Bull. Yamaguchi Med. School, Vol. 4, Nos. 2, 3. 1956

STUDY ON TREATMENT OF BONE AND JOINT TUBERCULOSIS

TETSUO ITO, GORO AWAYA AND TAKASHI ITO

Department of Orthopaedic Surgery, Yamaguchi Medical School, Ube

(Received November 8, 1956)

Bone and joint tuberculosis has long been treated with rest and immobilization, which often resulted in a quiescence or partial healing of the disease, but never resulted in a cure. Moreover, a great variety of operative procedures, such as posterior spine fusion and ilio-femoral arthrodesis, has never given a satisfactory result. Open operation into the lesion has been avoided, because after such procedure secondary infection or haematogenous dissemination of the disease frequently occured. However, recent advances in chemotherapy has brought about enomous changes in every field of therapeutics and has also thrown a light on the treatment of bone and joint tuberculosis. Many authers proved that, for early disease, chemotherapy alone give a good result. *Stevenson* (1954) stated that it is essential to confirm how far antibiotics enable surgeons to treat bone tuberculosis upon basic principles applicable to other infection of bone without fear of secondary infection: where there is diseased bone, to remove it, where there is pus, to relieve tension and evacuate it. *Orell* (1951), *Ostman* (1951), *Carl Hirsh* (1951), *Wilkinson* (1952), *Evans* (1952), *DeRoy* and *Fisher* (1952), *Johnson* (1953), and *Mercer* (1954) have all pressed for the direct attack upon the lesion, whether secondarily infected or not, under chemotherapy cover. *Ostman* claimed twenty-five out of twenty-seven cases successfully healed by primary intension after drainage of abscess under chemotherapy cover.

Fisher reported fourteen cases in which paravertebral abscesses were drained. *Kondo* and his colleague *Yamada* (1951) reported an excellent result obtained by focal debridement under chemotherapy aid. Moreover, *Orell* (1951), *Wilkinson* (1953), and *Mercer* (1954) performed parptial synovectomy and curettage of bone foci, which resulted in healing with a good range of movement. These various methods of treatment should be evaluated on the basis of principles of rational treatment. The purpose of this study is to obtain the basic principles of treatment of bone and joint tuberculosis. For this purpose, in 190 cases of spine and 68 cases of hip joint tuberculosis, appearance of primary infection and its extension, especially the natural process of healing of the disease and causes hindering it, were carefully observed. As the result of this investigation, the five basic princi-

ples of rational treatment were obtained. Furthermore, in 100 cases of various types of bone and joint tuberculosis, conservative and operative procedures based upon these principles were undertaken, and the results obtained were followed for a period of one to five years.

Clinical Study on Appearance of Primary Focus and its Extension

Tuberculosis of the spine and the hip joint not only far outnumber that of other bones and joints, but also causes the most complicated pathological changes which offer strong resistance to our treatment. Neverthless, in the majority of cases, nature's tendency to healing is observed. Therefore, it may sure that a careful observation of the course of tuberculosis of the spine and the hip joint open up a new path of improvement in treatment of the disease.

I. Clinical Observation of Tuberculosis of the spine

In 190 cases of spinal tuberculosis which had been conservatively treated in our clinic from 1949 to 1954, the course of the disease was radiographically followed for a period of one to five years.

The primary infection occured in three regions of a vertebral body; in the central, upper or lower epiphyseal part, and lateral wall. Table I shows relations

Table I

Site of Primary Infection of Spinal Tuberculosis

Age-group	Site of primary infection			
	Central part of the vertebral body	Upper or lower epiphyseal part of the vertebral body	Lateral wall of the vetebral body	indeterminable
0— 9	8	8	0	
10—19	3	14	0	
20—29	11	38	1	
30—39	7	18	1	
40—49	4	4	0	
50	6	3	0	
Total	39	85	2	64
(Percentage)	(30.9%)	(67.4%)	(1.7%)	

between the site of infection and the number of cases occurring in each decade; it should be noted that, in more than half of our cases, the primary infection occured in the region of the upper or lower epiphyseal plate of the vertebral body. Moreover, six patterns of the course of disease were found, as schematically illustrated in Figure 1. Abstracts from protocols are as follows:-

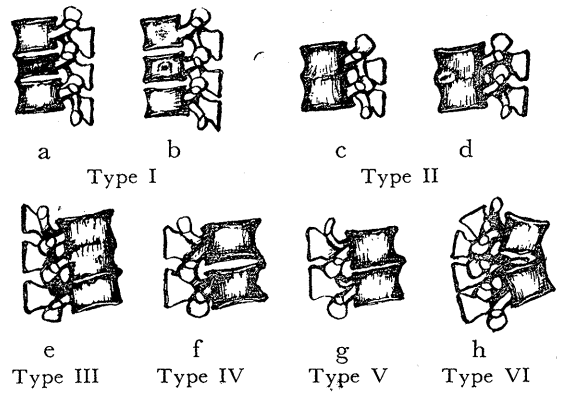


Fig. 1 Schematic illustrations of six patterns of the course of spinal tuberculosis.

1) Type I.

Tuberculous focus originating deep in the vertebral body frequently caused a flattening of the involved body without destruction of the adjacent discs (Fig. 1-a). In some cases the necrotic substance produced in the body seemed to be evacuated from the focus by compression of the involved vertebra, resulting in its flattening and calcification of the anterior longitudinal ligament. In other cases, the disease remained confined to a involved body as a localized focus, without its marked destruction (Fig. 1-b). In these cases, necrotic substance produced in the body seemed to be resorbed. This type of pathological change was found in 15 cases (9.0 per cent).

2) Type II.

The primary focus appearing in the epiphyseal or central region of the vertebral body usually spread into the neighbouring disc which was rapidly destroyed with consequent loss of the disc and involvement of the adjacent body, resulting in a sound or unsound fusion of the bodies (86 cases, 51.8 per cent). Although this type of healing is the most favourable course of disease, yet the time it takes is lengthened, several years or longer. Occasionally, it is dificult to obtain a sound healing, due to recurrence of the disease or sequestrum formation in the focus (Fig. 1-c and d).

3) Type III.

A complete destruction of one or more vertebral bodies and related discs resulted in a falling together of the unaffected bodies above and below the site of disease, associated with extreme kyphosis (32 cases, 19.9 per cent). In these cases, although the sinus commonly persisted for several years, it finally closed off after completion of union of the affected vertebrae. Therefore, it is clear that kyphosis inevitably develops as a result of healing of the disease, and should be not corrected by hyperextension of the spine (Fig. 1-e).

4) Type IV.

In cases with incomplete destruction of the disc, due to its resistance to extension of tuberculous change, the remaining healthy portion of the involved vertebra was frepuently fused with the neighbouring healthy vertebra by means of a

bony bridge formation around the partially destroyed disc (26 cases, 15.7 per cent). In sush cases, a sound healing rarely occured, the focus remained active, frequently contained necrotic substance within (Fig. 1-f).

5) Type V.

On rare occasion, the primary focus originating in the lateral wall of vertebral body remained superficially without further spreading in the deep (2 cases, 1.2 per cent). In such cases, a necrotic substance was easily evacuated from the focus, resulting in a sound healing of disease (Fig. 1-g).

