at any point from its tip up to the level of the ankle joint. Most of the cases show no displacement, and should be regarded and treated in exactly the same way as sprains of the external lateral ligament. If there is instability and tilting of the astragalus when the foot is X-rayed in inversion then immobilisation is necessary. If there is not, strapping support will be sufficient.

4. Novocain Injections in the Treatment of Sprains and Fractures.—It has been recommended that in minor injuries to the ankle and elsewhere that novocain solution should be injected at the point of swelling and tenderness. It is claimed that this method allows a quicker and more painless return to functional activity, and that the amount of swelling and stiffness is diminished by the injection. The method is an attractive one. It has two chief drawbacks, the first being the rather remote danger of sepsis, and the second the danger of masking the true nature of the injury by making it painless. The first objection should not apply if the usual aseptic precautions are carefully observed. The second objection is a serious one. In the hands of the experienced surgeon, who is able to discriminate between the potentially dangerous injuries and the simpler ones, the method has much to commend it. Applied indiscriminately it can be a double-edged weapon. The quick recoveries claimed for the injection of novocain are much more likely to be due to the absence of fixation and the early movements employed than to any direct effect of the injection, and where novocain is not employed a similarly quick recovery can be observed provided plaster of Paris is not used unnecessarily in the minor injuries. It seems to the author that the chief use of the method lies in its capacity to make the injured point painless so that one can have a free hand to test clinically and by X-rays for any potential instability.

B. Major Fractures.

The chief purpose of this article has been to draw attention to those minor injuries of the ankle, including fracture, which can safely and profitably be treated without immobilisation in plaster. The treatment of the more serious degrees of fracture with dislocation and displacement is not within the scope of this article. Suffice it to say that the tendency is to overtreat the minor injuries and to undertreat the major injuries. The "six to eight weeks in plaster" prescription is often applied with equal zeal to crack fractures in the malleolus as it is to a thoroughgoing Pott's fracture with marked displacement. It is hoped that a proper appreciation of the minor injuries will lead to a greater respect for the major injuries.

TUBERCULOSIS OF THE KNEE JOINT

By R. Y. PATON, M.A., F.R.C.S.(ENG.)

(Surg. Royal National Orthopaedic Hospital, etc.)

The knee-joint is a common site of tuberculous infection, second only to the hip-joint in frequency. The infection may arise at any age, but usually starts in childhood, and sometimes even in the first months of life. The slow, insidious development of a swelling of a knee-joint, with limitation of movement and pain on attempting movement must always be regarded with suspicion, and the knee treated as tuberculous until the diagnosis is finally settled. There may be a history of a strain or twist of the joint preceding the development of the symptoms, but it must always be borne in mind that such trauma may have been the means of producing these symptoms in a joint with a pre-existing tuberculous infection. On closer investigation, however, it is usually found that the trauma has nothing to do with the onset of the disease. The knee, as a result of its anatomical construction, whereby two large bones are but poorly adapted the one to the other, is always the subject of strain in normal activity and exercise, and the fact that the knee suddenly becomes painful during such exercise obviously does not mean that the injury has caused the tuberculous infection to settle down suddenly in the joint. The strain has brought to the notice of the patient the presence of an infection. Much more frequently the onset is very slow and gradual, and pain may be markedly delayed in making

its appearance. A slight ache or a feeling of tiredness in the joint may be the only symptoms, even with an appreciable effusion in the joint. Later the ache becomes more continuous and eventually pain supervenes. The swelling of the joint increases gradually and limitation of movement appears. The child develops a limp as a result of his unwillingness to use the joint freely, as moving the joint beyond certain limits, which gradually decrease, causes pain. As the infection in the great majority of cases starts in the synovial membrane and remains a synovial infection alone for a long period the weight-bearing articular surfaces are late in becoming involved, actual weight bearing, while harmful, does not cause pain in the earlier stages. It is the stretching of the inflamed synovial membrane lining the capsule and covering the ligaments which causes the pain, and the natural reaction is to prevent any movement likely to cause this stretching. When the original focus is in the metaphysis there is usually a passive effusion into the joint, and this will cause tension of the capsule and ligaments, but less pain and restriction of movement than when tuberculous synovitis is present. The tendency of this metaphyseal infection is to spread through the epiphysal line and so into the joint, unless, as a result of treatment, it can be prevented from doing so. If the infection is limited to the metaphysis the degree of pain in the joint proper may be very slight, although pain will be present in the bone itself.

