PLATE 3.

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FIG. 1.—Serial X-rays from a typical case of (intra-articular) tuberculous disease of the hip. A certain amount of bone destruction has occurred in spite of treatment.

On admission.

A. General rarefaction and narrowing of joint space.

After 5 months.

B. Erosion of femoral head commencing.

After 9 months.

C. Erosion of both joint surfaces.

After 13 months.

D. No further bone destruction.

After 17 months.

E. Recalcification commencing.
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FIG. II.—Multiple extra-articular foci. For every visible focus there are probably several that cannot be demonstrated radiographically.

FIG. III.—Pott's disease; operative fusion probably unnecessary.

FIG. IV.—Pott's disease; conditions unfavourable for spontaneous fusion. Operative fusion indicated.

FIG. V.—Successful iliac graft. The osteotomy was performed at a later date.
TUBERCULOUS DISEASE OF JOINTS.

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It is not possible to deal with more than the principles of treatment in a short discussion of this wide subject, and I propose, therefore, to consider only those joints most commonly affected, namely, the spine, the hip, and the knee.

GENERAL TREATMENT.

A tuberculous joint is the outward and visible sign of an inward and dangerous disease, and the very existence of a joint lesion indicates that there has been a latent bacillæmia, at some not very remote period. A tuberculous joint, of itself, is rarely a cause of death during the early days of the disease. Occasionally, a general dissemination from the hidden glandular focus may kill a patient at a time when the joint has just declared itself as being diseased; therefore general treatment is every bit as urgent and important as treatment of the local lesion.

Unfortunately, no specific remedy of proven value has yet been discovered, and we have to rely on the influence of rest, fresh air, good food, and sunlight which, though easy to name, are expensive, and sometimes difficult to supply. There is fairly general agreement about the nature and value of these measures, and it is only the climatologically minded who discuss the merits of the climate at this or that open-air hospital. But sharp differences of opinion are found about the local treatment of the disease, and this is where certain advances have been made during recent years.

THE COURSE OF THE LOCAL DISEASE.

It is essential that the course of the local disease under conservative treatment be clearly understood. It is almost as well defined as that of pneumonia or typhoid, the obvious difference being that the various stages are measured in months instead of in days. Some patients (as in the acute fevers named) succumb rapidly to the disease; in others there is no clear end point—the disease drags on for more than the usual period; but in the majority, as Calvé so properly insists, the disease responds to conservative treatment by healing within a fairly well defined period. The stages are as follows:—

1. Invasion. The initial embolic shower of bacilli is beginning to produce a reaction. The patient complains of trouble in the joint; for the first time physical signs of joint involvement are present, and the radiogram rarely shows more than a general rarefaction of bone: there is nothing to suggest tissue destruction. This stage lasts for a few weeks or months and passes imperceptibly into the stage of

2. Tissue Destruction. Now, the X-ray appearances become interesting: the bone may show cavitation, absorption of articular cartilage may be revealed as a narrowing of the joint space, and soft tissue involvement is often apparent clinically. The destructive process often continues for many months in spite of the most thorough treatment, and, if treatment has been neglected or delayed, may be extensive. Ménard pointed out that this destructive process may be resolved into two forms, that due to the intrinsic activity of the disease—which he called "ulcération tuberculeuse," and that due to mechanical factors such as
weight bearing or muscle spasm which cause attrition of the inflamed and softened joint surfaces—"ulcération mécanique." The first is beyond our direct control; the disease will take its toll however efficient the treatment. The second is prevented by timely local treatment, and such gross mechanical destruction as used to produce the "wandering acetabulum" is now happily rare. After several months, radiographic examination shows that bone destruction has ceased and the stage of

3. Quiescence—but not healing—has been reached. The local and general defences are sufficient to stem the advance of the disease, but the focus still contains many living tubercle bacilli. Clinically, the joint is no longer swollen, and serial radiograms show no further bone destruction. (Fig. I, Plate 3.) This is followed by

4. Healing. The joint is painless on manipulation and there is no swelling; the radiograms show an increasing deposition of calcium in the bone trabeculae and the appearance of a clear, if irregular, pencil line at the joint surfaces in place of the fluffy, ill-defined, margin so characteristic of the active disease. Pathologically, one finds that the tuberculous granulation tissue is becoming converted into fibrous tissue which shuts in caseous material and still surviving tubercle bacilli. A more or less firm fibrous ankylosis gradually develops, and on the strength of this ankylosis depends the safety of the joint. Tubercle bacilli persist in the scar tissue for months or years after the disease is clinically and radiographically cured, and are a potential source of trouble.