6) Type VI.

Multiple foci originating in the several vertebrae usually caused a large bony block composed of various types of pathological changes, as mentioned above (4 cases, 2.4 per cent). This type of disease seldom results in a sound healing (Fig. 1-h).

TABLE II

The Process of Spinal Tuberculosis

Age-group	Type					
	I	II	III	IV	V	VI
0— 9	3	8	16	1	0	3
10—19	1	11	3	3	0	0
20—29	3	35	8	10	2	0
30—39	4	21	5	6	0	1
40—49	1	7	1	3	0	0
50—	3	4	0	3	0	0
Total	15	86	33	26	2	4
(Percentage)	(9.0 %)	(51.8 %)	(19.9 %)	(15.7 %)	(1.2 %)	(2.4 %)

TABLE II shows the number of these various types occurring in each decade; and it is noted that the largest figure is that for type II. This fact suggests that, in the vast majority of cases, a firm bony contact of the affected bodies offers the most favourable condition for natural healing.

II. Clinical Observation of Tuberculosis of the Hip Joint.

In 68 cases, the occurrence of primary focus and its extension were followed for a period of one to five years. The pathological processes of hip joint disease are of two basic types, acetabular and femoral. Varieties are formed again in each basic type. Figure 2 shows the schematic illustrations of deformities of the hip joint encountered during the course of the disease. Abstracts from protocols follow:-

A) Primary Focus in the Acetabular Roof.

a) Primary focus appearing in the lateral portion of the acetabular roof usu-

ally ruptured into the joint cavity without a extensive destruction of the roof—Type I (Case 4, Figs. 9 to 13). In one case, the primary lesion extended to the superior acetabular margin without marked destruction of the femoral head, resulting in pathological dislocation—Type II (Case 11, Fig. 34).

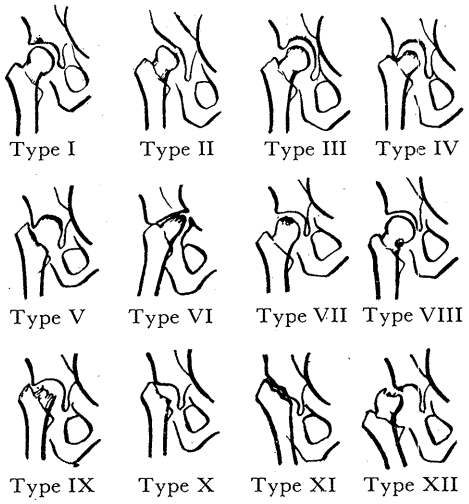


Fig. 2 Schemtac illustration of twelverns of the course of hip joint tuberculosis.

b) Primary focus appearing in the medial portion of the acetabular roof adjacent to the triradiate cartilage caused a variety of deformities.

1) The lesion usually ruptured into the joint cavity at an early stage. The lesion further tended to spread into the acetabular roof, resulting in a development of wandering acetabulum associated with intra-acetabular dislocation of the head of the femur—Type III (Case 5, Figs. 14 to 16). In eight cases with severe destruction of the acetabular roof, the uninvolved superior acetabular margin rode on the neck of the femur, consequently obstructing a approximation of the femoral head to the acetabulum—Type IV (Case 6, Fig. 17, and Case 12, Fig. 38). In this case, ankylosis of the joint can be expedited by excising the obstructing agent. In two cases, pathological dislocation occured owing to subsequent destruction of the head of the femur—Type V.

2) In three cases, the disease extended through the pelvis—central dislocation, Type VI.

B) Primary Focus in the Head of the Femur.

a) In two cases, the focus appearing in the head of the femur remained localized in the head that, however, escaped an extreme destruction—Type VII.

b) In most cases of femoral type, the primary focus appeared in the metaphyseal region of the neck, frequently resulting in a cure under chemotherapy alone or combined with surgical resection of the focus—Type VIII. In four cases, the disease extended to the head, causing its complete loss—Type IX. In an advanced case, pathological dislocation due to loss of the head and neck of the femur was encountered—Type X (Case 10, Fig. 30). Furthermore, extraacetabular pseudarthrosis due to subsequent destruction of the superior acetabular margin was seen in four cases—Type XI (Case 8, Fig. 22, and Case 9, Fig. 26). In this type of disease, a sound healing did not occur unless a shearing force acting on

the articular surface was removed.

C) Distensive Dislocation.

In two cases, an early dislocation, before an appearence of marked bone destruction, followed distension of the joint capsule caused by large effusion or granulation tissue in the affected joint regardless of whether the site of primary infection be the acetabulum or the head of the femur—Type XII (Case 7, Fig. 20).

In TABLE III showing the relative frequency of these types, it will be noted that the largest figure is that for primary focus in the medial portion of the acetabular roof adjacent of the triradiate cartilage.

TABLE III

Type of the Course of Tuberculosis of the Hip Jint

Site of primary bone infection	Type	Number of cases		Total
		Determined	Presumed	
Lateral porton of the acetabular roof	I	2	1	4
	II	1	0	
Medial portion of the acetabular roof	III	7	10	30
	IV	4	4	
	V	2	0	
	VI	1	2	
Head of the femur	VII	2	0	2
Neck of the femur	VIII	3	0	12
	IX	2	2	
	X	1	0	
	XI	2	2	
Acetabulum or Head of the femur	XII	3	0	3
Unknown				17
				68

Discussion

1) In spinal tuberculosis, the primary infection most frequenty occured in the epiphyseal part. Moreover, in hip joint tuberculosis, the primary focus commonly appeared in the medial portion of the acetabular roof adjacent to the triradiate cartilage and the neck of the femur. These facts suggest that the infection occurs principally in the metaphysis of the bone. Great preponderance of tubercle development in metaphysis over epiphysis in experimental bone

tuberculosis in rabbt may be taken as confirmatory to the foregoing interpretation.

2) Observation of the natural course of spinal tuberculosis revealed that a firm fusion of the affected vertebral bodies offers the most favourable condition for healing, which was obtained by compression of the lesion facilitating evacuation of the necrotic mass and approximation of the affected bodies. Formation of abscess or sinus which eliminates sequestrum and other products of necrosis may be regarded as a process of self-purification of the disease, even though it may take a tedious course.

Ishihara (1951) followed up course of spinal tuberculosis on eight hundred cases and arrived at conclusion that healing of the focus of disease is obtained only when compression of the affected area. The gist of his argument is as follows:- "Pathological changes in the spine caused by tuberculosis are formation of tubercles and granulation tissues which are followed by caseation and bone necrosis, not frequently replaced by cicatrix. In the focus containing caseous mass or necrotic bone, healing with scar or bone formation does not take place unless these necrotic substances are evacuated or absorbed. Compression by placing of sufficient load on the spine facitates evacuation of the necrotic mass and approximation of the healthy surfaces of the affected bodies above and below the lesion. It is certain, therefore, that compression of the affected area is as important in therapeutic success in the spinal as in the pulmonary tuberculosis."