The preponderance of cases where the synovial membrane is the original site of infection is overwhelming. Over 90 per cent start in this way. A small proportion of cases start on the metaphysal side of the epiphysis, in very young children. A smaller proportion have the initial focus in the epiphysis itself. Only very rarely is the patella the site of the original infection.

In the primary synovial infection, the synovia first of all is the site of chronic congestion, later becoming thickened and oedematous. This oedema eventually involves the whole of the synovia, and the periarticular tissues develop a doughy consistency. The serous exudation into the joint is increased as a result of the hyperaemia. But this effusion is only rarely of a marked degree, except in young infants, the swelling of the joint being due to the oedema of the synovial membrane and the periarticular structures. In the membrane, under the serous surface, tubercles are formed. These gradually increase in size, some of them coalesce, and later they undergo caseation. The next stage is ulceration through the serous membrane into the joint cavity proper. Tuberculous granulation tissue forms over the ulcerated membranes and gradually spreads to involve other structures in the joint. It slowly creeps over the articular cartilage, which in time becomes eroded. The infection then spreads through the ulcerated cartilage to the underlying bone. The infection also spreads into the ligaments, which are gradually destroyed, and unless the method of splinting is satisfactory pathological dislocation will occur. This dislocation is of a triple nature, flexion, backward subluxation and external rotation of the tibia on the femur.

In cases where the primary focus is in the bone, the commoner site is on the metaphysal side of the epiphysal line. It remains localised for some time during which period there is a sympathetic effusion into the joint. The focus in the metaphysis, if not eradicated by operation, gradually works its way through the epiphysal line and so into the epiphysis. From here it ulcerates through the cartilage into the joint, and so the sympathetic effusion becomes infected.

When the original site of infection is in the epiphysis the focus may be either immediately underneath the articular cartilage or adjacent to the epiphysal line. In either case the infection spreads rapidly into the joint, the direction of extension being usually through the articular cartilage, but occasionally the infection will also spread through the epiphysal line into the metaphysis. The articular cartilage rapidly becomes eroded and replaced by tuberculous granulations, while the joint is filled with tuberculous pus.

Clinical Onset

In very young infants a swelling of the knee-joint is usually the first symptom noticed, although an observant nurse might previously have noticed, while bathing the baby, that the movement of the knee-joint was becoming restricted, and that the movement caused pain. In infants the effusion is often large and accompanied by a feeling of heat in the joint. The pain may be severe. As the condition is sometimes almost of an acute nature the diagnosis has to be made from other causes of sub-acute synovitis in infants, congenital syphilis, Still's disease, pneumococcal, and other pyogenic organisms.

In older children, a slight limp may be noticed as the first symptom. The child tends to walk with the knee slightly flexed, and so walks on the toe. He tires easily and complains that the knee aches. As the primary focus is in the large majority of cases synovial the articular surfaces are not involved until later, so weight bearing does not cause any pain in the early stages. Swelling of the joint gradually appears, and the inability to straighten the knee fully becomes more noticeable. The muscles above and below the joint become wasted, thus accentuating the swollen appearance of the joint. On examination the periarticular tissues are felt to be swollen and doughy in consistency. An effusion of variable degree, but often only slight, can be demonstrated in the joint. The knee is held flexed by spasm of the hamstrings, while attempts to straighten the knee cause much pain. All movements are limited, and forcing movement beyond the limit causes pain. As the diagnosis must be made early, long before X-ray examination will reveal any abnormality, it is advisable to treat any case of chronic synovitis in a child when there is little pain but muscular wasting as tuberculous until a definite opinion is formed. The knee is of course X-rayed and the limb immobilised and extended in bed. Other tests are then made—the Mantoux test, Wassermann reaction, excision of an inguinal lymphatic gland for pathological investigation, and, if necessary, the injection of a piece of the gland into a guinea pig, biopsy—arthrotomy under strict surgical asepsis to remove a portion of the synovial membrane for histological examination, etc. Although there is no doubt that the tendency is for the disease to spread throughout the joint despite the institution of proper treatment, it is also certain that the earlier treatment is started the more possibility is there that the disease will be checked before much permanent damage is done. To achieve this, early diagnosis is therefore most essential, and experience in assessing the various findings on clinical examination highly valuable.