PRINCIPLES OF CONSERVATIVE TREATMENT.

Throughout this period the joint has been put at rest, and it matters little what apparatus is employed provided that its construction is rational and that it is used intelligently.

For a lesion in the spine or the lower limbs (with the exception of small lesions in the foot) the patient must be confined to bed.

The importance of traction is variously estimated, but it is fairly obvious that relief of pressure between the joint surfaces during the active stage of the disease must be of some value. Traction relieves muscle spasm, prevents deformity and subluxation (most important in the hip), and by separating the joint surfaces minimizes mechanical bone destruction. There is room for common sense in its application. At the hip it is almost always essential; at the wrist or elbow nothing more than simple fixation is required.

The thoracic region of the spine, where mechanical bone destruction may be so devastating, calls for special consideration. The natural kyphosis in this region tends to crush the involved vertebrae together, and the respiratory movements ensure constant grinding between them. (I have verified this several times during the performance of a costo-transversectomy.) Longitudinal traction over a long period is out of the question, but the same effect may be obtained by nursing the patient in the supine position on some form of hyperextension apparatus. Separation of the involved vertebrae occurs and can often be demonstrated radiographically; in this way mechanical bone destruction is reduced to a minimum.

Whether traction is employed or not, the joint must be rested by splinting.

It is important that traction or hyperextension should be discontinued as soon as it becomes apparent that bone destruction has ceased, and the lesion has
passed into the stage of quiescence. Separation of the joint surfaces is inimical to sound ankylosis, and can do no good if maintained too long. In practice it has been found a safe rule to allow the joint surfaces to fall together after three consecutive radiograms, taken at intervals of four months, show cessation of bone destruction, with recalcification and "clearing" (i.e. disappearance of the fluffy outline) of the joint surfaces.

After a short time the patient will be ready to get up. The disease is healing, and ankylosis is commencing. On getting up, and for a long period afterwards, a support will be required to protect the "young" ankylosis against trauma and forces that tend to produce deformity.

This is the time when a fixation operation may be so valuable. An extra-articular graft in the spine or hip, or an excision of the knee, converts a treacherous fibrous ankylosis into a stable bony union. The arguments in favour of such operations are very strong. A successful fusion enables a patient to dispense with apparatus at a very much earlier date (in the case of the hip there is the additional argument that no satisfactory splint, except a plaster spica, has yet been invented); it prevents the development of late pain or deformity due to yielding of the fibrous ankylosis; and, most important of all, the risk of recurrence is almost completely abolished. So long as the surfaces of a joint are bound together only by fibrous tissue, so long will there be a risk of sudden trauma tearing the ankylosis and liberating dormant, but still living, tubercle bacilli. A successful fusion operation means that the joint is bridged by, and often converted into, a mass of living bone.

The Extra-Articular Focus.

It occasionally happens that the focus of disease seems to be confined to the bone some distance away from the joint, and the question of early operative intervention arises. On the face of it, operation seems the obvious treatment. If the focus is eradicated the joint will be saved.

But it must be remembered that the bone infection is due to an embolic shower, and it is likely that for every obvious cavity there may be a number of smaller foci radiographically indemonstrable—some of them, perhaps, in the closest proximity to the joint (Fig. II, Plate 4). It is a common experience to find that thorough eradication of the demonstrable focus is followed, sooner or later, by involvement of the joint, and one is forced to the conclusion that the joint was either infected from the first, or, as seems more likely from the long interval that generally elapses, from a minute focus that could not be detected. Although intervention is sometimes successful it has yet to be shown that operation yields a greater number of satisfactory results than conservative treatment.

Early Fusion Operations.

The work of Hibbs and Albee suggested that early arthrodesis would enable surgeons to dispense with the prolonged recumbency and splinting inseparable from conservative treatment. Although this idea has long been abandoned by the majority of orthopaedic surgeons, it still seems to hold a place in the teaching of certain schools.

