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OSTEOPLASTIC ANTERIOR FUSION OF THE LOWER LUMBAR SPINE IN SPONDYLOLISTHESIS, LOCALIZED SPONDYLOSIS, AND TUBERCULOUS SPONDYLITIS

By

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Fixation operations on the spine have been chiefly undertaken posteriorly according to the methods of Albee and Hibb, or to modifications of these methods. The posterior approach to the spine is decidedly easier than an anterior approach, as the latter is made difficult and to a certain extent prohibited by the abdominal and thoracic organs and particularly by the large vessels which cover the spine anteriorly.

For spondylolisthesis *Capener* was the first to propose to operate transabdominally by driving a peg through the fifth lumbar vertebra into the first sacral vertebra. The operation according to this method was performed first by *Burns* (1933) and later by *Jenkins* (1936). They both used a bone peg from the tibia or fibula, although *Burns* later proposed the use of a metal peg in order to avoid possible resorption of the bone graft.

In the Edinburgh Med. Journ. (1936) and later in the Journal of American Surgery (Feb. 1939) *W. Mercer* gave a report of his "mosaic-plastic" technique in 3 cases of spondylolisthesis, using the transperitoneal approach. Two bone grafts were taken from the crest of the ilium and placed side by side with their long axes pointing sagittally and horizontally in a rectangular groove, previously chiselled out in the corresponding parts of the fifth lumbar and first sacral vertebrae. To avoid secondary dislocation, a metal screw was fixed in the grafts and in the body of the fifth sacral vertebra.

In Sweden, *Sten Friberg* in 1937 gave a report of 4 cases operated on according to Mercer's method. He did not, however, succeed in establishing a bony union between the two vertebrae, and in 1939 he concluded that the anterior route should be abandoned.

As early as 1906 *W. Müller* reported 2 cases of tuberculous spondylytis of the fifth lumbar vertebra, operated on from the anterior ap-

proach by excochleating the focus. However, a fusion of the two vertebrae by osseous grafting was not attempted.

Even though the anatomic conditions and the more simple technique invites a fusion posteriorly, there still exist several objections to present methods of posterior approach in fixation operations of the spine. Without further entering into the wide disagreement which exists concerning this topic, I only wish to stress the following facts:

A fusion posteriorly usually involves four or five vertebrae, thus necessitating large grafts, often with exposure of both tibiae to provide sufficient material. Moreover, fractures, deficient ossification, or resorption of the grafts have been reported in quite a few cases. Further, immobilization of the greater part of the lumbar spine, particularly in younger subjects, represents a major objection to this procedure. Also, secondary arthrosis in the small joints of the sound adjacent vertebrae is not an infrequent occurrence. Finally, in some cases it may be difficult to obtain a solid fusion between the fifth lumbar vertebra and the sacrum, the small spinous processes giving insufficient support to the graft.

On the other hand, it should be emphasized that the pathologic conditions in which fusion of the spine is indicated are situated in the vertebral *body*. A posterior fusion, therefore, represents an indirect fixation. Accordingly the immobilization will be less perfect, and therefore will have to involve several vertebrae, even if the pathologic process is confined to one or two vertebrae only.

In operations for tuberculous spondylitis, many surgeons no doubt use the technique of *Galland*, fusing only two spinous processes. When in those cases a progression of the disease has appeared, imperfect immobilization has been claimed as a causal factor.

To an even greater extent this factor will prevail in spondylolisthesis and spondylolysis where the spinous processes and the posterior portion of the vertebral arch are separated from the body by the fissure in the lateral arch, i.e., that portion of the vertebra which is apt to be dislocated. Thus, from a theoretical point of view, anterior fusion of the spine should be preferred in these cases. In fact, it is in these cases in particular that anterior fusion has been attempted.

However, transabdominal fusion of the spine has been carried out in only a few cases (12 cases, with 3 deaths up to 1938).