From this point of view, we cannot but emphasize that immobilization and hyperextension of the spine at the florid stage of the disease may be taken as a rational measure for preventing its extensive destruction, but that during the stage of arresting activity any form of hyperextension and posterior fusion of the spine will hinder bony fusion of the affected vertebral bedies. A close approximation of the involved bodies and placing of sufficient load upon them may cause functinal stress which promotes new bone formation in the focus. Until recently, bone and joint tuberculosis has been treated with immobilization and avoidance of weight bearing, but seldom resulted in a complete cure. Moreover, the results of posterior spine fusion for spinal tuberculosis or extraarticular arthrodesis for hip joint tuberculosis are far from being satisfactory. Relapse with recurrence of clinical symptoms, due to development of post-operative pseudarthrosis or progression of the local disease, is an occasoinal result. Hallock and Jones (1954) reported that pseudarthrosis occured in fifty or 26 per cent of 192 patients who had been treated with spinal fusion operation. As these auther stated, there is a persistent tendency for the spine to bend forward which produces a distracting strain on the fusion plate until the diseased bodies have made a firm contact. In hip joint tuberculosis, many surgeons recognize frequent occurrence of pseudarthrosis following extraarticular arthrodesis.

In these unsuccessful cases, it is obvious that such procedure had prevented a approximation of the head of the femur to the acetabulum, consequently hindered the natural process of healing. In hip joint tuberculosis with pathological dislocation or extraacetabular pseudarthrosis, a firm bony ankylosis can be expedited only by removal of these unfavourable mechanical conditions.

Recent advances in chemotherapy enable surgeons to undertake direct attack upon the lesion and to remove the factors hindering the natural processes of healing of the disease.

As mentioned above, Orell, Wilkinson and Mercer proved that, for early cases, partial synovectomy and curettage of bone foci resulted in cure with a good range of movement. In a majority of cases, however, the destructive process has progressed to such an extent that all hope of safe mobility is gone, and that only by ankylosis will the lesion be safely and soundly healed. In such cases, Kondo and his colleague Yamada confirmed that focal debridement with chemotherapy aid gives an excellent result.

Based on such a conception as above discussed, the therapeutic procedures both radical and consevative that are considered necessary in treating these bone and joint tuberculosis may be outlined as follows:-

1) Focal debridement.
2) Approximation of both ends of the affected joint.
3) Compression of the affected joint during the convalescent stage—loading on the affected joint.
4) Activation of the bony element about the focus to unite—Robertson-Lavalle's operation and intraarticular bone grafting.
5) Immobilization of the affected joint.

These principles have long been applied to nontuberculous affections of bone and joint. It is essential to determine how far these basic principles are applicable to treatment of bone and joint tuberculosis with various types of deformity.

Case Report

One hundred patients with bone and joint tuberculosis were treated with various procedures based upon the five principles, as discussed previously. In the vast majority of cases, operation was undertaken at the stage of arrested activity. In all cases, except in two cases of hip joint tuberculosis with extraarticular pseudarthrosis, focal debridement was performed whether alone or combined with other operative procedures, as shown in Table IV. Postoperative treatment has been done in accordance with the principles of conservative procedures, such as loading and immobilization.

TABLE IV

Cases Operated upon for Bone and Joint Tuberculosis

Affected Bone and Joint	Number of Cases
1) Focal Debridement	
Thoracic spine	1
Lumbar spine	18
Sacro-iliac joint	4
Synphysis	2
Hip	24
Knee	16
Ankle	4
Tarsal and metatarsal bones	6
Shoulder	1
Elbow	3
2) Approximation of Both Ends of the Affected Joint	
a) Resection of the superior margin of the acetabulum	
Hip	2
b) Open reduction of distensive dislocation	
Hip	2
3) Loading on the Affected Joint	
a) Subtrochanteric osteotomy of the femur for extraacetabular pseudarthrosis	
Hip	2
b) Step-cut of the upper end of the femur for extraacetabular pseudarthrosis	
Hip	4
c) Shelf stabilization operation for pathological dislocation	
Hip	1
4) Activation of the Bony Elements about the Focus to Unite	
Intraarticular bone grafting	
Hip	3
Shoulder	7
Total	100

In all cases, except in two cases of extraacetabular pseudarthrosis, focal debridement was performed whether alone or combined with other operative procedures, as shown in this Table.

1) Focal Debridement

In seventy-nine cases of this series, simple debridement of chief focus gave satisfactory late results, except in three cases of tuberculosis of the lumbar spine and a case of tarsal bone tuberculosis. Some of these cases will be presented in detail.

Case 1. Eight year old boy.

Admitted with spinal tuberculosis with bilateral iliac abscesses. Since six years ago he has had gradually increasing low back pain. Radiograph at admission showed flattening of the fifth lumbar vertebral body and an irregular dense shadow in the adjacent disc (Fig. 3). Streptomycin (1.0 g daily) and para-amino-salicilic-acid (PAS) (10.0 g daily) were given for fifty days. Twenty eight

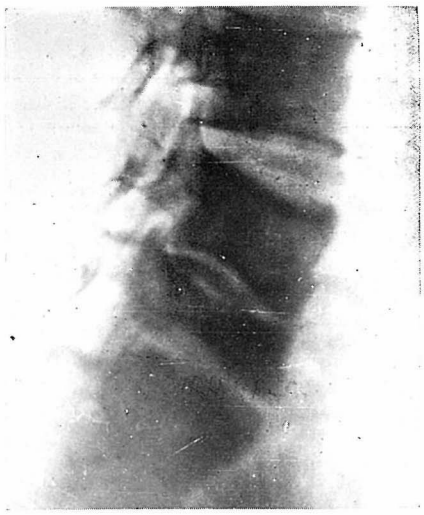


Fig. 3 Case 1. Flattening of the fifth lumbar vertebral body and an irregular dense shadow in the adjacent disc.

Fig. 4 Case 1. Eight months after focal debridement : sound bony fusion.

days after admission, debridement of the chief focus was undertaken through the left extraperitoneal route. The left iliac abscess was curetted and drained through the incision made in the left lumbar triangle. The drain was removed forth days after the operation, the sinus closing off in forty days more. Thereafter, weight bearing on the spine supported by application of plaster jacket was started. Eight months after operation radiograph showed a sound bony fusion of the affected vertebral bodies (Fig. 4).

Case 2. Man aged twenty-five.

Admittd with spinal tuberculosis with bilateral iliac abscesses. The patient had had pleurisy seven years ago, followed four years later by development of low back pain, kyphosis of the lumbar spine, and bilateral iliac abscesses. Radiograph at admission showed destuction of the body of the fourth lumbar vertebra and adjacent disc (Fig. 5); and abscessography proved the abscesses to arise from the diseased disc (Fig. 6). Streptomycin and PAS were administered for two months. Two weeks after admission, debridement of the chief focus and cleansing of the abscess wall were done. Operation revealed a large necrotic cartilaginous tissue in the focus. Four months after operation, radiograph showed a marked tendency to bony fusion (Fig. 7), and the iliac abscesses had already disappeared. Weight bearing was started on the spine supported with spinal brace.

