgrowth and curvature of the tibia* usually appears towards puberty. The curve is only in an antero-posterior plane, and affects the whole bone.

Joseph Marie Parrot, 1829–1883. Professor of Children's Diseases, Paris.

(vii) *Teeth.*—Hutchinson's notched and peg-shaped teeth affect the permanent incisors (fig. 1558), and Moon's turret-teeth, so called from the absence of the central cusp, occasionally occur in the permanent molars.

Acquired.—SECONDARY stage, bone pains may occur, due to localised patches of periostitis. Permanent periosteal nodes occasionally persist.

FIG. 1558.—Hutchinson's teeth, characteristic of congenital syphilis.

TERTIARY stage, a variety of osseous changes occur; the following are those usually described, but intermediate forms exist :

(*a*) *Periosteal Gumma.*—Single gumma arising in the periosteum characteristically occurs in the tibia, clavicle, and manubrium, although other bones may be affected. A firm, slightly tender swelling appears, which is obviously connected with the underlying bone. As the swelling enlarges, the superficial structures are progressively involved and the skin becomes reddened over the indurated tissues. Eventually the skin softens and sinuses form which allow the escape of necrotic material. A punched-out or serpiginous ulcer results, the floor of which is temporarily covered by a wash-leather slough. Secondary infection is probable, and necrosis of bone then follows.

The nasal septum and hard palate are not uncommonly affected. In these situations extensive necrosis of bone occurs, commonly resulting in perforation of the septum or the hard palate.

Multiple periosteal gummata occur characteristically on the skull (fig. 1559). This condition is now uncommon in civilised countries, but the

FIG. 1559.—Multiple gummata of the skull. (*A. J. King, F.R.C.S.*)

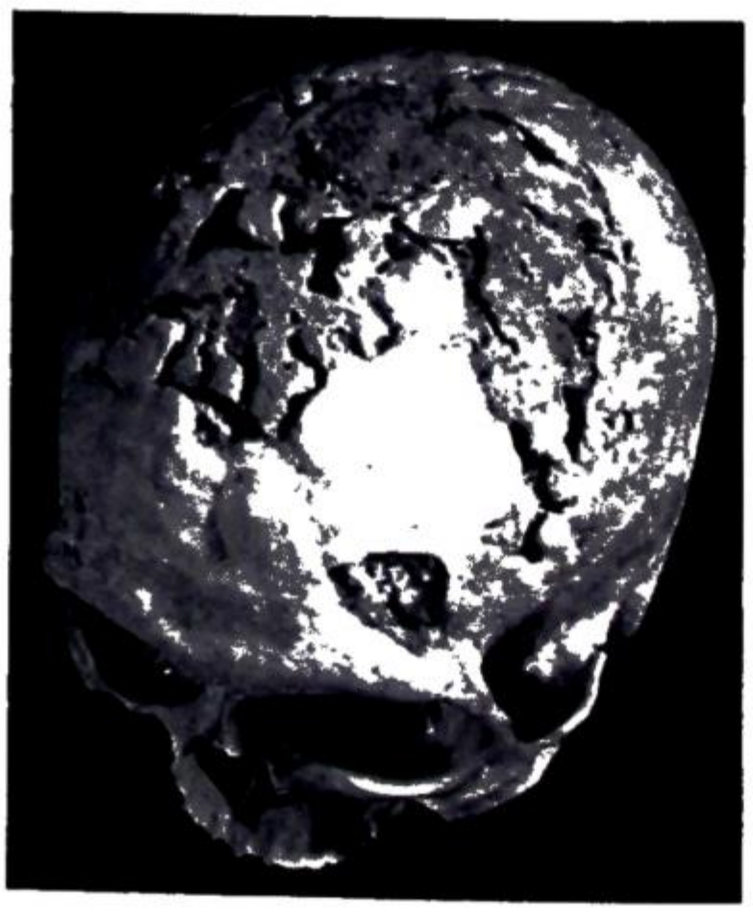


FIG. 1560.—'Worm-eaten' skull. (*R.C.S. Museum.*)

'worm-eaten' skulls of previous sufferers are common museum exhibits (fig. 1560). The local signs are similar to those described above, but secondary infection soon occurs owing to the depth of the hair follicles in the scalp.

Sir Jonathan Hutchinson, 1828–1913. Surgeon, London Hospital.
Henry Moon, 1845–1892. Dental Surgeon, Guy's Hospital.

Necrosis of bone follows, but sequestra may require years to separate, owing to relative avascularity of the compact bone, and associated endarteritis.

(*b*) *Endosteal Gumma*.—Syphilitic osteomyelitis occurring in the tertiary period affects the shafts of long bones. It is now an uncommon condition, but when it does occur errors of diagnosis are likely, and many a limb has been sacrificed unnecessarily under the impression that the bony enlargement was malignant, e.g. osteosarcoma. Perhaps in no other situation does syphilis more justly deserve its title of ' the great imitator.'

The chief symptom of syphilitic osteomyelitis is an aching pain in the bone, boring in character, particularly when the limb is dependent, or at night when covered by warm bedclothes. On examination, some local swelling may be obvious, and palpation reveals thickening of the bone, due to associated periostitis. Examination of the patient frequently reveals other signs of the disease, and the Wassermann reaction is usually positive. X-ray shows marked sclerosis and the formation of new periosteal bone. Biopsy should be undertaken in doubtful cases.

Even vigorous antisyphilitic treatment may fail to relieve the constant pain associated with an endosteal gumma, owing to the protection afforded by the surrounding zone of thickened bone, which prevents remedial substances in the blood from reaching the affected area. Hence trephining or ' guttering ' the bone is sometimes necessary so as to open up the medulla and allow the re-establishment of an adequate blood-supply to the interior of the bone.

(*c*) *Diffuse Sclerosis*.—This consists of thickening of all or any of the periosteal, cancellous, or medullary elements of a bone. The skull and shafts of the long bones are those most commonly affected (fig. 30), and in long-standing cases such a degree of density occurs that the medullary cavity is obliterated.

TUBERCULOUS DISEASE

Tuberculous disease of bone is always secondary to a primary focus in the respiratory tract or bowel. The disease commences either in the interior of the bone or in the periosteum and the organisms reach these tissues from the primary lesion via the blood-stream.

(*a*) **Tuberculous osteitis** starts by blood-borne bacilli lodging in cancellous bone. It thus most commonly occurs at the ends of long bones in relation to joints. Very soon a joint is involved and the clinical signs of tuberculous arthritis dominate the picture. The commonest example of tuberculous osteitis which remains as an osteitis without becoming an arthritis is Pott's disease of the spine. A rare but well-known example of tuberculous osteitis is tuberculous dactylitis affecting the phalanges of the fingers in children, but it is a condition which nowadays has practically disappeared (fig. 1561).

Tuberculous osteitis is insidious in onset, and for some weeks or months the patient may be conscious only of slight weakness or aching, particularly after use. On examination, some puffiness may be noticed, and palpation

August von Wassermann, 1866–1925. Director, Institute for Experimental Therapy, Berlin.

reveals slight thickening of the periosteum, due to œdema. At a later stage the skin becomes shiny, the bone is thickened and tender, and muscular wasting is evident. Finally, a subperiosteal abscess forms, which erodes the periosteum and finds its way to the surface, the last stage being represented by sinuses which lead down to the bone and allow the entry of secondary infection.

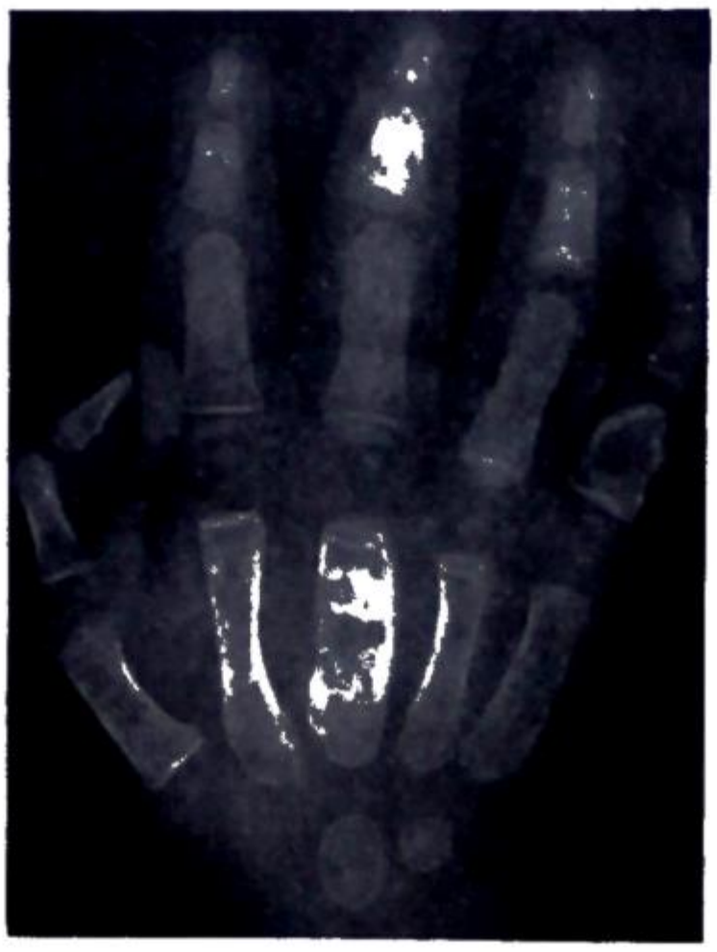


FIG. 1561.—Tuberculous dactylitis affecting third metacarpal and phalanges of fifth finger.

Bone destruction ('caries') is the characteristic feature of tuberculosis and this is seen in the X-ray as a general rarefaction of the bone with blurring of the bone detail and erosion of the shell of cortical bone underlying the articular cartilage. The formation of sequestra is not uncommon but these are small and not so dense as those in pyogenic bone infections. New bone formation and bone sclerosis are not characteristic of a tuberculous lesion but are seen when secondary infection is present.

(*b*) **Periosteal tuberculosis** most commonly affects the flat bones, e.g. the ribs, sternum, or skull, and especially the ribs. Infection commences in the deeper layers of the periosteum, which becomes œdematous, and is soon separated from the underlying bone by granulation tissue. Caseation and cold abscess formation follow, the superficial structures becoming progressively adherent and invaded, while the bone itself is eroded. In the case of a rib the abscess extends along the bone to discharge some distance from the site of origin. Finally, the skin is involved and the abscess discharges on the surface, and secondary infection follows. X-rays show erosion of the bone if the condition has advanced sufficiently.

Treatment.—In the treatment of local tuberculous lesions in a bone or joint, the surgeon must never forget that the patient is a tuberculous subject and that the systemic approach to the disease is the first essential.

It is useless to excise a diseased bone, or splint a tuberculous joint, if the patient is not gaining weight and if at that moment he may be starting with some other secondary complication, such as renal tuberculosis.

Outdoor therapy in a sanatorium is an absolute essential. Bed-rest, good food and exposure to open air will in most cases soon stimulate an appetite and help to decrease toxæmia, even in the absence of antibiotics. Recent advances with antibiotics and chemotherapy (streptomycin, either alone or combined with para-amino-salicylic acid and isoniazid) are greatly assisting the basic techniques of systemic therapy in open-air sanatoria.

Only when the systemic element seems to be under control should local surgery be considered. Often spontaneous healing will take place secondary to the improvement in the general condition of the patient. At other times the excision of areas of diseased bone, or the curettage of diseased

sites will help to clear up sinuses. Sometimes amputation is inevitable, but much less so since the advent of chemotherapy.

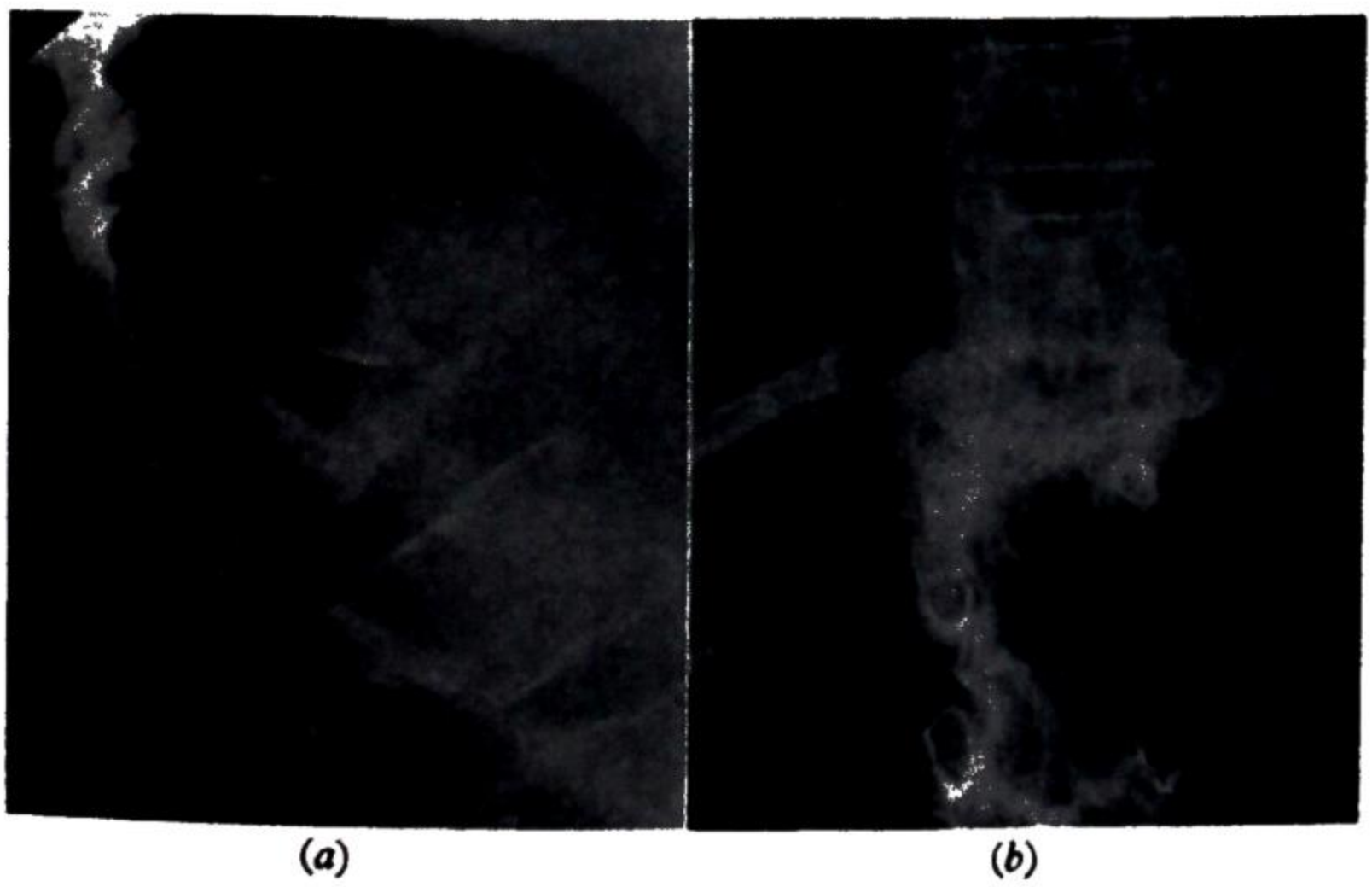
Healing of the local lesion is indicated clinically by the loss of swelling and local heat, and radiologically by the return of bone detail and normal bone density.

POTT'S DISEASE (TUBERCULOUS SPONDYLITIS)

Pott's disease of the spine is the commonest form in which tuberculous disease affects the skeleton. It can occur at any age, and though formerly it affected children more commonly than adults, since the second world war there has been a steady decline in the incidence among children. This is undoubtedly due to improved Public Health measures and improved nutrition. Though in the past the milk supply was held responsible for most bone and joint tuberculosis, this opinion now needs revision as most commonly the organism to-day is of human origin.

The most common site of Pott's disease is in the thoraco-lumbar region; lumbo-sacral and high thoracic disease is next in frequency with the cervical region as a relatively rare site.

The disease starts as an osteitis in the cancellous bone of a vertebral body adjacent to an intervertebral disc. It is characteristic of the development of the disease that the intervertebral disc is destroyed at a very early stage and there may be radiological narrowing of the disc space before loss of detail



(*a*) (*b*)

FIG. 1562.—Pott's disease: (*a*) Collapse and fusion of two vertebral bodies with single wedge. (*b*) Perispinal abscess shadow.

of the adjacent bone surface can be established in the X-ray with certainty. Further destruction of vertebral bodies occurs by extension of pus as a 'perispinal' abscess under the anterior common ligament and at the sides of the vertebral bodies (fig. 1562). Eventually collapse of the bodies occurs and a kyphosis will be produced whose degree of angularity depends on the number of vertebræ destroyed (see p. 1316). In Pott's disease collapse of

vertebral bodies anteriorly always causes a kyphosis and, for all practical purposes, never a scoliosis (figs. 1563 and 1564).

The perispinal abscess tracks along muscle planes, under the influence of gravity, and often becomes subcutaneous as a cold abscess at a site remote from the source of the disease. Thus low thoracic or upper lumbar disease may track as a psoas abscess, to appear above or below Poupart's ligament in the groin where it may be mistaken for a femoral or, less commonly, an inguinal hernia if it has a transmitted impulse on coughing (fig. 1565). If neglected, the natural sequel would be for the abscess to discharge and for a sinus with secondary infection to result.

FIG. 1563. — Pott's disease, with gross angular curvature.

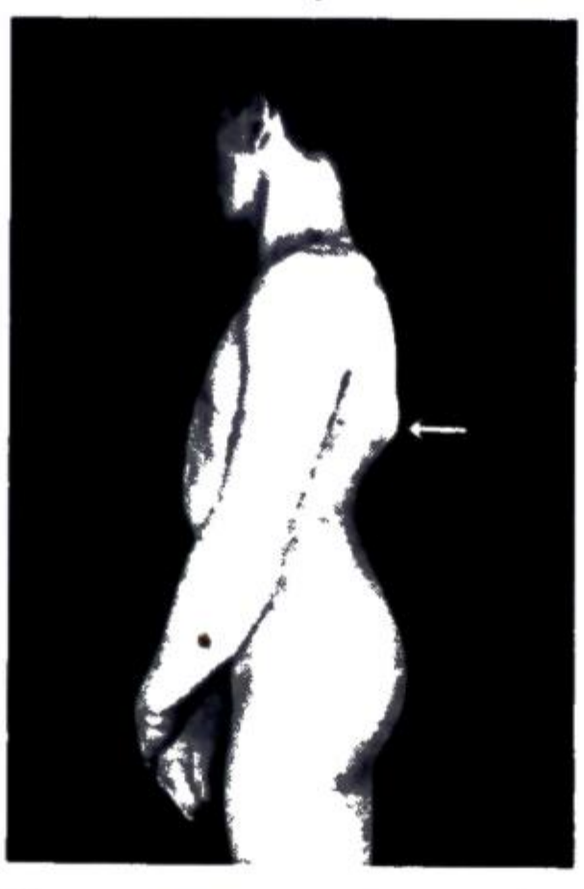


FIG. 1564. — Kyphosis due to Pott's disease.

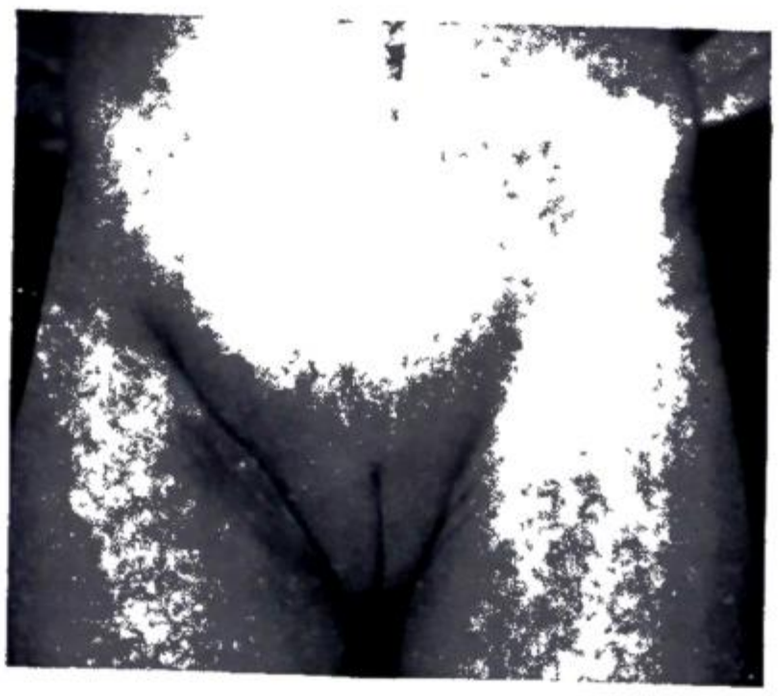


FIG. 1565.—A psoas abscess pointing in the right groin. (*Pybus.*)

In Pott's disease in the thoracic region (i.e. above the level of the cauda equina and at the level of the spinal cord), the pressure of a tense perispinal abscess communicating with pus inside the spinal canal can cause compression of the cord with paraplegia (Pott's paraplegia).

Clinical Features.—These vary to some extent with the level of the disease, but the following general remarks apply to all levels.

Symptoms.—It is characteristic of Pott's disease that the onset and initial stages of progress are so insidious that they can pass unnoticed until sometimes the dramatic symptoms of paraplegia, the development of a kyphus, or the appearance of a large cold abscess may be the first evidence of serious disease. Very often in adults vague symptoms of backache are dismissed for six to twelve months as 'rheumatism' or 'fibrositis,' and then X-ray examination shows extensive destruction of vertebral bodies and a perispinal abscess.

There will usually be the general systemic signs of lassitude, loss of weight, night sweats, and evening pyrexia.

Signs.—The most important sign, for the early clinical diagnosis of these cases, is rigidity of the spine. A moderate degree of limitation of forward flexion in a patient complaining for the first time in his life of indefinite mild backache is much more sinister than severe limitation of flexion in association with intense back pain in a patient who has had similar acute attacks in the past. The former may well be Pott's disease, whereas the latter is more likely to be an acute disc lumbago.

Palpation of the abdomen and groins should be carried out to exclude the presence of abscesses.

Palpation of the spine may reveal an early 'knuckle' kyphosis.

Examination of the knee-jerks and plantar responses, in dorsal disease, may reveal evidence of early pyramidal tract involvement, often before the patient complains of difficulty in using his legs.

Radiology.—Radiological examination of the spine will usually establish the diagnosis immediately. In the lateral view narrowing of an intervertebral disc space associated with a little erosion of an adjacent vertebral body is the earliest definite sign. In the antero-posterior view the presence of a perispinal abscess will confirm the diagnosis. Destruction of a vertebral body, without narrowing of a disc space, and particularly if without a perispinal abscess, is more likely to be a secondary deposit than Pott's disease.

In old-standing disease the perispinal abscess may be calcified (fig. 1566).

FIG. 1566. — Old-standing tuberculous disease of the second lumbar vertebra, with calcified psoas abscesses.

Treatment.—As in the management of a tuberculous joint (p. 1279) there are three phases of treatment to be distinguished:

Phase I.—Recumbency and general systemic measures (fresh air, diet, and antibiotic drugs). During this time the patient is immobilised on a spinal frame or in a plaster bed. In thoracic lesions below the mid-thorax the head can be left free, but in cervical and upper thoracic lesions the head will need restraint.

Abscesses are aspirated, and re-aspirated at intervals if they tend to refill.

In this way it may take one or two years to reach the stage of quiescence, as shown radiologically by the fact that further destruction has been absent for six months and perhaps that some tendency to recalcify may be detected. Quiescence cannot have been reached if palpable abscesses are still present.

Phase II.—Quiescent ambulation in apparatus. For most levels a posterior spinal support is sufficient to brace back the shoulders and counteract a forward stooping position. At higher levels a blocked leather collar may be needed. Under the protection of such appliances many cases will pass on to natural spontaneous healing, which (unlike tuberculous disease in

large joints) is a true bony fusion between the vertebral bodies. This often may take as long as five years to become complete. When this has happened, all external support can be discarded.

Phase III.—Arthrodesis (spinal fusion). If spontaneous fusion of the vertebral bodies has taken place or seems likely to be taking place, operative fusion is unnecessary. In cases where no evidence of spontaneous fusion can be seen and where the spine looks unstable, a posterior spinal fusion is frequently employed so that the patient can eventually discard all external support.

Technique.—Bone grafts are laid on the roughened dorsal surfaces of the spinal laminæ and on each side of the roughened and split spinous processes. The grafts may be taken from the tibia with an electric saw or may be chips of cancellous bone from the iliac crest. The erector spinæ muscle is closed over the graft and immobilisation for three months will usually be enough for the graft to become incorporated (fig. 1567). Protection for another three to six months in an ambulatory appliance is then needed before finally discarding all support.

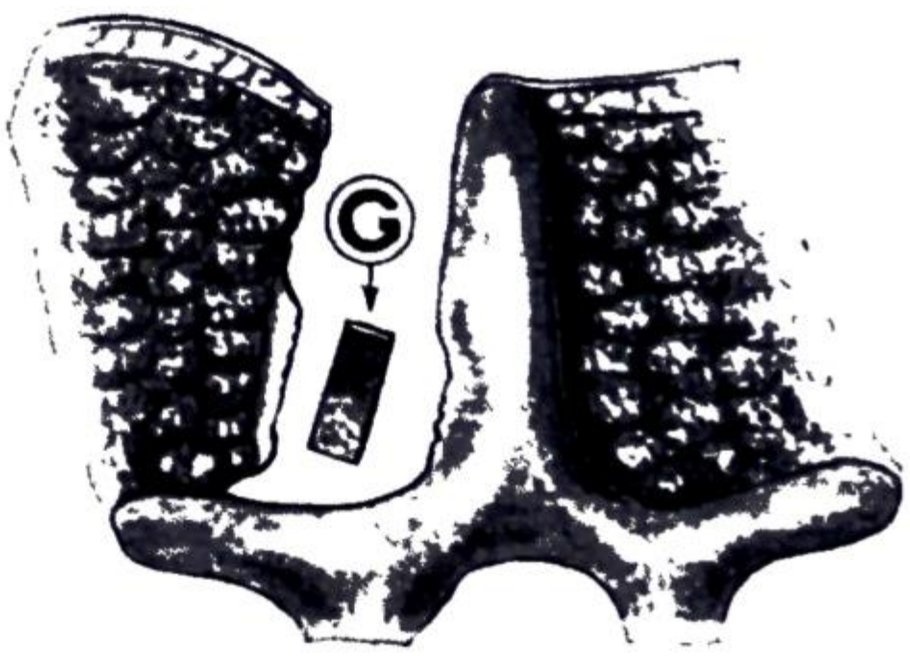


FIG. 1567.—G = graft, inserted between spinous process and muscles.

Pott's Paraplegia.—The onset of spastic paresis in Pott's disease is a sign of the utmost gravity, and there are still features of the ætiology which as yet are not sufficiently well understood for a dogmatic statement on the best form of treatment. There are so many possible elements causing the paraplegia that probably no single explanation fits all cases. Thus 'early onset' paraplegia, occurring *pari passu* with the earliest stages of the disease, does not have the same mechanical element which is generally present in the 'late onset' cases with severe kyphus, where paraplegia supervenes years after the start of the disease. Even cases of 'late onset' paraplegia, with acute angulation inviting the idea of pressure on a backward displaced bony projection, can still be due to recrudescence of active disease. In active disease it would be a great step forward if we could distinguish whether the paraplegia is due to mechanical compression by an extradural abscess or by a sequestrum, or whether it is due to inflammatory involvement at the level of active disease, and even, in some cases, to vascular thrombosis in the cord. Obviously mechanical decompression of the cord would help the first but not the last, and if mechanical causes are present it is important to remove them without undue delay.

Historically, it may be said that approximately 50 per cent. of Pott's paraplegias recovered spontaneously on ordinary sanatorium treatment (without antibiotics) and 50 per cent. got worse and eventually died. In those cases where the osseous lesion healed the paraplegia also healed, but where the osseous lesion turned into 'chronic grumbling disease' the paraplegia persisted. In an attempt to decompress the cord, the next phase in evolution was a laminectomy designed to evacuate pus from the spinal

canal and leave room for dorsal expansion to reduce pressure. The results were so uniformly bad that the method was soon abandoned, and the only surgical procedure advocated was that of 'costo-transversectomy' in which the perispinal abscess was drained by removing a rib. In many cases, especially with a tense-looking spherical perispinal abscess, decompression of the perispinal abscess can decompress the associated intraspinal abscess, and this procedure is still used with considerable success.

In recent years there has again been a revival of interest in the direct surgical decompression of the spinal cord, but more emphasis is now laid on the removal of sequestra or protruded disc material lying directly *in front* of the cord (antero-lateral decompression). Remarkable recoveries from paraplegia have followed this procedure, but it is still too early to make a final pronouncement on the indications for this severe operation.

Undoubtedly the degree of paralysis at the time of receiving the patient in hospital must have an important bearing on recovery—either by conservative or operative measures. Patients in flaccid paralysis or with extreme flexion contractions, with complete urinary retention, or when vibration sense in the legs is absent, are much less likely to make a recovery, by any method, than others less profoundly affected.

DEFICIENCY DISEASES

RICKETS

Rickets is a disease not exclusively affecting bones, but involving the body as a whole. The characteristic bony changes may be considered with advantage in this chapter.

Rickets is a deficiency disease, the essential cause being lack of vitamin D, which is a component of natural fats and oils. In addition, lack of sunshine and insufficient ingestion of calcium and phosphorus are contributory factors.

Though at one time extremely common in England (called, indeed, the 'English disease' by the French) simple rickets is now one of the rarest. The diseases in which calcium metabolism is disturbed by other causes (see later), at one time considered rare, are probably now the commoner type.