AUTHOR'S TECHNIQUE

My first 2 cases were operated on transperitoneally according to the technique described by *Mercer*. The two grafts were fixed by only

suturing the adjacent soft tissues. During the first two postoperative days both patients suffered considerably from abdominal distension but aside from this made an uneventful recovery. In spite of a fairly satisfactory approximation of the two grafts in the groove, roentgenographic examination, twelve weeks later, showed that the grafts

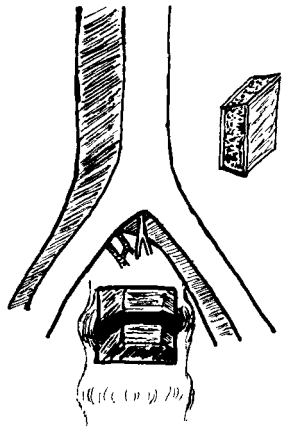

Fig. I.
The groove chiselled out in the two vertebrae. Inset, the anteriorly slightly wedge-shaped graft.

were displaced somewhat anteriorly, although without any apparent detrimental effect on the osseous healing of the two vertebrae or on the final result. One of these—a housemaid suffering from spondylolysis—after having been free of symptoms for a year, again complained of low back pain. With a plaster jacket she is still able to continue her house work.

Almost all writers have reported some difficulty in avoiding secondary dislocation of the grafts when employing *Mercer*'s technique. In one of *Mercer*'s own cases, later operated on for appendicitis, the peg was seen to be protruding from the posterior abdominal wall. In one of the cases reported by *Friberg* the graft was split by the os purum peg.

In order to avoid this secondary dislocation of the graft which when more pronounced, may jeopardize the result of the operation, I have used only *one* large graft. This is placed with its long axis vertically and in the frontal plane in the groove chiselled out in the two vertebrae and the adjacent portion of the intervertebral disc. The graft is taken from the iliac crest and trimmed slightly wedge-shaped. The anterior and posterior surfaces are covered by cortical bone while

all sides are formed of cancellous bone (spongiosa). The groove in the two vertebrae is made similarly wedge-shaped and somewhat higher at the bottom than in the front (fig. I). With the spine hyperextended, the graft may be easily pressed into the right position. After relaxing the spine, the graft is automatically held in place. For additional

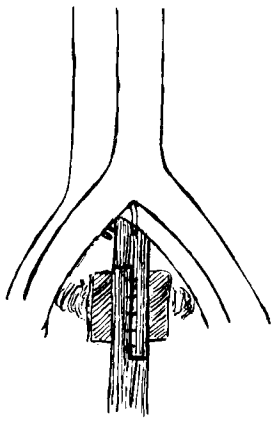

Fig. II.
The Z-like incision in the anterior longitudinal ligament sutured over the graft.

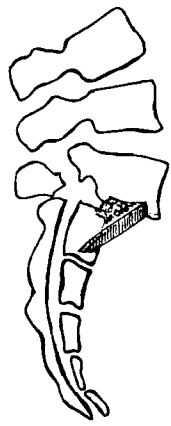

Fig. III.
The procedure in more severe types of spondylolisthesis.

security, a Z-like incision is made in the anterior longitudinal ligament of the spine, before chiselling out the groove. It is of minor importance whether or not some osseous substance is removed at this point, as this will only facilitate callus formation (fig. II). Furthermore, I prefer the extraperitoneal approach through a left paramedian excision extending from the symphysis to just above the umbilicus. When the rectus muscle is elevated a little, a peculiarly yellow-colored fat appears, indicating where the mobilization of the peritoneum should begin. This incision usually gives sufficient exposure. With the use of this method the postoperative shock and abdominal distension are considerably less than with the use of the transperitoneal route. Moreover, it avoids the suturing of the posterior peritoneum.

It is of equal importance that the procedure which employs the extraperitoneal route should be applied in fusion operations for tuberculous spondylitis, particularly in view of the fact that cold abscesses are encountered in the vast majority of these cases. The risk of spreading the tuberculous infection intraperitoneally during the operation seems far less with the use of this method than with the use of the transperitoneal route.

The following data, which concerns my second case, a patient with tuberculous spondylitis, having a large cold abscess in the left iliac fossa, shows that sufficient exposure is achieved with this incision. In an effort to prevent fistula formation through the operative wound in this case, I used a *right* paramedian incision, mobilising the peri-

Fig. IV.
Spondylolisthesis L IV-V. 3 months p.o.

toneum from the right. I had sufficient room to excochleate the tuberculous focus which was located in the *left* portion of the body of the fifth lumbar vertebra, and to perform the fusion between this vertebra and the first sacral.

I also recommend the extraperitoneal approach in spondylolisthesis when a fusion of the fourth and fifth lumbar vertebrae is required. In one such instance (fig. IV) I succeeded in establishing a fusion of the fourth and fifth lumbar vertebrae.