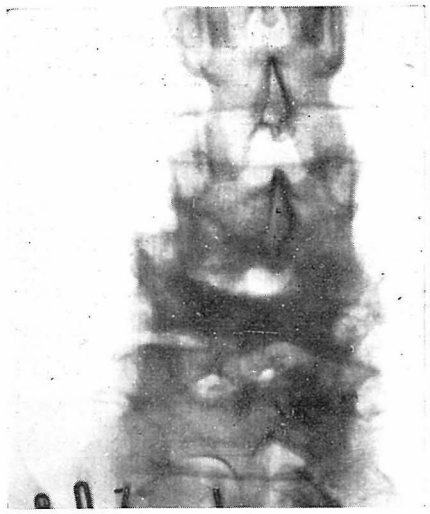


Fig. 5 Case 2. Destruction of the fourth lumbar vertebral body and adjacent disc.

Fig. 6 Case 2. Abscessography proves the abscesses to arise from the diseased disc.

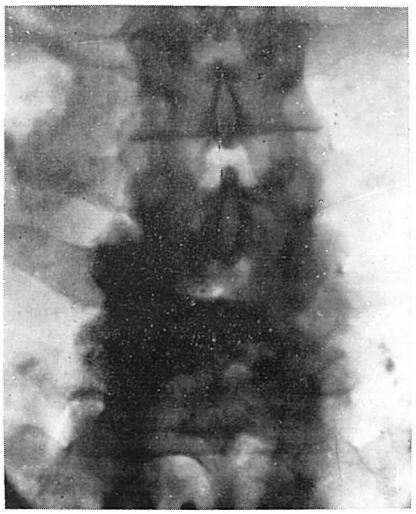


Fig. 7 Case 2. Four mour months after debridement of the chief focus and cleansing of the abscess wall: marked tendency to bony fusion.

Case 3. Man aged thierty-three.

Admitted with spinal tuberculosis with two sinuses. History dates back to ten years ago, when the patient developedlumbar caries with draining sinuses in the right lumbar and left inguinal regions with no tendency to healing all these years. Fistelographs showed the sinus in the right lumbar triangle to arise from the fifth lumbar interspace, that in the left inguinal region from fourth lumbar interspace, and these sinuses to communicate with other (Fig. 8). Streptomycin and PAS were given for two months. A month after a dmission, simple curettage of both sinus tracts and the chief foci through the sinuses was undertaken.

The operation revealed that the both foci formed wide cavities containing a small amount of granulation tissue which apparently was the major factor preventing a close contact of the affected bodies. The operation, however, failed to modify the conditions of discharging sinuses to any degree. Even a year later, no tendency to closure of the sinuses was seen.

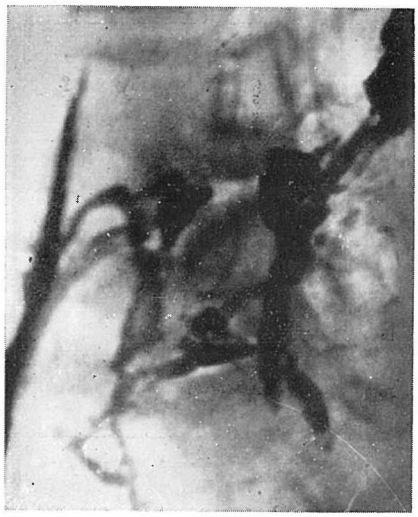


Fig. 8 Case 3. Fistelograph shows the sinus in the right lumbar triangle to arise from the fifth lumbar interspace, and that in the left inguinal region from fourh lumbar interspace, and these sinuses to communicate with other.

It is probable that in this case healing will not take place unless more radical removal of the factor preventing close contact of the affected bodies.

Case 4. Girl aged fifteen.

Admitted with tuberculosis of the left hip joint and pain on motion. A radiograph showed a large walled off tuberculous focus in the lateral portion of the left acetabular roof (Type I) and narrowed joint space (Fig. 9). Tomograph suggested that the focus located in the posterior region of the acetabulum and has not yet burst into the joint cavity (Fig. 10). Streptomycin was given for forty days. Curettage of the focus through extra-articular route was undertaken. Operation revealed that although the lesion spread under the acetabular acrtilage, the rupture into the joint cavity has not yet occured. A plaster cast was applied for four months.

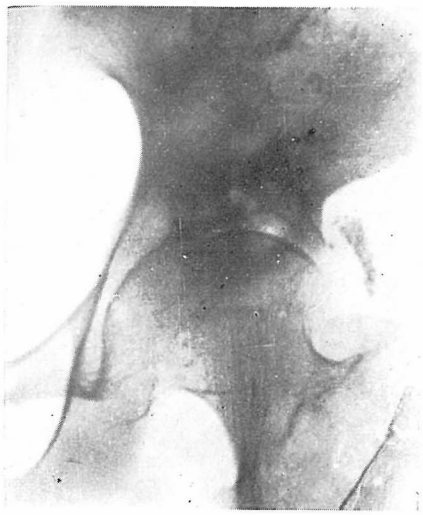


Fig. 9 Case 4. A large walled off focus in the lateral portion of the acetabular roof.

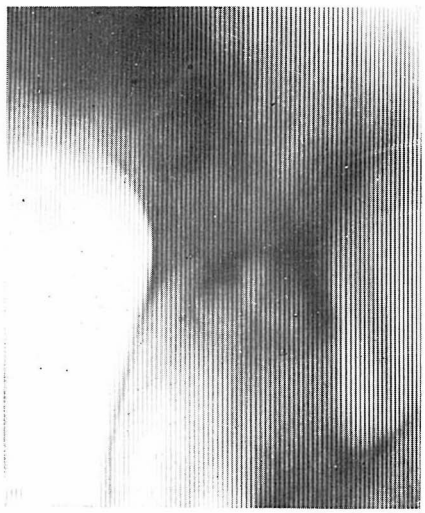


Fig. 10 Case 4. Tomograph shows the focus to locate in the posterior region of the acetabulm.

Fig. 11 Case 4. One and one-half year debridement of the focus through the extra-articular route: involvement of the femoral head.

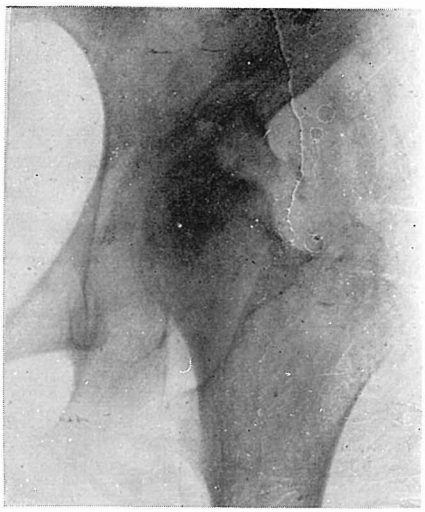


Fig. 12 Case 4. Eight months after focal debridement: sound ankylosis.

