

ARTHRODESIS IN THE TREATMENT OF TUBERCULOUS COXITIS SEQUELAE

BY

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The course of a tuberculous coxitis falls as a rule into three or four stages. *Bufoir* makes the following three divisions in the development of the disease:—

1. The opening phase, during which the first clinical signs make their appearance and the general condition is disturbed. He puts the length of this period at about 6 months.
2. The evolutionary phase, or the stage of full maturity, in which the process has become definitely localized and is causing destruction in the involved area. This is the abscess period. It lasts for from 1 to 3 years.
3. The stage of recovery.

Wade also distinguished three stages, viz.:—

1. The initial stage, during which the disease progresses despite all attempts at treatment. This stage may last for as long as 2 years.
2. A two-year period in which the disease either remains stationary or goes through stationary stages alternating with exacerbations.
3. The healing stage.

Sorrel, on the other hand, divides the course of the disease into four periods, viz.:—

1. The beginning stage.

2. The evolutionary stage, which usually lasts not longer than 2 years.
3. The stage of (beginning) recovery.
4. The scar stage, when the lesions have finally become completely cicatrized.

The 23 cases described in the present paper were in the final stages, according to the above-mentioned classifications, and they may thus be described as coxotuberculosis sequelae. One case was slightly different from the others, and may perhaps best be designated as an after-effect combined with a recurrence, the latter event, however, having occurred two years before the operation.

The aftermath of a tuberculous coxitis may not only cause the sufferer much discomfort, but it also constitutes a lurking danger which may unexpectedly launch a fresh attack on his life and health. While the aim of the earlier methods for the relief of tuberculous hips was to retain as much of the motion as possible, the surgeons of recent years have been gradually coming to the conclusion that operations achieving bony ankylosis are a better corrective measure. *Haglund* wrote, in 1923: "....., der nach einer destruktiven Tuberkulose im Hüftgelenk mit Ankylose theoretisch und praktisch als der günstigste zu betrachten ist", and further on: "Wie vielen Patienten, die in der Kindheit eine Coxitis durchgemacht und eine gewisse Bewegungsfähigkeit im Hüftgelenk behalten haben, verwünschen nicht diese Beweglichkeit, sobald sie erwachsen sind und das Hüftgelenk einer stärkeren funktionellen Beanspruchung ausgesetzt ist". Unfortunately, adults show little (if any) tendency toward spontaneous ankylosis after conservative treatment; the only result of these measures is generally that the patients are left with a more or less malposed hip, which is apt to relapse or to fall into contracture and involves varying degrees of disability. After conservative treatment, the process passes into a state of quiescence from which it may at any time become active again, especially in connection with over-exertion, and enter upon a progressive phase likely to have serious consequences. This latent state has previously been considered to be equi-

valent to recovery, but a mental reservation must be made with regard to this view; the state has been referred to by *Erlacher* as an illusory recovery. According to *Matti*, tuberculous arthritis must always give cause for suspicion as long as there is movement left in the joint. An estimation as to the state of the process can not be made on the basis of the length of time elapsing since manifest signs of the disease were present. *Rugh* (1920), for instance, reported a case of tuberculous coxitis in which the disease had recurred after remaining quiescent for sixty years. *Maffei* made the following statement with regard to cases which, from the clinical point of view, are apparently cured: "La malade est dans un état intermédiaire entre la guérison et la maladie". On the other hand, it is wrong to say, as *Bastos Ansart* did, that only ankylosis can really guarantee a cure and preclude the likelihood of a relapse. *Sorrel*, who devoted much attention to this aspect, examined over a definite period 50 patients (adults) who had applied to the hospital because of a recurrence. Of these, 19 showed complete bony fusion, and 17 imperfect union, and only in 14 cases was there a pseudarthrosis. *Gruca* had 3 cases with a bad form of relapse of a very old coxitis dating from childhood, in which there was good ankylosis; two of these patients, despite resection and drainage, died from amyloid degeneration. In 1933, *Eikenbary & Lccocq* put the question: "Does a Successful Fusion of the Tuberculous Hip cure the Tuberculous Process?" In reply to this question they described the findings in connection with the postmortem examination of a patient who had died of tuberculous meningitis two years after an arthrodesing operation on the hip. Solid fusion was found in the hip, but in the upper part of the femur and the remains of the femoral neck there were several typical tuberculous foci the nature of which was definitely established by microscopic examination. These authors wrote in conclusion: "Certainly the findings prove quite clearly that a successful fusion does not necessarily end the tuberculous process", but they admitted that the case must be exceptional. It is not possible to draw conclusions as to the likelihood of a recovery later on in life, if the patient lives. *Delahaye's*

observation in connection with the autopsy on a child whose death was due to tuberculous nephritis, and on whom an arthrodesis had been performed at least $1\frac{1}{2}$ years previously for the relief of luxation resulting from destruction, is evidence in the opposite direction. In this case, complete ankylosis and a total absence of old tuberculous lesions was observed at autopsy. It has not been possible to ascertain whether a pathologico-anatomic examination was carried out in this instance.

Thus, although arthrodesis does not absolutely preclude a recurrence of the disease, it can be said to provide a greater likelihood of safety in this respect than the earlier forms of treatment; or, to quote *Barr*: "We believe that a fused hip has a much better chance to remain arrested than one which has a little motion present". Further evidence in support of this view is provided by the statistical material of 150 cases published by *Hibbs*. Fusion of the hip had been obtained in 139 of these patients, and in none of them had there been a recurrence of the tuberculous process.

Besides the risk of a recurrence, the aftermath of coxotuberculosis is often the cause of other discomforts such as leg shortening, rapid fatiguability, pains on locomotion, and the necessity of wearing a surgical appliance, all of which may result in the patient's being unable to walk without artificial aid in form of a stick, crutches, or the help of an attendant. The following advantages are to be gained through an arthrodesis, viz. correction of the malposition, possibly supplemented by an osteotomy carried out either at the same operation or later on; suspension of the subjective discomfort in the form of pain, instability, and leg shortening; lessening of the possibility of a relapse. Furthermore, the patients are relieved both mentally and financially by escaping the use of braces.