This procedure may also be used in the more severe types of spondylolisthesis. In such cases, however, the graft must be placed with its long axis more steeply inclined (horizontally) and fastened down on the anterior portion of the first sacral vertebra. Further, a comparatively large cavity must be chiselled out in the inferior portion of the fifth lumbar vertebra. The space behind the grafts is filled with bone chips from the crest of the ilium. A wide and solid union is thus accomplished between the two vertebrae (fig. III).

In the 2 cases of tuberculous spondylitis operated on, the tuberculous cavity was also filled with bone chips. In one of these cases the entire intervertebral disc was removed, and cancellous bone slices were placed between the bodies of the two vertebrae.

The graft should be taken from the iliac crest, subperiosteally in

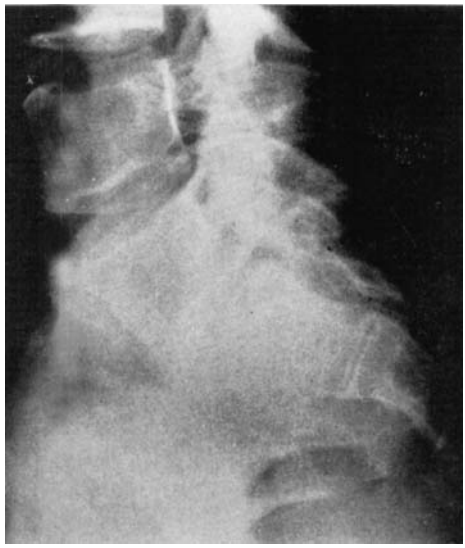

Fig. V.
Asymmetric transitional lumbosacral vertebra 3 months p. o.

one large piece. A piece measuring about 4 by 3 cm is shaped from the graft so as to fit into the groove. When the periost is left behind, a solid bone plate will be formed at the donor site. Herniation or other complications from this location have not been observed.

Before chiseling out the groove in the vertebrae the sacral vessels should be ligated. In handling these, fibres from the superior hypogastric plexus should be avoided, particularly in young men, as they are of some importance to ejaculation.

AUTHOR'S SERIES

I have used the anterior approach in fusion of the spine in 9 cases (8 women, 1 man). The indications were as follows:

Spondylolisthesis	1
Spondylolysis	1
Transitional fifth lumbar vertebra	1
Localized spondylosis	4
Tuberculous spondylitis	2

In answer to questions concerning the indications for surgery in spondylolisthesis and spondylosis, I believe that only those patients who have had longstanding pain and discomfort with at least partial disability for work, should undergo this type of operation. The same applies to patients who have obtained no relief after six to ten weeks of strict rest in bed, or after the use of a plaster jacket for three to four months.

In considering the indications for surgery in the two cases of tuberculous spondylitis, some further information about the reasoning and the technique applied seems necessary.

In the development of a tuberculous spondylitis four phases can be distinguished. The first phase is characterised by the hematogenous dissemination of tubercle bacilli from some tuberculous focus in the body, but there are so far no symptoms referable to the spine. The second phase is characterised by destructive changes followed by a contingent abscess and gibbus formation. The third phase is characterised by reparative changes while the fourth phase includes the development of compensatory lordoses. While the second or destructive phase, having an average duration of six months to two years, is an outstanding feature in tuberculous spondylitis, reparative changes are less marked. Bony and periosteal reactions as in pyogenic osteomyelitis are a rare occurrence in tuberculosis of bone. In the latter condition healing takes place chiefly by the production of a fibrous connective tissue with encapsulation of the caseous area including living tubercle bacilli. A real osseous healing of a tuberculous spondylitis is therefore exceedingly rare.

The anterior fusion of the spine in tuberculous spondylitis aims at a removal of the destroyed tissue and at the same time at the establishment of an osseous ankylosis between the bodies of the two vertebrae. This is done by depositing fresh cancellous bone in order to stimulate callus formation, and thus shortening the destructive and reparative phases of the disease.

If streptomycin is administered before and after the operation, one may presume that the risk of hematogenous spread as a result of the operation will be greatly reduced. Moreover, the patient's general condition and resistance to the tuberculous infection, which are very often poor in this phase of the disease, are simultaneously raised.

Fig. VI.
Localized spondylosis L IV-SI, 3 months p. o.