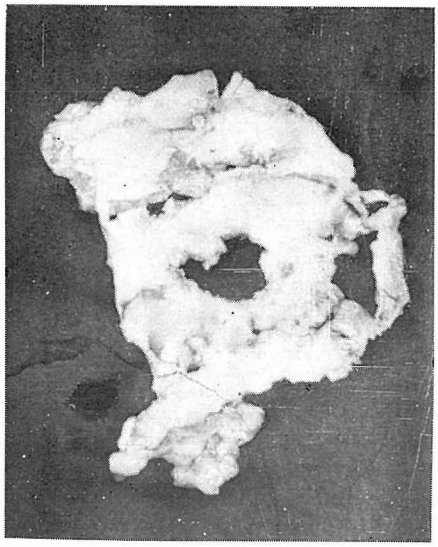


Fig. 13 Case 4. The articular cartilage which is easily torn off from the femoral head: a localized defect at the central portion cor-responding to the attachment of the lig.t eres.

Six months after operation, she had a wide range of movemet without pain. However, one and one-half year after operation, pain of the hip reappeared. A radiograph clearly showed destruction of the head of the femur (Fig. 11). Fccal debridement was performed, and plaster cast was applied for four months. Then the cast below the knee was removed and excercise was given for the knee. Eight months after the second operation, radiograph showed a bony ankylosis(Fig. 12).

In this case, the primary focus caused a localized bone defect of the acetabular roof which had an opening into the joint cavity, and walled off by sclerotic bone. The articular cartilages of the acetabulum and the head of the femur were easily torn off from the underlying bones. The articular cartilage of the femoral head showed a localized defect at the central portion corresponding to the attachment of the lig. teres (Fig. 13).

In the case of Type I and III, such pathological changes, as shown in Fig. 13, were frequently found. These findings may prove that the lesion spread into the femoral head through the attachment of the lig. teres.

Case 5. Child aged three.

Admitted with tuberculosis of the left hip joint with two sinuses in the left gluteal region. A year before admission, the patient developed primary bone focus in the medial portion of the left acetabular roof which rapidly extended upwards (Fig. 14). A radiograph at admission showed a sequestrum formation

Fig. 14 Case 5. Primary focus in the medial portion of the acetabular roof.

Fig. 15 Case 5. A year later: a sequestrum formation in the focus and wandering acetabulum followed by intra-acetabular dislocation of the femoral head.

Fig. 16 Case 5. Three years after focal debridement: a sclerosed acetabular roof with outward tilting of the superior acetbular margin and wide joint space.

and wandering acetabulum followed by inraacetabular dislocation of the femoral head (Type III, Fig. 15). Chemotherapy was started on admission. Two weeks after admission, debridement of the cheif focus and sinus tracts was done. A plaster cast was applied for six months and then changed to walker. One of two sinuses closed off ten days after operation and the other four months later.

Three years after operation, the disease had already healed with restoration of joint function. A radaioraph showed a sclerosed acetabular roof wth outward tilting of the supeior acetabular margin and wide joint space (Fig. 16).

In four infants, comprising three cases of hip joint and one case of shoulder joint tuberculosis, the disease healed with restoration of joint function, as shown in this case. This experience would suggest that arthrodesis should be refrained from when cure of the joint may be hoped for with mobility, especially, when the patient is an infant.

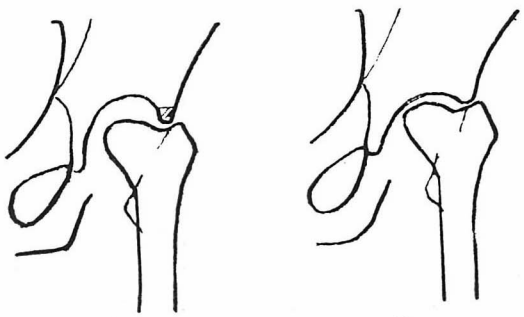
2) Approximation of Both Ends of the Affected Joint.

a) In hip joint tuberculosis with extensive destruction of the acetabular roof, occasionally the univolved superior acetabular margin rides on the neck of the femur, obstructing a close contact between the acetabulum and the head of the femur (Type IV). In such a case, resection of this superior acetabular margin assures a firm bony contact (Figs. 19-A and B).

Case 6. Child aged six.

Fig. 17 Case 6. The superior acetabular margin rides on the neck of the femur, resulting in a wide joint space.

Fig. 18 Case 6. A year after focal debridement and resection of the superior acetabular margin: bony ankylosis.



A B

Fig. 19 Case 6. Schematic illustration of resection of the superior acetabular margin.

Admitted with tuberculosis of the left hip joint of four years'standi ng. The patient had previously been treated with immobilization for two years without signs of healing. After removal of the cast, flexion deformity developed and gradually become marked with lapse of time. On admission, there was a thirty-degrees flexion deformity. A radiograph showed a marked destruction of the acetabular roof and the uninvolved superior acetabular margin riding on the nech of the femur, which resulted in a wide joint space(Fig. 17). Streptomycin was given for forty days. Focal debridement and resection of the superior acetabular margin were undertaken (Figs. 19-A and B). A plaster cast was worn for five months. Thereafter, the cast below the knee was removed. The patient was allowed to walk, and massage and excercise were given for the knee. A year after operation, a radiograph showed a sound ankylosis (Fig. 18).

b) Another mechanical condition preventing close contact of affected articular bone ends is a distensive dislocation caused by profuse effusion or granulation tissue produced in the affected joint (Type XII). In such cases, open reduction should be undertaken at the stage of arresting activity.

Case 7. Child aged five.

Admitted with tuberculosis of the left hip joint. The disease began three years ago. A year before admission, an adduction deformity and a sinus on the lateral side of the left thigh appeared. At admission, a radiograph showed dislocation with a slight destruction of the femoral head (Type XII, Fig. 20). Streptomycin and PAS were administered for two months. A month after ad-

Fig. 20 Case 7. Disensive dislocation with slight destruction of the femoral head.

Fig. 21 Case 7. Six months after focal debridement and reduction : bony ankylosis.

mission, focal debridement and reduction of dislocation were performed. Operative findigs were as follows:- The joint cavity was filled with ganulation tissue. The head of the femur was slightly destroyed and its sloughy articular cartilage was easily torn off from the underlying bone. However, the acetabular cartilage seemed to be intact. After curettage of granultion tissue in the joint, the acetabular cartilage was removed, and then the dislocated head was reduced in the original joint cavity. The sinus tract was cleansed. A plaster cast was applied for four months. Thereafter, the cast below the knee was removed. Six months after operation, a radiograph showed ankylosis (Fig. 21).

3) Loading on the Affected Joint.

Though, during the convalescent stage of joint tuberculosis, weight bearing on the affected joint is clearly one of the principal procedures of treatment, various surgical methods of unloading the affected joint have long been used, such as posterior spine fusion and other extraarticular arthrodesis.

In seven cases with various types of pathological dislocation of the hip joint, we have employed three different procedures based upon the principle of loading on the affected joint, such as subtrochanteric osteotomy (2 cases), step-cut of the upper end of the femur (4 cases), and shelf stabilization operation (1 case).

a) Subtrochanteric Osteotomy for Extraacetabular Pseudarthrosis of the Hip Joint (Type XI).