As has been mentioned in the introduction to this article, 23 cases of tuberculous coxitis sequelae have been treated by arthrodesing operations at the Stockholm Orthopaedic Clinic.

In a previous, much shorter communication the number of cases was stated as 24. A careful study of the etiologic aspect in one of these cases, however, brought out that it was not absolutely certain that tuberculosis was the cause of the patient's condition, and this case was therefore not included in the present series. Of these cases all except three have been re-examined by the writer. One of the missing three was impossible to trace, but when last seen at the Clinic displayed both clinical and roentgenologic union; another has replied by telephone to enquiries regarding his present condition and has had roentgenograms of his hips taken at the hospital in his home town; and as regards the third, who died of miliary tuberculosis eight years after the operation, both the clinical and the roentgenologic examinations, five years and three months after the intervention, proved that the hip had fused. Thus, as the end result, as far as ankylosis was concerned, could be estimated in these three cases, they have been included in the material. When judging the results from the functional standpoint, the patient who died and the one who could not be traced were excluded, and the group in which the functional results could be estimated therefore comprises 21 cases.

The postoperative observation time has been placed at one year at the least, this being the time usually counted as necessary to allow for the occurrence of consolidation. *Eurén* mentioned in his paper that if fusion has not taken place at the end of one year, it will not occur at all. The observation time has been divided up in the following manner: —

<i>Observation time</i>	<i>No. of cases</i>
1½-2 years	6
2¼-5 „	8
5¼-9 „	7
9¾ years and upwards	2

The youngest patient operated upon was 8 years and 8 months old, and the oldest 53 years, the average age being 27.4 years. For the purpose of the present investigation, the patients have been divided up into the following groups:—

<i>Age group</i>	<i>No. of cases</i>
8-10 years	2
11-20 „	9
21-30 „	4
Over 31 „	8

The duration of the disease before operation was at least 5 years, and the average duration in respect of all cases 16.5 years, distributed as follows:—

<i>Duration of disease</i>	<i>No. of cases</i>
0- 5 years	1
6-10 „	6
11-20 „	7
Over 20 „	9

All the surgeons engaged in this field are agreed regarding the wisdom of using arthrodesis on adults. In the matter of children, on the other hand, there is much divergence of opinion. *Hass* treats adults only, while the American surgeons can see no objection to using the operation on children. *Miller* has even practised the method on children as young as 3 years. A great many surgeons have been unwilling to arthrodese in children out of consideration for the following briefly enumerated factors, viz. the greater tendency to shock in children; the greater risk for the dissemination of the disease; the difficulty in obtaining ankylosis owing to the incomplete ossification of the greater trochanter; the possibility that the intervention may interfere with growth; and the gradually-developing adduction taking place during the years of growth, which makes it necessary to perform a second corrective operation later on and gives rise to the thought that one might just as well put off the operation until a later stage and in the meantime treat the case conservatively. *Payer* has declared that the classic arthrodesing procedure, i.e. removal of the cartilage with or without additional excision of the synovia, is a crippling operation which ought never to be resorted to before the patient has reached the age of 11 to 13 years. The same lower age limit was set by *Stoffel*, who pointed out the importance of shortening the stage

in the post-operative course characterized by consolidation of the connective tissue, during which there is a strong tendency towards contracture. According to *Stoffel*, this measure is only possible if the operation is reserved for older children and full-grown adults. As regards the growth-restricting effect, some surgeons declare that the growth is not inhibited unless the epiphyseal line is interfered with, and *Maragliano* has stated that in one of his cases he observed an accelerating rather than an inhibiting effect. Many authors have pointed out the difficulty of achieving permanent ankylosis, because of the consistency of the cartilage in the greater trochanter in children. The risk that pseudarthrosis will occur at the lower end of the graft is said to be very great. According to *Lanz* and *Wachsmuth*, the ossific centre in the greater trochanter appears in females, on an average, in the second or third year of life, and in males at the beginning of the fifth, and the average age for the disappearance of its epiphyseal cartilage 17 and 20 years respectively. As regards the actual ossification of the greater trochanter, *Richard & Graffin* stated that it is completed by the age of 10½-12 years, while *Maffei* considered that it is slowly proceeding up to the age of 14 years. *R. Jones* never did an arthrodesis on a patient younger than 8 years; *Mathieu* set the lower age limit for the performance of arthrodesis at 8 years, while *Bufnoir* stated that the best results are attained after the patient has reached the age of 12 years, although good results are possible from 7 years of age and upwards. Both *Sorrel* and *Tavernier* considered the 12 year limit to be too high, and were more inclined to set it at 6 to 7 years; this was also the limit set by *Eikenbury & LeCocq*. *Berard* stressed the fact that the bone substance in the hip is insufficient up to the age of 10 to 12 years, since the greater part of the bone still consists of cartilage and the rest is far too soft to provide material suitable for plastic procedures. By 10 years of age, the ossification has proceeded sufficiently far to allow a firm ankylosis after a juxta-articular arthrodesis. *Delahaye* emphasized the risk for external pseudarthrosis when ilio-trochanteric arthrodesing procedures are used on children under 12 years of age, and he

therefore devised his "Arthrødese iliodiaphysaire externe" for young children.

Two of our patients were between 8 and 10 years of age, and their hips were arthrodosed by bringing down an ilium graft alongside the joint and wedging its lower end under the temporarily removed greater trochanter. The results in both instances were good and bony fusion was obtained. The results with respect to ankylosis in the different age groups, among the 23 cases, will be seen in table 1.

TABLE 1.

Age group	No. of cases	Ankylosis		No ankylosis
		Bony	Fibrous	
8-10 years	2	2	—	—
11-20 "	9	7 ¹	—	2 ²
21-30 "	4	4	—	—
Over 21 "	8	6	1 ³	1
Total	23	19	1	3

¹ One patient died of miliary tuberculosis 8 years after the operation; 1 patient submitted to a second operation.

² In 1 case a second operation was recommended but was refused.

³ Clinical but not roentgenologic ankylosis.