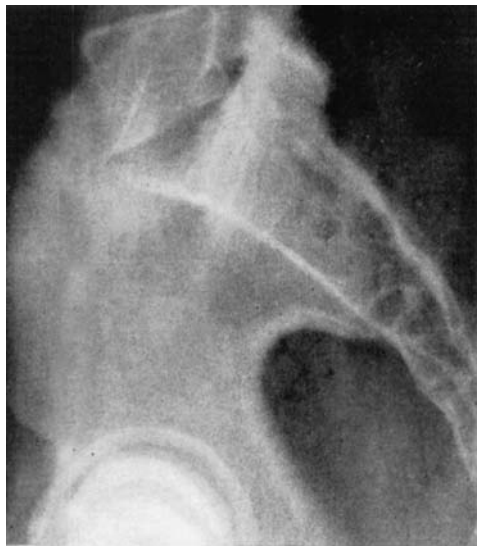

Fig. VII a.
Tuberculous spondylitis before operation.

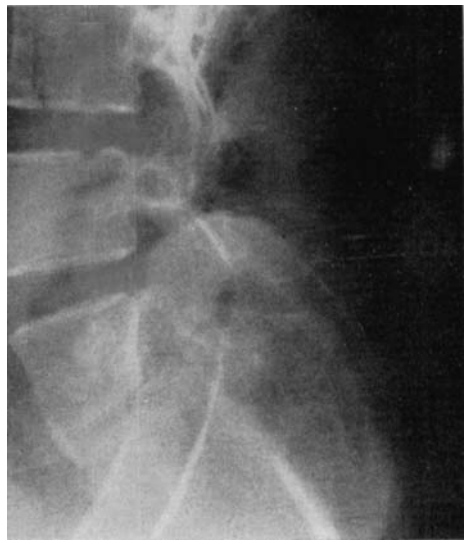

Fig. VII b.
Tuberculous spondylitis 6 months p.o.

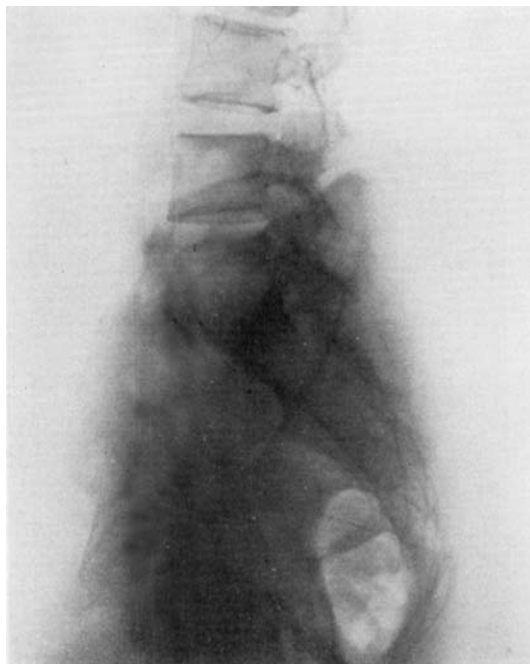

Fig. VII c.
Tuberculous spondylitis LV-SI, 22 months p. o.
Osseous union.

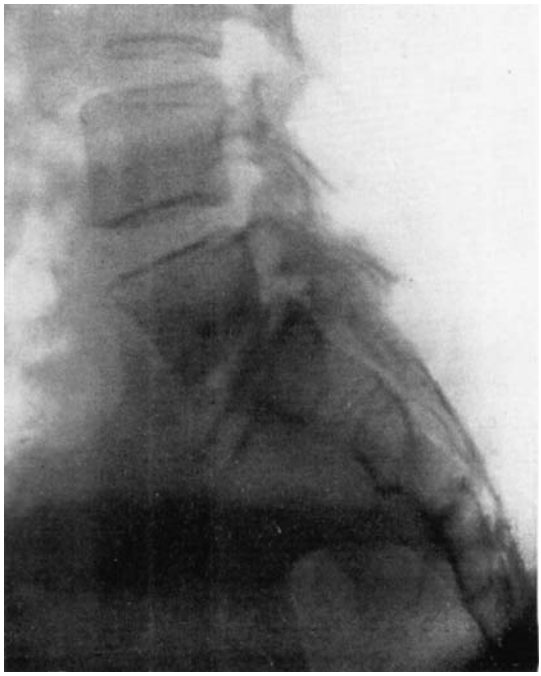

Fig. VIII a.
Tuberculous spondylitis LV-SI. Large cold abscess on the left side.