In the adult pain is generally much more of a feature in the clinical picture, especially in elderly patients. The onset is more insidious, and swelling appears gradually. The periarticular tissues become oedematous and doughy, and the muscles, especially the quadriceps, show progressive wasting. The invasion of the articular cartilage is earlier, and so weight bearing causes pain sooner than in younger patients. The tendency to abscess formation is more common in adults. These abscesses tend to spread around the joint capsule, and especially into the semi-membranosus bursa. On clinical examination, a markedly swollen joint held in a flexed position is seen, little fluid may be demonstrable in the joint, but the periarticular tissues are much thickened. Movement in all directions is limited. When the articular cartilages are eroded passive movement is less painful than active, and the patient complains of difficulty in getting to sleep at night as the joint surfaces rub together and cause "starting pains" as the patient endeavours to relax into sleep.

X-Ray Examination

Before we proceed to the discussion of radiological features in tuberculosis of the knee-joint, it cannot be too strongly stressed that changes in the structure of the bones and cartilage only become apparent, in X-ray examination, after the infection has been well established for some months. In some cases a year or even two will elapse before changes are seen, while in a few cases no X-ray evidence of the disease in the bones occurs at all. This will emphasise the great importance of relying on methods other than radiology for establishing the early diagnosis of tuberculous infection. The distension of the capsule will of course be demonstrated, but this can be due to many other causes.

The most constant finding is localised osteoporosis, which is present in nearly every case. It generally becomes evident a few months after the clinical signs are manifest. Osteoporosis is usually not noticeable when the case is first seen, if it is seen in an early stage. Its appearance and extent will depend upon the severity of the onset. The osteoporosis, which is homogeneous, initially extends for two to four inches in either bone and gradually fades into the normal structure of the bony tissues. It is due to decalcification, a result primarily of the hyperaemic reaction to the infective process. There is also an alteration in the cancellous structure of the bone throughout the osteoporotic area. The cancellous bone is less clearly defined than in normal bone. This loss of detail in the bone, combined with the osteoporosis, and the presence of fluid in the joint and thickened synovial membrane lead to a hazy appearance in the film. Osteoporosis and decalcification must not be regarded as peculiar to tuberculosis as they are present in other types of chronic synovitis, such as those due to gonorrhoea

or recurrent trauma, as well as in senility and wasting diseases. A late result of continued decalcification is seen in the alteration in the structure of the lamellae. A progressive widening of the trabeculation becomes evident after the first year of the disease.

As a result of the continuous hyperaemia of the region of the affected joint, enlargement of the epiphyses and the patella is frequently observed. This increase in size is frequently associated with irregularity in growth, and in the case of the patella premature and more rapid ossification is noticed when compared with the patella of the opposite knee. This stimulation of growth may also be observed in the metaphysis.

As the disease spreads from the synovia to the articular surfaces the erosion of the cartilage gradually becomes manifest. This leads in time to diminution of the joint space as the erosion spreads to involve more and more cartilage. Eventually in the large majority of cases the cartilage of both femoral condyles and the upper surfaces of the tibia show changes due to erosion. These erosions, once they are established, practically never show any tendency to be restored. In cases of metaphysial origin, as the infection works its way through into the joint, the tuberculous osteitis underlying the cartilage causes rarefied areas, which are really cavities filled with tuberculous material, and the cartilage rapidly gives way under this attack. These cavities in the bone sometimes contain small sequestra and only rarely are these sequestra of large size.

Still later X-ray appearances are of calcification of abscess cavities, extensive destruction of the articular surfaces, followed by dislocation and dissolution of the joint.

Differential Diagnosis.

In the young infant, as has already been stated, tuberculous infection of the knee-joint often is of an acute nature, the swelling being tense, hot and tender, and the diagnosis must be made from pyogenic arthritis. The general condition of the patient in the latter infection with marked pyrexia should help to decide the nature of the arthritis, which can however be most definitely settled by aspiration, under strictest aseptic precautions, of some fluid from the joint for bacteriological investigation.