Contrary to the practice at many clinics in other countries, the Stockholm Orthopaedic Clinic has not kept strictly to one type of operation. In view of the great variation displayed by the different cases, both as regards the extent of the destruction and the duration of the disease, it will be readily understood that this would hardly have been possible. If, for instance, advanced destruction of the femoral head and neck is present, and the greater trochanter is displaced towards the ilium, a plastic operation on the trochanter is indicated. On the other hand, this method is useless when the skeletal parts are intact. If a comparatively short time has passed since the disease was in the active phase, some form of para-articular arthrodesis is more suitable, so that there will be more chance of avoiding any infected tissue which is still present. The operative method

should be chosen on the basis of both the anatomic status of the joint and the length of time the disease has existed.

The following methods have been practised at our Clinic to secure hip fusion:—

Juxta-articular arthrodesis with an ilium graft which was either drawn downward or turned	15 cases
Juxta-articular arthrodesis with a pedunculated ilium graft ...	1 "
Plastic treatment of the trochanter	2 "
Para-articular arthrodesis with a tibia graft	1 "
Intra-articular arthrodesis	1 "
Partial intra- and juxta-articular arthrodesis with an ilium graft	2 "
Total intra- and juxta-articular arthrodesis with an ilium graft	1 "

In juxta-articular arthrodesing operations in which a drawn-down or turned ilium graft is used, the graft can be fixated either outside or inside the capsule. In 4 cases it is stated in the records that the extracapsular technique was used and in 9 the intracapsular, while in 2 instances information on this point is lacking. In the great majority of cases the joint was approached, for this operation, either through a *Sprengel-Smith-Petersen* incision, or a lateral incision. After the joint had been exposed, a thick graft was taken out of the iliac wing with an *Albee's* saw or a hammer and chisel. When the extracapsular technique was employed, the graft was moved downward until its upper end reached the lower part of the furrow made in the bone, while its lower end was either fitted into a hollow in the greater trochanter or inserted under the temporarily chiselled-up greater trochanter after this had been replaced in position together with the attached musculature. For the intracapsular variation, the joint capsule was opened on the dorsal aspect and excised within the parts corresponding to the graft which was later to be cut out. The graft was then taken out of the wing, its lower end including part of the acetabular rim, and brought down over the exposed, freshened femoral neck into a hollow in the greater trochanter, while the upper end was allowed to remain in the lower part of the chan-

nel made by the removal of the graft; another method used was to take out the graft and turn it before inserting it in position, in order that healthy bone would be sure to be obtained in the lower end which, according to general experience, constitutes the weakest part from the point of view of fusion.

As regards the juxta-articular arthrodesis with a pedunculated ilium graft, our aim was to follow the "pont-levis" method advocated by *Richard*, after first approaching the joint through a Sprengel incision. The graft employed proved to be too short, however, and we therefore had to supplement it with another ilium graft, the lower end of which was inserted under a bone flap in the greater trochanter.

In the cases treated by a plastic operation on the trochanter, in both of which there was advanced destruction in the joint, the approach was made through an *Ollier* incision, or a pure lateral incision, and the operation performed by a modified version of the *Hass* technique, the joint capsule being excised on the superior aspect, and the upper side of the neck of the femur freshened so as to obtain the largest possible contact surface. In one of our two cases, a pseudarthrosis formed at the lower end of the shifted trochanter, and the patient therefore underwent another operation at the end of four years. At this intervention, an arthrodesis by means of a tibia graft extending between the ischial tuberosity and the minor trochanter was attempted at one session, and at a second session a supplementary arthrodesis was done by driving five tibia grafts through the "acetabular rim" formed by the shifted greater trochanter.

As regards the other arthrodesing methods employed, only the partial intra- and juxta-articular procedure requires comment. With this method, the approach was made through a Sprengel-Smith-Petersen incision, after which the joint was opened. From the upper part of the femoral head and the roof of the acetabulum a wedge-shaped piece was then removed with a hammer and chisel, the space thus formed being filled with bone chips. A thick bone graft was next cut out of the iliac wing and in most instances brought down over the point into a bed prepared in the femoral neck and the greater trochanter (fig. 1).

Thus, with one exception, all the operations have been carried out inside the joint, or in its immediate vicinity. This involves certain risks, when it is a question of treating conditions such as tuberculous coxitis sequelae, especially when it is remembered that one can never be certain whether the disease has been cured or not. As a counter to this risk may be adduced

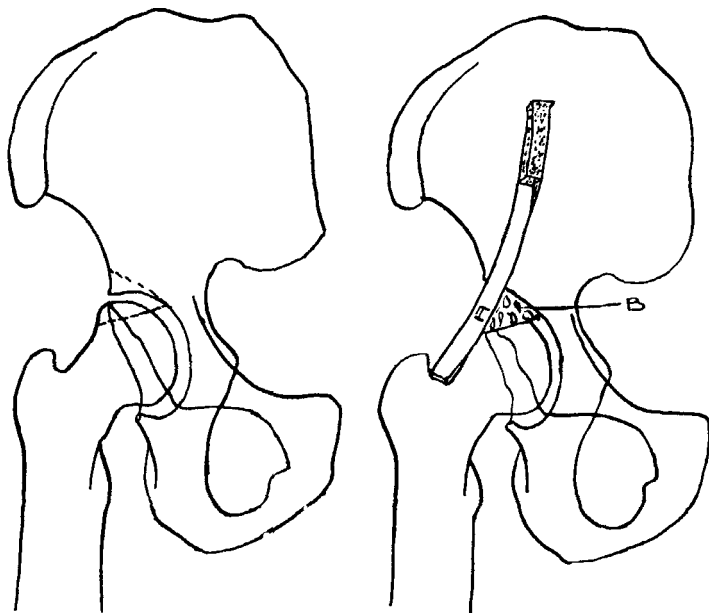


Fig. 1.