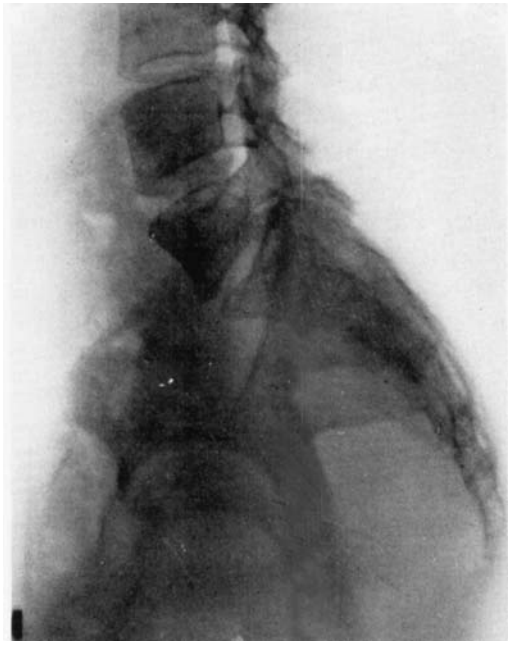

Fig. VIII b.
Tuberculous spondylitis LV-SI. 18 months p. o. No sign of cold abscess. Callus formation.

However, even with the use of the anterior approach, the operative procedure in tuberculous spondylitis is difficult, not only because of the close proximity of the large vessels, but also because of the presence of cold abscesses which are seldom missing in tuberculous spondylitis. The latter circumstance frequently complicates the operation and impedes primary union of the operative wound which is a prime requisite for a good result. Therefore, according to this line of reasoning, the *anterior* osteoplastic fusion of the spine should be accomplished *as early as possible* after a reliable roentgenographic diagnosis has been made, and *before* the destruction of the vertebral body has become too far advanced (kyphosis, cold abscess, or fistula formation, etc.).

Good primary results were obtained in all cases. All patients, except the two suffering from tuberculosis of the spine, have been able to take up their usual work within six months after the operation. They are now completely relieved of their back pains, and the mobility of the spine is good in all planes.

In one of the patients who suffered from tuberculous spondylitis, complete relief has continued for one and a half years after the operation, and the patient, a woman, has now been doing her routine housework for half a year. The second patient with tuberculous spondylitis, after an initial uneventful recovery, developed symptoms of a tuberculous pyosalpinx, three months after the operation. It is perhaps reasonable to assume that this bears a direct relation to the operative procedure. It is noteworthy, however, that also in this case healing of the wound by first intention was obtained, although a large cold abscess existed at the time of operation. At the time of the second operation (salpingectomy) there was no evidence of the cold abscess. On re-examination on Sept. 28, 1949, one year after the operation, the patient, a woman, stated that she felt entirely well. The sedimentation rate was 11 mm per one hour, and the patient's general condition was very good. Roentgenographic examination showed some callus formation, no further osseous destruction, and no evidence of congestive abscess. The patient was discharged wearing a plaster jacket. Plaster jacket was removed in March, 50. She is now doing her routine work as a hairdresser.

My present view on the anterior osteoplastic fusion of the spine can be summarized as follows:

The anterior fusion of the spine is, from a theoretical point of view, to be preferred to the posterior fusion according to Albee and others. The anterior fusion is no doubt a more difficult procedure.

However, it may be used for fusion not only of the fifth lumbar and the first sacral vertebrae, but also of the fourth and fifth lumbar vertebrae.

The extraperitoneal approach provides certain advantages and is as rule not more difficult than the transperitoneal route. Grafts taken from the crest of the ilium seem highly satisfactory osteoplastic material in these operations.

Anterior fusion of the spine seem suitable for spondylolisthesis and asymmetric transitional lumbosacral vertebra as well as for localized spondylosis (spondylopathia intervertebralis).

As to the value of anterior fusion in tuberculous spondylitis, it is too early to state an opinion, though the results encourage further trials for early cases of spondylitis in this region.

The operation, it may be added, should be combined with streptomycin treatment.

SUMMARY

Results are reported which were obtained by osteoplastic anterior fusion of the lower lumbar spine in 9 cases. In 2 cases the operation was performed transperitoneally according to *Mercer*'s method, while in the remaining cases it was performed extraperitoneally through a paramedian incision. Use was made of only one large bone graft which was trimmed wedge-shaped, to fit into the corresponding groove chiselled out in the two vertebrae. A Z-like incision was made in the anterior longitudinal ligament of the spine before chiselling out the groove for additional support of the graft by means of the ligament. In the author's opinion, the extraperitoneal approach involves less danger, as better exposure of the large vessels is achieved with the use of this method.