In young children, the condition due to congenital syphilis known as Clutton's knee has a clinical appearance resembling tubercle. There is, however, a marked absence of pain, and there is no muscular spasm or muscular wasting. Moreover, the condition is often bilateral, and other stigmata of congenital syphilis are present. The Wassermann reaction is positive.

Still's disease gives rise to difficulties in diagnosis. Although the condition becomes poly-articular, it often remains non-articular for a long period. The early treatment of immobilisation is fortunately the same. Still's disease is accompanied by enlargement of the lymphatic glands and occasionally of the spleen.

An abscess in either the lower end of the femur or the upper end of the tibia, whether pyogenic or tuberculous in origin, gives rise to chronic synovitis of a sympathetic nature. X-ray examination will reveal the presence of the focus in the bone.

Other types of infection which may resemble tuberculous arthritis are pneumococcal, gonococcal, typhoid and dysenteric. In pneumococcal arthritis the effusion is generally marked and the pain is only slight. If the child already has pneumonia the diagnosis is easy, but otherwise the joint should be aspirated for bacteriological investigation. The joint contents may be very thick and purulent, but occasionally are of more serous nature.

In gonococcal infections the arthritis tends to be poly-articular, but occasionally remains non-articular with close resemblance to a tuberculous knee. The periarticular tissues are swollen and oedematous, there is an effusion into the joint, and later, in some cases, erosion of the cartilage with destruction of the underlying bone may occur. The diagnosis rests on the investigation of the genito-urinary tract together with the complement fixation test.

In arthritis due to the bacillus typhosus the inflammation tends in most cases to be limited entirely to the synovial membrane, and the condition may become chronic and very resistant to treatment, and so suggest a tuberculous infection. Pain is not a marked feature, but limitation of all movement is present. The usual investigations for the presence of *B. typhosus* should determine the diagnosis.

A chronic arthritis is also seen occasionally in cases of dysentery due to Shiga's bacillus. The condition tends to be poly-articular and should be diagnosed on the history of the bowel infection, together with the bacteriological investigation of the stools.

Gummatous synovitis occurs most commonly in the knee-joint. The synovial membrane becomes very thickened and occasionally nodules may be palpable in the thickened tissue. Pain is not a marked symptom and the amount of effusion may be only slight. There is usually considerable wasting of the muscles with resultant weakness, and later, instability in the joint. The Wassermann reaction may be negative, and a definite diagnosis can only be made on the response to the administration of large doses of potassium iodide and intramuscular injections of bismuth.

Haemophilic arthritis also occurs most commonly in the knee-joint. In the chronic type the synovial membrane becomes very thickened, and the range of movement gradually decreases. Wasting of the muscles follows. The history should settle the diagnosis, and under no circumstances should the joint be aspirated.

In rheumatoid arthritis confined to one knee in elderly patients the condition often simulates a slow tuberculous infection. Here again the synovial membrane is the site of a chronic inflammatory change with resultant thickening, and later spread to the periarticular tissues. Women between twenty and thirty are most commonly attacked, and the disease is in most cases polyarticular. In some cases of involvement of the knee-joint only, the diagnosis can only be finally made as a result of a biopsy.

A slow-growing sarcoma of the lower end of the femur or upper end of the tibia may give rise to a chronic effusion into the knee-joint, but X-ray examination should reveal the true nature of the condition.

Treatment.

In children it is essential that the joint should be put at absolute rest at the earliest opportunity, and that this rest should be provided at a hospital where the necessary constitutional treatment for tuberculosis can be obtained. To secure satisfactory rest for the inflamed knee-joint it is not just sufficient to immobilise the limb in a splint; an extension must also be applied and this should be preferably a fixed extension and not by pulley and weight. The splint can either be a Thomas's knee splint or a well padded wooden back splint. In young children it may be necessary to apply a long Liston splint to the sound limb and trunk in order to prevent the child trying to get up or move the affected limb. The extension should be by strapping applied to the leg and tied firmly to the lower end of the Thomas's splint, which in its turn is tied to the foot of the bed, which is raised on blocks. The extension is thus brought about by the weight of the child. It is important to realise that this amount of extension is sufficient, and that it does work satisfactorily is demonstrated by the fact that when pain is a marked feature it rapidly subsides as a result of such immobilisation and extension. Any greater extension would result in damage, through prolonged stretching to ligaments already weakened by inflammatory changes and so lead to later instability in the joint. The extension should be sufficient to separate gently the opposing articular surfaces, and the patient should be able to get to sleep comfortably without any feeling of either tension on the limb or of the inflamed surfaces rubbing together.