Since rest is the most important feature in the local treatment of tuberculous joint disease, the early and complete fixation of a tuberculous joint by a bone graft would seem to offer a short cut to the ideal. Ménard's teaching, however, must not be disregarded. Bone destruction is due to the disease itself as well as to
mechanical factors, and will sometimes continue after an apparently successful fusion operation. The graft may then exert an influence which is actually harmful, for it may keep the involved surfaces apart after bone destruction has ceased, and so prevent the closure that is essential to sound healing. An excellent paper bearing on this aspect of treatment has recently been published by McKee(1). So far as our present knowledge goes, a fusion operation has no favourable influence on the course of the active disease, but, when performed in the healing stage, provides us with a perfect internal splint which renders permanent the satisfactory result of conservative treatment.

**SPINAL DISEASE.**

Seeing that extensive mechanical bone destruction is almost confined to the thoracic spine, hyperextension is required only for lesions in this region. A well fitting plaster bed is sufficient for the average case of lumbar disease or cervical disease, though in the latter a device for preventing flexion of the neck must be added in the case of children. In adults, most of whom will not tolerate frame treatment, a plaster bed is best, even for thoracic lesions, and moderate extension may be obtained by placing rubber pads beneath the site of disease. This treatment is continued until three radiograms, taken at intervals of four months, show cessation of bone destruction, calcification, and “clearing” of the margins of the involved vertebrae. This covers a period of about 14 months for an adult, and 21 months for a child.

The patient is then nursed face downwards in an anterior plaster shell. The involved vertebrae can now fall together and compensatory lordoses will develop above and below the lesion. Three to six months in this position is sufficient and in the case of a cervical lesion this stage in treatment may safely be omitted.

At the end of this period the patient is ready for a spinal support and it must be decided whether a jacket or a graft is required. The indications for grafting are not yet clearly established, but it is always helpful to consider the following points:

1. Is there broad contact between fairly healthy vertebrae, or is there an irregular mass of vertebral bodies riddled with cavities, and in poor contact with each other? In the first case conditions for spontaneous fusion are favourable and grafting will probably be unnecessary. In the second a graft will provide firm bony fusion posteriorly during the long period required for consolidation of the vertebral bodies (Figs. III & IV, Plate 4).

2. Cervical lesions almost invariably heal well without grafting, lumbar lesions often do so, thoracic lesions sometimes.

3. The patient’s age. Spine grafting is a severe operation for a child under ten, and unlikely to be successful in the aged on account of feeble osteogenesis and the generally poor prognosis.

4. The patient’s weight. The heavier the patient the greater the need for a graft.

5. The patient’s habits and occupation. For example, a waitress is more likely to require a graft than a music mistress.

If in doubt, no harm is done by discharging the patient wearing a spinal support, and observing how the lesion behaves subsequently. Generally, it will be found necessary for the patient treated on purely conservative lines to retain the support for at least two years after leaving hospital, but only for from six to
nine months if a terminal spinal fusion is performed. The indications for readmission of a patient for grafting are a persistent feeling of weakness in the back, pain not due to a recrudescence of disease, and absence of radiographic signs of progressive consolidation of the lesion.

**HIP DISEASE.**

Here it is important to distinguish between extra- and intra-articular disease.

An extra-articular focus may be found in the acetabular roof, in any part of the femur above the lesser trochanter, or, less commonly, in the inner wall of the acetabulum. It is clear that certain foci are surgically accessible, while others are beyond reach. Even when such a focus is clearly demonstrated radiographically, and there is no sign of erosion of either of the joint surfaces, it is difficult to be certain that the joint is intact. Calvé states that if there are clinical signs of joint involvement, that is to say, limitation of movement that does not disappear rapidly after the patient has been put to bed, the joint is undoubtedly involved. This has been my experience also.

If there is an accessible focus, and no sign of joint involvement, operative ablation is worth considering, though, as has already been stated, we are not yet sure that this is the best course to take. The operation should not be undertaken except by a surgeon thoroughly familiar with all the approaches to the region of the hip. For example, the ablation of a focus on the inner side of the femoral neck is a difficult task, and it must be emphasized that nothing short of complete removal of the focus is likely to be successful. Simple drilling into the centre of a focus is not sufficient; it undoubtedly provides a channel for drainage but does nothing to remove the growing edge of the disease.