Severe tuberculosis of the hip joint occasinally results in extraacetabular pseudarthrosis with adduction deformity. This condition is analogous to nonunion of fracture of the neck of the femur, and it has been recognized that the mechanical factors at work in this fracture are of first importance in obtaining sound union. In more vertical type of subcapital fracture, in which the angle between the line of facture and the long axis of the femoral shaft (fracture-shaft angle) is less than 30 degrees, a sound union does not occur, owing to action of effective shearing force and lack of vertical pressure upon the surface of fracture. In this case, Smith-Petersen's nailing and subtrochanteric osteotomy followed by abduction of the lower fragment (increase of fracture-shaft angle) produce effective vertical pressure upon the surface of fracture, resulting in union. Likewise, in hip joint tuberculosis with extraacetabular pseudarthrosis and adduction deformity, subtrochanteric osteotomy producing abduction was undertaken with good result (Figs. 25-A and B). Detail of one of two cases is presented in Case 8.

Case 8. Boy aged fifteen.

Admitted with left hip joint tuberculosis with fixed adduction deformity and three sinuses in the left femoral region. A radiograph showed a extraacetabular

pseudarthrosis with a forty degrees angle between the line of pseudarthrosis and the long axis of the femoral shaft and an increased density of the adjacent bone (Fig.22). Subtrochanteric osteotsomy producing abduction was performed (Figs. 25-A and B). A plaster cast was applied for three months, and thereafter long leg brace was used. Immediately after removal of the cast, a radiograph already showed a union (Fig. 23). Sinuses, except for one, closed off after operation. The remaining one was curetted six months later, resulting in a closure.

Fig. 22 Case 8. Extraacetabular pseudarthrosis.

Fig. 23 Case 8. Three months after subtrochanteric osteotomy: bony ankylosis.

Fig. 24 Case 8. Two years after operation: complete healing.

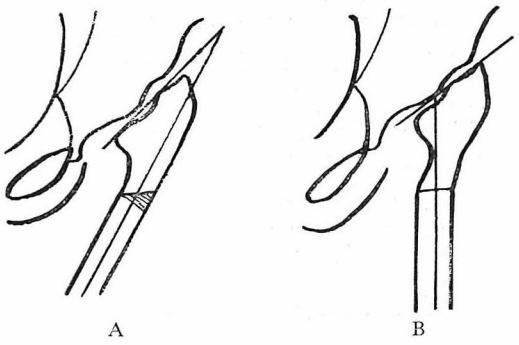


Fig. 25 Case 8. Schematic illustration of subtrochanteric steotomy.

Two years after operation, a radiograph showed a excellent result (Fig. 24).

Such outcome as above confirms the validity of the principle that loading on the affected joint, during the stage of arrested activity, is a method of choice in the treatment of joint tuberculosis. On basis of this principle, other two procedures, as described in following cases, were carried out.

b) Step-Cut of the Upper End of Femur for Extraacetabular Pseudarthrosis (Type XI) and Pathological Dislocation of the Hip Joint due to Loss of the Head of the Femur (Type X).

Case 9. Boy aged twelve.

Admitted with tuberculosis of the right hip joint associated with flexion defoemity. Three years before admission, a radiograph showed a marked destruction of the head and neck of the femur, without involvement of the acetabulum (Fig. 26). Radiograph at admission showed a typical extraacetabular pseudathrosis due to subsequent involvement of the superior acetabular margin (Fig. 27). In addition, ninety degrees flexion deformity of the joint was found. Chemotherapy was started immediately. Two months later, a step-cut operation was perfomed.

Fig. 26 Case 9. Primary focus in the neck of the femur.

Fig. 27 Case 9. Three years later: extra-acetabular pseudarthrosis due to loss of the head and neck of the femur and subsequent involvement of the superior acetabular margin.

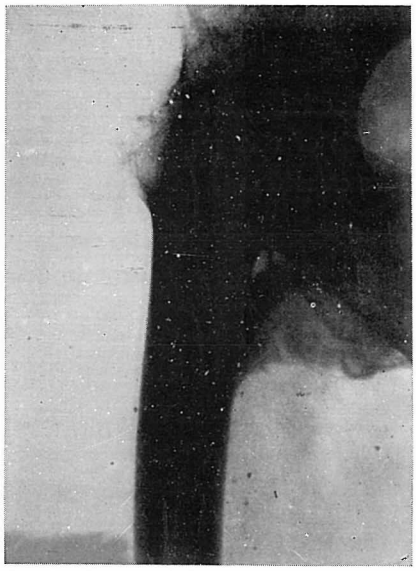


Fig. 28 Case 9. Three months after focal debridement and step-cut operation: sound ankylosis.

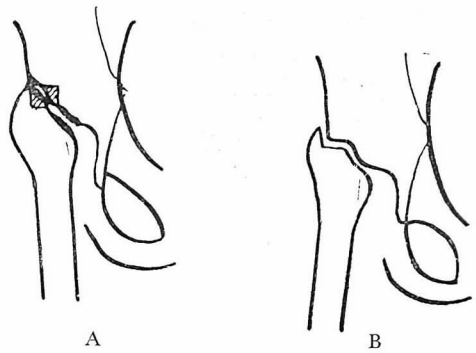


Fig. 29 Case 9. Schematic illustration of step-cut operation.

Details of the technique are as follows:- After debridement of the chief focus, the flexion deformity was corrected, and then the upper end of the femur was chiseled in step-cut fashion and impacted in the acetabulum so remodelled as to fit surely into it, as shown in Figs. 29-A and B. Plaster cast was applied for four months, whence it was changed to long leg brace. Three months after operation, a radiograph showed a sound union (Fig. 28).

Case 10. Boy aged sixteen.

Admitted with tuberculosis of the left hip joint with a sinus and pain on motion. The onset of the illness was eight years ago. A range of movement was 45 degrees in flexion and 40 degrees in adduction. A radiograph showed pathological dislocation due to loss of the head and neck of the femur (Fig. 30). Chemotherapy started on admission. Ten days later, debridement of the chief focus and the sinus tract and subtrochanteric osteotomy producing abduction were performed (Figs. 31, 33-A and B). A plaster cast was applied for three months. The sinus closed off three weeks postoperatively.

Fig. 30 Case 10- Pathological dislocation due to loss of head and neck of the femur. The acetabulum is well preserved.

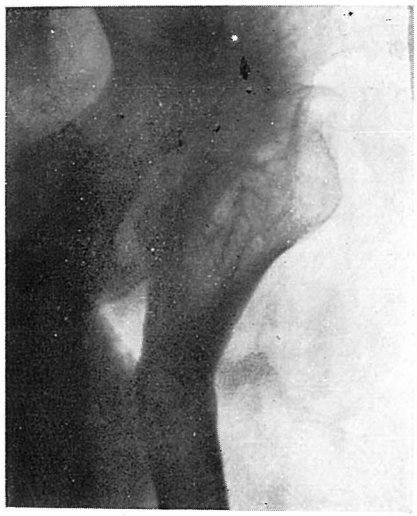
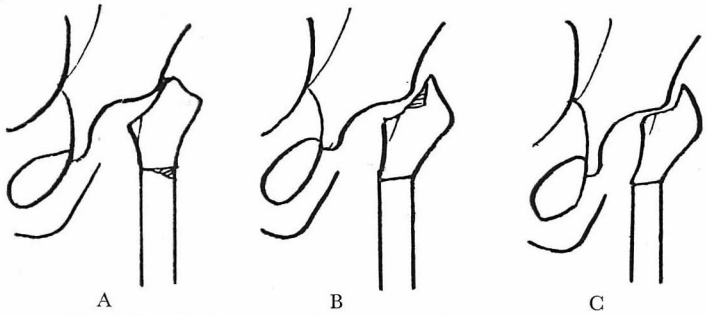


Fig. 31 Case 10. Focal debridement and subtrochanteric osteotomy.