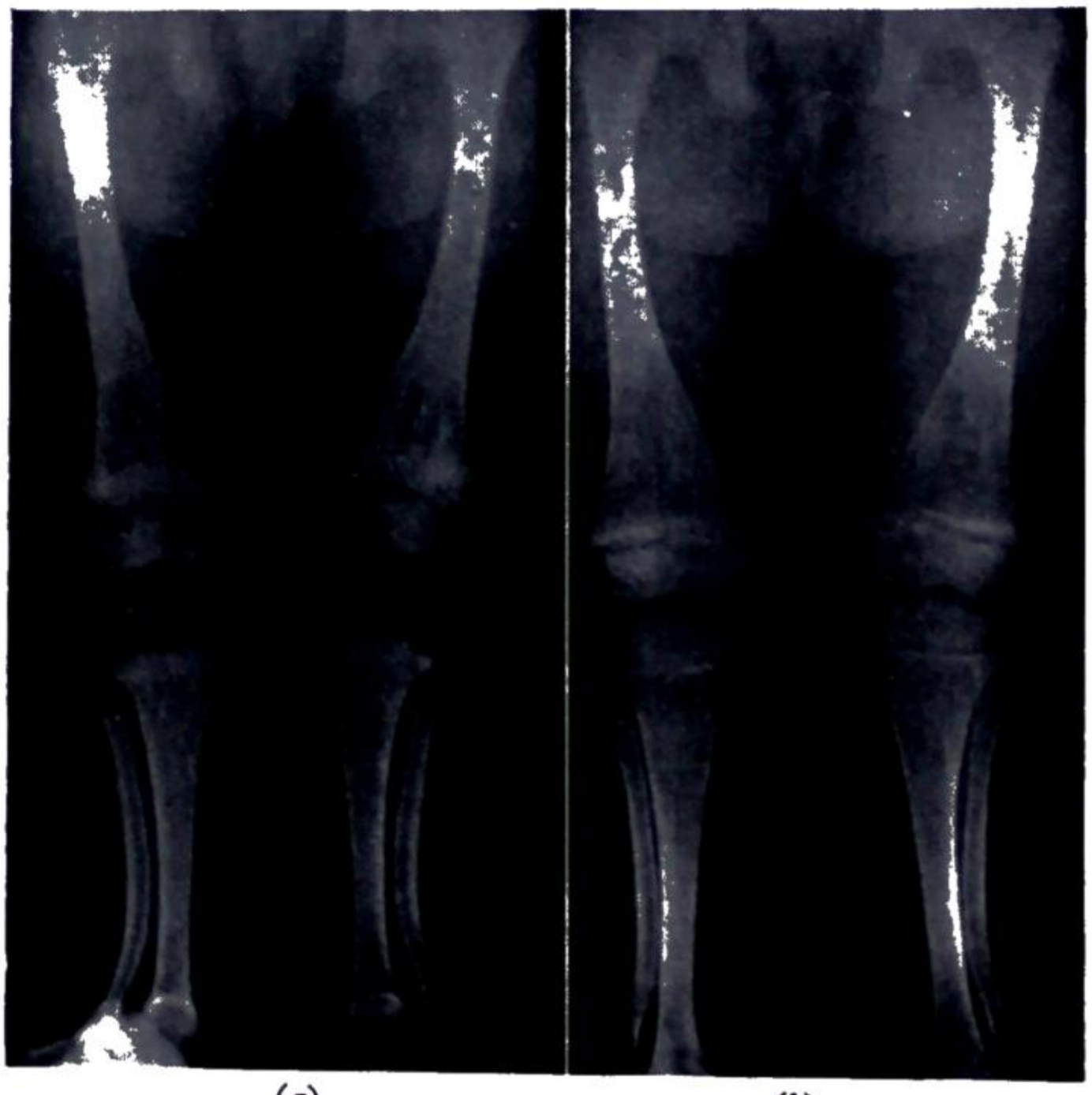
The pathological changes which occur mainly affect the epiphyses, the cartilages of which are enlarged both longitudinally and laterally. The most characteristic radiological abnormality in active rickets is the 'cupping' of the epiphyseal line. The epiphyseal line is blurred and concave towards the epiphysis (fig. 1568). Histologically the zone of provisional calcification is either absent or represented by irregular patches, and therefore no definite line of demarcation exists between the proliferating cartilage and the medullary spaces. Instead of being composed of bone, the new-formed trabeculæ are of osteoid tissue, which contains no calcium salts, while the medullary spaces are filled with vascular fibrocellular tissue instead of normal bone marrow. The deformities associated with rickets are due to lack of rigidity of this osteoid tissue. As the disease is overcome, calcium salts are deposited, and the deformed bones become normal in texture, or in some cases even denser than normal.

Deformities are due to the weight of the body, the influence of posture, or to the constant pull of muscles bending the softened bones.

Clinical Features.—The child is usually flabby, and sweating of the head is common. It is particularly susceptible to respiratory and gastro-intestinal disturbances, and the abdomen becomes protuberant owing to enlargement of the liver and spleen. Umbilical hernia is common as a result of prolonged distension.

Bony developments cause restlessness and peevishness, and the child, on account of epiphyseal tenderness, resents being handled. As the disease progresses deformities appear, among which the following are typical :

Epiphyseal Enlargement.—The increased width of the epiphyses can usually be felt (fig. 1569). These swellings disappear as the disease fades, and the formation of periosteal bone causes increased width of the shaft.



(*a*) (*b*)

FIG. 1568.—Rickets: (*a*) Florid state; (*b*) healing state.

Ribs.—The 'rickety rosary,' due to beading of the costo-chondral junctions, is of the same nature as epiphyseal enlargements. The swelling is more pronounced on the posterior surface. Harrison's sulcus is due to abdominal distension 'spreading' the lower ribs, and not to the inward pull of the diaphragm.

FIG. 1569.—Rickets, showing the deformed legs and pot-belly. (*Pybus.*)

Long Bones.—Bending of the long bones is more marked in the legs because of weight bearing. Natural curves are exaggerated and thus the femur shows increase of the normal anterior curve. Bending of the neck produces coxa vara.

The tibia is characteristically bent in two planes. An abrupt kink occurs in the lower third of the bone, the portion below this being bent backwards and inwards (fig. 1570). A well-marked buttress formation occurs in the concavity, and the anterior border of the bone is sharp, owing to lateral compression of the shaft.

The Skull.—Craniotabes occurs as a result of any severe constitutional disturbance, and if associated with rickets is most obvious in the region of the lambdoid suture. Closure of the fontanelles and dentition are delayed. As the skull develops it becomes broader and flatter than normal, and the increased width between the eyes indicates broadening of the base.

The Spine.—The child is tardy in its efforts to sit up. Kyphosis constitutes the first spinal deformity, which may be followed by scoliosis due to posture or to inequality of the legs.

The Pelvis.—Two types of deformity may result. In the flattened type the conjugate diameter is diminished, while if the lateral walls are approximated, a triradiate deformity results.

Stature.—Diminution in stature is due to the following reasons :

(i) The actual growth of bone is retarded, especially that of the tibia and femur, which may be as much as one-quarter shorter than those of a normal child of equal size and age.

(ii) Bending of the bones of the legs, and by spinal deformities.

Edwin Harrison, 1766–1838. A general practitioner, Horncastle, Lincolnshire, England.

Treatment.—Early recognition and appropriate treatment are rewarded by ready response. Fresh milk, cod-liver oil, and meat extracts are administered as freely as the child will digest them. Judicious exposure to natural or artificial sunlight or ultra-violet rays is beneficial, as by this means ergosterol, normally present in the skin, is converted into vitamin D.

Early bony deformities respond to appropriate splinting. In the case of the tibia, manual osteoclasis may be necessary, and should be performed during the third or fourth year.

OSTEOCLASIS is performed by resting the leg on a rubber-covered wedge, the leg lying on its outer side. Pressure is applied so that the fibula and then the tibia snap opposite the site of maximum deformity. Care must be taken to grasp the lower end of the bone as close to the deformity as possible, as cases have occurred where the lower epiphysis has been separated. A plaster of Paris casing is applied for three weeks.

In older children or adults osteotomies are sometimes necessary.

FIG. 1570.—Rachitic tibia, showing abrupt curvature in the lower third of the bone, and well-marked buttress formation.

RENAL RICKETS

is a rare condition, due to renal insufficiency during childhood, as a result of chronic interstitial nephritis, or, more rarely, polycystic kidneys. Thirst and polyuria, followed by headache and vomiting, are the symptoms which should suggest renal disease, but cardiovascular changes are absent. The blood urea content may be as high as 300 mg. or more per cent.

Bony deformities appear at any age, and in the early years separation of epiphyses may occur. After the first decade the changes somewhat resemble rickets, and deformity follows.

Death from uræmia is seldom delayed beyond puberty, and is hastened by any operative interference, such as osteotomy.

RESISTANT RICKETS

This is a condition in which rachitic changes are present in spite of a normal diet and normal intake of vitamin D. It will heal when very heavy doses of vitamin D are given for long periods. The nature of the resistance is unknown. The age of onset is usually about five years and thus considerably later than the appearance of ordinary rickets.

FANCONI'S SYNDROME

In this condition the calcium and phosphorus metabolism is disturbed by a renal abnormality in which glycosuria and albuminuria are often associated with cystinuria. There are rachitic changes in the epiphyses if the condition occurs in early life, or in adult life osteoporosis with deformity and fractures. There may be considerable nephrolithiasis due to loss of calcium through the kidneys.

LATE RICKETS AND OSTEOMALACIA

Later in life the dietary deficiencies which are responsible for rickets, particularly when associated with unfavourable hygienic and social conditions, may be associated with important bone changes which are called late rickets, or osteomalacia, according to the age at which they occur. The lesions of osteomalacia may be regarded as those of rickets in the absence of growth.

Late rickets is a rare disease which occurs during puberty or adolescence. In some cases careful enquiry and examination suggest that this is due to a recrudescence or relapse of the ordinary type of this disease. In a typical case of late rickets the head is not affected, and bending of the bones occurs close to the epiphyses. Severe pain occurs in the bones, which are tender on palpation, and gross deformity occurs in advanced cases. As with infantile rickets, ingestion of substances containing fat-soluble vitamin D results in rapid improvement.

Guido Fanconi, 1882–1928. Professor of Pedriatics, University of Zürich.

Osteomalacia is rare in this country, although in some localities, e.g. the Himalayas and North China, it is by no means uncommon. Nine-tenths of cases occur in females, mostly during the child-bearing age. The condition often appears during pregnancy, but the actual cause is an insufficiency of vitamin D and calcium salts. Tetany may occur in advanced cases.

The changes in the bone consist of decalcification of the osseous framework and metaplasia of the resulting matrix and medulla to fibro-cellular tissue. The compact bone may become as thin as paper, and the marrow represented by fatty fibro-cellular tissue of a vascular nature, which has been likened to liver or splenic pulp. Calcium and phosphorus contents of the blood are normal.

The main symptom is pain in the bones, which is deep-seated and aggravated by movements or pressure. Lassitude and asthenia follow, and gross deformities (fig. 1571) and fractures become increasingly in evidence, especially with repeated pregnancies.

FIG. 1571.—Pelvic deformity due to osteomalacia.

Treatment demands a food rich in calcium and substances containing fat-soluble vitamin D. Cæsarian section is sometimes necessary for subsequent pregnancies.

CŒLIAC RICKETS (*syn.* GEE'S DISEASE)

This disease begins in early childhood and is characterised by the passage of offensive fatty stools and changes in the bones similar to osteomalacia. The patient is usually ill-developed, anæmic, and in severe cases tetany may supervene. It is probably due to some gastro-intestinal disturbance which results in deficient utilisation or absorption of some essential factor. In most cases the serum calcium is below normal and the plasma phosphatase is increased.

Rapid improvement follows if a diet is given which is rich in calcium and low in fats, together with some preparation of vitamin D. Anæmia is combated with iron, and deformities require splinting pending regeneration of bones.

SCURVY

Scurvy is occasionally seen in children who are weaned at an early age. Most prepared foods are deficient in vitamins, and the anti-scorbutic vitamin (vitamin C) appears to be particularly susceptible to heat.

The disease appears in the sixth month and never after the sixteenth month; in addition, rickety changes of a variable degree may be superadded. Scurvy is characterised by subcutaneous or submucous hæmorrhage, subperiosteal extravasations which are markedly tender (they have been mistaken for acute osteomyelitis), and in more advanced cases by sponginess of the gums and even hæmaturia.

If neglected, the disease may progress to a fatal issue, preceded by separation of epiphyses, melæna, and emaciation.

Treatment consists in the administration of such anti-scorbutic remedies as fresh fruit juice, uncooked meat juice, cabbage water, mashed potato, and cream.

Scurvy in children is nowadays rarely encountered and most frequently is now seen in elderly patients on defective diet.

GENERAL DISEASES OF BONE

OSTEITIS DEFORMANS (*syn.* PAGET'S DISEASE OF BONES)

This condition, first described by Sir James Paget in 1877, occurs rather more commonly in men than in women. The generalised disease as Paget described it is uncommon, but in more recent years the detailed autopsy investigations of Schmorl show that localised forms of the disease occur in 3 per cent. of persons over forty years of age. This figure, of course, includes many subclinical and non-clinical forms of the disease as well as examples of the classical deforming condition that Paget described.

The ætiology of Paget's disease is completely unknown. Pathologically

Samuel J. Gee, 1839–1911. Physician to St. Bartholomew's Hospital, London.
Sir James Paget, 1814–1899, Surgeon to St. Bartholomew's Hospital, London, described the disease in 1877.
G. Schmorl, Contemporary. Professor of Pathology, Dresden.

it appears to be one of the 'fibrous dysplasias' of bone, and has some histological features very similar to those of osteitis fibrosa, though without the tendency to form cysts and collections of osteoclasts. The marrow spaces between the trabeculæ are filled with fibrous tissue. The dense regular cortex of a normal bone in Paget's disease is replaced by a spongy tissue which is two or three times thicker than the normal cortex and which is not clearly demarcated from the medullary canal which is correspondingly small, or even absent. The exterior of the bone is rough and pitted, due to the deposition of spongy subperiosteal bone. Though the bones are much thickened, they tend to bend and deform. Radiologically a number of variable appearances are present, often in the same patient, which range from an 'etched' or striated appearance (fig. 1572), to those of such extreme density that no accurate bone detail can be seen (fig. 1573). Sometimes the pathological process will affect only part of a single bone and the junction between normal and diseased bone may be quite sharp and clearly demarcated.

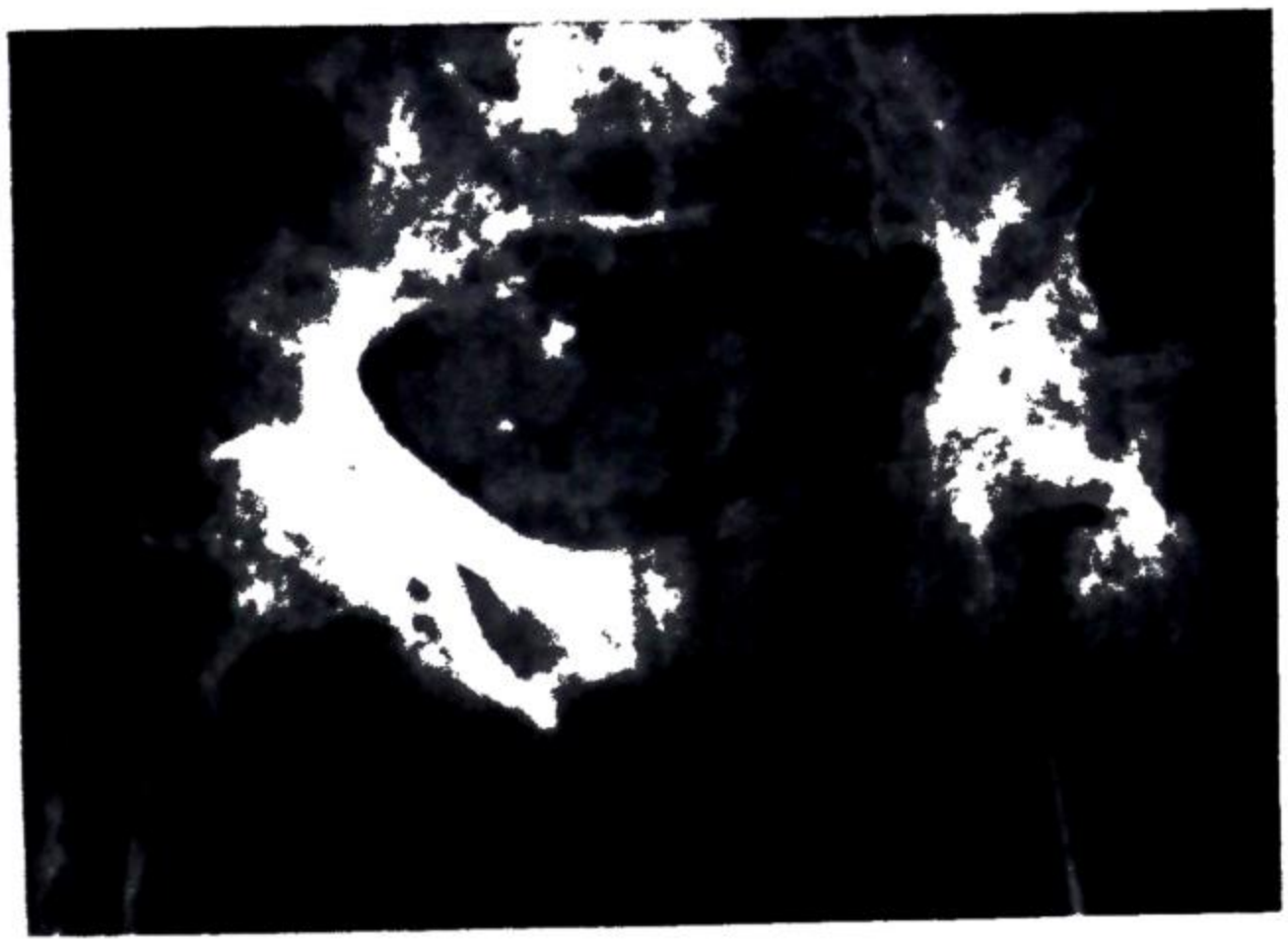


FIG. 1572. — Paget's disease of pelvis and hips—'etched' or striated appearance.

FIG. 1573.—Paget's disease—monostotic — in lower end of femur; sclerosed appearance.

The pelvic bones, spine, tibiæ, and clavicles are usually affected in the early stages. Enlargement of the skull and the 'cottonwool' appearance in the X-ray are very characteristic. In this respect it is interesting to observe that the base of the skull and the facial bones are usually normal. Involvement of the pelvic bones radiologically often resembles secondary prostatic carcinoma. The conditions are distinguished by estimation of the acid serum phosphatase which is normal in Paget's disease, and of course it will only offer difficulty in the male, when a rectal examination of the prostate should clarify the picture (p. 847).

Chemical investigation of the blood reveals no abnormality in the serum calcium but the serum phosphorus may be elevated. The alkaline serum phosphatase is usually increased and may reach twenty or thirty times the normal value.

Clinical Features.—(i) *Pain* is the most constant symptom, and is usually complained of long before the cause is realised. The tibia is one of the first bones to be affected, and the disease may remain localised in a single bone for years. The tibia in Paget's disease differs from a syphilitic osteitis in that the whole bone bends whereas in the latter condition the curvature is mainly due to periostitis affecting the anterior part of the bone, so that the palpable inner border is comparatively straight. Pain is intermittent, and in the case of a subcutaneous bone, hyperæmia of the skin occurs during exacerbations.

(ii) *Diminution of stature*, due to kyphosis and bending of the long bones of the legs (fig. 1574). A diminution of 13 inches (32 cm.) is recorded. The anterolateral bowing of the femora and the kyphosis give a simian or gorilla-like appearance in the generalised form of this disease.

FIG. 1574. — Advanced Paget's disease, showing large head and multiple bony deformities.

(iii) *Increased diameter of the head*, an early indication of which may be the necessity for larger hats (fig. 1575).

Complications.—*Spontaneous fracture* is common, and may first bring the patient under supervision. Radiographs often reveal partial transverse fracture, and probably a spontaneous fracture occurs in stages. The transverse character of the pathological fractures in Paget's disease is a very distinctive feature and may lead to a suspicion of Paget's disease before confirmatory changes in the radiological texture of the bone is noticed.

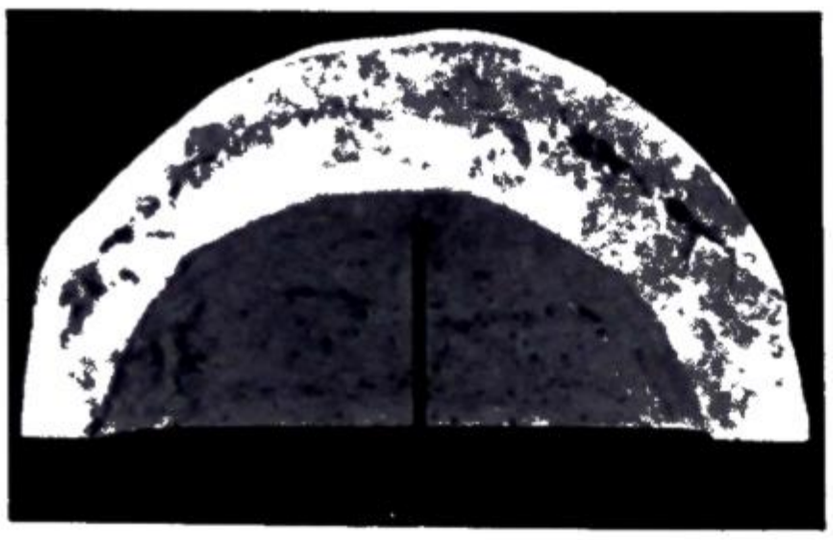


FIG. 1575.—Paget's disease of the skull.

In about 5 per cent. of cases Paget's disease is terminated by the development of *bone sarcoma* ; this may be either of the bone-forming or bone-destroying type, and its behaviour is not different from bone sarcoma occurring independently of Paget's disease.

Osteoarthritis occurs in joints adjacent to deformed bones, owing to alteration in the mechanics of the joint. Some degree of deafness is common, due to changes in the bony framework of the internal ear. Death commonly results from intercurrent pulmonary complications.

Treatment.—There is no known curative agent available to avert the progress of Paget's disease. In some cases of Paget's disease the pain due to

faulty mechanics can be relieved by osteotomy, and satisfactory union is the rule. Potassium iodide sometimes may relieve pain in this condition, as with most chronic inflammations of bones, but aspirin mixtures are better tolerated over long periods.

OSTEITIS FIBROSA CYSTICA (*syn.* RECKLINGHAUSEN'S DISEASE OF BONE)

This disease usually becomes obvious in the second decade of life, and generalised active bone resorption results in diffuse cystic changes that are widely scattered throughout the skeleton, involving particularly the long bones and the skull. The destruction of bone is associated with the development of fibrous tissue, and sometimes 'brown tumours' structurally comparable with giant-cell tumours of bone develop. Fractures, pain, bending of bones, and grotesque deformities occur, so that the patient becomes bedridden.

Cases of generalised osteitis fibrosa have an unduly high calcium content in the blood, often as high as 16 to 28 mg. per 100 ml. instead of the normal 9 to 11 mg., and metastatic calcification is sometimes associated with the disease.

Cases sometimes present themselves with bilateral renal calculi, treatment of which is postponed until the possibility of a parathyroid tumour has been considered.

The blood phosphorus is either normal or diminished in amount. Even when a parathyroid tumour is not palpable, i.e. 80 per cent. of cases, careful exploration is rewarded by its discovery, either embedded in the thyroid gland or lying at a lower level in the mediastinum. Removal of the parathyroid tumour is followed by an immediate drop in the calcium content of the blood, and by rapid amelioration of the symptoms. Following such an operation, reconstruction of the decalcified bones takes place.

Polyostotic Fibrous Dysplasia.—This is the fibrocystic disease of bone which manifests itself by softening, bending, and often fracture, in which there is no evidence of hyperparathyroidism. The distribution of the affected bones is asymmetrical and often shows a tendency to affect only one limb (monomelic). The condition differs from the fibrous dysplasia of hyperparathyroidism in that there are no alterations in blood chemistry, no generalised osteoporosis of the whole skeleton, and no bone pain. The condition is present in early life and leads to great deformity of the affected limb. The skull is often affected. Radiologically the affected bones are porotic and distorted with a thin expanded cortex and cystic changes in the marrow. In consistency the bones are soft and can often be cut with a knife. The ætiology is unknown.

Albright's Syndrome.—This is a variant of polyostotic fibrous dysplasia associated with areas of pigmentation of the skin. When it occurs in young females it is characterised by precocious puberty.

LOCAL CYST

This condition usually appears at the end of the first decade. The cyst first arises in the metaphyseal region of a long bone and subsequent growth often leaves the cyst at some distance from the metaphysis (fig. 1576). Though commonly classified under the heading of 'cystic diseases of bone' the solitary bone cyst is really quite a separate condition. It is the residue of an abnormal phase of activity affecting one epiphyseal line in a growing child. Subsequent growth is quite normal and if the cyst is treated the child develops normally in every respect.

FIG. 1576.—Simple solitary bone cyst.

Coxa vara sometimes follows a cyst in the femoral neck. Cysts in other bones usually attract the patient's attention because of spontaneous fracture.

Friedrich Daniel von Recklinghausen, 1833–1910. Professor of Pathology, Strasbourg.
Fuller Albright, Contemporary. Physician, Massachusetts General Hospital.

Radiography shows a clear cavity in the bone, which later becomes expanded.

Treatment consists in exposure of the bone and curettage of the cyst, which contains straw-coloured fluid, and is lined with a fibrous wall. Frequently the operation is completed by packing with bone chips though this is not always necessary. There is no abnormality of the calcium content of the blood, nor any parathyroid derangement with local cysts of bone.

LEONTIASIS OSSEA

This condition consists of an enlargement of the facial bones and jaws so that the air sinuses are diminished in size and the shape of the face is grossly altered by the external swellings. In the past the condition was thought to be a ' creeping periostitis' of infective origin, but the present opinion is that it is a localised form of fibrous dysplasia.

The early symptoms may be those of lachrymal duct or nasal obstruction. The facial bones then become enlarged, and adjacent bones are successively attacked. Eventually hideous deformity results (fig. 1577), and the patient's sufferings are increased by pressure on the eye, brain, and cranial nerves.

FIG. 1577. — Leontiasis ossea. (*G. H. Kirkland.*) (*British Journal of Surgery.*)

Leontiasis ossea has been mistaken for sarcoma of the maxillary antrum, chronic osteomyelitis of the jaws, bone syphilis, and ' frog face ' due to displacement forwards of the maxillæ by naso-pharyngeal tumours (fig. 137).

OSTEOGENESIS IMPERFECTA (*syn.* FRAGILITAS OSSIUM)

This rare familial condition is due to some congenital defect in the evolution of the connective-tissue cells. Normally, some of these develop into fibrous tissue, and others in connection with the osseous system become bone-forming cells. The blue sclerotics so characteristic of this disease are not simply due to diminution in thickness, and no abnormality can be detected on microscopic examination. The translucency is therefore due to some peculiarity of the fibrous tissue.

The main clinical feature is an abnormal tendency for bones to fracture. Pre-natal and post-natal types are distinguished, the former frequently being incompatible with survival and the latter often being so slight as to manifest the first fracture even as late as about five years of age. Thus the fœtus may be still-born, the skull being represented by a membranous bag with a few small bony plates, and evidence of antenatal fractures is common. In the infantile type the child is born alive, but the fragile limbs break with distressing ease. In less severe cases fractures begin to occur in childhood or adolescence. Stature is diminished, the skull is commonly flattened, and the ears pointed, so that the patient has an elf-like appearance. The fractures are said to be less painful than those occurring in normal bones, and although union occurs readily, deformity is common owing to multiple fractures. Otosclerosis commonly develops about the third decade. A certain degree of deformity is inevitable if multiple fractures occur.

Treatment consists in dealing with fractures as they arise, and of protecting the patient from the risk of injury.

OSTEOCHONDRITIS

Various lesions, the pathology of which is doubtful, are grouped under this term. The essential changes consist of spontaneous fragmentation of the ossific nucleus followed by reconstruction in a slightly deformed shape. Interference to the blood supply following trauma is traditionally given as a causative factor, but it is unsatisfactory when one considers that all healthy

children suffer repeated traumata without ill-effects. The essential ætiology is unknown but the bone changes appear to be a sequel to localised ischæmia.

In all cases symptoms are relatively mild and comprise aching of the affected limb and local tenderness. Relief is afforded by rest and prevention of strain. If the affected portion is palpable, such as the tibial tubercle, enlargement can be detected.

The more important of these conditions are :

Perthes Disease (*syn.* Coxa Plana, Pseudo-coxalgia).—This condition appears between the ages of five and ten, and is three times more common in boys than girls, and 15 per cent. of cases are bilateral. Calvé, of Paris, suggested the name ' pseudocoxalgie,' in order to distinguish the condition from tuberculous arthritis, because before the advent of radiology some cases diagnosed as tuberculous disease often surprised surgeons by their recovery of joint function and these were almost certainly suffering from Perthes disease. Slight pain and limp, especially after vigorous use, are the early symptoms. On examination, wasting is slight, and movements are restricted according to the extent of bony change. Thus, as the head

FIG. 1578.—Perthes disease of the left femoral head.

of the bone becomes flatter, so rotation is progressively restricted, and if coxa vara supervenes, then abduction also is limited. Flexion and extension, however, are free and painless, and this feature, combined with negligible wasting of muscles, and the robust health of the patient, should prevent an erroneous diagnosis of tuberculous disease. In these cases a week in bed results in the disappearance of the muscular spasm, after which the characteristic features of the underlying condition can be recognised.

A radiograph shows, in the early stages, slight broadening of the neck of the femur, the upper border of which is *convex*. Later the head of the bone becomes flattened (' mushroomed '), and the epiphysis is represented by two or more fragments, often of increased density suggesting ischæmia (fig. 1578). Finally the neck becomes thickened, and the epiphyseal fragments fuse to form an expanded and flattened head.

Surgeons were formerly content to restrict movements and limit weight-bearing, as by the application of a walking caliper. However, it is becoming increasingly appreciated that, although a deformed femoral head causes little disability for many years, osteoarthritis is prone to develop in later life.

Georg Perthes, 1869–1927. Professor of Surgery at Tubingen, Germany.
Jacques Calvé, Contemporary. Surgeon, Foundation Franco-Américaine Hôpital, Berck Plage, France.

Therefore treatment by recumbency and traction is to be recommended, in a form modified from that used for a tuberculous hip.

Osgood-Schlatter's disease is much commoner in boys than girls, and appears between the ages of ten and sixteen. It is frequently preceded by some unusual strain, e.g. training for sports. The tibial tubercle becomes unduly prominent and tender on pressure. A radiograph shows partial separation of the tongue-shaped portion of the epiphysis from the shaft (fig. 1579). Vigorous activities should be curtailed, and firm strapping provides mild support. If pain persists, a posterior plaster slab should be worn for a few weeks. Symptoms persist despite treatment, frequently as long as twelve months.

FIG. 1579.—Osgood-Schlatter's disease.

Sever's disease, or apophysitis of the os calcis, affects the epiphysis of the heel, which is present between the tenth and sixteenth years. A radiograph shows fragmentation and irregularity of the epiphysis (fig. 1580). The child should wear a boot which is cut away at the back (to relieve pressure) and the heel of which is raised (to relax the calf muscles).