Rest in bed with the limb extended and immobilised must be continued for many months, and for at least six months after all signs of active disease in the joint have disappeared. In cases which are going to clear up the doughy swelling around the joint gradually disappears and the normal contours of the knee re-appear slowly. X-ray examination at four-monthly intervals is advisable as a control of progress.

When the swelling has subsided and all signs of activity has disappeared the patient is allowed to get up in a weight-bearing caliper. A patten is fitted to the shoe of the sound limb, so that there is no possibility of any weight being transmitted through the affected joint. The weight-bearing caliper must be retained for at least two to three years, during which period the patient attends for periodical clinical and X-ray examination, as well as for adjustment of the caliper to ensure that no strain or pressure is being thrown on the joint. If at the end of this period of two or three years everything appears to be satisfactory the caliper can be made so that weight bearing is allowed, but the knee is held extended, and eventually the caliper can be discarded completely. As a result of conservative treatment on these lines a few cases are cured and regain an amazing range of movement in the joint and strength in the limb generally. In more cases, however, there is a period of a few months or even years of quiescence, after which pain gradually returns. Further conservative treatment is then essential until the

knee has become free from any signs of activity again. Such recurrences are frequent, and it often becomes necessary to bring about a bony ankylosis of the joint by operation. This can be done in children by removing the articular cartilage from the various articular surfaces and dissecting out the diseased synovial membrane and ligaments. The limb is then immobilised in plaster in a position of 5° flexion, and after six weeks the child is encouraged to walk about in the plaster. Sound bony ankylosis develops slowly in these cases and may take as long as two years. Throughout all this period some form of immobilisation, either a plaster case or a Thomas's splint, is essential to prevent movement, otherwise an unsound fibrous ankylosis will ensue, with the certain sequel of an increasing flexion deformity. An arthrodesis carried out on these lines gives a sound bony union, and does not interfere with the subsequent growth of the limb. Unless there have been abscesses or sinuses present the patient will not have any further trouble.

In the adult, treatment of the infected joint is different from that of a child in certain particulars, and also varies according to the age of the patient. The infection is generally of a much more active nature, and there may be other active foci present in the body. Immobilisation with fixed extension is essential until the acute stage has passed and the general condition of the patient has improved. The ultimate aim of the treatment is to get a bony ankylosis, and the decision has to be made when an excision of the joint can most safely be carried out. Should such an operation be attempted during the active stage of the disease, a grave risk is run of stirring up the activity, and of causing the disease to become generalised. Moreover, the operation is unlikely to be successful and numerous sinuses may develop, with the complication of secondary infection, and so lead to amputation. It is therefore advisable to postpone operative attempts to get bony ankylosis until after prolonged immobilisation and extension, when there are definite clinical and X-ray signs that activity has ceased. This means that more bone may have to be removed than would appear to be necessary in X-ray photographs taken in the earlier stages, but the resultant shortening of the limb is a small disability when compared to the disasters which may ensue from premature operation. The operation aims at getting a healthy femoral surface in apposition with a healthy tibial surface. All the infected synovial membrane and ligaments must be carefully removed together with any pockets extending upwards between the condyles or downwards behind the tibia. These posterior extensions of the disease are more likely to be missed owing to their position and resultant difficulty of access, but they must be sought for and eradicated. If the patella is much infected it must be completely removed; if the articular surface only is involved, this should be sawn off and a recess chiselled out of the patellar surface of the femur for its reception. No form of internal fixation should be used. Union can be encouraged and accelerated by driving the osteotome in various directions into the shafts of the femur and tibia without interfering with the cortex. The limb is immobilised in plaster in a few degrees of flexion, and has to remain in plaster until sound bony ankylosis has developed. When this satisfactory result has been obtained, the patient is often able to resume many of his normal activities, and even play games of lesser violent nature.

In adults over fifty it is doubtful whether conservative treatment followed by arthrodesis is advisable. The disease is of a more active nature, and may be associated with other tuberculous manifestations. Moreover, pain is much more a feature in these patients. The resistance to tuberculous infection appears to be reduced and the localisation of the disease to the joint is much less likely to occur in response to conservative treatment. Amputation through the middle third of the thigh is therefore the best treatment. The patient is immediately relieved of his continuous pain, and his general health improves in a remarkable manner. The provision of a well-fitting artificial limb enables him to return to normal life at an early date.