Fig. 32 Case 10. Six months after step-cut operation: bony ankylosis.



A B C

Fi. 33 Case 10. Schematic illustrations of operative tehniques.

Six months later, however, the sinus reappeared with profuse purulent discharge. Eight months after the first operation the second operation consisting of focal debridement and step-cut of the upper end of the femur was done (Fig. 33-C). Six months after the second operation, a radiograph showed ankylosis (Fig. 32).

c) Shelf Stabilization Operation for Pathological Dislocation of the Hip Joint due to Destruction of the Superior Acetabular Margin (Type II).

Case 11. Woman aged twenty-one.

Admitted with tuberculosis of the left hip joint with pain on motion. Eight years before admission, the patient developed hip joint tuberculosis associated with a draining sinus. The sinus had closed off after persisting for three years. A radiograph at admission showed a pathological dislocation due to loss of the superior acetabular margin (Fig. 34). Streptomycin was administered for forty days. Two weeks after admission, focal debridement and shelf stabilization

operation were carried out (Figs. 35, 37-A and B). A year after operation, a radiograph showed a bony ankylosis (Fig. 36).

Fig. 34 Case 11. Pathological dislocation due to loss of the superior acetabular margin. The head of the femur is well presvered.

Fig. 35 Case 11. Focal debridement and shelf stabilization operation.

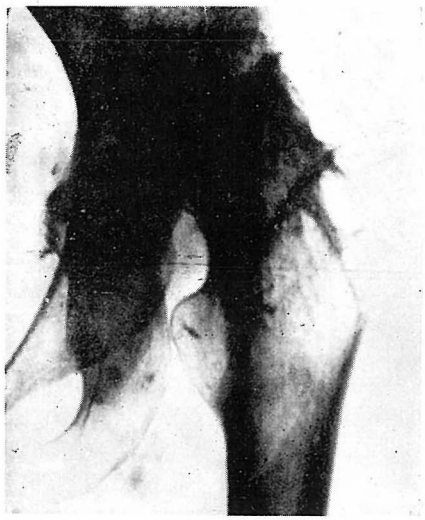


Fig. 36 Case 11. A year after operation: sound healing.

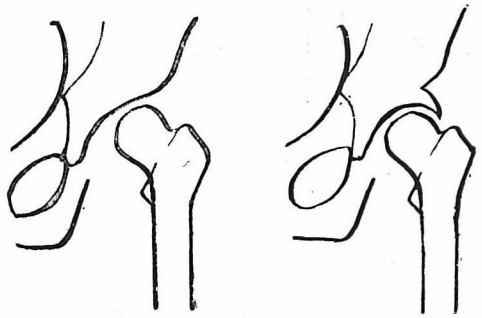


Fig. 37 Case 11. Schematic illustration of shelf stabilization opertion.

4) Activation of the Bony Elements about the Focus to Unite.

At the convalescent stage of joint tuberculosis, intraarticular bone grafting through the affected joint after focal debridement may expedite a more rapid

bony ankylosis, although loading on the affected joint promotes a new bone formation in focus. This procedure gave excellent results in ten cases, including three cases of hip joint and seven cases of shoulder joint tuberculosis. In hip joint tuberculosis, bone plate from the greater trochanter was inserted across the affected joint. In the shoulder joint, the upper arm was placed in abducted position and then the denuded acromion, after it was angled down by cutting of its base and the outer end of the clavicle, was impacted into the head of the humerus. The late results obtained were excellent in all cases. However, this prccedure should be refrained from when cure of the joint may be hoped for with mobility, especially when the patient is an infant.

Case 12. Girl aged twelve.

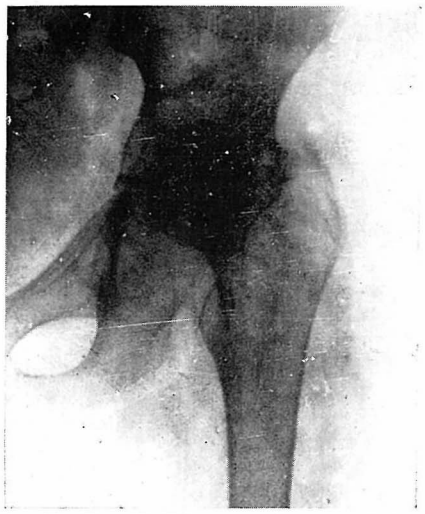


Fig. 38 Case 12. The superior acetabular margin rides on the neck of the femur, preventing a close contact between the acetablum and the femoral head.

Fig. 39 Case 12. Three years after focal debridement, resection of the superior acetabular margin, and intraarticular bone grafting: sound ankylosis.

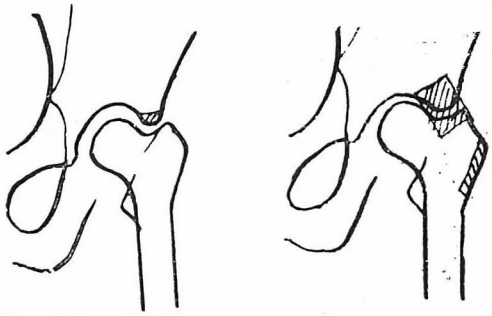


Fig. 40 Case 12. Schematic illustation of operative technique.

Admitted with tuberculosis of the right hip joint with a draining sinus. A radiograph showed rarefaction of the bone adjacent to the focus, widened joint space, and superior acetabular margin riding on the neck of the femur (Fig. 38). Streptomycin was given for forty days. The siuns closed off a month after ad-

mission. Focal debridement and intraarticular bone grafting were done. The operative technique was briefly as follows:- After focal debridement, the superior acetabular margin was resected and the bone plate taken from the greater trochanter was inserted through the joint (Figs. 40-A and B). A plaster cast was worn for five months, and then switched to long leg brace. Three years after operation, a radiograph showed a sound ankylosis (Fig. 39).

Discussion

As it has been proved, an open operation for bone and joint tuberculosis can be carried out without risk of dissemination of the disease. Moreover, it was confirmed that the five basic principles, described elsewhere, are applicable to all types of bone and joint tuberculosis when combined with chemotherapy. Especially, focal debridement is the most essential of the therapeutic procedures, and should be combined with other procedures based on the principles of the rational treatment. In joint tuberculosis of infants, simple debridement of the chief focus not so rarely results in a cure with restoraton of joint function. In advanced cases, however, only by ankylosis will the lesion be safely and soundly healed. In this series, extraarticular arthrodesis for hip joint, such as Trumble's and Brittain's operaion, was not undertaken, because focal debridement and other procedures, as discussed above, seemed to more essential. It is probable that ischio-femoral arthrodesis give a more satisfactory result, when combined with focal debridement.