Köhler's disease affects the scaphoid tarsal bone and occurs between three and eight years of age. The bone is at first fragmented and tender, but later is compressed and sclerotic (fig. 1581). Strapping support is usually adequate.

Calvé's epiphysitis affects the epiphysis, usually of one single vertebra in infants or very small children. It is often mistaken for tuberculosis. No deformity or disability results in later life.

Scheuermann's disease involves the dorsal vertebral epiphyses in adolescents (p. 1317). The development of a kyphosis is the first indication of the disease, which is confirmed by radiography. Five or six vertebræ at the mid-thoracic level become wedged to give a round kyphosis. In early stages remedial exercises and perhaps a spinal support improve the deformity, but often some kyphosis persists.

Freiberg's disease is uncommon and occurs in young adults. It affects the head of the second or third metatarsal, in the region of which tenderness and swelling are detected. The X-ray shows flattening of the articular surface and irregular sclerosis of the head. Treatment consists of a metatarsal bar, or, if necessary, at a later date, excision of the head of the bone (fig. 1582).

FIG. 1580.—Sever's disease.

FIG. 1581.—Köhler's disease, showing disc-like scaphoid.

Kienböck's disease of the semilunar bone of the wrist occurs in adults of any age (fig. 1300). In most cases a history of injury is obtainable, which is followed by pain, tenderness over the bone, and limitation of wrist movements. It is remarkable, and difficult to correlate with the ischæmic theory of origin, that it rarely, if ever, follows dislocations of the semilunar in severe injuries of the wrist. It is to be noted that though classed as 'osteochondritis' this particular condition of the

Robert Osgood, 1873–1956, Orthopædic Surgeon of Boston, U.S.A., and Carl Schlatter, Contemporary, Professor of Surgery, Zürich, described apophysitis of the tibia simultaneously in 1903.
James W. Sever, Contemporary. Consulting Orthopædic Surgeon, Children's Hospital, Boston, U.S.A.
Albert Köhler, Contemporary. Professor of Surgery, Berlin.
Holger Werfel Scheuermann, Contemporary. Director of Radiological Department, Military Hospital and Sundby-hospital, Copenhagen.
Albert H. Freiberg, 1868–1940. Professor of Orthopædic Surgery, Cincinnati, Ohio, U.S.A.
Robert Kienböck, Contemporary. Professor of Radiology, Vienna.

FIG. 1582.—Freiberg's disease of the head of the second metatarsal. (*F. P. Fitzgerald.*)

FIG. 1583.—Kienböck's disease of carpal semilunar.

semilunar is one of adult life. Treatment consists in immobilisation for six months in order to encourage regeneration. Severe cases pass on to traumatic arthritis of the wrist joint which may be controlled with a permanent leather wrist-strap or, in a few cases, necessitate wrist fusion.

ACHONDROPLASIA

This familial condition is due to maldevelopment of bones arising from cartilage. Thus the stature is markedly diminished and the limbs in particular are stunted. The legs are obviously short, and the fingertips reach only to the great trochanters, the arms thus resembling flippers (fig. 1584). The fingers themselves diverge, so that they resemble the spokes of a wheel. As the fibula is less shortened than the tibia, it frequently enters into the formation of the knee joint. The base of the skull, being developed from cartilage, is small in proportion to the vertex, so that the prominent forehead causes the bridge of the nose to appear to be depressed. Mental development is normal, and sufferers often find ready employment in circuses.

FIG. 1584.—Achondroplasia.

FIG. 1585.—Cranio-cleidodysostosis. (*Pybus.*)

CRANIO-CLEIDODYSOSTOSIS

is thought to be due to failure of development of bones arising in membrane. Thus the vertex of the skull and clavicles are ill-formed, so that the head appears flattened, and as the buttress action of the clavicles is lost, the heads of the humeri are approximated to, and may articulate with, the sternum (fig. 1302). A curious feature is delayed ossification of the pubic bones.

DIAPHYSEAL ACLASIS (*syn.* MULTIPLE EXOSTOSES)

This is a not uncommon hereditary condition characterised by the outgrowth of cancellous osteomata near the ends of long bones. Sometimes all the long bones may be affected and many dozens of growths may be present, but most commonly six to twelve outgrowths are encountered. The femur and tibia near the knee and the humerus at the shoulder are the most common sites.

The bone may be distorted in growth and a little dwarfing may occur. The outgrowth is often pedunculated with a cartilage cap on the tip from which it grows and a bursa overlying it (see fig. 1591).

The condition is regarded as a failure of 'tubulation' of the growing bone, i.e. a failure of the periosteum to remodel the external surface of the new bone produced by growth at the epiphysis.

The tumours may cause mechanical symptoms and need removal.

DYSCHONDROPLASIA (*syn.* MULTIPLE ENCHONDROMATA) OLLIER'S DISEASE

This differs essentially from multiple exostoses in that the growing epiphysis leaves behind masses of cartilage in the centre of the shaft. The lesion is thus cartilaginous and endosteal—not periosteal and of cancellous bone as in diaphyseal aclasis.

There is no hereditary tendency.

The condition may be localised to a single bone or single limb. When this happens the affected bone is dwarfed and the skeleton becomes asymmetrical. The long bones are affected—especially the femur and tibia at the knee and the upper end of the humerus and lower end of radius.

Very frequently the phalanges of hands and feet are commonly the site of these multiple enchondromata (see fig. 1588).

SCHULLER-CHRISTIAN'S DISEASE

is rare, and is a disease of the reticulo-endothelial system and concerned with faulty lipoid metabolism. Soft swellings occur in the scalp, beneath which the skull is eroded ('map-like' skull). Exophthalmos and diabetes insipidus develop and growth is retarded. Other bones are sometimes affected, in which case differential diagnosis is often difficult. The condition responds to deep X-ray therapy. Schuller-Christian's disease occurs in adult life, but two similar conditions occur in childhood to which different names are attached. In adolescent and young patients localised lesions in bone having the same pathology are termed *eosinophilic granuloma*. In infancy an analogous condition occurs which is almost always fatal, which received the name *Letterer-Siwe* disease.

FIG. 1586. — Osteopetrosis of the lumbar vertebræ. (*Karl Krebs, Aarhus, Denmark.*)

OSTEOPETROSIS (*syn.* 'ALBERS-SCHÖNBERG'S DISEASE')

is a rare and familial condition in which the bones become progressively more dense owing to excessive deposition of calcium (fig. 1586). 'Marble bones' is a misnomer, as although the bones are sclerotic they are friable and pathological fractures occur. *Osteopoikily* (speckled bones) is a similar but less extensive condition.

ACROMEGALY

Acromegaly is an endocrine disturbance, being the stimulation of bone growth, after fusion of the epiphyses, by the pituitary secretion of an eosinophilic adenoma of the anterior lobe of the pituitary.

Hunter's famous example of acromegaly, the skeleton of the Irish giant, now in the museum of the Royal College of Surgeons of England, showed an enlarged sella turcica when the skull was opened at Harvey Cushing's suggestion.

The early signs are enlargement of the hands and feet, at first confined to the soft tissues, but later bony thickening also occurs. The jaws enlarge, especially the lower, which becomes prognathic, and separation of the teeth

Pierre Ollier, 1847–1905. Professor of Surgery, Lyons.
Arthur Schuller, Contemporary. Radiologist, St. Vincent's Hospital, Melbourne.
Henry Asbury Christian, Contemporary. Professor of Medicine, Harvard.
Heinrich Ernest Albers-Schönberg, 1865–1921. Professor of Roentgenology, Hamburg.

indicates that the enlargement is partly interstitial. Overgrowth of facial bones also occurs, especially of natural ridges and at the sites of muscular attachment. The frontal sinuses of the skull are markedly enlarged. The lips, nose, and ears show a variable amount of thickening (fig. 1308). When the disease is established the spine is kyphotic.

As the disease is associated with new-growth and enlargement of the pituitary gland (p. 987), symptoms of increased intracranial pressure supervene. Vision is affected, partly owing to this general increased pressure, and also as a result of local pressure of the enlarged gland on the optic chiasma giving rise to bilateral temporal hemianopia. More rarely an optic nerve is compressed with consequent blindness of the corresponding eye. Involvement of the fifth nerve, and proptosis from pressure on the cavernous sinus, to which the ophthalmic veins pass, sometimes occur.

If the eosinophilic adenoma develops before puberty, there will be generalised stimulation of growth—gigantism—and later these cases often show the facial signs of acromegaly.

A radiograph will demonstrate enlargement of the sella turcica (fig. 1306).

Operation should be undertaken only for intolerable headache or threatened blindness.

Harris's Lines.—Radiographic examination of long bones in children and adolescents sometimes reveals transverse lines of compact bone near the epiphyses (fig. 1587). These are due to arrest of growth which accompanies some severe constitutional disturbance.

FIG. 1587.—(1) Harris's lines. Two abnormalities are also seen—(2) an os trigonum, and (3) an epiphysis at the base of the fifth metatarsal. These may be of importance in compensation cases, but an X-ray of the other foot will show a similar condition.

TUMOURS OF BONES

The various types of bone tumours are the neoplastic counterparts of the different tissue components that constitute bone. Thus we can relate chondroma and chondro-sarcoma to cartilage, bone-sarcoma to bone-forming osteoblasts, giant-cell tumour of bone to the bone-destroying osteoclasts, fibrosarcoma of bone to the periosteal connective tissues, and other tumours such as myeloma and Ewing's tumour to the hæmopoietic tissue of bone.

It is important to bear in mind that various groups of bone tumours are not to be regarded as absolutely clearly defined and that although these 'labels' are the ones attached to the commoner types observed, an individual tumour may on occasions show features of more than one of these types (Sissons).

There have been several attempts to classify primary tumours of bone on a pathological basis, but none have been satisfactory. In view of the failure

H. A. Harris, Contemporary. Emeritus Professor of Anatomy, Cambridge University.
H. A. Sissons, Contemporary. Department of Pathology, Royal College of Surgeons.

of attempts to make a precise classification a helpful one, Platt recommends the broadest possible approach, as set out below.

CLASSIFICATION OF BONE TUMOURS (PLATT)

Primary	**Benign**	Osteoma Chondroma
	Locally Malignant	Osteoclastoma
	Malignant	Periosteal Fibrosarcoma Osteogenic Sarcoma (sclerosing and osteolytic types) Ewing's Sarcoma Multiple Myeloma
Secondary	Secondary to primary neoplasm arising in other tissues	

CHONDROMA

Cartilaginous tumours, usually benign, may arise in connection with the epiphyseal cartilage.

The tumours are composed of hyaline cartilage, the cells of which are variable in size and shape. All stages of transitional forms link non-progressive developmental abnormalities and benign chondromas to malignant chondro-sarcomata, and no sharply dividing line can be drawn between the two extremes.

Chondromata are conveniently classified according to the type of bone from which they arise :

(*a*) **Small Bones of the Hands and Feet.**—As these tumours arise within the bone, they are termed *en*chondromata. They most commonly appear during childhood. The affected bone becomes gradually and painlessly expanded, and the local condition may suggest dactylitis. However, the more advanced age of the patient and the absence of evidence of local inflammation or of any general manifestation of disease should prevent an error of diagnosis. A radiograph shows a clear expansion of the bone (fig. 1588), and sometimes the presence of small specks of calcification help to distinguish it from a bone cyst. If allowed to grow, destruction of the bone is inevitable, and finally myxomatous degeneration may occur.

FIG. 1588.—Multiple enchondromata of phalanges.

It is to be noted that if multiple enchondromata occur the condition is probably not truly a neoplasm but is a generalised disease of the skeleton (i.e. Ollier's disease, see p. 1240). The true neoplasm occurs as a more or less solitary enchondroma.

Sir Harry Platt, P.R.C.S. Contemporary. Late Professor of Orthopædics, Manchester

Boeck's sarcoidosis may simulate enchondromata in that cavitation sometimes occurs in digital bones. However, the presence of granulomatous swellings in lymph nodes, salivary and lachrymal glands, and elsewhere (p. 177) should clarify the diagnosis.

Treatment consists in scraping out the tumour. In the case of a digit a postero-lateral incision is made, which passes between the extensor tendon and the digital vessels and nerve.

(*b*) **Long Bones.**—Centrally placed chondromata can occur near the ends of long bones, but in adults there is always a strong suspicion of malignancy. The upper end of the humerus is a common site in the adult.

(*c*) **Flat Bones.**—These tumours grow from such bones as the ribs, scapula, and pelvis, and form characteristically hard and painless swellings. However, they may remain unnoticed until myxomatous degeneration causes pain and increase in size and a malignant transformation may be suspected and proved. In the pelvis and upper end of the femur these cartilaginous tumours may attain very large dimensions (fig. 1589). As there is frequently extensive bone formation scattered among the cartilage (and giving a mottled appearance in the X-ray), these tumours are termed osteochondromata or ossifying chondromata. They usually remain benign and cause trouble by mechanical obstruction, but malignant changes are always to be feared.

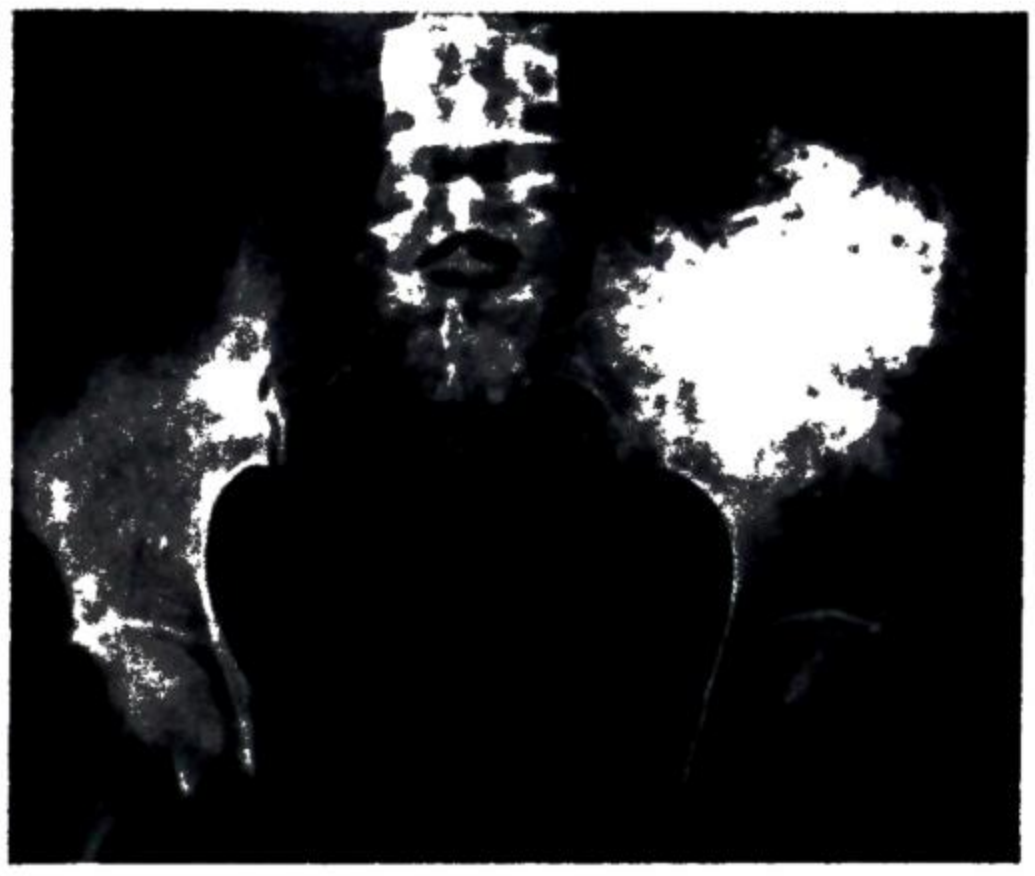


FIG. 1589.—Osteochondroma of the ilium.

Treatment of these large osteochondromata is by excision whenever possible. The operation may be formidable in the pelvis and there are occasions when amputation of the affected extremity is necessary—taking with it the affected half of the pelvis (hemipelvectomy or inter-innomino-abdominal amputation).

FIG. 1590.—Ivory osteoma arising from the mastoid antrum.

Caesar Peter Moeller Boeck, 1845–1917. Professor of Dermatology, Oslo.

OSTEOMA

Osteomata are of two varieties, ivory or cancellous.

Ivory osteomata are uncommon, but are occasionally found on the skull, particularly in connection with bones which form the walls of air sinuses (fig. 1590).

Treatment.—Removal is indicated if pressure symptoms result, e.g. deafness from auditory obstruction, displacement of the eye, or involvement of nerves.

Cancellous osteomata are comparatively common tumours and are found near the ends

of long bones (fig. 1591). It is to be noted that these cancellous 'osteomata' are probably not true neoplasms as growth ceases when ossification of the bone is complete; when multiple, as they frequently are, they are the result of a growth disorder (failure of 'tubulation' of the growing end of the bone) and should be classed as diaphyseal aclasis (see p. 1240).

FIG. 1591.—Typical cancellous osteoma, growing away from the epiphysis. A fracture has occurred near the base.

A *subungual exostosis* is an irregular bony outgrowth under the nail of the big toe, which is lifted off the underlying phalanx. It is included in this section for convenience, but it is not a neoplasm. It is due to pressure of an ill-fitting boot and consequent periosteal irritation. The nail should be removed or displaced, and the bony excrescence excised by means of a chisel or bone-cutting forceps.

GIANT-CELL TUMOUR (*syn.* OSTEOCLASTOMA)

The giant-cell tumour occupies a middle place in the range of malignancy of bone tumours from the completely benign (the chondromata and osteomata) to the malignant (the sarcomata) because it is a *locally malignant* tumour with an occasional tendency to metastasis.

Giant-cell tumours occur most commonly at the end of a long bone, particularly in the vicinity of the knee joint. A very characteristic feature is that they always originate in what originally was the epiphyseal region of the bone. Tumours with similar histological structure occur in relation to tendons (p. 1303), where they arise from synovial tissue. On the gums a similar tissue gives rise to one variety of epulis (p. 149), but there is evidence that this is not a true neoplasm and should be classed as a giant-celled granuloma (Jaffe).

Osteoclastomata usually occur during the third or fourth decades of life, and are presumed to arise from osteoclasts, which are giant cells normally engaged in absorption of bone. Clinical features depend upon whether the affected bone is subcutaneous or surrounded by muscle. If subcutaneous, a swelling is noticed first which is painless. Expansion of the bone follows, which process consists in destruction of the bone from within, while at the same time a thin shell of new periosteal bone is formed (fig. 1592). This new formation of bone occurs more slowly than the destructive process, so that the bone becomes larger but progressively thinner, and eventually 'egg-shell crackling' may be detected. The expansion of the tumour is characteristically eccentric and extends into the articular extremity of the bone to reach a site subjacent to the articular cartilage. Finally, the growth, if ignored, erodes the compact bone, and a soft, pulsating swelling results (fig. 1593).

Henry L. Jaffe, Contemporary. Director of Laboratories, Hospital for Joint Diseases, New York.

(*a*) (*b*)

FIG. 1592.—(*a*) Osteoclastoma of the upper end of the femur. (*b*) Two years after curettage of the contents with diathermy coagulation of the interior.

In the case of deep-seated bones, enlargement and consequent destruction of the bone may be unnoticed, in which case the first evidence of the tumour is either a spontaneous fracture or a pulsating swelling.

Owing to the slow rate of growth of these tumours, pain is not a prominent feature though a dull ache is often present. When a large osteoclastoma is adjacent to a joint, e.g. the lower end of the femur, a 'sympathetic' effusion may occur as a result of local hyperæmia. A radiograph confirms the abrupt expansion of the bone, and presents well-marked bony trabeculæ which give the appearance of a multilocular cyst ; in fact the cyst is unilocular and the trabeculæ are thickenings in the cyst wall. The appearance often resembles a collection of soap bubbles.

FIG. 1593. — Osteoclastoma with gross expansion of shaft.

In the diagnosis two features are worthy of stress by repetition : the tumour arises in the epiphyseal region of the bone and is rare before the age of thirty years.

Macroscopically, the tumour appears as a soft, maroon-coloured tumour, with localised extravasations of blood (fig. 1594). Histologically, characteristic giant-cells are strikingly evident ; these large cells, about 120 μ in diameter, are irregular in shape, and contain from twelve to fifteen deeply staining nuclei. The remainder of the tumour consists of spindle cells, extravasated blood, and numerous blood-vessels. 'White' osteoclastomata occasionally occur, usually at the lower end of the radius.

Treatment.—Until recently it was believed that osteoclastomata were only locally malignant, but a more careful 'follow-up' shows that in about 8 per cent. of cases metastases occur in the lungs. Whenever possible surgical removal should be the method of choice. X-ray treatment of osteo-

clastomata has been used with great claims for success, but the heavy irradiation which is necessary to kill the tumour cells, which are not specially sensitive, at the same time destroys the articular cartilage of the involved joint, and though the tumour may be necrosed the joint is the seat of painful arthritis. In the spine and pelvis, deep X-radiation is usually the only procedure available.

FIG. 1594.—Osteoclastoma of the upper end of the tibia. Typical site.

At the knee, and most other sites in the extremities, curettage of the cavity, followed by packing with bone chips, will give excellent results if carried out radically.

Curetting.—The bone is opened with a gouge or chisel, and the growth scraped away with a sharp spoon, care being taken not to penetrate the adjacent articular cartilage. The cavity is swabbed with pure carbolic acid, any excess being removed with spirit. If necessary, the cavity is reduced in size by compression of its walls, or bone chips may be inserted. If the cavity is small, it is sufficient to allow it to fill with blood-clot.

In some cases one of the following procedures will be preferable to curettage or radiation :

(*a*) LOCAL EXCISION.—If removal of the bone will cause little disability, then excision is performed, e.g. rib or fibula. This method is certain in its result, and convalescence is speedy.

In the case of the upper end of the fibula the external popliteal nerve must be isolated above the swelling, as it lies under the tendon of the biceps, since its anatomical relations in the region of the tumour will be distorted. The nerve is traced downwards and held aside, and the fibula is divided and cleared of muscles from below upwards.

(*b*) AMPUTATION.—In the case of extensive destruction of a bone, such as the lower end of the femur or head of the tibia, amputation is usually performed, rather than to attempt to arthrodese the knee by bridging a gap by a bone graft at the site of a resection.

MULTIPLE MYELOMA (*syn.* KAHLER'S DISEASE)

This is a not uncommon condition in which multiple endosteal tumours occur and are associated with marked bone destruction. The lesions involve spine and ribs most frequently and the skull and femora are other common sites. The proliferating tumour cells are plasma-cells, and for this reason the condition is sometimes known as plasma cytoma. The involvement of bone marrow is widespread and the sternal marrow is practically always affected even in the absence of clinical evidence, thus the diagnosis can often be confirmed by examination of

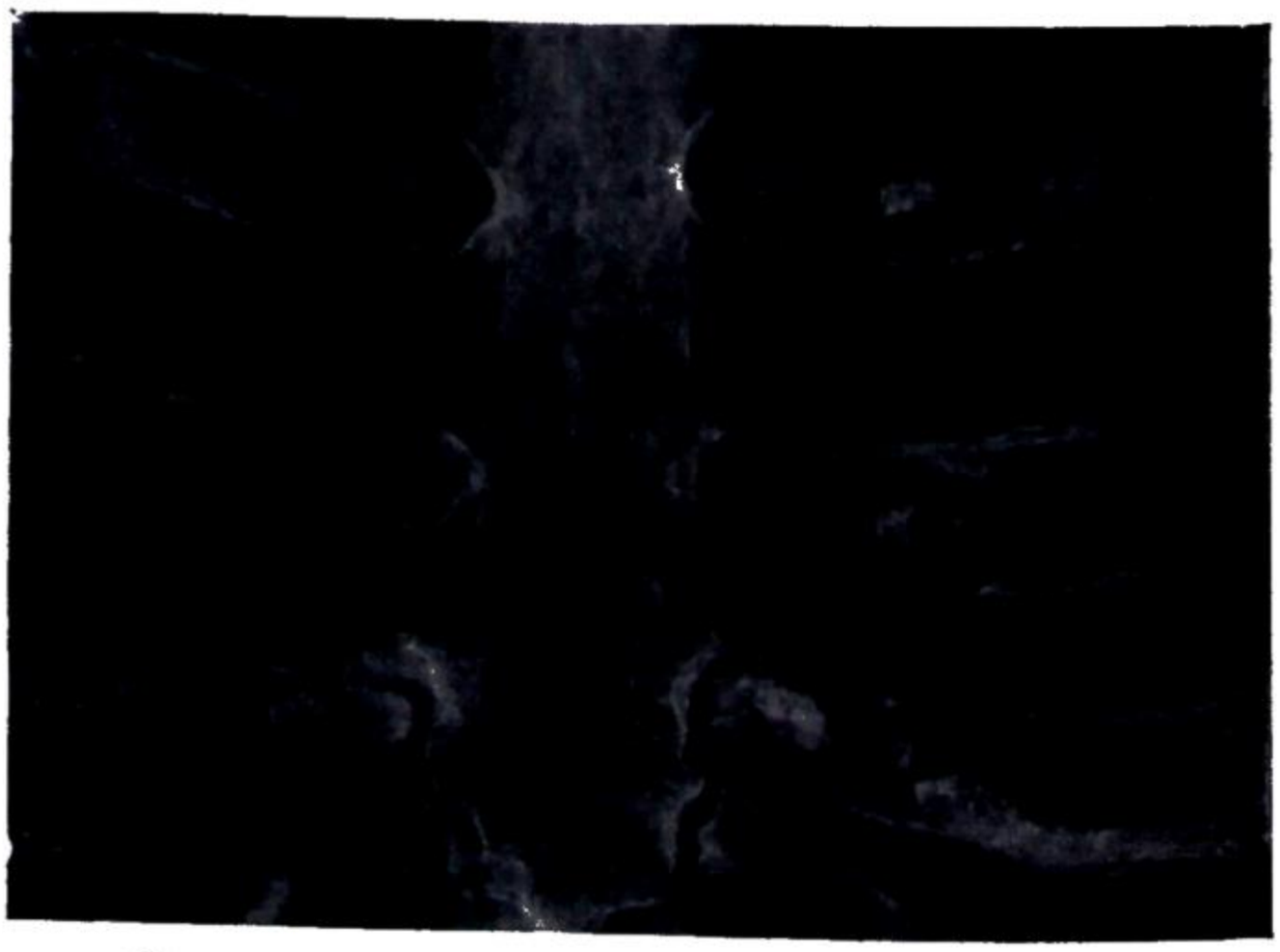


FIG. 1595.—Myelomatoses of sternum and ribs. (*Dr. L. S. Carstairs.*)

Otto Kahler, 1849–1893. Professor of Medicine, Prague.

smears of sternal marrow. The multiple nature of the lesions and the sharply delimited bone destruction gives a radiographic appearance that is sometimes suggestive of metastatic carcinoma (fig. 1595). Like metastatic carcinoma, it may cause the pathological fracture of affected long bones. The proteose, first described by Bence-Jones, appears in the urine in most cases, but it may absent itself for a period in any patient. It precipitates on the addition of nitric acid and disappears on warming. Owing to extensive bone destruction the blood calcium is usually increased, and if renal inefficiency coexists the blood phosphorus is also raised. The condition is associated with severe anæmia and is encountered most commonly over the age of fifty years.

In a relatively small number of cases only a single bone is involved by a myeloma lesion. Sometimes these cases remain well after X-ray therapy, but more often the development of additional lesions shows the condition to be one of generalised disease. Death may result from uræmia following obstruction of the renal tubules by protein, or some intercurrent disease in a bedridden sufferer.

SARCOMA

Periosteal fibro-sarcomata are spindle-shaped tumours which arise from the periosteum, or from the insertion of tendons or muscles, and strictly speaking should therefore be regarded as tumours of these structures rather than of the bone itself. Local and free excision, including the periosteum in the neighbourhood, occasionally results in cure, but, as in the case of fibro-sarcoma arising from a muscle sheath, incomplete removal will be followed by recurrence of the tumour with increased malignancy. They are very slow growing, and though tending to recur after local removal the survival rate is favourable even if amputation is necessary.

Osteogenic sarcoma is a highly malignant tumour which is believed to arise from the osteoblastic cells of bone. This, however, does not mean that it always produces new bone—indeed in many cases only bone destruction is in evidence. One presumes that the bone-forming sarcomata arise from the later stages of development of the osteoblast and the osteolytic sarcomata from the more primitive stages of development of the osteoblast. The clinical presentation and the radiographic appearance show great variety, depending on the osteogenic or osteolytic properties of the tumour and on its site of origin. In the same way the histological appearances often show a large variety of cells indicating origins in a tissue which is a common precursor of cartilage, bone, fibrous, and myxomatous tissue. Dissemination occurs by the blood-stream.

Osteogenic sarcoma most commonly occurs during puberty or adolescence, and is practically unknown after the age of fifty, except as a complication of Paget's disease. The favourite sites are the ends of the shafts of long bones. The leg is affected five times as often as the arm, and the majority of these tumours occur in the region of the knee (lower end of femur, upper end of tibia). The patient's general health is not affected until the final stages of the disease.

On inspection of the affected part large distended veins are often seen in the skin overlying the tumour. On palpation a spindle-shaped swelling is detected of bony-hard consistency. Characteristically, the mass is at the end of a long bone arising in the metaphyseal region. Eventually soft tissues are invaded, and finally the tumour involves and fungates through the skin. Dissemination occurs early, the lungs being commonly affected via the

Henry Bence-Jones, 1814–1873. Physician, St. George's Hospital, London.

systemic veins (fig. 1596). A blood-stained pleural effusion is sometimes the first evidence of pulmonary involvement.

The radiographic appearances of bone sarcomata vary according to the rate of growth of the tumour. In some cases (osteolytic type) erosion of the bone is the principal feature, but in others (osteogenic type) bone characteristic spiculation is sometimes evident (fig. 1597). Frequently the production of new bone is seen best where

FIG. 1596. — Ossifying metastasis in the lung from osteosarcoma of the femur.

FIG. 1597.—'Sun-ray' pattern in osteogenic sarcoma. Rare site. Most common site is the knee. 'Sun-ray' appearance is not common.

the limits of the tumour are stripping up the periosteum from the surrounding hone. This gives an appearance often known as Codman's triangle, but it bas no special diagnostic significance.

FIG. 1598.—*Osteogenic sarcoma:* Note that the tumour is metaphyseal and eccentric and that the underlying cortex is eroded. The extra-osseous mass seen here is much larger than what might be expected from the mere trace of new bone which was present in the radiograph.