A method practised at the Stockholm Orthopaedic Clinic.

the far more effective fixation of the joint which is obtained the nearer the graft can be placed to it, and the greater chances for the nutrition of the graft the closer the contact which can be achieved between the graft and the adjoining bones. In 6 cases diseased tuberculous tissue was found during the operation. In 3 of these the operation was negative with regard to the desired result—bony ankylosis. In most instances, the tuberculous changes were encountered inside the joint or in the

capsule, but they also occurred in the form of small, circumscribed foci, in some cases outside the capsule, in the form of abscess remains, and in others between the bones, above the acetabulum. The time elapsing between the appearance of the first symptoms, in the 6 cases, was 5, 9, 11, 13, 15, and 30 years respectively. In the last-mentioned instance, however, there had been a recurrence of the disease two years before the operation. This fact is evidence in support of the statement made at the beginning of this paper, that conclusions as to the presence or absence of still active tuberculous material can *not* be drawn from the time which has elapsed since the disease became quiescent.

The length of time which had passed since signs of the active phase of the disease were present will be seen from the following list, distributed among the different types of operation:—

Juxta-articular intracapsular arthrodesis	
with an ilium graft	5-39 years, average 15.6 years.
Juxta-articular extracapsular arthrodesis	
with an ilium graft	6-30 years, average 14.5 years.
Juxta-articular (intra- or extracapsular	
arthrodesis?) with an ilium graft ...	9 and 12 years.
Para-articular arthrodesis with a tibia	
graft	34 years.
Plastic reconstruction of the trochanter ...	16 and 24 years.
Intra-articular arthrodesis	39 years.
Partial intra- combined with juxta-artic-	
ular arthrodesis	18 and 23 years.
Total intra- combined with juxta-artic-	
ular arthrodesis	11 years.

The symptoms which led to the operation were somewhat different in the various age groups. In the two youngest age groups, comprising patients of 8 to 20 years—11 patients in all—the discomfort consisted mainly of a limp and hip deformity which had gradually become worse, and fatigue on exertion, while only 2 patients had complained of pains. In the older age groups, on the other hand, pains were the dominant symptom, and these were at times so severe that the patients could only with difficulty move about indoors. In addition to the pain,

these patients also complained of increasing joint stiffness, leg shortening, and a limp. In two of the younger patients tenotomy of the adductor muscles had been done at an earlier stage, in 1 case subtrochanteric osteotomy, and in 1 pertrochanteric osteotomy to correct a malposition; after the last-mentioned intervention, however, the hip had gradually resumed its abnormal attitude. In 3 cases among the older age groups also, a subtrochanteric osteotomy had been done on an earlier occasion, but the malposition had gradually recurred.

As may be seen in table 1, bony ankylosis was achieved in 19 of the 23 cases (82.6 per cent), fibrous ankylosis in 1 case (4.3 per cent), and no ankylosis was obtained in 3 cases (13.1 per cent). The results obtained from the different arthrodesing methods are shown in table 2.

TABLE 2.

Arthrodesing method	No. of cases	Ankylosis		
		Bony	Fibrous	None
Juxta-articular intracapsular, ilium graft drawn down ...	9	8	1	—
Juxta-articular extracapsular, ilium graft drawn down ...	4	3	—	1
Juxta-articular, (intra- or ex- tracapsular?) graft drawn down	2	1	—	1
Juxta-articular, pedunculated ilium graft	1	1	—	—
Plastic reconstruction of tro- chanter	2	2	—	—
Para-articular, tibia graft	1	1	—	—
Intra-articular	1	1	—	—
Partial intra- + juxta-artic- ular	2	2	—	—
Total intra- + juxta-articular	1	—	—	1
	23	19	1	3

As has already been mentioned, diseased tuberculous tissue was encountered during the operation in 6 cases. In 3 instances this diagnosis was verified by a pathologico-anatomic exami-

nation; in 2 the finding consisted of the caseous foci characteristic of the tuberculous disease, and in 1 pus welled out when an incision was made in the capsule during an operation intended to be extracapsular. Among the cases in which the desired result, bony ankylosis, was not achieved, 3 of these cases were included, 2 among those showing no union at all and 1 in addition to the case showing only fibrous ankylosis. Of these cases 2 were treated by intracapsular arthrodesing operations and 1 underwent an extracapsular operation. The hip fused in 3 of the patients in whom tuberculous tissue was observed.

From the other contributions on the subject it is not easy to draw definite conclusions as to what effect the entering of a diseased focus may have on the fusing process. In most of the publications, the statements are only concerned with small series, and the papers containing more comprehensive material deal mainly with another complication arising in connection with the finding of tuberculous tissue, viz. the occurrence of postoperative sinuses. *Kappis* pointed out, in 1935, that the opening of the tuberculous focus leads to disturbances in the fusing process, despite the fact that definite statements to this effect do not occur in the literature. *Bufnoir* considered that healing is delayed, and will be less satisfactory, if diseased tissue is encountered, and he stressed the fact that if an abscess is observed the operation should not be continued. *Kidner* was of the opinion that the active state of the disease in no way contra-indicates the operation, but that it may be the factor deciding whether firm bony union will be obtained or not. *Miller*, on the other hand, has said: "Opening a tuberculous hip seems to attenuate the lesion, much like opening the abdomen in tuberculous peritonitis", a statement which he justified on the grounds that in two of his cases in which only exploration of the hip joint had been undertaken because the operation had to be broken off for other reasons, fusion by spontaneous ankylosis had occurred, a circumstance which he had never observed in an unopened joint. In all probability, *Hass* came nearest the truth. He believed that opening up the tuberculous area need not constitute an obstacle to the obtaining of *primary* fusion.

This view tallies with the experiences at our Clinic. *Sorrel* found diseased tissue in connection with four extra-articular arthrodesing operations, and two of these gave incomplete ankylosis and sinuses; *Kidner* observed pus in 5 cases and obtained fusion in 3, while in 2 the hips had not fused even at the end of twelve months, although the symptoms had disappeared and "new formation of bone" was present; *Farrell* noted pathologic material in 5 instances, and had 1 death from tuberculous and amyloid degeneration and 4 incomplete ankyloses as a result; and *Bufoir*, finally, in 10 cases operated upon by the Mathieu II method, discovered tuberculous tissue in 4 and had a pseud-arthritis in 2 of these.