As for spinal tuberculosis, many problems still require solution. We do not believe that all patients with spinal tuberculosis should be immediately subjected to radical surgery. In case with localized focus preventing bony contact of the affected vertebral bodies, focal debridement should be performed. However, in tuberculosis of the upper lumber and thoracic spine, it is dificult to take a direct view of the chief focus, consequently the operation may give an unsatisfactory result. A simple open drainage of abscess does not always seem to result in a cure, as it does not in chronic osteomyelitis. In spinal tuberculosis with paraplegia, laminectomy and costotransversectomy have no place in the treatment. *Bosworth* (1953) claimed that a solid spine fusion was essential to permanent recovery from paraplegia. We have had no experience with such operation. It should be emphasized that, in spinal tuberculosis, the well designed combination of chemotherapy and conservative and operative procedures is necessary in obtaining a good result of treatment.

Conclusion

1) In 190 cases of spine and 68 cases of hip joint tuberculosis which had been conservatively treated in our clinic, appearance of primary infection and its

extension, especially natural processes of healing of the disease and causes hindering it, were radiographically followed for a period of one to five years.

2) From these investigations, the five basic principles thought to be essential to treatment, focal debridement, approximation of both ends of the affected joint, compression of the affected joint at the convalescent stage—loading on the affected joint, activation of the bony elements about the focus to unite and immobilization of the involved joint, are obtained.

3) In one hundred cases of bone and joint tuberclosis, various therapeutic procedures based on the five principles were carried out with excellent results, except for three cases of tuberculosis of the lumbar spine and one case of tarsal bone tuberclosis.

4) Focal debridement is the most essential of the therapeutic procedures, and should be combined with other pocedures based on the principles of rational treatment.

References

Bosworth, D. M., Wright, H. A., and Fielding, J. W.: The treatment of bone and joint tuberculosis; Effect of 1-Isonicothinyl-2-Isopropylhydrazine. A Preliminary Report. *J. Bone and Joint Surg.*, **34**-A, 761. 1952.

Bosworth, D. M., and Wright, H. A.: Streptomycin in bone and joint tuberculosis. *J. Bone and Joint Surg.*, **34**-A, 255, 1952.

Bosworth, D. M., and Wright, H. A.: The use of iproniazid in the treatment of bone and joint tuberculosis. *J. Bone and Joint Surg.*, **35**-A, 577, 1953.

Charnly, J. C.: Positive pressure in arthrodesis of the knee joint. *J. Bone and Joint Surg.*, **30**-B, 478, 1948.

Dobson, J.: Prognosis in tuberculosis of the hip. *J. Bone and Joint Surg.* **33**-B, 149, 1951.

Dobson, J.: Tuberculosis of the spine. *J. Bone and Joint Sug.*, **33**-B, 517, 1951.

Dobson, J.: Ischio-femoral arthrodesis for tuberculous arthritis in children. *J. Bone and Joint Surg.*, **34**-B, 525, 1954.

DeRoy, M. S., and Fisher, H.: The treatment of tuberculous bone disease by surgical drainage combined with streptomycin. *J. Bone and Joint Surg.*, **34**-A, 299, 1952.

Evans, E. T.: Tuberculosis of bones and joints. With special reference to the influence of streptomycin and application of radical techniques to certain effects and complications of the tuberculous lesion. *J. Bone and Joint Surg.*, **34**-A, 267, 1952.

Fett, H. C., and Zorn, E. L.: Compression arthrodesis of the knee. *J. Bone and Joint Surg.*, **35**-A, 172, 1953.

Gruca, A.: The treatment of quiescent tuberculosis of the hip joint by excision and "dynamic osteotomy". *J. Bone and Joint Surg.*, **32**-B, 174, 1950.

Ghormley, R. K.: Chemotherapy in bone and joint tuberculosis. *J. Bone and Joit Surg.*, **34**-A, 254, 1952.

Girdlestone, G. R., and Somerville, E. W.: Tuberculosis of bone and joint. second edition. Oxford University Press, London, 1952.

Hirsh, C.: Surgical interventions on paravertebral tuberculous abscesses. *Acta Orthopaed. Scand.*, **21**, 1951.

Hallock, F. H.: Tuberculosis of the spine. An end-result study of the effects of the spine-fusion operation in a large number of patients. *J. Bone and Joint Surg.*, **36**-A, 219, 1954.

ISHIHARA, T: Prognosis of tuberculosis of the spine. *Rinsho-geka*, **2**, 4, 1950.

ISHIHARA, T: Immobilization, hyperextension of the spine, correction of its deformity and loading on the spinal tuberculosis. *Rinsho-geka*, **3**,138, 1950.

JOHNSON, R. W., HILLMAN, T. W., and SOUTHWICK, W. C.: The Importance of direct surgical attack upon lesion of the vertebral bodies, particulary in Pott's disease. *J. Bone and Joint Surg.*, **35**-A, 17, 1953.

KONDO, E., and YAMADA, K.: Operative treatment of bone-joint Tuberclosis. Acta Tbc. Jap. **1**,75, 1951.

KATAYAMA, R. (1954): *Textbook of orthopaedics.* First edition. Tyugai-igakusha, Tokyo, Japan, 1954.

KIRKALDY-WILLIS, W. H.: Ischio-femoral athrodesis of the hip in tuberculosis. *J. Bone and Joint Surg.*, **32**-B, 187. 1950.

MERCER, W.: The management of the tuberculous hip joint. *J. Bone and Joint Surg.*, **36**-A, 1123, 1954.

ORELL, S., FELLAEDER, M., and LINDAHL, O.: Treatment of bone and joint tuberculosis by streptomycin with operation. *J. Bone and Joint Surg.*, **33**-B, 473, 1951.

OSTMAN, P.: Combined surgical and chemo-therapy of abscesses in bone and joint tuberculosis: Early results. *Acta Orthopaed. Scand.*, **21**, 204, 1951.

STRATFORD, B.: The Trumble graft; a review of thirty-six cases. *J. Bone and Joint Surg.*, **35**-B, 247, 1953.

SETVENSON, F. H.: Treatment of skeletal tuberculosis with streptomycin. *J. Bone and Joint Surg.*, **34**-B, 518, 1952.

STEVENSON, F. H.: The chemotherapy of tuberculosis of bones and joints. *J. Bone and Joint Surg.*, **36**-B, 5, 1954.

STEVENSON, F. H.: The natural history of pleural effusion and orthopaedic tuberculosis. *J. Bone and Joint Surg.*, **37**-B, 80, 1955.

WILKINSON, M. C.: Treatment of Pott's disease by curettage of spinal lesion. *J. Bone and Joint Surg.*, **34**-B,153, 1952.

WILKINSON, M. C.: Synovectomy and curettage in the treatment of tuberculosis of Joints. *J. Bone and Joint Surg.*, **35**-B, 209, 1953.

WILKINSON, M. C.: Chemotherapy of tuberculosis of bones and joints. *J. Bone and Joint Surg.*, **36**-B,23, 1954.