Radiological signs by themselves are often misleading. Diagnosis can only be by a balance of history, clinical appearance, biopsy, and radiology. Clinically the presence of a palpable extra-osseus mass is essential to the diagnosis if the lesion is in a site capable of palpation. The mass will always be bigger than the radiological changes might suggest (fig. 1598). Similarly, in the history, the appearance of a mass for some time before the development of pain is against a sarcoma, where pain always precedes the mass.

A tumour commencing endosteally erodes and destroys the pre-existing bony tissue as it expands, and eventually spontaneous fracture may occur or the appearance of a soft pulsating swelling indicates that the bone is extensively destroyed.

Besides the other types of primary bone tumour, such possibilities as an acute inflammatory process, an endosteal gumma, or a metastatic tumour must always be considered.

If the diagnosis is doubtful and the W.R. negative, then a biopsy must be performed, as exact diagnosis is essential for treatment and prognosis. Biopsy is alleged to encourage dissemination, but if a tourniquet and diathermy are employed, the slight risk is far

outweighed by the importance of a diagnosis. Diagnosis can be so difficult that no amputation should ever be proposed without a previous biopsy lest a limb be sacrificed for what later may turn out to be a non-malignant condition.

Treatment of an osteogenic sarcoma depends on the site and extent of the growth:

(*a*) *Amputation* is the usual procedure, providing the diagnosis is accepted, and should be performed as high as possible above the tumour. In the case of the femur or humerus disarticulation should be performed through the hip or shoulder joint, or even by a hind- or fore-quarter amputation (fig. 1599). However, the prognosis is extremely gloomy, but amputation relieves the patient of a limb which will become increasingly painful, and fungation and risk of secondary hæmorrhage are obviated.

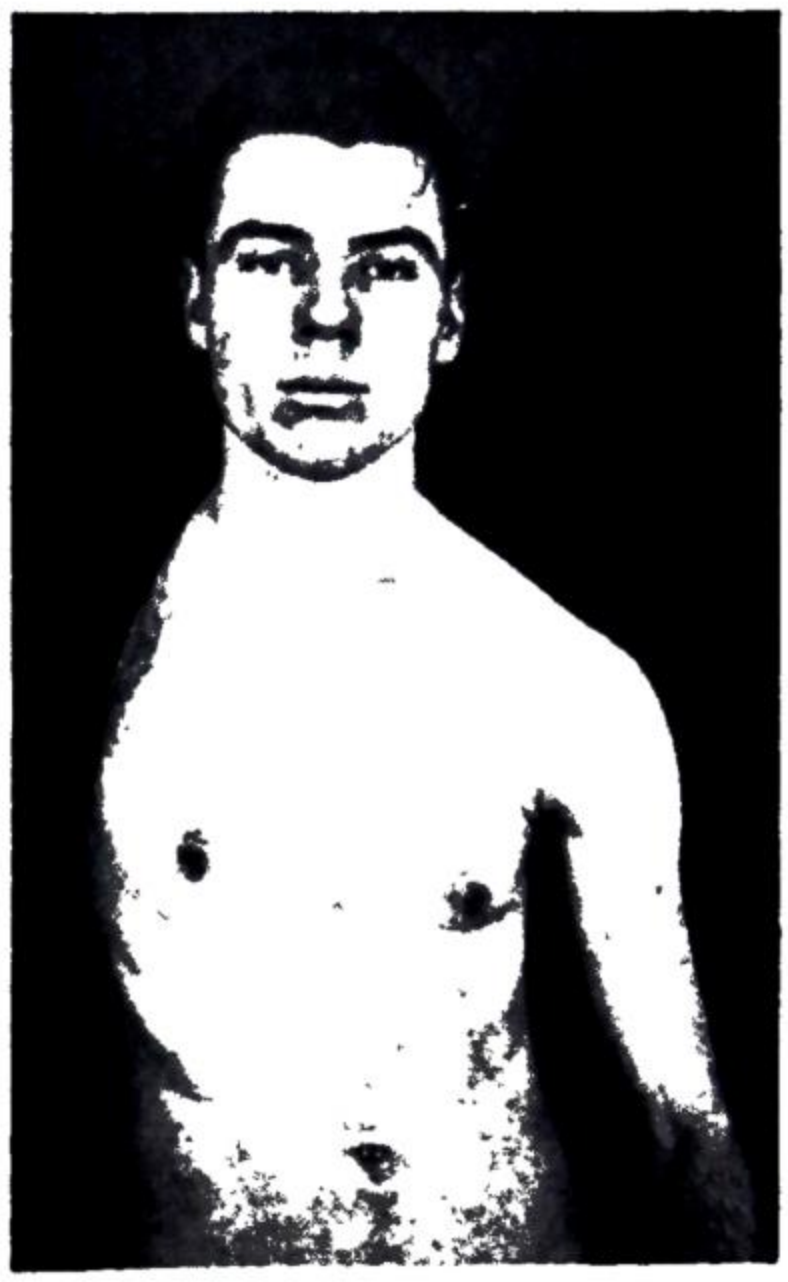


FIG. 1599.—The appearance after a fore-quarter amputation.

(*b*) In certain situations local excision of the affected bone and the insertion of a bone graft have been adopted. Earlier permission is likely to be given for this procedure, as compared with amputation. Also, in the early stages local recurrence is unlikely, and if secondary deposits have occurred, even amputation cannot retard their progress. Hence in situations where bone grafting yields good results, such as the upper limb, the arm may be saved, and cases are on record where this line of treatment has been adopted and the unmaimed patient has survived for many years.

X-ray therapy has little influence in retarding the progress of the tumour, and there are many surgeons who believe that the patient's general condition is rendered more miserable by X-ray therapy than without it.

Prognosis.—Out of 650 cases collected by the American Registry of Bone Sarcoma, only seventeen *appear* to have been cured—sixteen after amputation, and one following treatment by radium. Platt reported twenty-three five-year survivals after amputation in 128 patients.

Recurrence within a year is likely to occur in viscera or other bones if the primary growth is situated near the trunk. In more distant tumours recurrence is usual within three years, although we have known a case in which secondary deposit appeared in the spine thirteen years after amputation through the thigh for periosteal sarcoma of the tibia. Thus the time limit for a 'cure' is almost unlimited. An X-ray of the chest may reveal secondary deposits in the lungs, which indicates that the expectation of life is, at the most, a few months.

EWING'S TUMOUR

This rare tumour has the following characteristics: acute onset with pyrexia, local tenderness, a situation in the middle of the shaft of a long bone, a patient between five and sixteen years of age, a pattern of longitudinal layers of subperiosteal ossification likened to the layers of an onion (fig. 1600)—and, finally, striking radio-sensitivity.

Sir Harry Platt, P.R.C.S., Contemporary. Late Professor of Orthopædics, Manchester.
James Ewing, Contemporary. Professor of Oncology (Tumours), Cornell University Medical College, U.S.A.

It is probable that a number of pathological entities can give rise to this syndrome, and in addition to the ' angio-endothelioma ' that Ewing regarded as its corresponding pathological counterpart, there must be mentioned not only other unusual forms of primary endosteal tumour (such as sarcoma derived from reticulo-endothelial tissues) but also metastatic lesions, particularly neuroblastoma, which occur in children of this age.

One of the characteristic clinical features of this disease is the ease with which it can be mistaken for a subacute, or chronic, osteomyelitis. Even the round cells which compose it have been mistaken for pus, and the temperature is often slightly elevated.

The prognosis is poor, even after amputation, as secondary deposits occur in other parts of the skeleton, and eventually in lymph nodes and viscera. Deep X-ray

FIG. 1600.—Ewing's tumour. (*Karl Krebs, Aarhus, Denmark.*)

therapy causes striking retrogression of the primary growth, which is an important point both in differential diagnosis and treatment, but secondary deposits are less radio-sensitive. Platt points out that in the American Registry of Bone Sarcoma thirteen out of the fourteen five-year survivors of Ewing's sarcoma had been treated by amputation. Local recurrence after an adequate course of radiotherapy demands amputation.

SECONDARY TUMOURS

Secondary bone tumours are far commoner than primary bone tumours and shouldal ways be considered first before the diagnosis of sarcoma is made.

FIG. 1601.—Osteoblastic (sclerotic) carcinomatous secondaries in the vertebræ and pelvic bones. The primary was in the prostate.

Carcinoma.—Carcinoma of bone occurs either by direct extension, as in the case of the chest wall following carcinoma of the breast, or by metastasis.

Secondary deposits are liable to occur particularly as a result of a primary growth in the following situations :

(i) *Breast* is traditionally regarded as the commonest source of secondary carcinoma of bone. Secondary deposits occur in about 50 per cent. of fatal cases, the favourite situations being the spine, pelvis, and upper ends of the femur and humerus.

(ii) *Prostate.*—This gland is

commonly associated with osseous dissemination. The usual manifestation is diffuse sclerosis of the pelvis and lumbo-sacral regions (fig. 1601). This osteoblastic type of metastasis is peculiar to the prostate and, in the early stages, it may be difficult to distinguish the X-ray from Paget's disease (p. 1232). Œstrogens are worthy of trial.

(iii) *Kidney*.—Any bone is liable to be affected, perhaps most commonly the pelvis. A bony swelling or a spontaneous fracture is sometimes the first evidence of a carcinoma of the kidney. Occasionally the deposit is solitary, and may reach a very large size while the primary hypernephroma is still very small. In these cases nephrectomy and resection of the affected bone is feasible.

(iv) *Bronchus*.—Carcinoma appears to be increasing in frequency and secondary deposits in bones are also becoming increasingly common. Some surgeons believe that the bronchus now rivals the breast in frequency of secondary deposits in bone.

(v) *Thyroid*.—The flat bones, especially the vertex of the skull, are likely to be affected. These tumours in particular are very vascular, and apparently are capable of function, as after complete thyroidectomy for carcinoma the post-operative myxœdema has disappeared on the appearance of secondary deposits.

Secondary deposits in bone usually cause very severe persistent pain, and if occurring in the vertebræ pain is liable to be referred along spinal nerves. In most cases a swelling eventually becomes palpable (fig. 1602); the presence of superficial veins and possibly pulsation indicate the vascular nature of the tumour. Spontaneous fracture is common, and if immobilised,

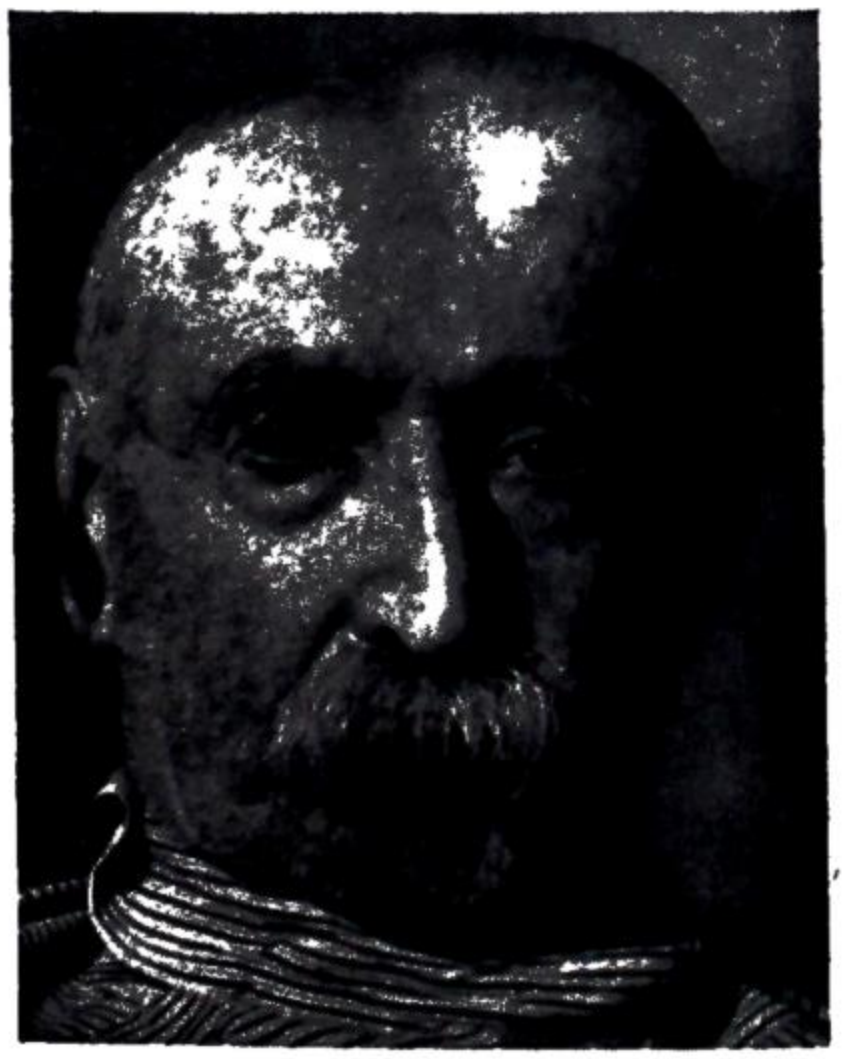


FIG. 1602.—Secondary deposit in the skull from a carcinoma of the prostate.

FIG. 1603.—Secondary carcinoma, showing destruction of the upper end of the humerus and the glenoid cavity. The primary was in the breast.

union often occurs if the patient survives for a sufficient length of time. The use of the intra-medullary nail for these pathological fractures in the femur is a great help in rendering these unfortunate patients comfortable.

A radiograph (fig. 1603) shows irregular destruction of bone with little

surrounding reaction unless fracture has occurred, in which case evidence of callus formation is sometimes seen.

If a tumour in bone raises a suspicion of secondary carcinoma, then the common primary sites must be carefully examined. Carcinoma of the breast, prostate, or bronchus can usually be detected by ordinary tests. The presence of a slowly growing carcinoma of the kidney is often difficult to diagnose in the absence of hæmorrhage, but a pyelogram will usually show a 'spidery' pelvis. Primary carcinoma of the thyroid gland is sometimes so unobtrusive as to be impalpable, or a tumour which clinically appears to be a simple adenoma may actually be malignant.

Treatment.—Secondary osseous deposits are often sensitive to deep X-ray therapy. Pain is relieved, and a spontaneous fracture or paraplegia may be prevented and much suffering thereby obviated. Therefore, unless metastases are widespread, irradiation should receive consideration.

Secondary deposits arising from the prostate are often checked, and may even temporarily disappear, following the administration of œstrogen (see p. 857).

The estimation of the amount of acid phosphatase in the serum is of value in the diagnosis of prostatic secondaries, and also in prognosis. Normally 0·5 to 2 units of acid phosphatase is present in 100 ml. of serum. Over 5 units is very suggestive of prostatic secondaries, and 10 units or more is diagnostic. The value of treatment by œstrogen is assessed by the degree of diminution in the amount of acid phosphatase. This test is also useful in distinguishing prostatic secondaries from osteitis deformans, as in the latter case the acid phosphatase is not increased, but the alkaline phosphatase is above normal.

OSTEOID OSTEOMA

This is a rare condition first described by Jaffe, of obscure origin but probably inflammatory, causing an isolated, painful, bone lesion in young adults.

The patient complains of chronic aching pain, usually in the shaft of a long-bone but occasionally in a cancellous bone as in short-bones of the tarsus. No abnormality is found on clinical examination of the affected part. X-ray examination shows gross thickening of the bone affecting the cortex eccentrically. The denseness of the sclerosis may be so extreme that no special feature may be detected in an ordinary X-ray, but if films are made using extreme penetration it is sometimes possible to demonstrate a small central cavity, 0·5–1·0 cm. in diameter.

The condition is almost certainly self-limiting but it can cause pain for several years before spontaneous cure occurs. Operative treatment, which consists of a widespread excavation of the bone until the cavity is reached, relieves symptoms immediately. When the central nidus is reached it is recognised by its dark red, or maroon, coloration. In a histological section the lesion is quite characteristic and easily recognised, consisting of a circular cavity in the surrounding sclerosed bone which contains inside it a spherical mass osteoid tissue and vascular stroma.

CHAPTER XLVIII

INJURIES TO JOINTS

JOHN CHARNLEY

Sprains are due to overstretching of ligaments with consequent partial rupture. Perhaps the ligaments most commonly affected are the external lateral of the ankle and the internal lateral of the knee. Localised pain, which may be sickening in severe cases, and tenderness over the site of the torn ligament, are immediate features. Extravasation of blood occurs in the neighbourhood of the torn ligament, and a sympathetic effusion occurs into the associated joint.

Treatment consists in the immediate application of a pressure bandage made of one or two layers of wool and flannel bandage. The bandage must be applied firmly so as to limit further effusion. After two or three days graduated movements are instituted, and subsequently care is taken to relax the damaged ligament, e.g. the boot raised on its inner side in order to relieve strain on a torn internal lateral ligament of the knee joint.

DISLOCATIONS

Dislocations are either complete or partial (subluxation). Three types of dislocations are recognised : congenital, pathological, and traumatic.

Congenital dislocation most commonly occurs in the hip joint, and is considered in the chapter on Deformities.

Pathological dislocations are due to:

(1) *Destruction of the joint by disease*, e.g. 'travelling' acetabulum in advanced tuberculous arthritis of the hip joint, or subluxation of the knee in cases of triple deformity (*vide* p. 1283).

(2) *Paralysis* of muscles which support a joint, as in the case of infantile paralysis of the shoulder girdle, or of the muscles around the hip joint. In spastic paralysis (Little's disease) the hips may dislocate as a result of persistent adductor spasm.

(3) *Neuropathic*, e.g. Charcot's joint. Softening of the ligaments predisposes to stretching, and pathological dislocation is liable to occur, even in the hip joint.

Traumatic dislocations occur most commonly in the middle part of adult life. In children separation of an epiphysis is more likely, while in older people atrophy of bone predisposes to fracture. Traumatic dislocations are always accompanied by tearing of the capsule and injury to surrounding tissues, especially to muscles and ligaments which are attached to adjacent bones. Nerves and blood-vessels are occasionally injured, e.g. the circumflex nerve following dislocation of the shoulder joint and the sciatic in dislocation of the hip.

The likelihood of any individual joint suffering dislocation depends upon the shape of the articular surfaces, and the support given by muscles and ligaments. The shoulder joint is commonly dislocated, as the glenoid cavity

William John Little, 1810–1894. Physician to the London Hospital.
Jean-Martin Charcot, 1825–1893. Physician at the Salpêtrière, Paris.

is shallow, and the support given to the head of the bone by muscles and ligaments is somewhat lax. Conversely, in the case of the hip, the acetabulum is deep, and muscles closely support the joint ; therefore dislocation is uncommon.

Clinical Features.—(*a*) Pain—due to local trauma, or pressure on nerves, e.g. the displaced head of the humerus may press on the brachial plexus.

(*b*) Loss of function.

(*c*) Deformity. The limb is shortened or lengthened, or malalignment is present.

(*d*) The end of the bone may be detected in an abnormal position. This is the *absolute* sign of a dislocation. Unless the dislocation is accompanied by a fracture, movement of the shaft of the bone causes corresponding movement of the articular end.

(*e*) Restricted mobility. In this a dislocation is quite unlike a fracture where abnormal mobility is present.

Treatment.—Reduction is obtained by manipulation, extension, or operation. Manipulation is carried out as soon as any attendant shock has subsided, and in any case all avoidable delay must be eliminated. In the case of large joints surrounded by powerful muscles, general anæsthesia is desirable in order to overcome muscular spasm. The path taken by the displaced bone should be visualised, and movements carried out so that this path is retraced without causing additional damage to soft tissues. From two to four weeks of partial immobilisation is advisable after reduction, in order to allow healing of the soft tissues ; the larger joints require a longer period of rest than the small ones, e.g. interphalangeal. Operative measures are sometimes necessary, e.g. thumb (p. 1261), and in the case of larger joints open reduction is required should manipulation fail.

Attempts at reduction by manipulation are seldom justified after a lapse of three or four weeks. If considered advisable, late cases are treated either by open reduction, with or without arthrodesis, or by excision of part of an implicated bone or conversion into an arthroplasty.

DISLOCATIONS OF SPECIAL JOINTS

LOWER JAW

The usual cause of dislocation of the mandible is a blow on the chin when the mouth is partly open. Dental operations, particularly those performed under general anæsthesia, and excessive yawning are other causes.

If the dislocation is unilateral, the jaw is displaced towards the opposite side, and saliva dribbles from the partially open mouth. A hollow is palpable immediately in front of the tragus, and the condyle can be seen in a slightly anterior situation. In bilateral cases the mouth is fixed in a partly open position, and both condyles are displaced in front of their normal situations.

Reduction can usually be performed with ease by pressing the padded thumbs on the lower molar teeth, at the same time rotating the body of the

jaw upwards with the fingers. A general anæsthetic is occasionally necessary. After reduction a four-tailed bandage is worn for three weeks.

STERNO-CLAVICULAR JOINT

Violence affecting this joint is transmitted along the clavicle, but in the majority of cases fracture of the clavicle occurs before force sufficient to cause dislocation reaches the sterno-clavicular joint. Moreover, the sturdy rhomboid ligament anchors the inner end of the clavicle to the first costal cartilage. When dislocation occurs the inner end of the clavicle is displaced forwards and downwards, or backwards and upwards, the first of these being the more common. Backward dislocation may cause severe dyspnœa from pressure on the trachea, or congestion of the head or arm owing to obstruction to the great veins at the root of the neck. Owing to the subcutaneous position of the bone, the dislocation is readily recognised.

THE ACROMIO-CLAVICULAR JOINT

Dislocation of this joint is not uncommon as a result of a fall on the shoulder; owing to the obliquity of the articular surfaces, the outer end of the clavicle is forced upwards and over-rides the upper surface of the acromion. The conoid and trapezoid ligaments which hold the clavicle down to the coracoid process must of necessity be ruptured to permit this over-riding. The prominence caused by the displaced outer end of the clavicle is readily palpable (fig. 1604). The dislocation is easily reduced by elevation of the shoulder, but withdrawal of support results in immediate redislocation. Treatment consists in flexing the forearm, and applying 'Elasto-plast' so that pressure is exerted on a pad situated over the outer end of the clavicle (fig. 1605); the arm is then supported by a sling. There are some who advocate immediate open reduction and internal fixation for complete fresh dislocations. If an unreduced dislocation causes disability, resection of the outer end of the clavicle is sometimes advised but it is rarely necessary as the patient can be encouraged by active exercise to generate a painless pseudarthrosis in the new position.

FIG. 1604.—Dislocation of acromio-clavicular joint.

FIG. 1605.—The application of pads and strapping for dislocation of the acromio-clavicular joint.

SHOULDER JOINT

Owing to the wide range of movement, the shallowness of the glenoid cavity, and the lack of support by ligaments and muscles, particularly on the inferior aspect, dislocations of this joint are of common occurrence, and are caused by sudden violence to the joint with the arm in abduction. In the majority of cases a subcoracoid dislocation occurs.

On *inspection* of the shoulders an alteration of contour is obvious, unless

the patient is very obese. The rounded appearance of the shoulder is lost owing to displacement inwards of the head of the humerus, and consequently on inspection the 'point' of the shoulder appears more angular than normal (fig. 1606). The axis of the arm passes upwards and inwards, and a fullness is noticed below the outer part of the clavicle. On *palpation* the angular shape of the shoulder is even more readily appreciated than on inspection, and loss of resistance is felt beneath the acromion process indicating absence of the humeral head from its normal position. Pain and limitation of movement are complained of by the patient.

FIG. 1606.—Subcoracoid dislocation of the left shoulder.

The contour of the shoulder is of importance in diagnosing various lesions of the shoulder (fig. 1607).

The following academic tests are rarely necessary, provided that a careful examination is made.

Hamilton's Ruler Test.—The acromion process and the external condyle can be connected by a straight line.

Callaway's Test.—The axillary folds are lowered, and therefore the vertical measurement around the axilla is increased on the injured side.

Dugas' Test.—Owing to the abduction of the lower end of the humerus it is impossible to place the hand of the patient on the opposite shoulder.

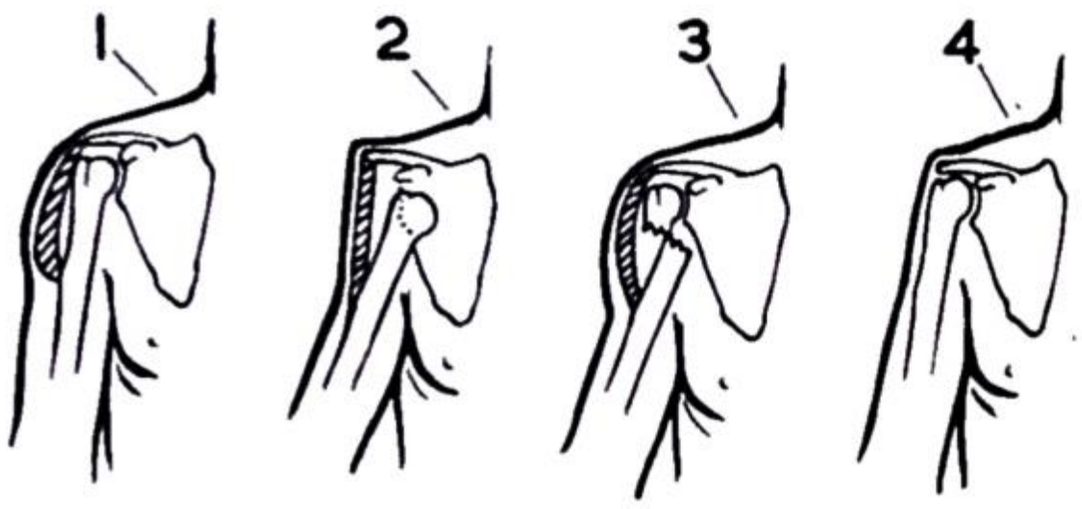


FIG. 1607.—Contours of the shoulder.
(1) Normal—rounded and mobile.
(2) Dislocation—angular and fixed.
(3) Fracture—rounded and fixed.
(4) Paralysis of deltoid with wasting (circumflex palsy)—angular and mobile.

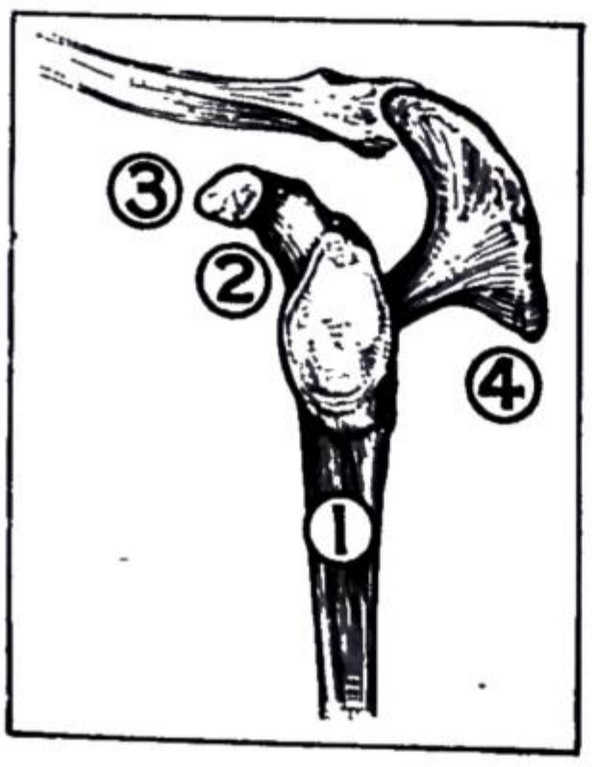


FIG. 1608.—1. Subglenoid. 2. Subcoracoid. 3. Subclavicular. 4. Posterior or dorsal.

Varieties (fig. 1608).—Dislocations of the shoulder, in the first instance while the arm is abducted, are usually subglenoid but the head of the humerus resting in a precarious manner on a narrow ridge of bone usually slips forward into the *subcoracoid* position. Should the exciting force continue to act, the head of the bone moves farther inwards, and comes to rest in the subclavicular position. Occasionally the head of the bone is displaced backwards to give a 'dorsal' dislocation of the shoulder.

Luxatio erecta is a rare variety (under 1 per cent.), in which the head of the humerus is displaced into the subglenoid position, the arm being fixed in extreme abduction.

Treatment.—A general anæsthetic is usually advisable, particularly in a muscular subject, or when delay has allowed muscular spasm to supervene.

Frank Hastings Hamilton, 1813–1886. Orthopædic Surgeon at Wilmington, Vermont, U.S.A.
Thomas Callaway, 1822–1869. English Surgeon who practised in Algiers.
Louis Alexander Dugas, 1806–1884. Professor of Surgery, Medical College of Georgia, U.S.A.

Kocher's Method.—The patient may be either sitting or lying. The following manipulation is then performed in a smooth and deliberate manner according to the three stages of the illustration (fig. 1609):

(1) The elbow is flexed and adducted and the arm externally rotated so as to stretch the subscapularis muscle, which has contracted owing to the inward displacement of the upper end of the humerus. This manipulation must be performed slowly and to its fullest extent.

(2) When full external rotation is obtained, the elbow is brought in front of the chest, at the same time exerting traction.

(3) The forearm is then rotated inwards so that the fingers sweep across to lie on the opposite shoulder if reduction has been successful. Usually sudden reduction will be detected during this last movement.

FIG. 1609.—Kocher's method for reduction of a dislocated shoulder.
(F. P. Fitzgerald.)

Traction.—If Kocher's method fails, traction can be applied by placing the unbooted foot against the chest wall in the patient's axilla while supine. A steady pull is maintained on the forearm in an outward and downward direction. This method is usually known as the Hippocratic method. If reduction does not result by the time maximum traction has been applied, it will usually be produced by internal or external rotation of the arm while traction is maintained.

Operation.—In cases which have been dislocated for several weeks manipulative measures fail and open reduction may be necessary. In old people even this may not be necessary if they have got over the discomfort of the orginal injury, and quite good function is possible with the fibrous ankylosis in the dislocated position.

After-treatment consists in supporting the arm in a sling in a slightly abducted position which is conveniently maintained by an 'axillary muff.' If the arm is kept in an adducted position, e.g. bandaged to the chest wall, the loose inferior portion of the capsule is thrown into folds which become adherent to each other, and thus return of full abduction is hindered. Finger and wrist movements are encouraged immediately, and active movements of the shoulder are commenced a few days later if the patient is elderly and therefore likely to get a very stiff shoulder. In young people abduction to more than a right angle should be prohibited for one month, as this may precipitate recurrent dislocation.

Theodore Kocher, 1841–1917. Professor of Clinical Surgery, University of Berne.

COMPLICATIONS

FRACTURE.—Dislocation of the shoulder may be complicated by fracture of the surgical neck of the humerus. Not uncommonly the great tuberosity is avulsed, but apposition occurs when the dislocation is reduced (fig. 1610).