In addition to the non-occurrence of ankylosis, sinuses may also follow operation, if tuberculous tissue has been encountered. These fistulas often disappear again rapidly, but if a secondary infection supervenes, or if the patient happens merely to be in a run-down condition, they can have serious consequences, or even result in death. *Kappis* has described a case which ended fatally in consequence of a postoperative sinus in a generally run-down patient. The relative incidence of postoperative sinuses is dependent both on whether the tuberculous focus has been entered or not,—and in this respect not only the lesions visible to the naked eye but also those distinguishable under the microscope play their part—and also on the duration of the disease. *Calvé & Galland* had no postoperative sinuses in 29 cases operated upon by a strictly extra-articular technique, while in 2 cases treated by intracapsular operations, by the *Hibbs* technique, fistulas occurred. *Alpert*, who modified *John D. Wilson's* method to make it wholly extracapsular, had 1 death, but no sinuses out of 17 cases, while *Hibbs*, using his own method, which is intracapsular, had sinuses in 50 per cent of his cases. That the frequency of postoperative fistulas ought to be higher the shorter the duration of the illness, seems a plausible hypothesis, and *Wilson's* statistical figures, for instance, provide evidence in support of it. Out of 27 cases operated upon 5 to 24 months after the inception of the disease sinuses appeared in 75 per cent, and in 11 cases operated upon

at a later stage in the disease fistulas were formed in only 36 per cent. *Henderson* had sinuses in 2 out of 3 cases when the operation was performed in the first stage of the disease, and in 43 cases operated upon at a comparatively late stage they occurred in only 28 per cent. That this complication need not necessarily occur if the former diseased area is contacted at operation has been demonstrated by *Sorrel*, who had fistulas in

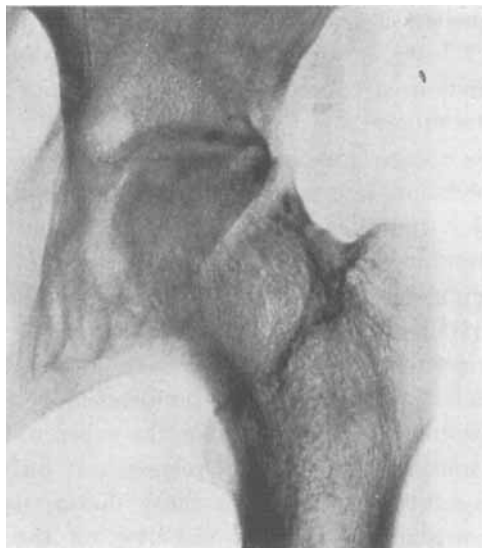


Fig. 2 a.

The aftermath of tuberculous coxitis, showing deformation and sclerosis of the joint.

only 50 per cent of the cases after 8 operations in connection with which the area of former infection was touched. In our series, as stated earlier, diseased tissue was observed in six incidences, but only 2 patients had subsequent sinuses. In one of these, fusion occurred at the end of 4 years, and in the other after 1 year and 8 months. Thus, in our series, we had sinuses in 2 out of 23 cases operated upon, or 8.7 per cent.

Finally, there remains to discuss still another complication likely to arise as a result of arthrodesis, namely, fracture or

pseudarthrosis of the graft, in consequence of which the joint ankylosis does not occur. As regards the fractures, these may be divided into those of traumatic origin, due to a sudden blow, and those developing insidiously, brought about by poor fixa-

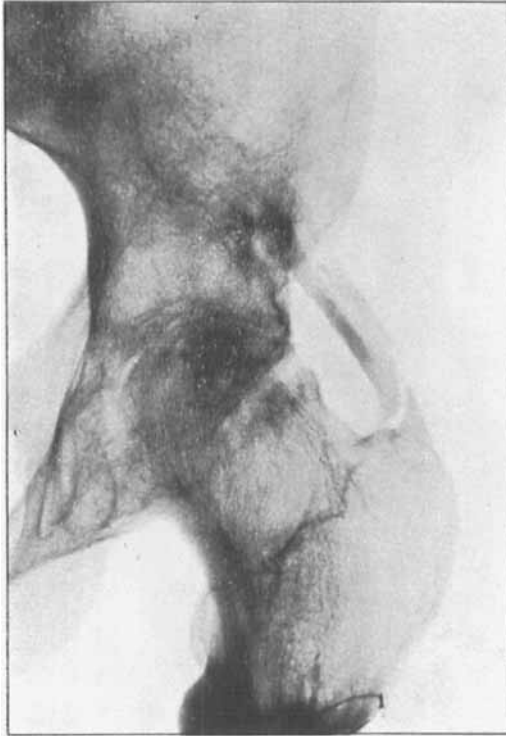


Fig. 2 b.

The same case 1 year after the operation.

"Fracture" of the graft, with beginning absorption.

tion, on account of which there arises at the part of the graft subjected to the greatest stress a reconstruction zone involving absorption of the bone, similar to *Looser's* "Umbauzonen". These last-named conditions, therefore, should not be called fractures, and in the remainder of this paper they will be referred to as "fractures". Fractures of one form or another would seem to be

typical of the para-articular arthrodesing operations, and pseudarthrosis of the juxta-articular procedures. In our material, "fracture" of a graft occurred in 2 cases and pseudarthrosis in 3.

In one of the cases submitted to a plastic operation on the

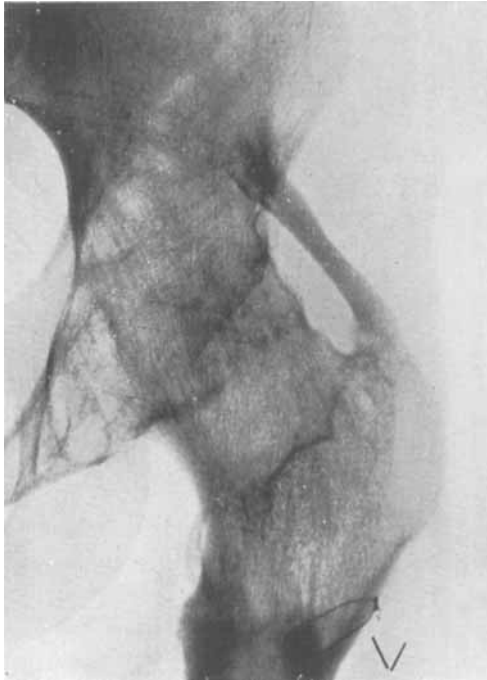


Fig. 2 c.