In these cases when the lesion is in the metaphysis and the effusion into the joint is not an infected one but only of a sympathetic nature, it is advisable to try to eradicate the focus from the shaft. As soon as X-ray examination has revealed a definite focus in the bone, the infected area should be carefully curetted out. The wound is completely sewn up without drainage and the limb is immobilised in plaster. The effusion into the joint rapidly absorbs and the plaster will become loose, when it should be replaced by a further plaster. As the focus in the metaphysis, if untreated, will gradually eat its way through into the joint, it is only common sense to try and prevent this sequence by early surgical eradication of the focus, especially when it is situated in such an accessible position.

Summary.

1. Tuberculosis of the knee-joint is in the very large majority of cases initially a synovial infection, and remains so for a long period, and is sometimes entirely confined to the synovia.
2. X-ray examination is of no real value in the early diagnosis which must be made and treatment started long before X-ray changes are apparent.
3. Despite treatment the disease tends to involve the whole joint, leading to fibrous ankylosis and, in cases where nature is assisted by surgery, bony ankylosis.
4. Immobilisation must be combined with extension for a very long period, followed by ambulatory treatment in a weight-bearing caliper, with the sound foot raised on a patten; and later, gradual progress to weight bearing, the knee being protected from strain for many months.
5. There is usually a tendency to recurrence after periods of apparently complete quiescence.

THE TECHNIQUE OF EXCISION OF THE INTERNAL SEMILUNAR CARTILAGE

By K. I. NISSEN, F.R.C.S.

(*Orth. Surg., E.M.S. Royal National Orthopaedic Hospital, Stanmore;*
Hon. Orth. Surg. to the Harrow Hospital)

The differential diagnosis of internal derangements of the knee was described in detail by Bristow (1) in an excellent number of this Journal, copies of which are still available. I propose to describe a common technique for removal of the internal semilunar cartilage, and while doing so, to give the reasons for certain preferences. The surgeon aims to excise the cartilage as completely as possible with minimal trauma, and at the same time to inspect the joint. The operation must of course be performed under the strictest non-touch technique, the essential points of which have again been stressed by Fairbank (2)

Preparation for Operation.

After a hot bath and scrub, the skin is prepared from the upper thigh down to and including the toes. The nurse or sister who prepares the patient should wear an efficient mask, for there is no doubt that some of the alarming infections which occur from time to time are respiratory in origin. I have known a streptococcal and a pneumococcal infection to develop in two successive patients from the same ward. Patients themselves tend to be talkative during preparation, and should lie down with heads turned away.

Three spirit preparations are given, iodine being avoided on account of some risk of dermatitis. The protecting towels need to be fixed securely either by a circular bandage or by strips tied at intervals. The whole of the leg from the groin downwards is included. The towels must not be disturbed in any way till the tourniquet has been applied and the patient is in position on the operating table, for otherwise the careful ward preparation may be rendered worthless.

The Anaesthetic.

Gas and oxygen is usually sufficient, as any venous congestion is of no account when a tourniquet is used. The deep sleep that follows induction by an intravenous anaesthetic should not be mistaken for surgical anaesthesia. If a spinal anaesthetic be given, the perineum is protected by a large pad of wool in case of sudden relaxation of the rectal sphincter.

The Application of the Tourniquet.

An Esmarch's bandage is entirely satisfactory, as the operating time is short and the femur well covered by muscle. Unless the assistant is skilled, the surgeon is wise to apply the non-sterile tourniquet himself. The limb, still encased in towels, is elevated and the rubber bandage is applied firmly, with successive turns just not overlapping, from the foot to the upper thigh. The next two or three turns completely overlap one another and are just firm. They act as a base which prevents the final constricting turns from cutting into the flesh. With a large patient two bandages may be required.

Entirely insufficient tension leads to venous congestion which can be recognised from the colour of the skin immediately the towels are removed. In such a case the tourniquet is released, and after the limb has been held vertical for a minute or two, it is quickly reapplied. On the other hand the tension may gradually become insufficient from diminution in bulk of