RECURRENT DISLOCATION.—*Vide infra.*

NERVES.—Any part of the brachial plexus, or adjacent nerves, may be involved. Owing to its limited mobility and proximity to the head of the humerus, the circumflex nerve is most commonly injured (10 per cent. of cases), but recovery usually ensues in from two to six months.

MUSCLES.—The tendon of the supraspinatus muscle is occasionally ruptured, as is evinced by inability to abduct the arm. If this is suspected, the shoulder should be explored by operation, as suture of the torn tendon is only possible if the injury is a recent one.

VESSELS.—Damage to vessels is rare, but complete rupture of the brachial artery is occasionally reported.

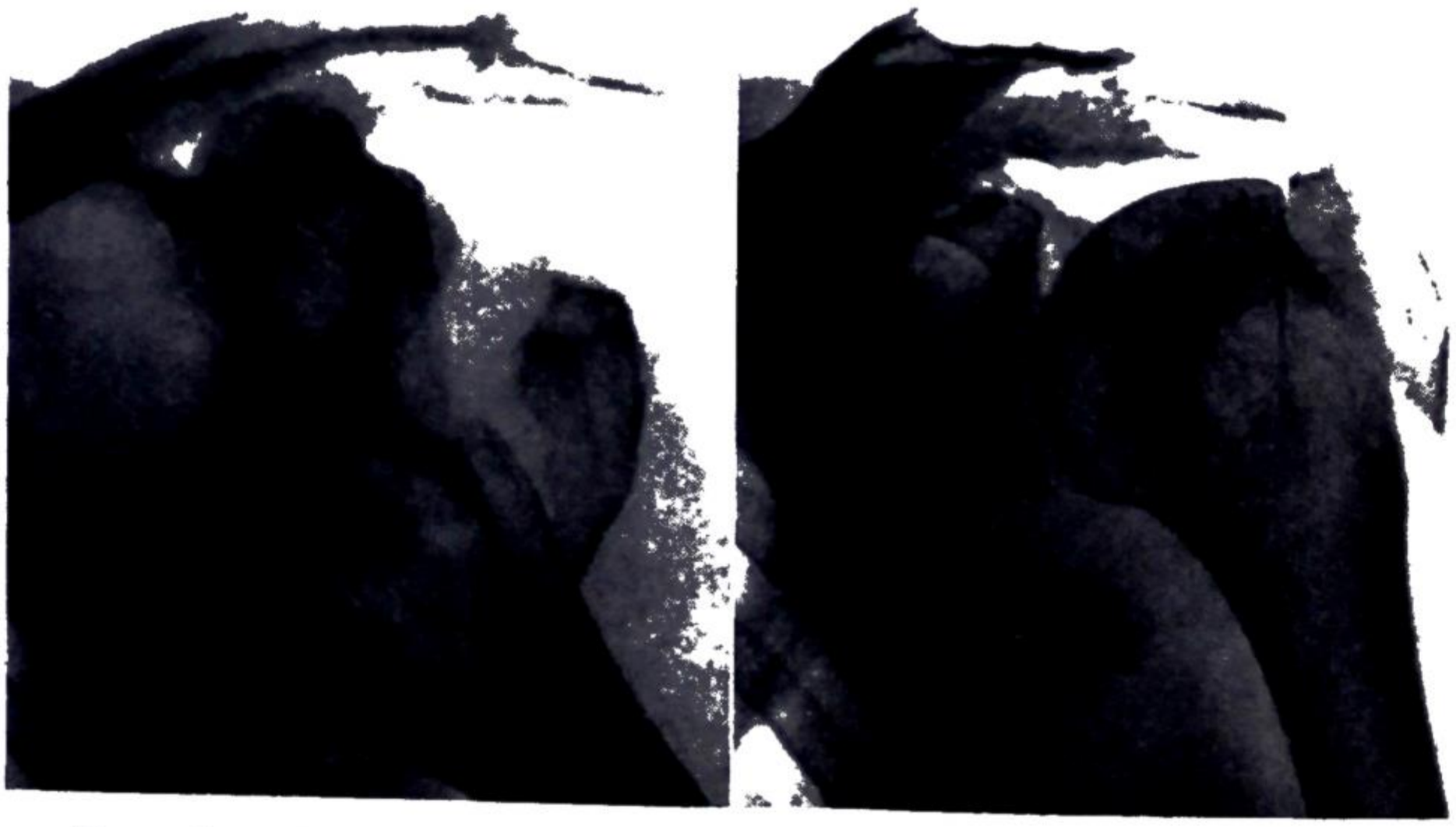


FIG. 1610.—Subcoracoid dislocation of the shoulder with avulsion of the greater tuberosity. Good apposition after reduction.

RECURRENT DISLOCATION

In cases in which after-treatment has been inadequate, or in persons who are subjected to frequent injury, e.g. epileptics, weakness of the capsule persists, and it may even happen that the patient is able to dislocate the joint voluntarily. If disability occurs, Bankart's operation gives consistently good results, but there are many modifications. Bankart postulates that recurrent dislocation is due to separation of the anterior part of the glenoid fibro-cartilage. The joint is exposed, and the coracoid process is divided and displaced downwards with the attached muscles. The subscapularis muscle and capsule are divided and the joint is thus opened. Sutures are inserted so that the detached labrum is firmly stitched to the capsule of the joint. Further stability is obtained by double-breasting the capsule, and the subscapularis is then repaired. The coracoid process is replaced and held in position by sutures inserted into the adjacent soft tissues. External rotation is not permitted for at least a month, after which active exercises are encouraged. It is probable that permanent restriction of external rotation is the basic cause for the success of operations for this condition.

If the patient is unsuitable for operation, an appliance is fitted which prevents unlimited abduction.

A. A. Blundell Bankart, 1879–1951. Consulting Surgeon, Royal National Orthopædic Hospital, London.

FRACTURE—DISLOCATION

This serious accident is due to continuation of force after the shoulder has been dislocated, the fracture occurring through the surgical neck of the humerus. The condition is difficult to recognise except by X-ray. Crepitus is obtained on manipulation, and more pain and extravasation are present than in cases of dislocation only.

Reduction by manipulation is unlikely to be successful, owing to the small size of the upper fragment and consequent difficulty in controlling it. In a young patient an attempt at open reduction is therefore usually necessary, the bone being exposed by an incision which separates the deltoid and pectoralis major muscles. Attachments of soft tissues to the head of the bone must be carefully preserved, otherwise avascular necrosis may follow. The operation is not commonly needed because most of these cases occur in elderly patients, provided that there is no pressure on neurovascular structures, and early movement will eventually give a useful fibrous ankylosis.

ELBOW JOINT

In dislocation of the elbow the forearm is most commonly displaced postero-laterally in relation to the humerus (figs. 1611 and 1612). Forward dislocation is usually accompanied by fracture of the olecranon.

FIG. 1611.—Posterior dislocation of elbow.

FIG. 1612.—Lateral dislocation of the elbow.

Dislocation of the elbow is distinguished from supracondylar fracture of the humerus by the fact that the normal relations of the bony points around the elbow are distorted (fig. 1613). Also on inspection the forearm is apparently shortened, and the measurement between the external epicondyle and radial styloid process confirms this shortening.

Reduction is effected by flexing the arm to a right angle and applying traction to the forearm. The reduction takes place with a loud snap and is immediately stable unless the elbow is fully extended. The joint is kept at rest in a sling for three weeks.

Myositis ossificans is a well-known complication affecting the brachialis anterior muscle after dislocation of the elbow joint. When recognised, it is of the utmost

importance to avoid over use of the elbow and to make sure that the patient is not applying passive stretching movements in order to increase the range of motion (see p. 1307).

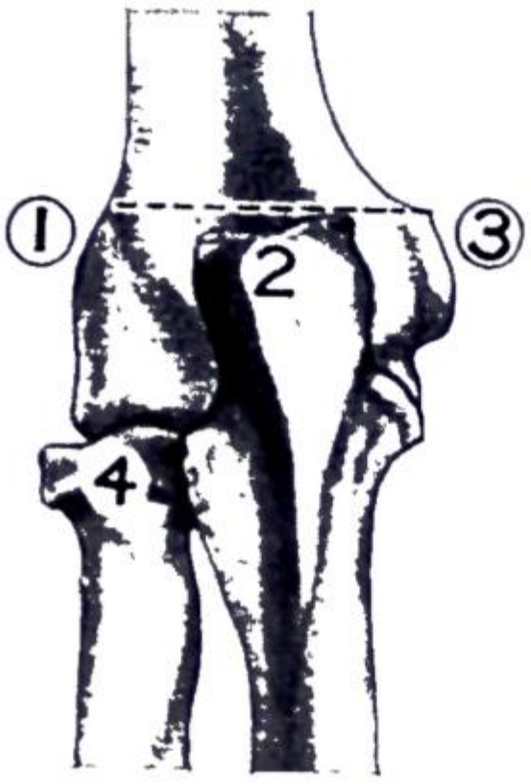


FIG. 1613.—1. External condyle. 2. Tip of olecranon process. 3. Internal condyle. 4. Head of radius.

Anterior dislocations are associated with fracture of the olecranon process. Reduction is obtained by traction with the arm extended, and the olecranon process must then be exposed by open operation and mechanically fixed in position by a screw or wire suture.

INCARCERATION OF THE MEDIAL EPICONDYLE

In children the epiphysis of the medial epicondyle is frequently avulsed as part of the injury of a dislocated elbow, but in rare cases the separated epicondyle becomes trapped inside the joint when it is reduced. Clinically this complication can be suspected if there is anæsthesia or paræsthesia in the distribution of the ulnar nerve in the hand. X-ray will show the epicondyle in the joint, but it is easily overlooked if not carefully searched for.

When recent the epicondyle is usually easily extracted by manipulation, but a late case may need open operation and excision.

DISLOCATION OF THE CARPUS

The commonest element in dislocations of the carpus is dislocation of the lunate. When this occurs the lunate is extruded through the anterior capsule of the wrist joint and lies in the carpal tunnel, causing median nerve pressure in this confined space.

The injury occurs in severe falls from heights on to the outstretched hand in workmen. It is important not to miss the injury because when seen fresh it can usually be reduced with the greatest ease by simple traction and hyperextension combined with pressure on the site of the dislocated bone.

The condition is most likely to be missed if associated with a fracture of the radial styloid or a fracture of the carpal scaphoid, because then the inexperienced surgeon may look no further in the radiograph. A well-centred lateral X-ray clearly reveals the dislocated semilunar in front of the carpus, but a poor lateral view may conceal the dislocation. The antero-posterior view at first sight may be passed as normal, but close inspection will show that the bones of the proximal row of the carpus (scaphoid, lunate, and triquetral) are not disposed round the head of the capitate (os multangular major) with the intervention of a regular joint space as in the normal wrist (fig. 1614).

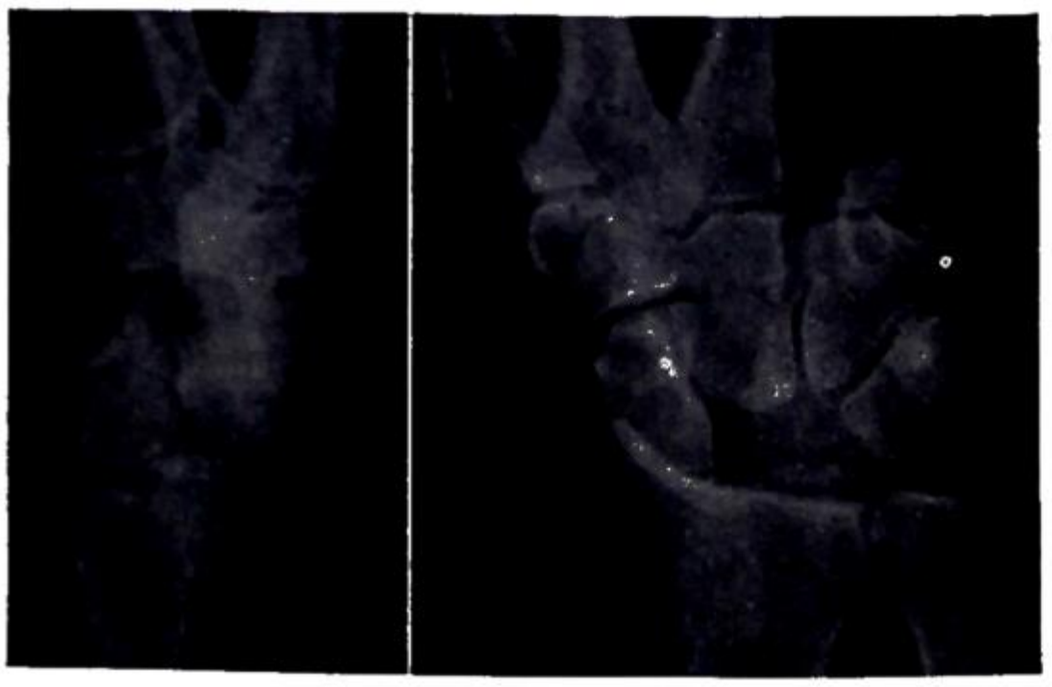


FIG. 1614.—Midcarpal dislocation. Sometimes can be missed in antero-posterior view if not scrutinised carefully.

Dislocation of the lunate is always part of a more serious injury which is that of a midcarpal dislocation which has reduced itself and therefore will not be visible radiologically (fig. 1615). In old unreduced cases the lunate will have to be excised, but in cases of not more than a few weeks' duration an open reduction is often worthwhile.

Dislocation of the head of the **radius** occasionally occurs as a congenital abnormality (see p. 1320). In cases due to trauma the head of the bone usually passes forwards and hinders flexion of the joint. Fracture of the shaft of the ulna (Monteggia's fracture) is commonly associated with forward dislocation of the head of the radius, and can be readily recognised by palpa-

tion of its subcutaneous border (fig. 1616). Traction of the forearm combined with pressure on the radial head usually permits of reduction, but as the orbicular ligament is torn the dislocation tends to recur. In children the head of the radius can usually be retained in position in the fully flexed position of the elbow. In adults the key to the reduction is provided by internal fixation of the fractured ulna. Once this has been done, it is usually possible to hold the head of the radius in position by plaster after manipulation.

FIG. 1615.—Anterior dislocation of the lunate bone.

FIG. 1616.—The 'Monteggia' fracture. Combination of dislocation of the head of the radius with fracture of the upper one-third of the ulna.

Metacarpo-phalangeal and **inter-phalangeal** dislocations can he reduced easily by traction and flexion, with the exception of the metacarpo-phalangeal joint of the thumb. Traction should be applied, and a bandage, placed as a clove-hitch round the thumb, may assist in securing a firm grip. Manipulation frequently fails, the commonest cause of failure being the interposition of the glenoid (anterior) ligament between the two bones. This tough ligament, firmly attached to the base of the phalanx, is carried backwards, and lies like a curtain between the phalanx and the head of the metacarpal (fig. 1617 (A)).

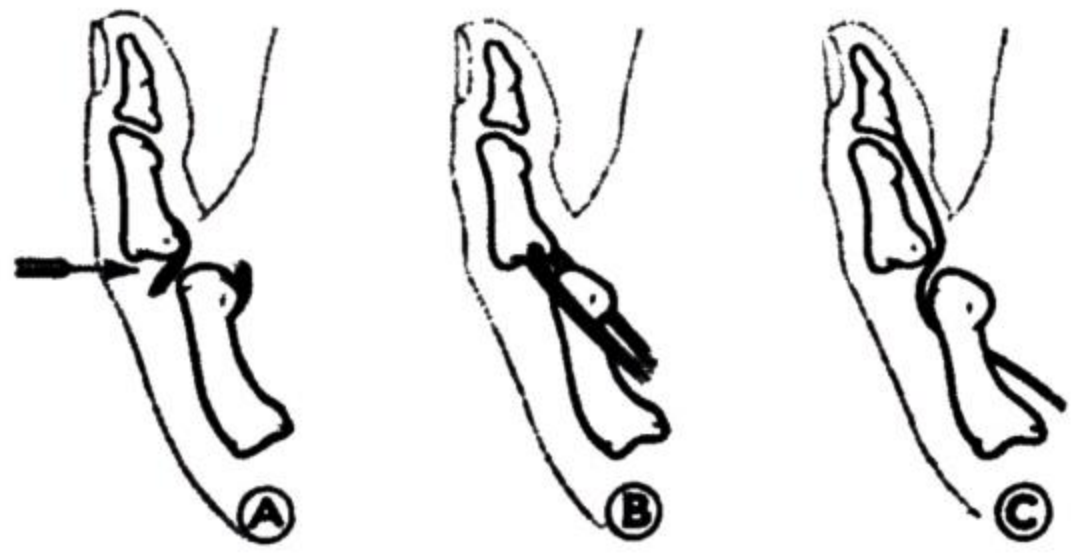


FIG. 1617.—Causes which prevent reduction of a dislocation of the metacarpo-phalangeal joint of the thumb.

Other causes of failure in reduction are buttonholing of the two slips of the flexor pollicis brevis (fig. 1617 (B)), and interposition of the long flexor tendon (fig. 1617 (C)). If a satisfactory manipulative reduction of this joint cannot be achieved, it should be explored at operation with the least possible delay. If operation is postponed for several weeks, the exact cause of the obstruction may be difficult to find, even when the structures are exposed.

HIP

Owing to the depth of the acetabular cavity and the strong support afforded by ligaments and muscles, traumatic dislocation of this joint is relatively uncommon.

Dislocation of the hip most commonly occurs when the hip is flexed, and especially so if it is also adducted, because in this position the head of the bone is in contact with the relatively weak under-surface of the capsule. The usual causes are a weight falling on the back of a person in a stooping position, as in a coal-miner struck by a 'fall of roof,' and in car and motor-cycle accidents (fig. 1618).

FIG. 1618.—Traumatic 'dorsal' dislocation of the hip. There is also a fracture of the cotyloid labrum.

Posterior dislocations are the common types of hip dislocation. The head of the bone escapes into the sciatic notch (sciatic variety), and then passes up on to the dorsum of the ilium (dorsal variety). In both cases the leg is flexed, adducted, and inverted, so that the sole rests upon the opposite instep. Pain is sometimes referred along the sciatic nerve, which may be paralysed by direct injury. X-rays should always be taken to confirm the dislocation and detect any associated fracture.

Reduction is usually accomplished without difficulty, if the injury is recent and provided that the anæsthetist obtains adequate relaxation of the muscles. The patient is placed supine on a mattress on the floor, and the iliac crests are steadied by an assistant. The surgeon stands over the limb and flexes the knee and thigh, bringing the head of the bone beneath the acetabulum. The femur is then pulled vertically upwards so as to draw the head forward from its posterior position. The essence of the reduction lies in the vertical lifting of the femur with the maximum force the surgeon can exert. Sometimes reduction will occur with this vertical traction alone. Otherwise the hip must be internally and then externally rotated while maximum upward traction is being exerted before the head of the femur suddenly snaps into its socket.

Usually the reduction is quite obvious when it occurs, and if the acetabulum is intact the reduction is stable. If a large fragment of the posterior margin of the acetabulum has been fractured, the hip will easily re-dislocate when upward traction is released, but it will usually remain stable if the hip is extended before releasing traction.

Following reduction a plaster spica should be applied to below the knee for two months, or longer if the rim of the acetabulum is fractured. In about 10 per cent. of cases avascular necrosis of the femoral head is inevitable, due

to damage to the ligamentum teres and the anastomosis nourishing the head, and osteoarthritis is a common sequela.

Anterior dislocation of the hip is exceedingly rare and can be either obturator or pubic (fig. 1619); in both cases the limb is in a position of flexion, abduction, and eversion.

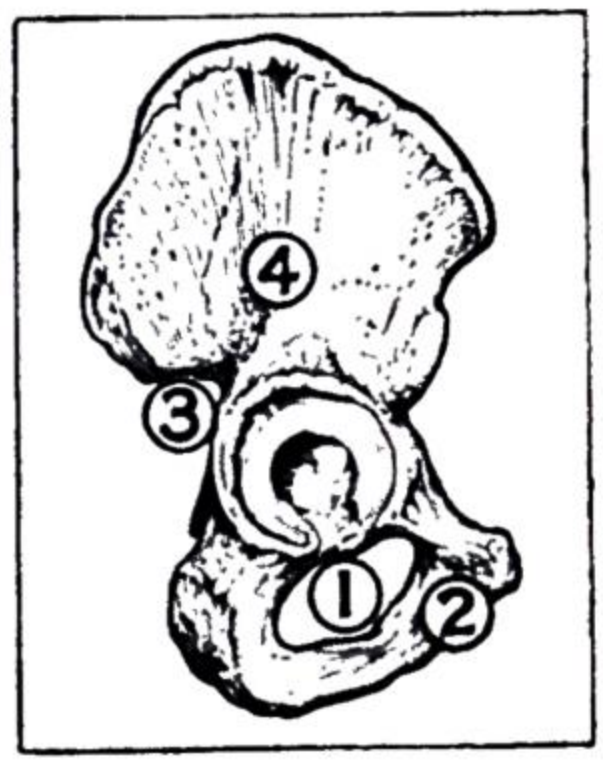


FIG. 1619.—1. Obturator. 2. Pubic. 3. Sciatic. 4. Dorsal.

Central dislocation of the hip occurs as a form of fracture of the pelvis when a blow is delivered to the great trochanter driving the head of the femur through the floor of the acetabulum.

KNEE

Complete dislocation of this joint is rare, but subluxation is common, following rupture of one or other cruciate ligament, or both. The diagnosis is usually obvious, although rapid effusion into the knee joint tends to render immediate recognition difficult. The most common direction of dislocation is for the femur to pass forward, and the popliteal vessels are occasionally compressed.

Reduction is effected by flexion and traction, and aspiration of the distended knee joint is often advisable. The joint should be immobilised in plaster in slight flexion for three months. Quadriceps drill is instituted to begin with, and weight-bearing is permitted after about a month. Instability sometimes persists owing to rupture of the cruciate ligaments (*vide* internal derangement).

PATELLA

This sesamoid bone may be dislocated by direct violence and by far the most common direction is outwards. The diagnosis is readily made on palpation. Reduction is effected by laying the patient on his back with the leg and thigh extended. The quadriceps muscle is thus relaxed, and the bone can be manipulated into position.

Recurrent dislocation of the patella is not uncommon, especially in girls or young women. Sometimes it is associated with a marked genu valgum which increases the angle between the direction of pull of the patella tendon and the quadriceps tendon and so disposes to lateral movement of the patella. Most commonly recurrent dislocation occurs without genu valgum and is almost certainly due to a lack of development of the lateral femoral condyle. Operative treatment is usually fairly successful and most commonly the tibial tubercle, with its inserted patella tendon, is transplanted medially, and slightly distally, to prevent the lateral movement. In severe cases excision of the patella has been successfully employed.

INTERNAL DERANGEMENT OF THE KNEE JOINT

This term is used to describe recurrent incidents of a mechanical nature in the knee often following knee injuries. The 'internal' nature of the derangement is suggested if the mechanical incident is followed by synovial effusion.

Two special conditions exist: (1) tears of the cruciate ligaments and (2) tears of the semilunar cartilages.

(1) **Tears of the cruciate ligaments** are always the result of severe

injuries, and frequently at sport. They are the result of a subluxation of the knee, and the lateral ligaments are of necessity ruptured at the same time. The injury is followed immediately by a hæmarthrosis and the joint is usually grossly swollen in a few minutes, the patient being unable to walk on the limb.

Careful testing, especially under anæsthesia, will show abnormal mobility of the joint—the tibia sliding forward on the femur and the knee hyper-extending if the anterior cruciate ligament is torn, and the tibia sliding backwards if the posterior cruciate is damaged.

Provided that the serious nature of the condition is recognised the ligaments usually heal well if protected by a plaster cylinder in slight flexion for three months. Thereafter strong quadriceps exercises and physiotherapy to recover flexion will be needed for about six months.

In some cases the patient has a permanently unstable knee which " lets him down " and attempts have been made to repair the ligaments by various operations but with doubtful success. Many of the patients with this complication are compensation cases with no incentive to recovery. In this respect the excellence of recovery in athletes is very significant. The complete recovery of quadriceps power, which is always in the patient's capability, is the key to full recovery of function in knee-joint surgery.

For the same reason the use of a knee-cage in permanent laxity of the knee should not be encouraged as it perpetuates any hysterical tendency.

(2) **Cartilage.**—Injuries of the semilunar cartilages are very common as the result of accidents at sport, and particularly in football. The medial meniscus is torn perhaps ten times more frequently than the lateral meniscus.

The exact mechanism whereby the cartilage is torn is still not completely explained, but certain facts are quite clear. The tear occurs most commonly as a result of rotation on a flexed knee which is taking the weight of the body. In the case of the right knee, the medial meniscus is damaged when the player is turning his body, and his femur, towards the left. This movement abducts the tibia and the medial meniscus is presumably drawn into the joint and pinched between the medial femoral condyle and the medial tuberosity of the tibia. In this position it splits along its length so that the free inner rim is separated from the periphery which is attached to the joint capsule. The lateral meniscus is torn less commonly than the medial because it is more mobile and not so adherent at its periphery to the capsule. Once the longitudinal split has been started, it may extend to give three main varieties : (a) anterior pedunculated tear, (b) posterior pedunculated tear, and (c) the complete, ' bucket-handle ' tear, which is by far the most common lesion (fig. 1620).

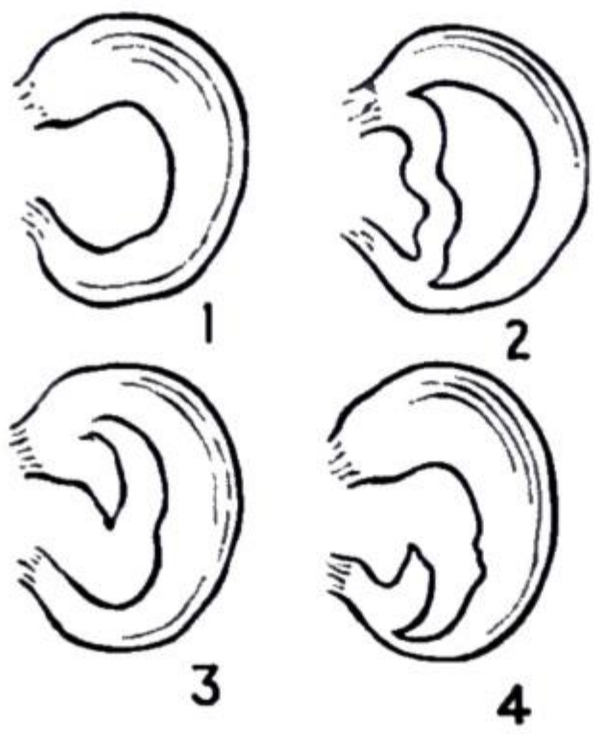


FIG. 1620.—Tears of medial meniscus.
(1) Normal.
(2) ' Bucket-handle.'
(3) Posterior.
(4) Anterior.

In making a diagnosis of a cartilage tear a careful history is of paramount importance, and very few patients will forget the dramatic circumstances of

the first injury. Frequently this will disable them for two or three weeks, and will invariably be accompanied by a large effusion. In a few cases there will be no history of injury, but here it is not uncommon to find that the tear occurred when kneeling. In these cases it seems that the meniscus can get into an abnormal position when kneeling, and if the patient suddenly stands up the meniscus fails to get back into position quickly enough and sustains a tear.

If seen shortly after the first injury, the diagnosis will be made on the history, the presence of effusion, the inability to extend the knee fully (though flexion may be possible to some extent), and by localised tenderness over the joint line on the inner aspect of the knee. In such a case the knee is 'locked' because the displaced fragment is obstructing extension, and unless the patient accidentally releases the obstruction it will be necessary to 'unlock' the knee.

Manipulation of the Locked Knee.—Many complicated manœuvres have been described by which the displaced fragment can be made to return to the position from which it came, but in fact the essential feature is effective relaxation of the muscular spasm under full anæsthesia. Frequently the displaced fragment 'goes back' at the first movement of the knee as soon as full anæsthesia has been achieved. If this does not happen, the surgeon manipulates the knee in an endeavour to open up the medial joint line and give an opportunity for the displaced fragment to slip out from the centre of the joint. If a satisfactory 'snap' is not achieved and full extension does not immediately result, it is probable that the tear is irreducible by non-operative means and operative treatment may later be necessary.

Once a cartilage has been torn there is no likelihood of it healing, even if the reduced fragment lies in contact with the rim from which it was originally torn; this is because the fibro-cartilage of which it is composed is avascular and incapable of healing. The decision whether or not to operate to remove the torn fragment depends on the amount of trouble the injury causes in subsequent months. Even a large 'bucket-handle' tear lying in the intercondyloid notch, which manipulation has failed to reduce, will eventually adapt itself to its new site and may cause no trouble. On the other hand, the patient may recover from the first injury and thereafter have repeated episodes of locking from minor violence.

When deciding to advise operation it is of paramount importance that the diagnosis should be established beyond all question. The poor results of cartilage surgery are those in which, at operation, to the surgeon's surprise, the suspected cartilage proves to be normal. Until the diagnosis is proved there is no hurry in advising surgery, and every new episode will help to clinch the final diagnosis. There is no place for 'exploratory arthrotomy' in suspected cartilage injuries, because experience has shown that the results of a negative exploration are disappointing.

Of all the signs and symptoms in making a diagnosis of cartilage injury, the most important *sign* is marked local tenderness over the affected meniscus and the most important *symptom* is a volunteered statement of the ability to *un*lock the knee by various wriggling manœuvres which the patient has learned by experience. 'Locking' of the knee is a very unreliable symptom

of cartilage injury but, on the other hand, sudden spontaneous '*un*locking' is almost positive proof of a cartilage tear.

The significance of accurate localisation of tenderness is indicated in fig. 1621.