The same case 7 years after the operation. The "fracture" in the graft has fused. Secondary ankylosis of the joint.

trochanter a pseudarthrosis occurred after the first intervention, at the lower end of the greater trochanter. Bony ankylosis was obtained after a second operation, however, when 5 tibia grafts were used. In 4 of the cases in which tuberculous tissue was encountered at operation, pseudarthrosis arose as a sequel to "fractures". Two of these cases present features of interest. The first was that of a 9 year old boy upon whom a juxta-arti-

cular arthrodesis was performed by drawing down an ilium graft. In this case a "fracture" of the graft arose which gradually developed into a pseudarthrosis, despite postoperative brace treatment. In addition, the hip became malposed again, and 5 years and 4 months after the first operation a subtrochanteric osteotomy was therefore done. Following the immobilization in plaster-of-Paris in connection with this intervention which was continued for over two months, a secondary ankylosis of the actual hip joint arose, while the pseudarthrosis in the graft, on the other hand, remained unchanged. The other case (fig. 2 a) was that of a man of 20 years treated by para-articular arthrodesis with a tibia graft, and a supplementary subtrochanteric osteotomy. When examined at the Clinic one year postoperatively, his hip showed clinical ankylosis, but on the roentgenogram the graft was seen to be "fractured" close to the greater trochanter and the joint space was still visualized (fig. 2 b). He was advised to wear a brace for four more months and to return for another examination which, however, he did not do. He gave up the brace on his own initiative after six months, and roentgenographic examination 7 years after the operation showed not only that the "fracture" in the graft had fused but that a secondary bony ankylosis of the hip joint itself had taken place (fig. 2 c).

Leaving out of consideration as causative factors in the occurrence of both fractures and pseudarthrosis, first, the entering of the diseased area at operation; second, the fractures of traumatic origin; and third the pseudarthroses following arthrodesing procedures on children, due to failure to pay sufficient attention to the inadequately ossified greater trochanter, the chief reasons for the appearance of both an insidious "fracture" and pseudarthrosis are in all probability, firstly, faulty technique through which adequate contact surfaces fail to be produced, and secondly, insufficient postoperative fixation. The part played by immobilization will be discussed later on. While the pseudarthroses are generally located at the lower end of the graft, the "fractures" occur as a rule in the lower third of the graft, usually in line with the joint space.

The pseudarthroses commonly arise at the point where the graft is fixed to the greater trochanter. This circumstance has been thought by many authors to be due to the difficulty of securing satisfactory fixation at this end. The great diversity of reconstructive methods at the trochanteric end would seem to confirm this fact. Another reason put forward in explanation of why pseudarthrosis arises especially at the end opposing the trochanter is that with the methods in which the graft is inserted under the greater trochanter which has been temporarily excised and later replaced, the periosteum, if it is retained, forms a restricting membrane which hinders fusion. As against the view that the trochanteric end of the graft is the weakest, may be placed the statistical material presented by *Hallock & Toumey*. Out of 170 cases selected at random the first operation was a failure in 51 instances. It was found that among these, 31 hips had not fused at the ilium, 6 at the femur, 12 in the middle of the graft, and 2 at the epiphyseal line of the graft.

In the statistics presented, the large majority of cases were children and it is therefore possible that the consistency of the cartilage in the greater trochanter is partly the explanation of why these figures diverge from the observations made by other investigators. *Hallock & Toumey* themselves declared that the reason for the failures was probably both faulty technique, resulting in inadequate contact surfaces, and insufficient immobilization, but they offered no suggestions to account for the predominance of the cases of defective fusing at the proximal end of the graft. According to *Agerholm-Christensen*, however, this end constitutes the weakest point when Hibb's method is used.

Like the pseudarthroses, "fractures" of the graft which, as already pointed out, generally follow para-articular arthrodesing procedures in which long tibia grafts are used, are usually located at the lower end of the graft, but unlike the first-mentioned complication, they are situated 1 to 2 cm. above the site of insertion into the trochanter. This point, according to *Berard*, is the part of the graft subjected to the greatest mechanical

stress. The fracture can either be directly due to a trauma, or else may appear in the shape of an insidious "fracture". In the case of the traumatic variety, these generally occur in joints in which there has been a fair amount of motion before the arthrodesis; they arise either through a direct fall on the joint or as the result of the application of a heavy strain. The insidious "fractures", on the other hand, arise stealthily and are the more dangerous because they can be entirely overlooked and are thus likely to give rise to a secondary pseudarthrosis. Just as the stealthy "fracture" can arise quite unnoticed, so it can heal spontaneously, but even if this occurs there is the risk that the hip may become malposed owing to stretching of the callus.

In most of our cases, both the pseudarthrosis and the "fracture" arose in patients in whom the immobilization had been ineffective. In order fully to understand the part played by immobilization, it would seem necessary to examine in some detail the different stages through which a bone graft must pass before it becomes sufficiently healed to be capable of withstanding strain of any intensity. Directly after being implanted the graft as such does not take part in the fixation; this depends wholly on the external fixation, which is secured as a rule by a plaster-of-Paris bandage. Only in exceptional cases have we substituted some form of traction treatment for the plaster. In order that the graft may pass through the stages essential to the fusing process, the most careful attention must be paid to the fixation. During the period immediately following the operation, a decalcification process goes on in the graft, as a result of which its power to withstand strain from without is considerably reduced. The duration of this process is estimated differently by different authors; when a pedunculated graft is used it is said to be shorter. *Girdlestone*, *Zanoli*, and some other investigators, have preferred to use a pedunculated graft since in their opinion this more rapidly and safely ensures a firm bridge. According to *Richard*, with a pedunculated bone flap the decalcification is confined to the outer end of the graft, and is less pronounced than when a free transplant is used, and