The after-treatment of such a case is as important as the operation itself. Powerful traction by Pugh's method (see below) should be continued until the cavity has been almost obliterated by the formation of new bone, and during the whole of this period a careful watch should be kept for signs of joint involvement. They appear in a depressingly high proportion of cases. But where the joint remains intact, the result is superb; free painless movement is preserved.

Most extra-articular foci are situated in the inner acetabular roof, immediately lateral to the tri-radiate cartilage and are, therefore, not surgically accessible. Pugh conceived the idea of treating these cases by powerful traction without fixation, which he obtained by applying an extension to the affected limb and attaching it to the foot of a steeply inclined bed. The weight of the child's body is now the distracting force, and the more the child wriggles the greater the pull. By this method it is hoped to preserve intact the shell of bone that separates the focus from the joint, and it is occasionally successful. In most cases, however, joint involvement appears sooner or later. During the last six years I have had only two successes from this form of treatment among all the cases admitted to the Royal National Orthopædic Hospital, Stanmore.

The treatment of the intra-articular lesion, whether primarily synovial or due to spread from an extra-articular focus, follows the same lines as the treatment of tuberculous disease of the spine.

Traction by a weight and pulley, the sound side of the body being fixed to a long splint of the Liston type, is a good old-fashioned method dating from the
The immobilization is poor, there being no rigid splint on any side of the affected joint, and when a bed-pan is placed beneath the patient the hip sags into slight hyperextension. Yet in practice it works well, and, from being completely against it, I have come to regard it as an entirely satisfactory method in the average case. This conclusion is derived from a comparison of methods used concurrently at the Country Branch of the Orthopaedic Hospital over a long period.

The Robert Jones abduction frame is a much more scientific affair; it immobilizes both lower limbs completely, and is of the greatest value when one is dealing with severe painful hip disease, or a child who is too unruly for simple weight extension. The only objection to the apparatus is that the immobilization is so perfect that considerable atrophy of the lower limbs, and in adults troublesome stiffness of the joints, is present at the conclusion of this stage in treatment and for a long time afterwards.

The merits of these three forms of apparatus, all widely used in this country, may be summarized as follows:—

\[
\begin{array}{ccc}
 & \text{Extension.} & \text{Fixation.} \\
\text{Pugh's extension} & ... & +++ & 0 \\
\text{Weight and Pulley} & ... & ++ & + \\
\text{Jones' frame} & ... & + & +++ \\
\end{array}
\]

Fixation and traction are continued, as in the spine, until serial radiograms show the three characteristic signs of quiescence; the duration of this period is about twenty-one months in a child, and rather less in an adult. The patient is then allowed to walk in a short closely fitting plaster spica, and this will benefit him in three ways. The heart and lungs will be able to resume their normal activity (which is of importance if operation is contemplated), the head of the femur will be pushed firmly into the acetabulum so rendering conditions favourable for ankylosis, and an opportunity is afforded for getting back movement in the knee on the affected side—which is always more or less stiff.

The indications for arthrodesis of the hip are more pressing than for any other joint. Spontaneous bony ankylosis of a tuberculous hip is rare, even after sinus formation and secondary infection, and the fibrous ankylosis that commonly results is rarely sound. Furthermore, no really satisfactory apparatus for controlling the hip over long periods has yet been invented. Hence a successful arthrodesis enables the patient to dispense with apparatus, and offers a fair guarantee against the slow development of a flexion-adduction deformity or recurrent disease.

The operation, however, must hold out a reasonable prospect of success, for it is not an operation of necessity, as ordinarily understood, and it is a relatively severe procedure. It is now fairly certain that an iliac graft is better than a tibial, and methods have recently been devised whereby the operation may be carried out with safety in children, Seddon\(^2\), Barr\(^3\). A successful result is one of the most gratifying things in surgery (Fig. V, Plate 4). The stiffness of the joint is not a great disability (it would be present in any case), the patient is released from all apparatus and is free to live a normal active life with a good prospect that local relapse is unlikely. In my own series of cases, dating back to 1931, there has been no trouble of any kind in those where fusion was successful, and I consider that the operation is called for in almost every case.
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It is only fair to say that this somewhat radical view regarding the desirability of arthrodesis as the final stage in the conservative treatment of tuberculous disease of the hip is by no means general, at any rate so far as children are concerned. At the same time it is interesting to note that surgical opinion is moving in this direction and that the staunchest conservatives are beginning to advise the operation more frequently.