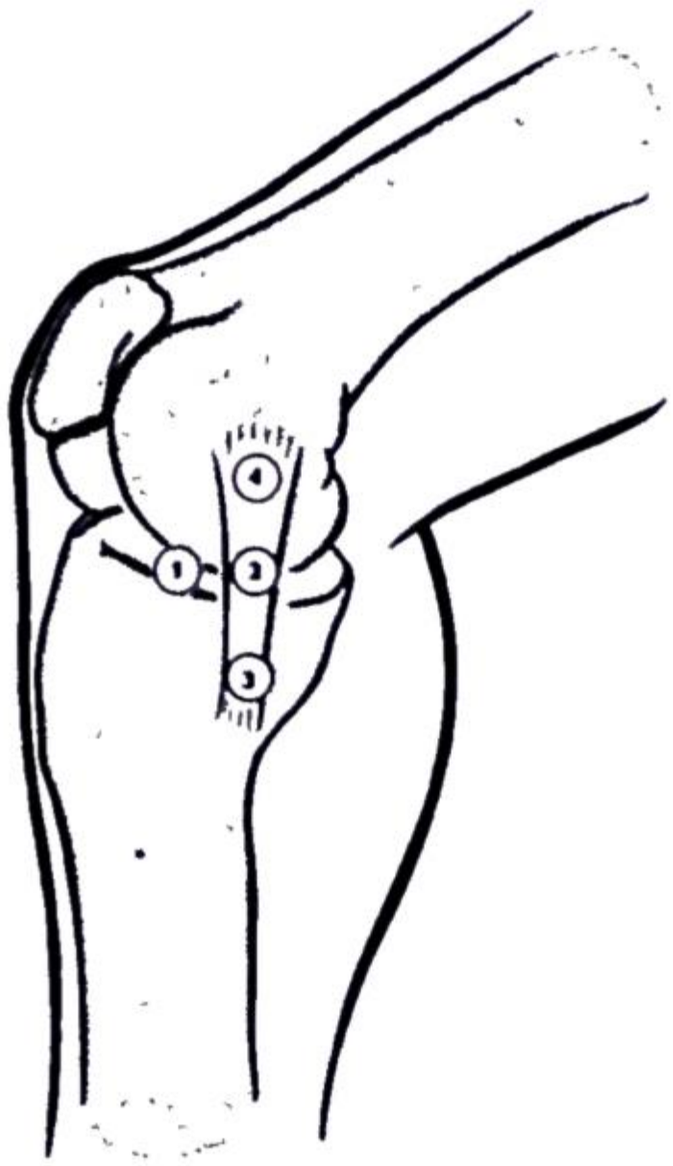


FIG. 1621.—Sites of localised tenderness in knee injuries.

(1) and (2) on joint line. Tears of medial meniscus.

(3) and (4). Sprains at tibial and femoral attachments of medial collateral ligament.

It is customary, and proper, to insist on the most absolute aseptic precautions possible during this operation. Careful skin preparations and 'no-touch' technique in the theatre are a *sine qua non*. An Esmarch's rubber bandage or a sphygmomanometer is applied as a tourniquet. The internal cartilage is exposed through either an oblique or transverse incision on the inner side of the joint. The skin knife is then discarded and skin edges draped. The torn cartilage is steadied by a blunt hook and the anterior attachment to the head of the tibia is divided. The cartilage is then grasped by forceps and pulled forward till the posterior attachment can be reached and divided. If the common 'bucket-handle' tear is present, it is necessary only to remove the detached fragment. The synovial membrane, capsule, and skin are sutured, and a firm bandage applied before the tourniquet is removed, so as to limit bleeding into the joint. The limb is steadied between sandbags, and quadriceps drill is commenced on the following day.

CYST OF SEMILUNAR CARTILAGE

A *cyst* of a semilunar cartilage is a myxomatous degeneration occurring in the substance of the cartilage itself. The external cartilage is affected more commonly than the internal, and a tense swelling appears over the interarticular groove (fig. 1622). The cyst sometimes appears suddenly. The cartilage, together with the cyst, should be removed if symptoms are persistent, but, like a 'ganglion' in any other site, if desired it can be ignored and will eventually disappear spontaneously after a number of years. Pain in these cases invariably follows exertion, and rest relieves the tension which is the cause of the pain. Local removal is unsatisfactory, as recurrence is inevitable; if surgical intervention is necessary, complete menisectomy must be performed.

FIG. 1622.—Cyst of the right internal semilunar cartilage.

ANKLE

Owing to the deep mortise formed by the tibia and fibula, dislocation of the ankle joint, without fracture, is extremely rare. Dislocations of the talus are more common than formerly, due to the high-velocity accidents of transport.

Subastragaloid dislocation occasionally occurs as a result of severe twists or wrenches, e.g. the patient being dragged by a horse with a foot in the stirrup. If manipulation fails, open reduction is necessary.

CHAPTER XLIX

DISEASES OF JOINTS

JOHN CHARNLEY

TRAUMATIC SYNOVITIS

THE term 'traumatic synovitis' is accepted by long use, though scientifically it is open to criticism. The term is valuable in indicating that a joint reacts to injury initially to produce local physical signs which are almost indistinguishable from those of an early infection.

Traumatic synovitis is caused by such accidents as aseptic penetrating wounds (including operations), direct blows, sprains, or nipping of a loose body or cartilage. An effusion follows, either serous or blood-stained, according to the severity of the lesion. The joint assumes a position of ease, i.e. in which the synovial cavity has the greatest capacity, and palpation or movement is painful and local heat may be present.

Treatment consists, in the early stages, in rest, combined with cold lotions and firm bandaging, in order to minimise further effusion. Plaster fixation is unnecessary, and not advisable because plaster cannot give continuous gentle pressure as the effusion absorbs. If effusion is excessive, aspiration is sometimes advisable to relieve pain, and the time necessary for absorption is shortened. When the early symptoms have abated, muscle drill and subsequently active movements are employed in order to prevent adhesions and to maintain muscular tone.

ACUTE SUPPURATIVE ARTHRITIS

Acute infection of a joint (acute suppurative arthritis) occurs as a result of:

(i) Direct infection, as by a penetrating wound or a compound fracture which involves the joint.

(ii) Local extension, from some neighbouring focus, such as acute arthritis of the hip joint from osteomyelitis of the femoral neck.

(iii) Blood-borne infection, the usual organisms being streptococcus, staphylococcus, and pneumococcus, and less commonly the gonococcus and B. typhosus.

The knee joint, owing to its large size and exposed position, is the commonest joint to be involved by penetrating wounds, while suppurative arthritis from blood-borne infections is more likely to be the cause in other joints.

Clinical Features.—*General.*—The systemic effects of a suppurative arthritis are usually severe. Occasionally the condition is a complication of a septicæmia ('septicæmic joints'), and in this case the severity of the toxæmia can easily be explained.

Local.—Pain, especially on attempted movement. The joint is held in the position of greatest capacity, and swelling is usually evident. Palpation reveals increased heat and tenderness. Movements are limited by muscular spasm, and attempts at either active or passive movement cause severe pain.

Joint.	Position of ease.	Site of maximum swelling.	Position for ankylosis.
Shoulder	Adducted	Under the deltoid, along the tendon of the biceps, and in the axilla	40° to 50° of abduction, with elbow joint just anterior to the coronal plane and hand in front of the mouth.
Elbow	Flexed at a right angle and pronated	On either side of triceps tendon	90° of extension semi-pronated. If both sides, one elbow at 75° of extension, the other at 135°. These positions may be modified according to occupation.
Wrist	Slight flexion	Under extensor and flexor tendons	Dorsi-flexed to allow a firm grasp.
Hip	Flexed, abducted, and everted	Upper part of Scarpa's triangle	20° to 30° of flexion to allow sitting, and in neutral position as regards abduction.
Knee	Flexed	Suprapatellar bursa, and either side of patellar tendon	5° to 10° of flexion to allow foot to clear ground in walking.
Ankle	Slightly extended and inverted	Anteriorly and on either side of the Achilles tendon	Just at the right angle, with slight inversion to discourage flat-foot.

It will be seen that in most cases the position of ease differs widely from the position which is most useful should ankylosis occur. As any case of arthritis may be followed by ankylosis, the first duty of the surgeon is to anticipate this possibility by immobilising the joint in the best position for ankylosis, as indicated in the preceding table.

Treatment.—Chemotherapy and penicillin are prescribed, and have greatly reduced the incidence and severity of joint infections, as a result of both prophylactic and therapeutic administration. In the early stages the limb is supported and fixed by a suitable splint or appliance in the correct position, an anæsthetic being administered if necessary. Weight-traction, which was commonly used in the past with the idea of holding joint surfaces apart and preventing damage to the inflamed cartilage, is no longer much favoured. The following lines of treatment are then to be considered.

(i) *Aspiration*, which is useful for both diagnostic and therapeutic reasons. Thus the nature of the fluid can be ascertained, and smears or cultures assist in identifying the causative organism and its resistance to antibiotics, so that suitable chemotherapy can be instituted. Aspiration also reduces the tension within the joint, thereby relieving pain, and obviating the stretching of ligaments and capsule.

(ii) *Aspiration and Injection.*—After fluid has been aspirated, 200,000 units of penicillin may be injected into the joint. Repeated injections of penicillin

into a joint are probably unnecessary. Penicillin is also administered parenterally, and the limb is suitably splinted.

(iii) *Arthrotomy and Drainage.*—In more serious cases the joint is opened, washed out, and drainage tubes inserted down to the synovial membrane. This procedure could only be considered if bone destruction has involved the articular surfaces and when some degree of ankylosis is all that can be expected when healing has occurred. Though commonly seen during the early part of the Second World War, this technique is today but rarely needed, due to the effect of antibiotics. The knee joint is drained through an antero-lateral incision, combined, if necessary, with a postero-lateral incision which passes behind the ilio-tibial band and in front of the biceps tendon. In all cases adequate immobilisation is essential.

Extra-articular abscesses sometimes require to be opened and drained. In the case of the knee joint, pus is particularly liable to track upwards beneath the quadriceps, where its presence may be overlooked.

(iv) *Excision.*—If the condition of the patient deteriorates in spite of treatment, or if suppuration is prolonged, then drastic surgical ablation of the diseased bone is necessary. In the knee or ankle joint the solution is simply that of amputation, and an excellent functional result can be expected with an artificial limb, and also with rapid convalescence. In certain cases, such as the elbow, wrist, or shoulder, being non-weight-bearing joints, an excision of the joint can be life-saving and the resultant flail limb is still useful to the patient. Even in the hip joint, excision is a valuable procedure (Girdlestone's operation) and, despite the unstable pseudarthrosis which results, the patient can walk on a weight-bearing caliper provided with a ' bucket-top.' Needless to say, a patient's life must never be jeopardised in an endeavour to spare a limb, particularly as the affected joint will eventually be more or less disorganised.

(v) *Amputation* is indicated if at any stage the patient's life is threatened, or prolonged suppuration leads to amyloid disease (which is particularly liable to occur in connection with prolonged infection of the hip joint). Also, in some cases a painful and disorganised joint causes such disability that an artificial limb is preferable.

PENETRATING WOUNDS OF JOINTS

Owing to its size and exposed position, the knee joint is most commonly affected by penetrating wounds. For the purposes of treatment such wounds can be classified according to the risk of subsequent infection.

(i) *Infection is unlikely*, e.g. recent puncture by a small and comparatively clean article, such as a needle. In these cases the needle is removed and the wound is sterilised with an antiseptic. The limb is immobilised in the position of rest and antibiotics administered. Usually a mild, transitory effusion occurs, which subsides in two or three days. Should general and local symptoms or signs suggest that infection is occurring, then the joint is aspirated, and treatment continued along the lines already indicated for acute arthritis.

G. R. Girdlestone, 1881–1951. Late Nuffield Professor of Orthopædics, Oxford.

(ii) *Infection is probable*, such as penetration by a rusty nail, particularly if delay has already permitted infection. In these cases emergency operation must be performed, and the wound excised layer by layer until the joint is opened. Irrigation is advisable if obvious contamination has occurred, as by fragments of rust. The wound is partially or completely closed according to the risk of infection (the synovia is always closed), and the limb is immobilised in the most useful position should ankylosis follow. A prophylactic course of penicillin is prescribed.

(iii) *Infection is certain*, e.g. extensive laceration of the capsule, or less severe wounds which have been neglected. Recent extensive wounds, which formerly would inevitably have become infected, often do remarkably well following thorough débridement, insufflation of penicillin powder, encasement in plaster, and chemotherapy. If infection supervenes or is already established, the wound is rendered as surgically clean as possible, and drainage is provided if necessary. The limb is immobilised, and further treatment conducted on the lines indicated for acute arthritis.

GONOCOCCAL ARTHRITIS

Owing to more efficient treatment of gonococcal urethritis and conjunctivitis, articular complications are now uncommon.

Joint lesions occur at any stage after infection, but are most common when the initial infection is subsiding, or during an exacerbation after urethral manipulations.

The following types of gonococcal arthritis occur :

(i) **Rheumatism** is characterised by attacks of pain in one or more joints. The duration is variable, and pain frequently attacks different joints in succession. No physical signs are detectable, and the condition subsides gradually.

(ii) **Acute Arthritis.**—Usually a single large joint is affected, especially the ankle, elbow, or wrist, the last particularly in females. The symptoms and signs of acute infective arthritis are present, and destruction is sometimes sufficiently extensive to cause bony ankylosis. Characteristically the patient never looks as ill as would be expected if the local pain and heat were caused by a suppurative arthritis of staphylococcal or streptococcal origin. On aspiration the fluid may be found to contain gonococci, but in less acute or later cases it is sometimes sterile. Treatment is conducted on the lines already indicated.

(iii) **Chronic arthritis** is a polyarticular infection, in which there is but slight effusion in the joints. Considerable œdema of the synovial membrane and periarticular structures occurs. Troublesome adhesions and stiffness are to be expected.

Treatment.—Limitation of movement arising from fibrosis of extra-articular structures, or fibrous and sometimes even bony ankylosis, are characteristic features of gonococcal affections. A course of chemotherapy or antibiotics is prescribed, and as soon as the acute phase of inflammation has abated judicious physiotherapy and active movements must be instituted.

SYPHILITIC DISEASES OF JOINTS

Inherited.—*Painless Effusion.*—This has been aptly described as "symmetrical, silent, serous, syphilitic synovitis," and is associated with the name of Clutton. It is characterised by a painless effusion into a large joint, most commonly the knee. This condition is frequently bilateral, although

Henry Clutton, 1850–1909. Surgeon to St. Thomas's Hospital, London.

the swelling of the two joints may not synchronise. The effusion causes a sensation of weakness and insecurity, and on examination the joint is seen and felt to be distended. Movements are only limited if the amount of fluid mechanically prevents the full range.

The condition occurs between the ages of ten and eighteen, and other stigmata of inherited syphilis are usually present. This condition is one of the four characteristic signs of inherited syphilis, which appear about puberty, and give rise to ' the halt, the deaf, the blind, and the impotent,' i.e. halt owing to Clutton's joints, deaf because of otitis interna, blind following interstitial keratitis, and impotent secondary to orchitis.

If no confirmatory clinical evidence of syphilis is discovered, then the family history is usually suggestive, and finally the W.R. of the patient and parents, or even of the fluid aspirated from the joint, should be tested.

Acquired.—During the *secondary* stage a transient or variable effusion sometimes occurs in any of the larger joints. The condition is painless and sometimes, like most secondary lesions, symmetrical.

Lesions of the *tertiary* stage are nowadays of extreme rarity. Gummatous synovitis in some respects simulates tuberculous disease, but the condition is painless, and therefore muscular spasm and wasting are not pronounced.

NEUROPATHIC JOINTS

The most important pathological conditions of joints secondary to affections of the nervous system occur in connection with :

I. Parasyphilis.
II. Syringomyelia.
III. Other lesions of the Nervous System.

I. PARASYPHILIS

Owing to the more efficient treatment of syphilis, Charcot's joints now occur with diminishing frequency. About 4 per cent. of tabetic patients develop an arthropathy, of which 85 per cent. occur in the lower limbs, the knee being the commonest joint to be affected. Two quite distinct types of neuropathic joint are distinguishable radiologically; the ' hypertrophic ' shows large osteophytes, bone sclerosis, and all evidence of new bone production; the ' atrophic ' type merely shows osteoporosis and the resorption of the articular ends of the bones forming the joint. In either case, an effusion, which varies in amount, is present, and complete *absence of pain* is a striking feature. Examination of a typical case, following the routine which should be adopted for all joints, comprises :

(i) *Inspection.*—The joint is distended, and if the effusion is generous, it assumes the position of greatest capacity. In advanced cases the joint is obviously disorganised (fig. 1623).

(ii) *Palpation.*—The presence of fluid is confirmed, and in hypertrophic cases irregular masses of bone are readily palpable. Bursæ which communicate with the joint, such as the psoas or semimembranosus bursa, are sometimes distended.

Jean-Martin Charcot, 1825–1893. Physician at the Salpêtrière, Paris.

(iii) *Movements.*—Soft crepitus is usually noticed, and the laxity of the capsule and ligaments allows an abnormal range of movement. The patient will often astonish the inexperienced observer by the way he can walk without pain on a joint which is completely disorganised and threatening to subluxate.

FIG. 1623.—Charcot's disease of the right knee. (*Dr. Worster-Drought.*)

FIG. 1624.—Charcot's knee joint. Hypertrophic type.

(iv) *Measurement.*—Shortening of the limb sometimes occurs owing to absorption of bone, and some degree of muscular wasting may result from disuse.

(v) *Radiograph.*—Irregular masses of bone are seen in the hypertrophic variety (fig. 1624). The atrophic type will show irregular and eventually almost complete absorption of the articular ends of the affected bones.

(vi) *General Examination.*—A Charcot's joint can present itself as the first cause of a tabetic patient seeking treatment. Lightning pains, Romberg's sign, ataxia, or other symptoms are usually present, while examination commonly reveals Argyll-Robertson pupils and loss of tendon reflexes, particularly the knee and ankle jerks. Deep pain sense is lost, as can be tested by squeezing the tendo-Achillis.

Treatment consists in supporting the joint by a suitable appliance, e.g. a knee brace or a walking caliper.

Arthrodesis of the knee is the obvious solution of the unstable Charcot knee joint, but it is notoriously difficult to obtain osseous union in tabes dorsalis.

II. SYRINGOMYELIA

is due to gliomatous degeneration round the central canal of the spinal cord, and usually occurs in the lower cervical region. Joint complications occur in about 15 per cent. of cases of syringomyelia, and closely resemble the Charcot's joints described above, except that the arm is more often affected

Moritz Romberg, 1795–1873. Professor of Medicine in Berlin.
Douglas Argyll-Robertson, 1837–1909. Ophthalmic Surgeon, Edinburgh Royal Infirmary.

than the leg (80 per cent.) (fig. 1625). The shoulder is most frequently attacked and, as with ball-and-socket joints, is of the atrophic type.

Further examination of the patient reveals other evidence of syringomyelia, such as :

(*a*) *Dissociation of Sensation in the Hands.*—The sensibility to pain and variations of temperature are lost, but tactile sensation and muscular sense remain. Owing to disturbed sensation, slight injuries, notably cigarette burns, occur unnoticed.

(*b*) *Trophic Changes.*—Wasting occurs of all the muscles of the hand, and later the forearms. Also the tissues are more prone to injury, and healing is delayed. Eventually the soft tissues and finally the phalanges become absorbed (fig. 1626).

FIG. 1625.—Neuropathic joint of syringomyelia. Atrophic type.

FIG. 1626.—Trophic loss of the fingers, due to syringomyelia. Morvan type.

(*c*) *Scoliosis* is sometimes present, owing to asymmetrical irritation of the pyramidal tracts and unbalanced action of the spinal muscles.

(*d*) *Unequal pupils*, due to asymmetrical irritation of the oculo-pupillary fibres, which pass down the cervical cord, and leave it in company with the first dorsal nerve, passing thence via the rami communicantes to the inferior cervical sympathetic ganglion, and along the carotid sheath and ophthalmic artery to the ciliary ganglion.

(*e*) *Spasticity of the legs*, due to interference with the pyramidal tracts.

Syringobulbia, as evinced by hoarseness and dysphagia, may subsequently develop.

Treatment of the joint condition entails adequate support, pressure being carefully guarded against, as owing to insensitiveness to pain pressure sores are particularly liable to occur.

III. OTHER LESIONS OF THE NERVOUS SYSTEM

Long-standing impairment of the trophic innervation of a limb is followed by changes in the small joints of the hands and feet. Such causes include spina bifida and peripheral nerve lesions, e.g. injury, neuritis, or leprosy. Of particular interest are the rather rare cases of neuropathic arthropathy produced by diabetic neuritis. These diabetic neuro-arthropathies most commonly affect the foot and ankle (i.e. distal part of the extremity).

HYSTERIA (*syn.* MIMETIC JOINTS)

Disability in connection with a joint sometimes occurs in patients of hysterical tendencies, and is most commonly seen in adolescent or young adult females. The history in some cases is suggestive, in that the onset follows some emotional crisis, or mimicry of some joint condition seen in another patient. The larger joints are usually affected, the commonest being

Augustin Marie Morvan, 1819–1897. A Physician of Lannelis, Finisterre.

the hip, knee, and ankle. There is usually a bizarre quality about the gait and behaviour which does not occur in the known patterns of organic disease.

An especially marked example is ' hysterical inversion of the foot.' The patient walks on the outer border of the foot—the condition coming on quite suddenly in a patient otherwise previously in normal health.

The more important clinical features are as follows :

(*a*) *Inspection.*—The limb is often in an extreme position which is unusual for any early pathological condition, e.g. in the case of the hip joint the thigh may be markedly flexed, adducted, and inverted. Wasting of muscles, if any, is slight, and is due to disuse.

(*b*) *Palpation.*—Gentle palpation may appear to cause intolerable pain, but if the attention is distracted, considerable pressure will pass unnoticed. Otherwise no abnormal features are discovered.

(*c*) *Movements.*—All movements are restricted, and if the patient is requested to move a joint, both the group of muscles which carry out the movement, and also the antagonistic muscles, are contracted, so that the limb is rigidly fixed. This phenomenon can easily be appreciated by palpation of the muscles, while the patient attempts to carry out the desired movement.

(*d*) *Radiograph.*—In long-standing cases disuse atrophy of bone occurs, as is shown by thinning of the compact layer, and loss of density of the cancellous tissue owing to absorption of calcium salts.

(*e*) *General Examination.*—Other hysterical manifestations will probably be found, such as globus hystericus, anæsthesia of the palate, and glove or stocking anæsthesia.

Treatment.—Psycho-analysis might be employed in order to correct the abnormal mental outlook. Symptomatic treatment directed to the joint includes encouragement regarding movements, or an anæsthetic is given, and the position of the joint altered.

CHRONIC ARTHRITIS

Chronic arthritis can be classified as follows :

(1) Tuberculous.
(2) Gummatous.
(3) Rheumatoid.
(4) Osteoarthritic.

Tuberculous arthritis originates either in the synovial membrane or in the bone. In the knee and elbow, the disease usually first attacks the synovial membrane, whereas in other joints, notably the hip, the initial focus of infection is generally in the adjacent bone. In children synovial disease is commoner than in adults.

Four types of tuberculous arthritis are recognised :

(i) *Synovial.*—Characterised by œdema and infiltration of the synovial membrane and periarticular tissues, giving rise to the typical ' white swelling ' (fig. 1627). The synovial membrane becomes thickened and succulent, and subserous tubercles appear. Gradually the normal structure is lost, and the membrane becomes converted into granulation tissue. Bone destruction is not a prominent feature in synovial disease, and though abscesses may form they are not as common as in the ' osseous ' type of focus.

(ii) *Osseous.*—The infection commences in the bone adjacent to the joint and extends into the joint by the continuous invasion of the intervening tissue. This type is more insidious than the synovial type, and symptoms are usually

present before clinical signs are obvious. Thus, in a child, an osseous focus in the neck of the femur or in the roof of the acetabulum may cause a limp and mild discomfort, yet the child may have a full range of passive movement, without spasm, when examined. In the later stages, when the osseous focus has invaded the joint, there is extensive bone destruction, abscess formation, and even pathological dislocation.

(iii) *Caries sicca* is seen most commonly in the shoulder joint. Gradual destruction of the bones occurs with very little synovial œdema and, as the name implies, without abscess formation. Though 'dry caries' is usually associated with tuberculous disease of the shoulder, even here it is not as common as the ordinary pus-forming tuberculous arthritis. The main danger in caries sicca is that it may be erroneously diagnosed as a 'frozen shoulder' and may be manipulated and thereafter subjected to persistent active movement.

FIG. 1627.—Tuberculous disease of the ankle joint.

(iv) *Hydrops.*—Excess of fluid is a rare occurrence in tuberculous arthritis because the main bulk of a swollen tuberculous joint is the thickened synovia, but occasionally the knee joint becomes distended with fluid containing fibrin, which is later converted into flat, oval objects, referred to as 'melon-seed bodies' (fig. 1655).

Clinical Features.—*Symptoms.*—Tuberculous arthritis presents an insidious onset, aching after use and stiffness following rest being early symptoms. Pain is not severe, but sudden strains and twists are deliberately or subconsciously avoided. When erosion of cartilage has occurred, 'starting pains' are characteristic, and occur just when the patient is dropping off to sleep. They are due to relaxation of the muscles which guard the joint, so that slight movement between the articular surfaces causes friction between the exposed and sensitive bones. Swelling of the joint is sometimes noticed by the patient, and is due to œdema of the synovial membrane and periarticular structures.

Some deterioration of the general health is to be expected, and the temperament of a child may completely alter, so that happiness and contentment give way to peevishness and fretfulness.

Signs.—Following the routine which always should be adopted for the examination of joints, we find:

(*a*) *Inspection.*—Both extremities are exposed, and the position of the affected limb is observed. Deformity in the early stages is due to the position of ease which the joint automatically assumes; later, more marked deformity results from disorganisation. Swelling of the joint is due to thickening of the synovial membrane by the granulomatous tissue so characteristic of the tuberculous process. The swelling fades away above and below the joint and is characteristically spindle-shaped. This spindle-shaped or globular swelling (seen very well in the knee) is accentuated by the marked wasting of the associated muscles, which is an important and characteristic feature

of a tuberculous arthritis (fig. 1628). In a case suspected to be an early tuberculous arthritis of the knee, the presence of good thigh muscles would be strongly against the diagnosis. The whiteness of the overlying skin is due to pressure of the œdema emptying the cutaneous capillaries, and this 'white swelling' thus stands in marked contrast to the pink or red blush which is to be expected in pyogenic infections. It is to be noted that, though white in appearance, an active tuberculous joint is still warm to the touch. This should not be confused with the 'cold abscess' which often accompanies an acute tuberculous arthritis. A cold abscess is cold (i.e. ordinary body temperature, not warmer) to the touch and the overlying skin is not reddened.

FIG. 1628.—Tuberculosis of the left knee joint, showing flexion, swelling, and wasting of muscles.

In the later stages abscesses and sinus formation are apt to occur.

(*b*) *Palpation*.—An active joint will be unduly warm to palpation. A somewhat boggy or doughy thickening of the synovial membrane will be detected if this structure is sufficiently superficial. This doughy thickening of the synovia of the joint, together with the wasting of the muscles above and below it, may give the false impression that the bone-ends are actually enlarged. One characteristic of tuberculous disease is that all bony landmarks are usually submerged by and obliterated under the synovial thickening.

(*c*) *Movement*.—The patient is requested to move the joint as far as possible in all directions, and it will be noted that active movements are limited in all directions.

The surgeon then puts the sound limb through its full range of movements, in order to gain the confidence of the patient, and also to ascertain the degree of mobility present in that individual patient. The passive movements of the affected limb are then tested, if possible while the patient's attention is diverted. In cases of tuberculous arthritis, active and passive movements are limited in all directions owing to protective spasm of muscles.

(*d*) *Measurement*.—The presence of muscular wasting is confirmed, and the amount of shortening, due to lack of growth or disorganisation of the joint, is estimated.

(*e*) *Radiograph*.—Three types of change, singly or associated, are seen in tuberculous arthritis:

(i) *Generalised osteoporosis* due to disuse and hyperæmia. This can exist without any destructive changes, and is, in fact, the ordinary radiological appearance of a tuberculous synovitis.

(ii) *Loss of Bone Pattern*.—This is the so-called 'ground-glass' appearance in which the sharply defined outline of the cancellous trabeculæ is lost, as though the film were seen through 'ground glass.' In its simple form the bones retain their normal outline so that true destructive changes are not certainly present. In more advanced cases the outline of the individual bones may be lost (fig. 1629). This means that the individual bones are surrounded by granulation tissue which has

eroded the thin shell of subchondral bone which normally gives them their clear-cut radiographic outline.

(iii) *Gross Destruction.*—Here large parts of the bone-ends are eroded away on both sides of the affected joint.

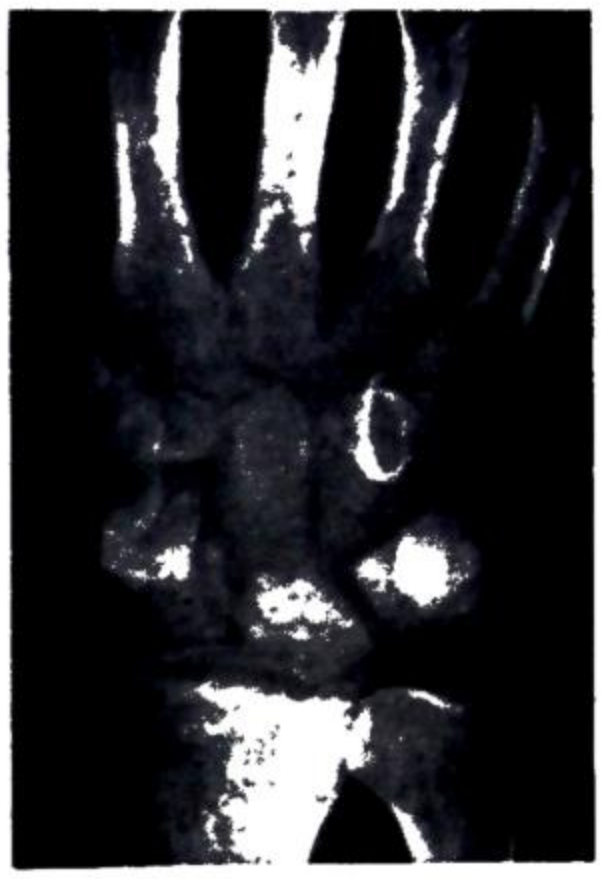


FIG. 1629.—Tuberculosis of the wrist joint.

(*f*) *General Examination.*—Evidence of tuberculous trouble in other organs, either active, latent, or healed, may be discovered.

(*g*) *Special Tests.*—The erythrocyte sedimentation rate is increased. A negative tuberculin test is useful in excluding tuberculosis in children and sometimes it is helpful in young adults. Examination of pus aspirated from an associated abscess will often establish the diagnosis either by the direct staining of a smear or by culture or guinea-pig inoculation.

Excision and microscopical examination of a regional lymph node shows invasion by *Mycobacterium tuberculosis* in a significant number of cases. Since the advent of streptomycin the danger of causing a sinus by direct biopsy of the synovial membrane of a tuberculous joint has become negligible, and lymph node biopsy is thus being abandoned for the much more certain method of direct synovial biopsy.

In suspicious cases the patient should be confined to bed as a therapeutic test and the joint immobilised. Mild toxic affections (such as may be associated with tonsillitis), or slight effusions due to injury, will rapidly respond, but a tuberculous lesion will do so less quickly. A tuberculous joint may improve quickly under rest, but it will relapse as soon as normal use is permitted.