even three to four months after the intervention the roentgenograms will show that the graft has thickened well, has good contours, and is definitely fused. This method has its anatomic limitations, however, and that is, when the distance between the greater trochanter and the ilium is wide. *Agerholm-Christensen* held the view, based on roentgen evidence, that the physiologic decalcification is most intense three to four months after the operation. This view concords with the observations we had a particularly good opportunity to make in one of our cases. In this instance, the graft was most decalcified at three months. At six months traces of recalcification were noted, and finally, ten months after the operation, the graft was completely recalcified. The same times were also mentioned by *Berard*. After this period, the graft gradually increases in volume and calcium content—a sign that it is becoming functionally adjusted—until it finally reaches its maximum strength one to two years after the intervention; if this does not occur, complete absorption of the whole graft takes place. *Cunéo* put the fragile phase of the graft at six to eight months, while *Firica* maintained that the critical period may last as long as one year. These times are not hard-and-fast; in some cases the various stages may be completed sooner and in others later. *Massart*, for instance, asserted that he had seen good roentgenographic fusion of a bone graft within 6 months, at the end of which time it had doubled its volume. In our series, the shortest time required by the graft for fusion was 2½ months. In most instances, however, the time taken was about six to seven months.

If a firm fixation of the joint results from the grafting, there occurs after a time a secondary bony ankylosis in the hip joint itself. This occurred, in the material at this Clinic, in 17 cases out of the 19 in which hip fusion was obtained. In one of the remaining cases, the interval since the graft fused is too short as yet for there to have been time for a secondary ankylosis to form, especially in view of the fact that tuberculous tissue was encountered at the operation. The other case is that

of the patient who could not be traced for the present investigation. In the case in which complete secondary bony ankylosis of the joint occurred most rapidly the time was 9 months.

Besides aiming at a solidly fixed hip, the arthrodesing operation also has as its object the correcting of any malposition of the hip joint which may be present. With the intra-articular methods, this end can often be attained after the cartilage has been wholly or partially excised or possibly also after a supplementary subcutaneous tenotomy of the adductor muscles has been performed, but with the juxta- and para-articular arthrodesis, on the other hand, the deformed hip is not always corrected. In these cases it is necessary to do an additional subtrochanteric osteotomy, either at the same session or after a short interval which, to save as much time as possible, ought not to be longer than 3 months. As regards the most advantageous position from the point of view of function, various angles have been suggested. Definite figures are given by some authors. *Adams*, for example, stated that the best functional position is 20 to 25 degrees of flexion, less than 18 degrees of abduction, and slight outward rotation, and *Berard* considered an attitude of 10 to 15 degrees of flexion and 20 to 35 degrees of abduction to be the best. *Haglund* thought the best position after a healed coxitis was 20 degrees of flexion, slight abduction in proportion to the leg shortening, and slight outward rotation. To stipulate a general position for the hip joint as regards function is in my opinion not possible, seeing that a number of factors must be taken into consideration when making the decision, viz. the age and occupation of the patient, and the actual leg shortening. When the hip is fixed in an abducted position coxitic scoliosis arises. When the patient is fairly old, with a comparatively stiff lumbar spine, lumbago may be brought on through the scoliosis, and in these cases therefore any difference in the length of the legs following the operation ought, if possible, to be compensated in some other way. The age also plays some part, in that in young children it is advisable to make the angle of flexion a little less than in adults, since in young persons, in consequence of the muscular traction on the comparatively soft bone, the

angle may tend to increase; the abduction position, on the other hand, ought to be exaggerated slightly since, in this plane the drawing power of the adductor muscles is the dominant factor. Owing to the last-named difficulty, some surgeons have begun to resect the obturator nerve in children also, in order to lessen the strong pull of the adductor muscles. As regards the occupation, this is of significance from the standpoint that, if the patient's work involves much standing, the attitude of the hip should be less flexed, say, at 20 to 25 degrees, while when the work is mainly done sitting down, the angle of flexion may be a little greater, say, 30 to 35 degrees. To conclude, the actual leg shortening is the final criterion when the size of the angle of abduction is to be decided in each individual case, and no definite figure for the latter can therefore be given. It should furthermore be borne in mind that, to facilitate locomotion from the functional standpoint, the ankylosed leg ought rather to be about 1 cm. shorter than the healthy leg, and preferably even functionally shorter than this, than functionally too long, a mishap which may occur if the abduction is made too pronounced. Figures relative to the functional length of leg were available in 20 cases for the purpose of the present investigation. In 4 cases there had occurred functional lengthening of between 1 and 7 cm. In the remaining 16, on the other hand, there was functional shortening of from 1 to 8 cm. The greatest actual leg shortening which was compensated by an abducted position of the hip was 7 cm.

Finally, to turn our attention to the functional result, this could be estimated in 22 cases. Only the untraced patient needed to be excluded from our series in this respect. On the other hand, as regards the patient who died 8 years after the operation while he was attending an occupational training course, the result must be regarded as functionally good, seeing that his condition with respect to the hip joint did not prevent his working at a suitable trade. Thus, in both these cases the functional result was good; one of the patients, however, is incapable of working on account of mental illness.

The *postoperative treatment* applied at our Clinic during the past few years has been along the following lines. Immediately after the operation, a double plaster-of Paris spica is applied, extending to, and covering, the foot on the operated side and as far as the knee—which is left free—on the healthy leg. The patient is kept immobilized in this spica for three weeks, at the end of which time the back of the plaster on the foot and lower part of the operated leg is cut away in order that movement therapy on the knee and the foot may be started. After six weeks the healthy hip is released, and the patient is then generally given a small plaster bandage on the operated hip. A further six weeks are then spent in bed, in this plaster; thus, until a total of 12 weeks have passed since the operation. The hip is then roentgenographed, and if the result of this is satisfactory the patient is allowed to get up, on crutches at first, and with no weight-bearing on the operated side. By slow degrees the hip is allowed to bear weight, roentgenograms being taken repeatedly as a control. If these show that consolidation is in progress the plaster is retained until complete fusion has occurred. If this has not taken place within 6 to 7 months the patient is provided with an unjointed leather brace. In my opinion, this measure is not really advisable. Consolidation can, in fact, take place after this time, and if the patient is given a removable brace the immobilization, and consequently the whole result of the operation, will be jeopardized, whereas a well-fitting plaster bandage which can not be taken off ensures a much more effective fixation of the hip. When the arthrodesing operation was first brought into practice at this Clinic the spica was usually removed after a much shorter period than is the custom at the present time. This is also the reason why, among the earlier cases, there are many in which there was a recurrence of the adduction deformity after the intervention.