DISEASE IN THE KNEE.

The clinical division into extra- and intra-articular lesions is the same here as in the hip, with the difference that all extra-articular foci near the knee are surgically accessible. This would appear to simplify the operative treatment, but there is a complicating factor which may be ignored in the case of the hip. The growth discs at the knee are the most important in the lower limb, and no operation must be considered in which there is likely to be extensive removal of a growth disc—otherwise the result will be a more or less short and deformed limb.

Among the cases of tuberculous disease of the knee dealt with at the Country Branch of the Orthopedic Hospital, there have been very few in which operative ablation of an extra-articular focus was indicated, and I have not sufficient personal experience to venture an opinion as to its merits. Intra-articular (synovial) disease predominates—a most unfortunate state of affairs, seeing that a stiff knee is a very real handicap.

Treatment of the intra-articular disease follows the general principles already discussed. The Thomas knee-splint is a most efficient apparatus, and an extension applied to the leg can be firmly tied to the end of the splint, and usually remains secure on the liveliest child. Occasionally, a mischievous child will persist in unfastening the apparatus and it becomes necessary to enclose the limb in a long plaster spica. This has the disadvantage of obscuring an abscess that may form (though a window at the side of the knee will help), and allowing posterior luxation of the tibia to occur if there is a very swollen knee and much spasm of the hamstrings.

Periodic radiographic examination of the joint does not always yield such clear information as in the spine and hip. For many months there may be no change apart from general rarefaction and slight narrowing of the joint space. Then, suddenly, erosion of one or more surfaces of the joint appears, but it is a terminal collapse rather than a progressive destruction and the three signs of healing very quickly follow. Therefore, if the radiograms of a case of tuberculous disease of the knee do not show the destructive changes so characteristic of disease in the spine or hip, the temptation to get the patient up must be resisted, and it is wise to continue with fixation for the usual period, that is, about 20 months; it is likely that, towards the end of this time, signs of bone damage will appear.

Ambulatory treatment is allowed in a walking-caliper, and, as in the spine and hip, the question of arthrodesis has to be considered. It is possible to perform an excision of a tuberculous knee with a fair prospect of success at any age between eight and forty years; if the resection of the joint surfaces does not remove more than half the thickness of the femoral and tibial epiphyses, no disturbance of growth need be feared. The trouble is that, if a child with an apparently successful fusion of the knee is allowed to walk without apparatus, bending will occur—not at the joint line—but at the lower femoral epiphyseal
line, and a more or less severe flexion deformity will appear. This can be prevented only by the wearing of a caliper until the epiphyses have almost united. The operation on the child, therefore, has little to commend it, and is best postponed until late adolescence.

The position in adults, where excision may be regarded as the routine treatment, is rather different from anything we have yet considered. The disease, if treated conservatively, goes through the usual stages of invasion, destruction, quiescence, and healing. Excision of the knee differs from the fusion operations on the spine and hip, in that access to the joint is so complete that thorough removal of the disease can be combined with the removal of the joint surfaces that constitutes the essential part of the arthrodesis. It follows, therefore, that operation in the stage of invasion, when the disease is still confined to the synovial membrane, may be carried out successfully, provided that the diseased tissues are resected widely. If the disease has reached the destructive stage (great swelling and thickening, and a radiogram showing erosion of bone), the chances of arresting the disease by operation are considerably diminished. Indeed, intervention at this stage may be followed by widespread infection of the limb (on two occasions I have had to perform amputations after untimely excisions), sinus formation in the incision, or, at least, failure to obtain bony fusion.

A joint in this condition is best treated conservatively, and arthrodesis is performed late, when the lesion is becoming quiescent, as in disease of the spine or hip.

Excision of the knee after the age of 45 is not likely to be successful, and there is fairly general agreement that amputation is the most satisfactory form of treatment for middle-aged and old patients.

(2) Seddon, H. J. St. Bartholomew's Hospital Reports, 1936, lxix, 199.
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