Differential Diagnosis.—The diagnosis of a typical tuberculous joint causes no difficulty, but less typical cases may be confused with the following conditions: rheumatoid arthritis in a single joint, infective arthritis, hæmophilic joints (p. 89).

Diagnostic Triad.—When considering the possibility of hip symptoms being due to an early tuberculous arthritis, a useful diagnostic triad, taught for many years by Sir Harry Platt, concerns the most likely cause of hip disease at different age groups:

0– 5 Congenital Dislocation
5–10 Perthes Disease
10–15 Slipped Epiphysis

Tuberculosis can start at any age, but these three diseases never start outside these age groups. Perhaps the only exception to this rule is when Perthes disease starts in a congenital dislocation under treatment.

Natural History.—(i) *Resolution.*—Restoration of complete movement probably never occurs after a tuberculous arthritis, but after synovitis in children a considerable degree of painless movement is sometimes regained. This is particularly the case in the knee joint, where synovitis without destructive arthritis is common. Even here, in later life the damaged joint

Sir Harry Platt, F.R.C.S., Contemporary, Emeritus Professor of Orthopædic Surgery, University of Manchester.

may become the site of osteoarthritis if it bears weight, and a late arthrodesis may then be necessary.

(ii) *Fibrous ankylosis* is the natural end-result of a healed tuberculous arthritis. If the fibrous ankylosis is very firm, it may function almost as well as a bony ankylosis—in which case it is called a 'sound' fibrous ankylosis. If considerable motion persists, it is likely to become painful at a later date and to show defective function, even in the absence of reactivation—in which case it is called an 'unsound' fibrous ankylosis and arthrodesis is to be advised.

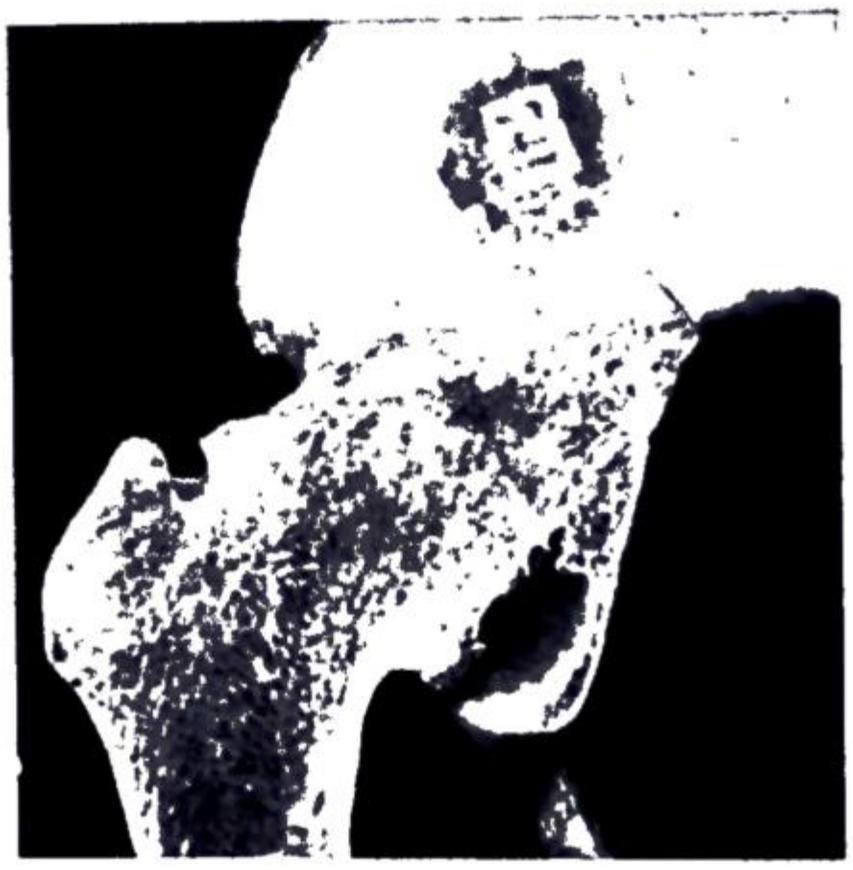


FIG. 1630.—Bony ankylosis of the hip joint with adduction of the femur, and a 'travelling acetabulum.' Result of secondary infection superimposed on a tuberculous arthritis. (*London Hospital Museum.*)

(iii) *Bony ankylosis*, apart from surgical intervention, only occurs spontaneously after a tuberculous arthritis as a result of secondary infection, which gains entry to the joint along sinuses formed by abscesses bursting through the skin (fig. 1630). There is one important exception to the rule that a tuberculous arthritis only heals spontaneously by fibrous ankylosis; in tuberculous caries of the spine the vertebral bodies commonly heal by osseous fusion.

(iv) *Cold Abscess.*—This almost invariably accompanies bone destruction by tuberculosis.

(v) *Pathological Dislocation.*—This frequently follows bone destruction and is rendered likely by the action of muscle tone with the joint in a position of deformity.

(vi) *General Dissemination.*—Acute miliary tuberculosis occasionally occurs as a result of blood-borne infection, particularly if the general resistance of the patient is undermined by any debilitating condition. This complication was in the past, prior to chemotherapy, a common cause of death in children, and tuberculous meningitis was often the final phase of the clinical picture.

(vii) *Toxæmia.*—If sinuses occur and prolonged suppuration follows, toxæmia is likely, and if of sufficiently long duration amyloid disease may develop. Amyloid disease is prone to occur if the hip is involved, for such a mutilating procedure as amputation through that joint is naturally dreaded and postponed by the patient.

Prognosis depends upon the following factors:

(i) *Age of Patient.*—In general, though the cause of severe crippling, tuberculous arthritis is not fatal in childhood. In adult life the disease is much more serious and the prognosis is very bad when starting in the elderly.

(ii) *Family History.*—Lack of resistance appears to be a familial characteristic, and when the disease occurs in a member of a tuberculous family the prognosis is less bright.

(iii) *The Stage of the Disease.*—Cases which are diagnosed in the early stages and which receive appropriate treatment are more likely to make a good recovery than those which have been neglected.

(iv) *The Presence of other Tuberculous Foci.*—If pulmonary or renal complications

exist, the outlook is not good. A second osseous lesion is less serious than an osseous lesion combined with a visceral lesion.

Treatment.—GENERAL TREATMENT in a suitable centre is instituted without delay, and maintained until the condition is assumed to be cured. Fresh air, natural and artificial sunlight, suitable food, and cheerful surroundings are all of great importance. Of all these, the continuous exposure to fresh air is the most important. Children continue their education and adults are employed in occupational therapy. Streptomycin is a powerful agent in the treatment of osseous tuberculosis, either by itself or with P.A.S. (para-amino-salicylic acid) and I.N.H. (iso-nicotinic-hydrazide). Streptomycin undoubtedly allows the surgeon to operate successfully on many cases of tuberculous arthritis, which in the past would never have been suitable for surgical intervention or, if they had been operated on, would have broken down and developed tuberculous sinuses. Antibiotics have substantially reduced the annual mortality rate in sanatoria by clearing up the profusely discharging sinuses caused by secondary infection. Many cases of osseous tuberculosis died of miliary tuberculosis and meningitis, but these complications, thanks to streptomycin, have been substantially reduced in frequency.

The response to general treatment is judged by the fall of temperature and pulse-rate, absence of night sweats, increase in weight, rise in blood count, and the fall of the blood sedimentation rate.

LOCAL TREATMENT.—Three phases can be distinguished in the local treatment of a tuberculous joint :

Phase I.—Bed rest, with splintage, until quiescence is established (six to twelve months average—may be more).

Phase II.—Ambulant treatment in splints of leather and steel (may continue indefinitely, patient wearing splint the rest of his life).

Phase III.—Arthrodesis (here the fibrous ankylosis, resulting from the natural ' healing ' of a tuberculous arthritis, is made permanently safe by being converted into an osseous ankylosis by operative intervention).

Phase I consists of immobilisation of the joint, with aspiration of abscesses to prevent the spontaneous discharge of a cold abscess, and thereby to prevent the development of a sinus with the serious complication of secondary infection.

The limb is immobilised in the optimum position until some six months have elapsed after the last sign or symptom has disappeared. The actual length of time for which treatment should be continued, after the disease is apparently stationary, depends on the general condition of the patient, local response to treatment, including X-ray appearances, and the actual joint affected. The hip joint and spine in particular require prolonged fixation, and one year's further treatment is usually advisable after the disease is apparently stationary.

If the limb is in an unsuitable position when first seen, e.g. considerable flexion of the knee joint, then the deformity is usually overcome by weight traction which is applied in the line of the bone below the affected joint. Cases with slight deformity

often respond to a period of rest in bed, which results in disappearance of some of the muscular spasm, and permits the joint to be placed in the correct position. Occasionally a single forced manipulation under anæsthesia followed by plaster fixation is permissible.

Immobilisation is obtained by means of an appliance or apparatus specially suited to the part. For the *hip joint* a Jones's abduction frame, which fixes the spine and hip joints, is commonly applied. For the *knee joint* the Thomas's knee splint is used with skin traction. For the *ankle* a metal talipes shoe is usually preferred to plaster. The *spine* is treated either in a plaster bed with a turning case or on a Thomas's spinal frame. The *shoulder* in a spica and the *elbow* and *wrist* in either plaster or blocked leather supports.

Signs of Quiescence.—Quiescence is judged by local signs. The patient may look and feel very well even after only three months of convalescent therapy, but the tests for quiescence are made on entirely local phenomena :

(*a*) Absence of heat.

(*b*) Absence of abscess formation.

(*c*) Absence of muscle spasm.

(*d*) Absence of swelling, often shown by reappearance of loose skin which can be picked up from the subjacent joint.

(*e*) Absence of further destructive signs in the X-ray (i.e. not necessarily signs positively indicative of healing). The absence of further destruction after six months is presumptive evidence of the start of healing—which is what quiescence means.

Phase II.—Here the patient is allowed out of bed in an ambulant splint : back support for a spine, leather hip-spica for a hip, caliper splint for a knee, block leather or plaster splint for shoulder, elbow, and wrist.

Some patients may retain these appliances permanently—especially if they have other lesions, such as renal or pulmonary disease, which make them unsuitable for operative treatment.

Phase III.—Surgical intervention (arthrodesis) is only indicated when the disease is quiescent.

It must be clearly understood that operative intervention is not undertaken to make the tuberculous arthritis heal more quickly. Healing of a tuberculous process is a battle between the organism, the patient's resistance, and antibiotics. Surgery is only indicated in osseous tuberculosis to consolidate the local victory which the general resistance of the body has temporarily achieved over the invasive process.

The natural process of healing of a tuberculous lesion of bone is always a precarious affair. Fibrous ankylosis leaves small abscesses containing encysted pus. The presence of slight movement in the fibrous union can cause these abscesses to become re-active years later. Arthrodesis insures against this danger.

The operation which at the moment is most widely used in tuberculosis is arthrodesis, but other operations which find a place in the surgical repertoire in osseous tuberculosis are :

(1) Sequestrectomy and curettage of sinuses.

(2) Local excision of diseased bones and joints. This is nowadays rarely required and joint excision is almost entirely replaced by arthrodesis.

(3) Amputation. Most commonly this was practised for severe des-

tructive lesions of the tarsus. Even in these lesions, amputation is becoming less commonly practised as a result of antibiotic therapy.

SPECIAL JOINTS

Sacro-iliac.—Owing to vagueness of the early symptoms and late appearances of definite signs, the correct diagnosis is often delayed. A local ache, vague sciatica, and sometimes a detectable limp are the earliest slight symptoms. The condition should always be remembered in the differential diagnosis of the common complaint of sciatica. After a few weeks a boggy swelling appears over the back of the joint, which gradually enlarges to form an abscess. Rectal or vaginal examination may reveal a similar condition in the pelvis. When the disease is established, pressure on the iliac crests causes pain. A radiograph confirms the diagnosis.

Treatment necessitates operation as soon as the condition is quiescent, as obliteration of the joint causes no disability, and removal of diseased tissue and fixation of the joint favours a cure in the shortest possible time. Access is gained by removal of the posterior superior spine and adjacent iliac crest. Tuberculous granulation tissue and diseased bone are removed with a sharp spoon and gouge, and a bone graft or peg is driven through the bones so as to bridge the joint.

Hip.—The disease usually commences in bone, either in the under-surface of the neck of the femur or in the acetabulum.

Early symptoms include a limp, and pain commonly referred to the knee joint along the geniculate branch of the obturator nerve.

FIG. 1631.—Tuberculosis of the left hip, second stage. The arrow indicates a periarticular abscess.

FIG. 1632.—Active tuberculosis of hip in child — 'wandering acetabulum.'

During the *first stage* of this condition the joint is held in the position of ease, i.e. flexed, abducted, and everted. The abduction gives rise to apparent lengthening of the limb. As the joint becomes more painful, the patient is increasingly inclined to assume a recumbent position, during which the patient lies on the sound and painless hip. Thus in the *second stage* the affected joint gradually becomes adducted and inverted, and flexion becomes

more marked (fig. 1631). Owing to adduction, the limb now is apparently shortened. The *third stage* corresponds with the start of articular disorganisation, including absorption of the femoral head and acetabular cavity (fig. 1632). The position of adduction, flexion, and inversion encourages the head of the femur to press more strongly against the dorsal lip of the acetabulum than into the central depths of the socket as occurs in the normal or abducted position of the hip. Absorption of bone, combined with continuous pull of spastic muscles, results in a 'travelling acetabulum' in which the dorsal lip of the acetabulum is eroded to allow the head of the femur to escape on to the dorsum ilii, i.e. 'pathological dislocation.' During the third stage disorganisation of the joint leads to true shortening of the limb, in addition to the apparent shortening due to adduction (fig. 1633).

FIG. 1633.—Tuberculosis of the left hip, third stage. (*Pybus.*)

In considering the differential diagnosis, such conditions as spasm of the psoas (from a chronic appendix abscess) and tuberculosis of the gluteal bursa must be considered. Early acute slipped epiphysis with superadded spasm may cause confusion, but a week or so in bed results in disappearance of the spasm, after which the typical signs of unmasked coxa vara become evident (p. 1326).

The Thomas Test for Fixed Flexion Deformity.—When a patient with a fixed flexion deformity of the hip stands erect, he is able to bring the knee of the affected limb to the side of the normal knee by tilting his pelvis and so producing a marked lumbar lordosis. This same concealment of a flexion deformity occurs when the patient lies in bed with both knees side by side. It is to reveal this concealed deformity in bed that H. O. Thomas first described his test, which is carried out in this way: place one hand under the lumbar spine to assess the amount of lordosis existing between the back and the surface of the bed or couch; take hold of the *normal* leg and flex the knee and hip as much as is necessary to flatten the lumbar lordosis. In this position the diseased hip will assume its true position, and if a flexion contracture is present the knee of the diseased side will rise from the bed, and the angle between the thigh and the horizontal will be the amount of fixed flexion deformity (fig. 1634).

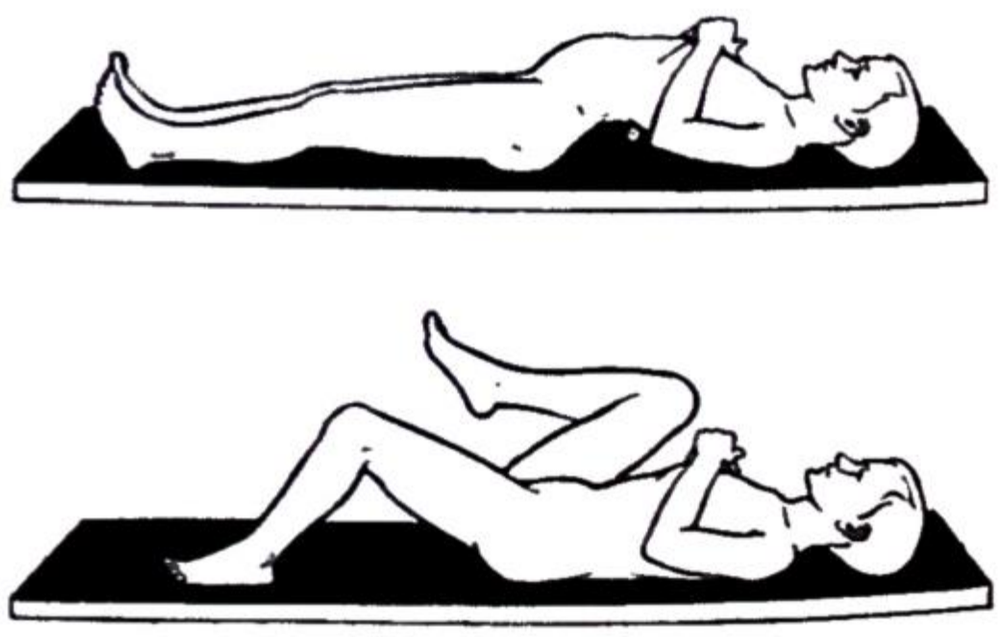


FIG. 1634.—*Principle of the Thomas Test* for flexion contracture in the hip. Flexion contracture can be concealed by an excessive lordosis in the lumbar spine. By flexing fully the *normal* hip until the lumbar lordosis is abolished, Thomas showed that the diseased hip will take up a flexed position—this is the true amount of flexion contracture present.

Treatment is conducted along the lines already prescribed. Deformity is corrected, usually by weight traction, and then a Robert Jones's frame fitted and later a plaster hip-spica. When the disease is quiescent, either arthrodesis is performed, or if for any reason operation is contraindicated, a blocked leather hip-spica fitted.

Operative measures such as arthrectomy or excision of the head of the

Hugh Owen Thomas, 1834–1891, who practised as a bone setter in Liverpool.

bone are obsolete, as excellent results are obtained by a fusion operation, e.g. extra-articular arthrodesis.

Extra-articular Arthrodesis.—As firm ankylosis in good position is the best result which can be expected, time is saved and this result obtained more certainly by arthrodesis. Extra-articular techniques are often preferred to intra-articular operations in tuberculosis, but experience with streptomycin now indicates that intra-articular procedures can be used with relative impunity.

The technique of hip fusion known as the ischio-femoral arthrodesis (Brittain) is probably the one most extensively used for tuberculosis of the hip. In children it is certainly a highly satisfactory procedure. It is an extra-articular method and combines a subtrochanteric osteotomy (which allows a fixed deformity to be corrected) with a tibial bone graft which thus short-circuits the hip joint (fig. 1635). Under the protection of the bone graft the diseased hip frequently undergoes spontaneous osseous fusion with complete disappearance of all tuberculous cavities.

In a very small number of cases where suppuration persists and the patient's life is in danger a disarticulation of the hip may occasionally be indicated.

FIG. 1635.—Brittain's ischio-femoral, extra-articular arthrodesis of the hip.

Knee.—The knee joint is commonly affected by tuberculous disease, and the diagnosis is, as a rule, not difficult. In neglected cases the position of 'triple deformity' will occur, which consists of flexion, external rotation, and backward subluxation of the tibia, the latter occurring when the cruciate ligaments have become softened and destroyed. Arthrodesis of the knee joint yields good results provided bony ankylosis is obtained.

The technique most widely used for arthrodesis of the knee is probably that of compression arthrodesis. This is an intra-articular method in which the articular surfaces are sawn away to give flat surfaces of cancellous bone which are then pressed firmly against each other by transfixing the femur and tibia, above and below the joint level, by transverse stainless steel nails (fig. 1642). The outer ends of these nails are approximated by means of special clamps. Under these conditions union occurs in six weeks and consolidation is complete in three months.

Ankle.—Tuberculous disease of this joint usually commences in the synovial membrane. Puffiness first appears under the extensor tendons, and later at the sides of the Achilles tendon.

Arthrodesis is most commonly performed through an incision on the outer side of the joint, and a sliding bone graft from the tibia is inserted into the talus. In advanced cases with multiple sinuses, amputation is indicated, and should be performed at the modern site of election, i.e. about 5 inches (12·5 cm.) below the upper end of the tibia.

Shoulder.—On examination, wasting of the deltoid muscle is obvious

H. A. Brittain, 1904–1954. Orthopædic Surgeon, Norfolk and Norwich Hospital.

(fig. 1607), and the arm is held against the chest wall. Movements are all limited, and pain is produced when they are attempted. Treatment consists in fixation of the joint in 45° of abduction, and care must be taken to observe that true abduction is obtained and not apparent abduction due to rotation of the scapula.

It is erroneously stated in most text-books that the commonest form of tuberculous disease of the shoulder is 'caries sicca.' This is not so; cold abscesses form round the tuberculous shoulder joint quite as often as round any other joint. The term 'caries sicca' is a relic of the era before X-ray examination, and the very common 'frozen shoulder' in those days was probably diagnosed as 'dry caries.' In modern times the error is quite the reverse: there is a danger of the occasional 'caries sicca' being diagnosed as a 'frozen shoulder' and treated by repeated manipulations and active exercise. X-ray examination will easily distinguish, because the term 'caries' means that destructive changes will be seen in the X-ray.

Following routine principles, arthrodesis is advisable when the disease is quiescent but, on the other hand, a sound fibrous ankylosis of the shoulder following the natural healing of tuberculosis in a sedentary worker need not always be arthrodesed because it has to take very little strain (unlike the weight-bearing joints). In women good results can sometimes be obtained by excision of the shoulder joint because a stiff shoulder makes it difficult for a woman to dress or arrange her hair.

Elbow.—In this joint the disease usually commences in the synovial membrane. The arm becomes weak and aches after use, and a doughy swelling appears on either side of the triceps tendon. Fixation is obtained by a plaster-of-Paris cast. Abscesses usually appear posteriorly. Arthrodesis is usually advised, though excision can give a satisfactory result with a mobile elbow if the patient is not faced with heavy work.

Wrist.—This joint is not uncommonly affected in elderly patients. Carpal bones are readily destroyed, and abscesses appear under the extensor tendons on the back of the wrist. In elderly patients the wrist frequently demonstrates the curious condition of 'senile tuberculosis,' in which an appearance of gross destruction, getting neither better nor worse over a period of years, can be present without any signs of systemic ill-health. However, as a rule the onset of tuberculosis in the elderly carries with it a very high mortality; patients who start with tuberculosis of the spine or the hip after sixty have a very poor chance of survival.

RHEUMATOID ARTHRITIS

is seen in both sexes but most commonly in young females and commences in the small joints of the hands and feet. It gradually spreads to the large joints, thus causing progressive crippling, until the patient may become almost helpless. It is of unknown ætiology being in the past attributed to toxic absorption from septic foci. It is probably a systemic disease affecting the collagenous part of the locomotor system, which in turn seems to be controlled by the endocrines, as is suggested by the response to cortisone or

ACTH. During the earlier stages of the condition bouts of pyrexia occur periodically, associated with sweating, tachycardia, and exacerbations of pain and swelling in the affected joints. Fibrosis and contraction of ligaments gradually occur, and eventually the fingers become flexed and the hand fixed in a position of ulnar adduction (fig. 1636). This disease is apt to run a painful course to more or less complete crippledom.

Still's disease is a similar condition occurring in children, usually as they approach the second decade. In addition to joint changes, splenic and lymphatic enlargement and a lymphocytosis are also associated.

Rheumatoid arthritis starting late in life often has not the acute systemic disturbance associated with this polyarthritic condition in early adult life. In both cases the activity of the disease is clearly shown by the blood sedimentation rate, which is markedly elevated in this condition. A typical level of B.S.R. from active rheumatoid arthritis is 40 mm. in the first hour (Wintrobe).

FIG. 1636.—Typical rheumatoid arthritis of the hand.

Because the nature of rheumatoid arthritis is unknown, the treatment is at the moment empirical and symptomatic. Gold injections seem to improve a small but significant number of the cases who can tolerate the treatment. The great difficulty the patient experiences in carrying out the simplest household duties results from the pain and spasm associated with disorganised joints, and this can be controlled to a certain extent by very heavy doses of aspirin. Joints can be supported with bandages or plaster splints, and in some cases comfortable fibrous ankylosis can be brought about by prolonged splintage. Treatment is mainly directed to prevent deformity.

Rheumatoid arthritis offers very little scope for surgery, but in a few cases the correction of fixed deformity by osteotomy, or capsulotomy of flexed joints, may be of value. Very painful arthritis of the knees can be relieved by arthrodesis, but arthrodesis is not of much value in other joints affected by rheumatoid arthritis.

ANKYLOSING SPONDYLITIS (*syn.* MARIE-STRUMPELL, SPONDYLOSE RHIZOMELIQUE)

This is a crippling disease which seems to have some features in common with rheumatoid arthritis, but which forms a distinct clinical entity.

The disease essentially is a process of ossification of the ligaments and capsular ligaments of joints, which results in complete bony ankylosis of the great central articulations of the body (unlike rheumatoid arthritis which is not specially an ankylosing state and which affects the small joints of the distal

Sir Frederick Still, 1868–1941. Consulting Physician to King's College Hospital, and the Hospital for Sick Children, London.
Maxwell M. Wintrobe, Contemporary. Professor of Medicine, Johns Hopkins Hospital, Baltimore.

extremities first). Whereas rheumatoid arthritis affects mainly females, ankylosing spondylitis is more common in men, starting in early middle life.

The articulations most affected, in order of frequency, are sacro-iliac joints, spine (from below upwards), hips, costal joints, and shoulders.

In addition to bony fusion of these joints, the spine flexes forward so that eventually the unfortunate patient is literally bent double and is forced to seek help when he can no longer see in front of himself no matter how much he may try the motion of looking upwards (' poker back ').

In the early stages of the disease, attacks of pain may simulate ' fibrositis,' but suspicion will be aroused if the stiffness of the back persists when the exacerbations of pain have subsided. Frequently, continuous bone ache is a very disturbing symptom.

X-ray will establish the diagnosis by the complete bony obliteration of the sacro-iliac joints and by the presence of ossification of the spinal ligaments (' bamboo spine,' figs. 1637 and 1638).

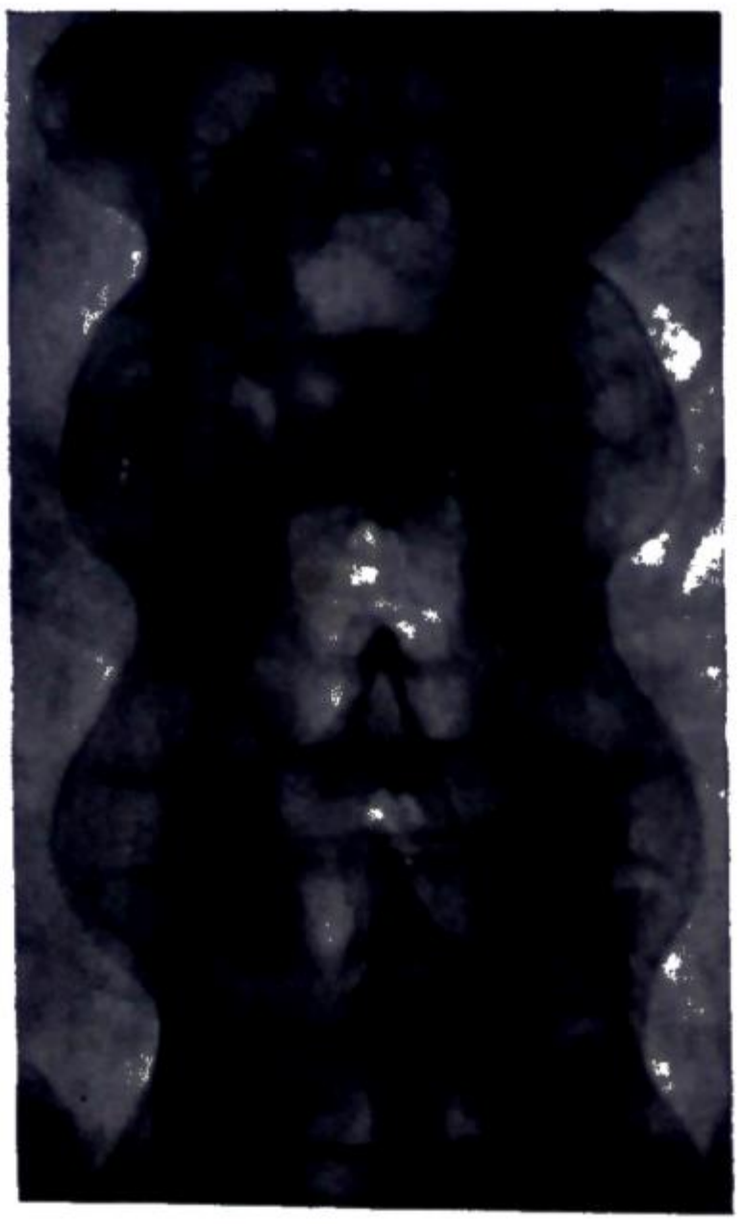


FIG. 1637.—Ossification of the lumbar spine (' bamboo ' spine).

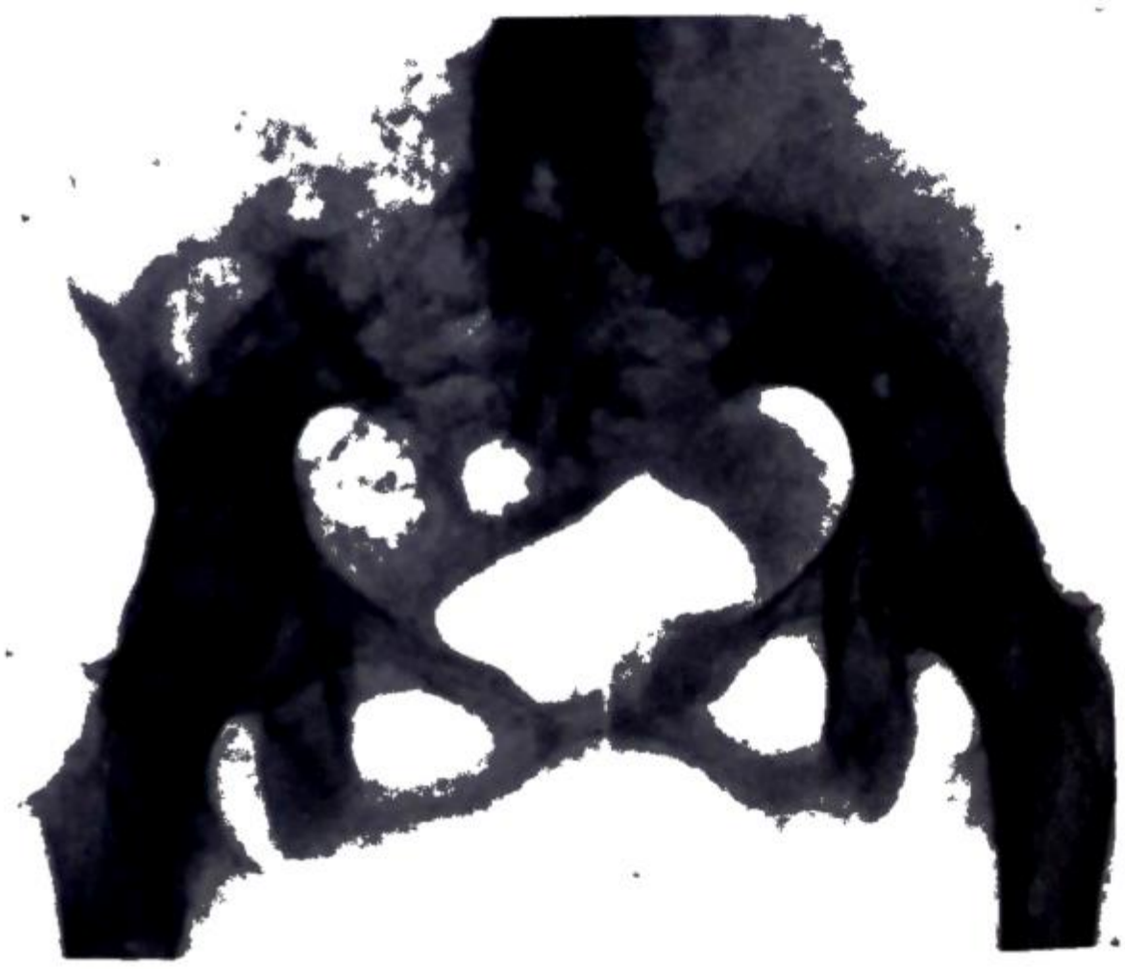


FIG. 1638.—Ankylosing spondylitis: fusion of sacro-iliac and hip joints.