In conclusion, there remains the question of which form of operation should be chosen for these conditions, and what ought to be done if a pseudarthrosis or a fracture of the graft arises. With regard to the most suitable operative method, there is still much difference of opinion. Many authors, especially per-

haps Mathieu, consider that the procedure should always be extracapsular, since there is then the greatest chance of avoiding the diseased area. That tuberculous tissue can not always be avoided by using an extracapsular technique, however, has been proved in the foregoing pages, in which are mentioned three cases where old tuberculous lesions were encountered both in the soft parts around the joint and also interosseally, above the acetabulum, during extracapsular operations. Among the 6 cases at our Clinic treated by the extracapsular method, the tuberculous area was entered in 4 (in 1 of these owing to an incision mistakenly made in the capsule), and in 1 of these the hip did not fuse. Among the 15 cases submitted to one or other of the intracapsular operations, the formerly infected area was encountered in 2, and in neither of these cases was ankylosis obtained. (With regard to 2 patients the records do not indicate whether the operation was extracapsular or intracapsular.) In the two patients with postoperative sinuses, the arthrodesing method had been extracapsular. This series, however, is perhaps too small to allow definite conclusions to be drawn regarding the choice of the operative method. One might venture to say, however, that as the extracapsular technique does not guarantee that the tuberculous lesions will be avoided, and since the chances of fusion are greater the closer the contact between the graft and the freshened bone surface, some form of intracapsular method is probably more suitable. As to the best type of intracapsular procedure, the anatomic relationships in the individual cases will no doubt be the best guide.

With regard to the fractures of traumatic origin, these heal well in a couple of months if a fresh immobilization is undertaken at once. The insidious "fractures" can also be made to heal by renewed immobilization if they are detected at an early stage. From these "fractures", however, there often arises a pseudarthrosis, the treatment of which should then be the same as that commonly practised in the case of the trochanteric pseudarthroses, namely by a second operation. One ought not, however, to be so eager to re-operate as Tavernier, who did a second operation on all hips displaying no ankylosis after three

months. If a pseudarthrosis is to be treated operatively, the use of thick tibia grafts over the old, freshened graft, after all pseudarthrosing tissue has been excised, is recommended.

SUMMARY

After a general discussion on arthrodesis as a measure to relieve the aftermath of tuberculosis of the hip, the author goes on to review the various types of arthrodesing operations practised by other surgeons in order to obtain bony ankylosis of the hip joint in coxalgia sequelae, dealing in some detail with the procedures which have been found useful at the Stockholm Orthopaedic Clinic.

The second section of the paper describes the observations made in connection with a follow-up investigation on the 23 cases of coxotuberculosis which have been submitted to arthrodesis at this Clinic. The types of operation employed and the success achieved are mentioned. Bony union was obtained in a total of 19 cases. Our experiences in connection with the encountering of diseased tuberculous tissue, and with various complications such as pseudarthrosis and "fractures" of the graft occurring after arthrodesing procedures, are discussed in the light of the present series.

Finally, after treating shortly the most suitable attitude for the arthrodesis hip, the postoperative measures employed at this Clinic are described and an opinion expressed as to the most advantageous arthrodesing method for these conditions.

RÉSUMÉ

La valeur de l'arthrodèse de la hanche en tant que méthode susceptible d'apporter un soulagement aux suites de la coxalgie est discutée et l'auteur donne un aperçu des différents types d'opération de l'arthrodèse pratiqués par d'autres chirurgiens pour arriver à ce but. Il est fait un exposé plus détaillé des méthodes que la Clinique orthopédique de Stockholm a plus spécialement estimé être appropriées.

Dans la 2ème partie de cet article, il est rendu compte des observations faites au cours de l'examen subséquent de 23 cas de coxalgie, traités par arthrodèse de la hanche à la Clinique de Stockholm. Les méthodes opératoires et les résultats obtenus sont communiqués. Dans 19 cas les opérations conduisirent à une guérison avec ankylose osseuse. Sur la base de la casuistique communiquée, il est discuté ensuite des expériences tirées de cas dans lesquels on a rencontré, au cours de l'opération, une tuberculose active et différentes autres complications (pseudarthroses et "fractures" des greffons) après l'opération.

Enfin, la question de la meilleure position de la hanche traitée par arthrodèse est sommairement examinée, les directives à suivre pour le traitement ultérieur sont décrites et l'auteur expose son avis sur l'opération de l'arthrodèse qu'il estime la plus favorable à ces malades.

ZUSAMMENFASSUNG

Der Wert der Arthrodese als Methode zur Linderung der Folgen von Coxitis tuberculosa wird erörtert, und der Verfasser gibt eine Uebersicht über die verschiedenen Typen von Arthrodeseoperationen, die von anderen Chirurgen zu diesem Zwecke angewandt werden. Es wird ausführlicher über die Methoden, die man in der orthopädischen Klinik in Stockholm am zweckmässigsten gefunden hat, berichtet.

Im zweiten Abschnitt der Abhandlung wird über die Beobachtungen, die bei der Nachuntersuchung von 23 Fällen von Coxitis tuberculosa in der Klinik zu Stockholm gemacht wurden, Bericht erstattet. Die angewandten Operationsmethoden und Resultate werden mitgeteilt. In 19 Fällen führten die Operationen zu fester Heilung mit knöchiger Ankylose. Die Erfahrungen aus den Fällen, wo man während der Operation auf Gewebe mit aktiver Tuberkulose und verschiedenen anderen Komplikationen — Pseudarthrose und »Frakturen« des Knochentransplantats (Span) nach der Operation — stiess, werden auf Grund der mitgeteilten Kasuistik erörtert.

Endlich wird kurz der Frage der zweckmässigsten Stellung