Bony and periosteal reactions as in pyogenic osteomyelitis are a rare occurrence in tuberculous spondylitis. On the basis of this fact the author has successfully removed the tuberculous focus in the bone in 2 cases and filled the cavity with cancellous bone chips from the iliac crest, in conjunction with osteoplastic fusion of the two vertebrae, according to the method described. Primary healing occurred in both cases despite the presence of a cold abscess at the time of operation. The aim of the operation is to shorten the destructive and reparative phases of the disease and to effect a bony fusion of the vertebrae, *before* essential deformation of the spine has time to develop. An essential point is, therefore, that the operation be performed as early as possible, i.e., before the destruction of the vertebral body has become too far advanced.

Relief was maintained in all cases in the author's series after an observation period of one and a half to two years.

RESUME

Il est rendu compte de 9 cas de fixation ostéoplastique de la colonne lombaire inférieure — deux pratiquée par voie transpéritonéale d'après la méthode de Mercer, les autres opérés par voie extrapéritonéale par coupe paramédiane. Il n'a été utilisé qu'une seule mais grande transplantation légèrement cunéiforme fixée par le lig. long. ant. coupé en forme de Z pour empêcher un déplacement secondaire. D'après l'auteur, l'opération extrapéritonéale est moins dangereuse, car on voit bien les vaisseaux et la réaction post-opératoire est plus faible.

En prenant comme point de départ le fait que dans les cas de tuberculose osseuse le pouvoir de réaction périostale et de reformation osseuse est diminué — contrairement à ce qui est le cas dans les ostéomyélites pyogènes ordinaires — l'auteur a dans deux cas extirpé avec succès le foyer tuberculeux, en remplissant le trou par des copeaux spongieux d'apophyse, en même temps qu'il fixait les deux vertèbres atteintes par voie ostéoplastique d'après la méthode mentionnée ci-dessus. Guérison primaire dans les deux cas, bien que l'opération ait découvert des abcès par congestion. L'opération a pour but de raccourcir la période de destruction et celle de la guérison pour arriver à la formation d'un bloc de vertébres avant que se soit produite une déformation marquée de la colonne vertébrale. C'est pourquoi cette opération doit être pratiquée à un stade aussi récent que possible de la maladie.

Aucun symptôme n'a été relevé chez les malades après 2 ans et 1 an et demi d'observation respectivement.

ZUSAMMENFASSUNG

Es werden 9 Fälle von osteoplastischer Fixation der unteren Lendenwirbelseule besprochen, die von vorne her ausgeführt wurden 2 wurden transperitoneal ausgeführt nach der Methode von Mercer. Die übrigen wurden extraperitoneal von einem paramedianen Schnitt aus operiert. Man benützt nur ein, jedoch grösseres Transplantat, das eine leicht keilförmige Form hat und das man mittels des Z-förmig durchschnittenen lig. long. ant. fixiert, um eine sekundäre Verschiebung zu vermeiden. Nach der Meinung des Verfassers ist der extraperi-

toneale Weg weniger gefährlich, da man eine gute Übersicht über die Gefässe hat und die postoperative Reaktion geringer ist.

Mit Rücksicht auf die mangelhafte Fähigkeit der tuberkulösen Knochenprozesse mit periostaler Knochenneubildung zu reagieren — im Gegensatz zur pyogenen Osteomyelitis — hat der Verfasser in zwei Fällen mit gutem Erfolg den tuberkulösen Herd enfernt und die zurückbleibende Höhle mit Spongiosagewebe von der crista ilei ausgefüllt, zusammen mit der osteoplasischen Fixation der erkrankten Wirbel mittels der angegebenen Methode. Primäre Heilung in beiden Fällen, obwohl Senkungsabszesse bei der Operation vorhanden waren. Die Operation hat das Ziel des Destruktions und Abheilungsstadium zu verkürzen und eine Blockwirbelbildung zu erreichen ehe eine wesentliche Deformierung der Wirbelsäule eingetreten ist. Sie soll daher so frühzeitig als möglich ausgeführt werden.

Sämtliche Patienten waren symptomfrei nach einer Beobachtungszeit von 1½—2 Jahren.

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