The patient often looks ill and is usually ill-nourished. In active disease the blood sedimentation rate is usually elevated to the order of 40 mm. (Westergren) in the first hour.

Treatment.—There is at the moment no known treatment for this distressing condition. Fortunately the less severe cases often ' burn themselves out ' before the full picture of spinal ankylosis in gross deformity is reached. Severe cases often succumb to chest complications as a result of the ankylosis of the thoracic cage.

Deep X-ray therapy to the spine seems to be of real value in a significant number of cases and is worth while as far as the relief of spinal pain is concerned. Beyond this, surgery can only offer splintage to prevent further deformity, or osteotomies to correct established deformity, and arthroplasty to release ankylosed hip joints.

A. Westergren, Contemporary. Professor of Pathology, Stockholm.

Spinal osteotomy is being used with success to correct gross cases of rigid flexion deformity of the spine, thereby improving the patient's unfortunate lot.

OSTEOARTHRITIS

Osteoarthritis is quite unlike rheumatoid arthritis both clinically and pathologically. It seems to be mainly a mechanical 'wearing out' of a joint and is not associated with any systemic disturbance. It is generally a monarticular lesion (unlike rheumatoid arthritis) and occurs mainly in the weight-bearing joints. It affects patients in late life, and more commonly the hips or knees than the small joints of the distal extremities. Almost all elderly subjects have some degree of this condition in hips, spine, or knees even in the absence of symptoms and merely as the natural result of the ageing process.

A reason why local mechanical causes (as opposed to toxic causes) may be the ætiological factor in osteoarthritis is seen in the condition of 'traumatic osteoarthritis.' Traumatic osteoarthritis follows injuries to joints, especially fractures, which have disturbed the perfect mechanical 'fit' of the articular surfaces, and thus all the changes of osteoarthritis eventually develop in a joint which prior to the injury was known to be quite healthy. Examples are those of Pott's fracture of the ankle; traumatic dislocation of the hip, followed years later by osteoarthritis; arthritis of the wrist following non-union of the carpal scaphoid.

FIG. 1639. — Osteoarthritis of lateral compartment of knee superimposed on genu valgum.

Even in the absence of injury which has disturbed the anatomy of the joint, it may be possible to detect other anatomical errors which have made the joint 'wear out' more quickly than normal (fig. 1639). Thus in the hip a slight congenital subluxation may exist for forty years without causing symptoms and then give rise to osteoarthritis because the weight of the body is being taken on one part of the femoral head instead of being evenly distributed over a larger area. Similarly, a unilateral slipped femoral epiphysis or Perthes' disease may leave a femoral head which is no longer spherical and this will wear out before the normal hip on the other side.

Joints which have been damaged by inflammatory disease but which have made a reasonable functional recovery will also later wear out and become osteoarthritic. Frequently the knee joints in rheumatoid arthritis will later take on some of the characteristics of osteoarthritis due to the mechanical effects of attrition.

It is sometimes useful to call these types of osteoarthritis 'secondary osteoarthritis' to imply that a pre-existing cause is known. In cases where no known cause pre-existed, the disease is often called 'primary osteoarthritis.'

Pathological Changes.—Thickening of the synovial membrane occurs, and as this progresses a villiform process may develop which on movement is nipped between the bones, and when unduly enlarged is termed a 'lipoma arborescens.' The thickened synovial membrane overlaps the edge of the articular cartilage, and under this fringe cartilage cells proliferate. Thus lipping or osteophytic growth occurs, as the cartilage cells subsequently ossify. Owing to the degeneration of the cartilage it is worn away on pressure-bearing surfaces, with resulting erosion and grating on movement. The underlying bone thus exposed reacts to pressure, and becomes dense and smooth, i.e. 'eburnation' (fig. 1640).

FIG. 1640.—Osteoarthritis of the knee joint, showing thickened synovial fringes, lipping of the cartilaginous margins, and eburnation of bone on surfaces exposed to friction.

Not infrequently exacerbations occur with synovial effusion, and as a result a bursa communicating with the joint is apt to become distended. In the knee an effusion distending the semimembranosus bursa is often called a Baker's cyst, but in actual fact this is a rare condition while the ordinary 'semimembranosus bursa' is a very common condition. This latter occurs in young patients with normal knee joints, and is probably nothing more than a simple ganglion which does not communicate with the joint cavity.

Occasionally chondrification or ossification occurs in the synovia, and in the case of the knee joint a solid mass sometimes appears due to chondrification of the synovial membrane lining the suprapatellar pouch. Ossified synovial villi or osteophytes sometimes become detached and form loose bodies in the joint.

Clinical Features.—The early symptoms of osteoarthritis are pain and stiffness. Pain is characteristically aggravated by changes in the weather, so that the appropriate term 'barometric joint' is sometimes used. Stiffness is intensified by rest, and the joint must be 'worked loose' before the range of movement is recovered. In advanced cases creaking, or locking of the joint by osteophytes, is noticed.

The signs depend upon the extent to which the disease has progressed. In the early stages some effusion, thickening of synovial membrane, and perhaps a little wasting of muscles are the only features. At a later stage lipping or osteophytes are sometimes palpable, while grating or creaking is detected on movement. The range of movement eventually diminishes and a painful ankylosis in a deformed position is the rule.

Radiologically osteoarthritis in characterised by loss of joint space at the site of maximum pressure, sclerosis of the adjacent one surfaces, osteophytic lipping of the joint margins and cyst formatio 41).

William Morant Baker, 1839–1896. Surgeon to St. Bartholomew's Hospital, Lond

Treatment.—In the early stages, the joint should be protected from exposure and cold, and in the case of the knee joint a knitted woollen cap should be worn. Rest to the joint should only be permitted during painful exacerbations, and movements and massage are resumed as soon as they can be tolerated. Radiant-heat baths, diathermy, and rubefacients are useful.

The surgical treatment of osteoarthritis is not to be considered until the patient is driven to it by pain or severe reduction of activity. The operative procedures available are the two extremes, i.e. arthrodesis or arthroplasty. Often osteotomy can be used if deformity is the primary disability. Considerable experience is necessary in choosing the most suitable surgical

FIG. 1641.—Osteoarthritis of hip.

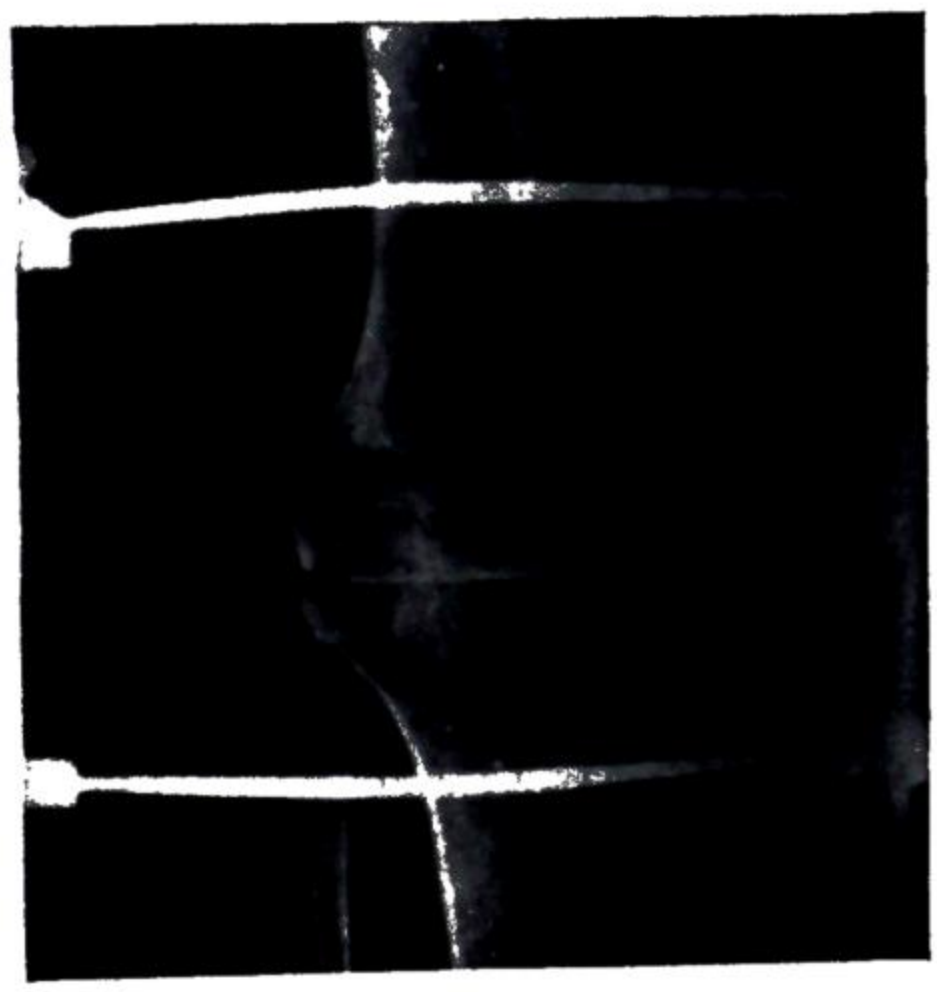


FIG. 1642.—Charnley compression arthrodesis of the knee.

procedure for the requirements of the particular patient. The problems differ in different joints, but the two most commonly requiring attention are (1) the knee, and (2) the hip.

Osteoarthritis of the Knee.—Arthroplasty of the knee is not favoured by British surgeons. The results of arthrodesis of the knee are so excellent, and the benefit so quickly appreciated without protracted rehabilitation, that arthroplasty of the knee need only be considered on very rare occasions (fig. 1642). The complete freedom from pain, and the ability to walk without a stick, are so much appreciated that the nuisance of the knee being stiff is easily tolerated, even by female patients. Bilateral osteoarthritis offers a more serious problem, but even here there are many cases, provided that the patient is intelligent and co-operative, which are enormously benefited by bilateral knee arthrodesis.

Osteoarthritis of the Hip.—The choice of the best surgical method is still a matter of discussion; the status of the two rival methods (arthroplasty and arthrodesis) tends to vary in each decade as new technical improvements are made in one or other method. Obviously, arthroplasty is indicated if osteoarthritis of the hips is bilateral (fig. 1643).

FIG. 1643.—Bilateral osteoarthritis of hips treated by arthroplasty (Judet prosthesis left; Smith-Petersen cup right).

Unilateral osteoarthritis in patients under fifty years of age is probably best treated by arthrodesis, because it is still doubtful whether many arthroplasties will remain painless much more than ten years. Sound bony ankylosis of the hip, in good position, with a fully mobile knee gives a very excellent result in patients of active and agile temperament. Patients who have an osteoarthritic hip which is already ankylosed, though very painful, are very suitable for arthrodesis because they are already accustomed to a stiff hip.

Arthroplasty of the hip, though often imperfect from a mechanical point of view (necessitating a stick and not permitting long distances to be walked or weights to be carried) is often preferable to arthrodesis in elderly women, especially if they still have a good range of movement in the painful hip.

The actual techniques of arthroplasty are continuously changing as experience accumulates. In the 'cup' arthroplasty of Smith-Petersen a stainless steel cup it is placed between the acetabulum and the head of the femur; in the technique of Judet the head of the femur is resected and replaced by a prosthetic head of metal or plastic.

Osteotomy.—A special type of osteotomy was introduced by MacMurray for the treatment of osteoarthritis, and can be used even though the hip is ankylosed in bad position. The principle is to divide the femur just above the lesser trochanter and displace the distal fragment medially to impinge against the side wall of the pelvis. When the osteotomy is united this provides a bone block to adduction, and so the patient sustains body-weight on the bone block and by-passes the hip joint. (See p. 1201, as used for ununited fracture of the neck of the femur.)

LOOSE BODIES IN JOINTS

Loose bodies (a definition which excludes foreign bodies introduced from without) arise from the various constituents of the joint:

SYNOVIAL FLUID.—A single fibrinous body sometimes results from a hæmorrhagic or inflammatory effusion (fig. 1644), or less commonly the joint contains many loose bodies (fig. 1645). In tuberculous disease 'melon-seed' bodies may be present in large numbers.

SYNOVIAL MEMBRANE.—Villous processes, such as those which occur in osteoarthritis, become detached, especially if bone or cartilage develops within them (synovial chondromatosis).

BONE.—Injury may cause separation of a small portion of bone, e.g. a tibial spine. Osteophytes are occasionally detached in cases of osteoarthritis. If the loose body contains living cells, growth may continue, nutriment being obtained from the synovial fluid.

Osteochondritis dissecans (*syn.* Paget's quiet necrosis) is the commonest cause of a single loose body in young people. It most commonly occurs in the knee joint (fig. 1646), and the loose body arises most frequently from

Marius N. Smith-Petersen, Contemporary. Professor of Orthopædic Surgery, Harvard.
T. P. MacMurray, 1887–1949. Professor of Orthopædic Surgery, Liverpool University.

the lateral aspect of the medial condyle adjacent to the intercondyloid notch. The spontaneous separation of the fragment of bone, together with overlying cartilage, about the size of a sixpence or a shilling, seems to result from the

FIG. 1644.—Loose bodies in knee joint.

FIG. 1645.—Sesamoid bone in the outer head of the gastrocnemius muscle (fabella). Oval in shape and behind the condyles.

sequestration of the underlying bone, and it has been suggested that this is caused by the thrombosis of an end artery supplying an area of bone of this size. Possibly direct trauma caused by the impact of the tibial spine against the condyle determines the thrombosis. The condition can, however, occur on the posterior surfaces of the femoral condyles which is against this traumatic theory.

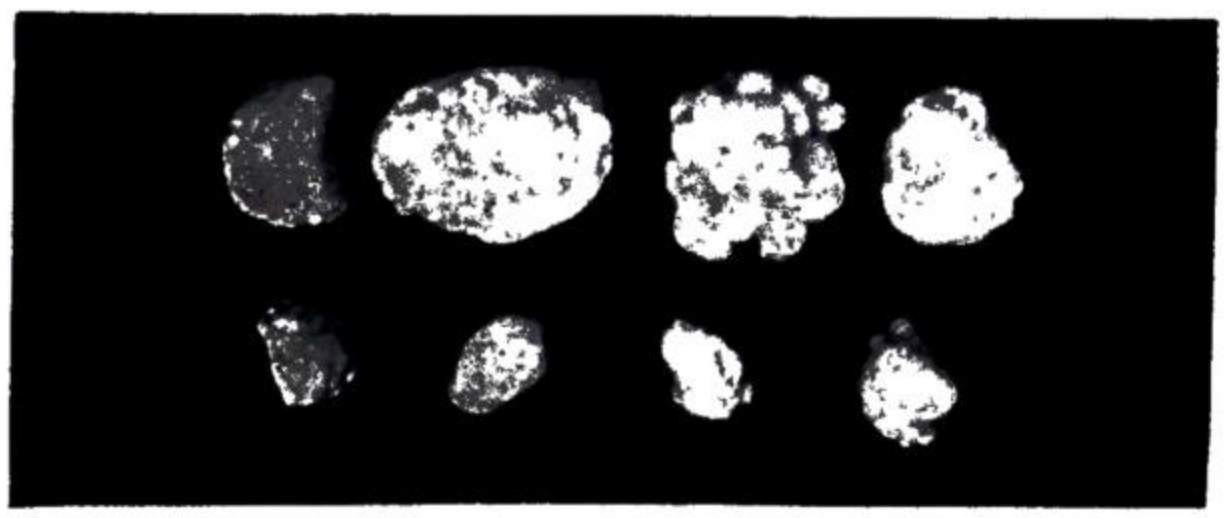


FIG. 1646.—Loose bodies removed from a knee joint. (*Actual size.*)

Osteochondritis dissecans often starts without any definite history of trauma at about the age of eighteen. It presents as a mild traumatic effusion. Symptoms of a vague character may persist for many months and then settle completely. The separation of the fragment may not take place till some years later, and the joint may then suddenly lock 'out of the blue,' all past history of knee trouble having been forgotten.

Symptoms.—The commonest symptom caused by a loose body is locking of the joint. This causes severe pain and is followed by synovial effusion. Locking is often only momentary, and some slight manœuvre of the joint by

the patient causes the body to slip out from between the bones and so unlock the joint. Repeated attacks of locking and synovitis eventually result in degeneration of the joint and osteoarthritis. Occasionally the patient learns to manipulate the joint so that the loose body becomes palpable, in which case it is felt to slip away from under the examining finger when the position of the joint is altered. This free mobility explains why loose bodies are sometimes referred to as 'joint mice.' A radiograph usually reveals the presence of the body.

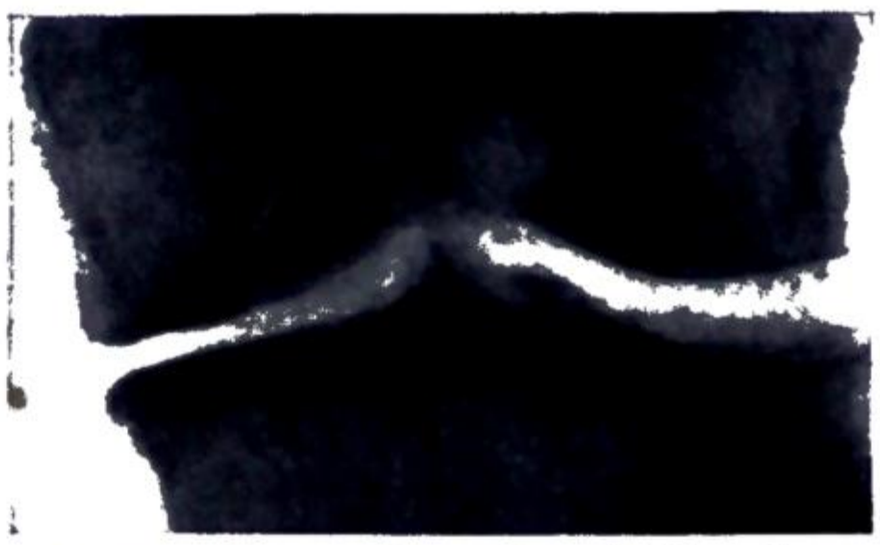


FIG. 1647.—Osteochondritis dissecans affecting the internal condyle. (*Karl Krebs, Aarhus, Denmark.*)

Treatment.—Unless the joint is already disorganised, the loose body should be removed in order to relieve symptoms and prevent the onset of osteoarthritic changes. In the case of the knee joint, the body should be manipulated, if possible, so that it comes to lie in the suprapatellar pouch. It is then imprisoned in that situation by a firm, sterile, elastic bandage passed around the extended joint, so that a small vertical suprapatellar incision is sufficient to allow removal. If the loose body cannot be found, a full arthrotomy and exploration may be needed and the joint put through a range of movement till the loose body presents in the wound.

HÆMOPHILIC JOINTS (See p. 89)

SNAPPING JOINTS

Many people are able to produce loud clicks from what would appear to be otherwise normal joints. There are two main sources of these clicks, intra-articular menisci in joints which possess these structures, and the movement of tendons over bony anatomical prominences near the join .

Sometimes these clicks may be sufficiently disturbing to warrant surgical treatment, but more often than not the trouble is that the patient is rather neurotic, finding a trivial discomfort intolerable and persistently evoking the click by a sort of 'self-inflicted' habit. In these cases strong reassurance must be tried because the results of operative treatment are often rather disappointing. The condition is to be distinguished from the 'trigger' phenomenon of stenosing teno-synovitis.

Common examples of snapping joints due to intra-articular menisci are seen in the jaw and the knee. Examples due to snapping (or 'clicking') tendons are found in the hip, shoulder, and peroneal tendons.

Snapping jaw is generally caused by derangement of the articular meniscus. In patients where the jaw locksor a palpable click is elicited, removal of the cartilage is often valuable, though it should only be done after six months of reassurance and after any errors of dental occlusion have been corrected by appropriate orthodontic measures. Patients without any easily detectable click and complaining mainly of pain will usually settle on firm reassurance.

Patients insisting on the operation should be warned that some drooping of the associated eyebrow might occur as a result of damage to the uppermost branch of the facial nerve and that transient deafness due to œdema of the external auditory meatus may last some weeks.

Snapping knee is due to a congenital abnormality of the lateral meniscus (congenital discoid cartilage). There is no neurotic element in these cases. Instead of the cartilage developing in its normal shape as a disc with a central aperture, it is present as a solid disc, thicker in the centre than at the periphery, which slips about causing a click. The click is often of surprising magnitude, being clearly audible even at some distance. The knee will jump as though it is dislocating. The condition is usually first noticed between late childhood and puberty. Operative removal completely cures this rather uncommon condition.

Snapping hip is caused by the tendon of tensor fasciæ femoris (i.e. the ilio-tibial band) slipping backwards and forwards over the prominence of the great trochanter. There is usually a strong neurotic element in these cases. If the click is very severe, the fascia can be divided at the level of the trochanter.

Snapping Shoulder.—Patients with indefinite pain in the shoulder, probably originating in the supraspinatus tendon or the subacromial bursa, often insist that it must be related to ' clicks ' which they can elicit from their shoulder. In the majority of cases they are unrelated and the patient can be reassured.

CHAPTER L

MUSCLES, TENDONS, AND BURSÆ

JOHN CHARNLEY

INJURIES OF MUSCLES AND TENDONS

Contusion of a muscle results from direct injury. Localised pain follows attempts at contraction, and an extravasation of blood occurs within the muscle sheath. This extravasation often appears at a considerable distance from the actual site of injury, e.g. hæmorrhage from a torn rectus femoris in its upper part usually appears near the patella.

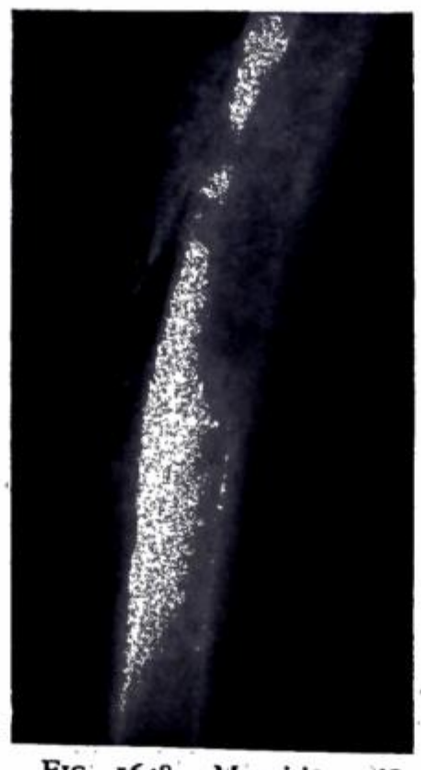


FIG. 1648.—Myositis ossificans of the thigh. Late appearance of bone on anterior aspect of the femoral shaft.

Rest and pressure dressings are required for the first two days, and, when risk of further extravasation has passed, gentle active movements will expedite absorption, and prevent, or limit, subsequent stiffness.

The rupture of some deep fibres of the quadriceps with a hæmatoma on the anterior surface of the femur is a not uncommon spontaneous injury in sport, but it may also result from a direct contusion. If too vigorously managed and passively stretched, this is a notorious site for 'myositis ossificans' (fig. 1648).

Rupture of a muscle usually occurs at the junction of tendon and muscle itself. Thus the *quadriceps extensor* ruptures immediately above the patella. It is an injury which occurs in elderly patients, often after a trivial indirect injury such as stumbling. The gap is easily visible and palpable when the patient contracts the quadriceps muscle (fig. 1649). The patient is unable actively to extend the knee. Repair with mattress or interlocking stitches is necessary. The prognosis regarding complete restoration of function is less favourable than in the case of a fractured patella, as accurate approximation of the muscle is difficult, and the fibrous union in the muscle tends to stretch.

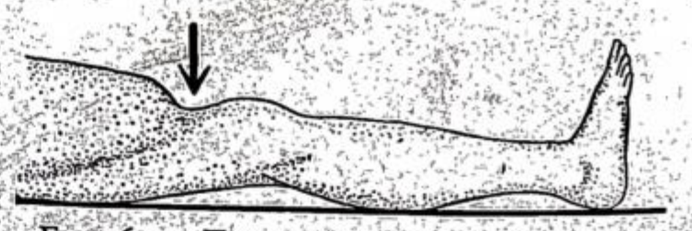


FIG. 1649.—Torn quadriceps femoris muscle.

Rupture of the muscle belly of *rectus femoris* occurs at about mid-thigh level. This is an injury of young athletic persons and is by indirect violence during very great effort. Extension of the knee is still possible after the

CHAPTER L

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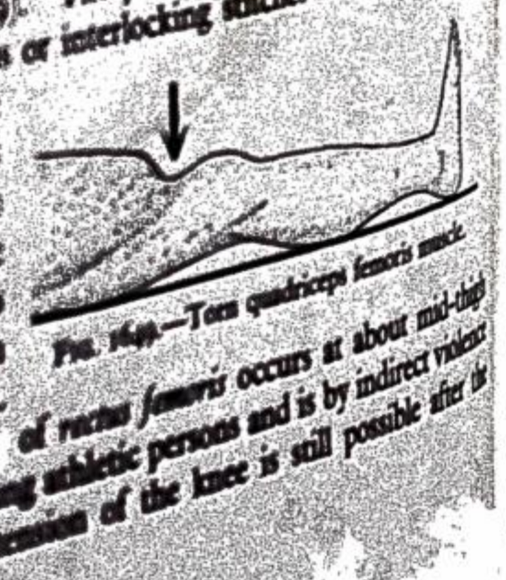

FIG. 1649.—Torn quadriceps femoris muscle.

of rectus femoris occurs at about mid-thigh
of young athletic persons and is by indirect violence.
Extension of the knee is still possible after the

pain of the rupture has subsided. When all local œdema has disappeared, the proximal end of the muscle will become prominent and stand out as a visible lump when the patient contracts the thigh.

Rupture of Tendons.—Normal tendons rupture with great rarity; indeed, with the exception of 'mallet finger,' all tendon ruptures occur in or after middle-age and sometimes in association with local attrition by friction against bone. The *Achilles tendon* is the commonest tendon to rupture, and as it is frequently diagnosed incorrectly, special note should be made of its clinical features. It is an injury most common in males in later life and, though it can happen during games and severe exertion, it more frequently occurs as a result of a stumble when the violent contraction necessary to regain balance causes the rupture. The sensation of rupture is often mistaken for a blow on the back of the leg and the patient will often turn round to see who has hit him. The rupture usually occurs about 1 inch to 1½ inches (2·5 cm. to 3·75 cm.) above the insertion of the tendon into the os calcis, and thus usually occurs in the substance of the tendon itself.

Clinically, a gap is easily palpable at the site of the rupture, and in early cases this is sometimes even visible (fig. 1650). The foot can be dorsiflexed to a greater extent than the normal foot. The power of plantar flexion is markedly reduced, but it is to be noted that it is never completely absent. This is a most important point, because one can be led to imagine that the tear must be incomplete by the fact that some power of plantar flexion exists. This power is, of course, exerted by the long flexors of the toes, tibialis posterior, and peroneus longus. Very few cases of suspected 'partial' rupture of the tendo Achillis are in fact incomplete; it is dangerous to make this diagnosis without an expert opinion, because suture of the tendon is much more difficult if the operation is delayed.

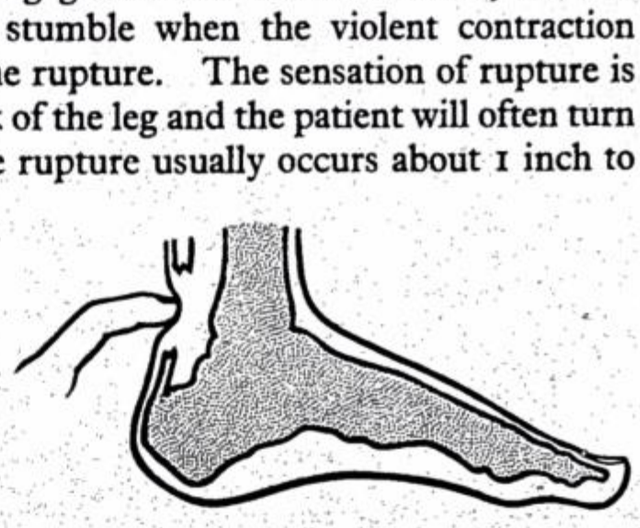

FIG. 1650.—Palpable gap in diagnosis of rupture of Achilles tendon.

FIG. 1651.—Spontaneous ruptured long head of the biceps tendon and 'bunching' of the muscle nearer the elbow than normal.

Early suture of the Achilles tendon gives excellent results, but late suture is usually disappointing because the proximal end has retracted and lost its elasticity, so that the gap cannot be closed by plantar flexion of the foot and flexion of the knee (in which position the gastrocnemius and soleus muscles are relaxed).

The *tendon of the long head of biceps* is sometimes torn where the tendon is frayed in the bici tal groove in the case of osteoarthritis of the shoulder join (fi 651). Recognition is easy, as on flexing the forearm the soft u belly is downwards wards the elbow. Some hypertrophy