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# Simultaneous anterior decompression and posterior instrumentation of the tuberculous spine using an anterolateral extrapleural approach

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**Injury to the spinal cord and kyphosis are the two most feared complications of tuberculosis of the spine. Since tuberculosis affects principally the vertebral bodies, anterior decompression is usually recommended. Concomitant posterior instrumentation is indicated to neutralise gross instability from panvertebral disease, to protect the anterior bone graft, to prevent graft-related complications after anterior decompression in long-segment disease and to correct a kyphosis. Two-stage surgery is usually performed in these cases. We present 38 consecutive patients with tuberculosis of the spine for whom anterior decompression, posterior instrumentation, with or without correction of the kyphus, and anterior and posterior fusion was performed in a single stage through an anterolateral extrapleural approach. Their mean age was 20.4 years (2.0 to 57.0).**

**The indications for surgery were panvertebral disease, neurological deficit and severe kyphosis. The patients were operated on in the left lateral position using a 'T'-shaped incision sited at the apex of kyphosis or lesion. Three ribs were removed in 34 patients and two in four and anterior decompression of the spinal cord was carried out. The posterior vertebral column was shortened to correct the kyphus, if necessary, and was stabilised by a Hartshill rectangle and sublaminar wires. Anterior and posterior bone grafting was performed.**

**The mean number of vertebral bodies affected was 3.24 (2.0 to 9.0). The mean pre-operative kyphosis in patients operated on for correction of the kyphus was 49.08° (30° to 72°) and there was a mean correction of 25° (6° to 42°). All except one patient with a neural deficit recovered complete motor and sensory function. The mean intra-operative blood loss was 1175 ml (800 to 2600), and the mean duration of surgery 3.5 hours (2.7 to 5.0). Wound healing was uneventful in 33 of 38 patients. The mean follow-up was 33 months (11 to 74). None of the patients required intensive care.**

**The extrapleural anterolateral approach provides simultaneous exposure of the anterior and posterior aspects of the spine, thereby allowing decompression of the spinal cord, posterior stabilisation and anterior and posterior bone grafting. This approach has much less morbidity than the two-stage approaches which have been previously described.**

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Injury to the spinal cord and kyphosis are the two most feared complications of tuberculosis of the spine. Damage to the cord may occur in active as well as in healed disease.[1] Pressure on the spinal cord may occur as a result of tubercular abscess, granulation tissue, tubercular debris, caseous tissue, or stretching of the cord over an internal gibbus, and requires surgical decompression. Panvertebral disease may cause pathological subluxation or dislocation of the spine and the resultant instability can damage the cord. Anterior decompression and instrumented stabilisation may be required.

Late-onset paraplegia may be seen when the tuberculous spine heals with a kyphosis of 60° or more, and in children if the kyphosis progresses with growth.[2,3] In the first instance the kyphosis needs to be corrected as early as possible in the active stage of the disease. In a child correction should be undertaken if they have 'spine-at-risk' signs suggestive of progressive kyphosis.[4] These are subluxation or dislocation of the facet joint at the apex of the kyphosis, the presence of retropulsion, the translation of a vertebra in the coronal plane and the posterior toppling sign. In the last, if a line drawn along the anterior border of the distal healthy vertebra in an upward direction meets the upper half of the proximal healthy vertebra, the spine is considered to be unstable. If two of the four signs are present, the kyphosis is considered to be progressive.[3]

Instrumented stabilisation is indicated when a patient presents with a panvertebral lesion or

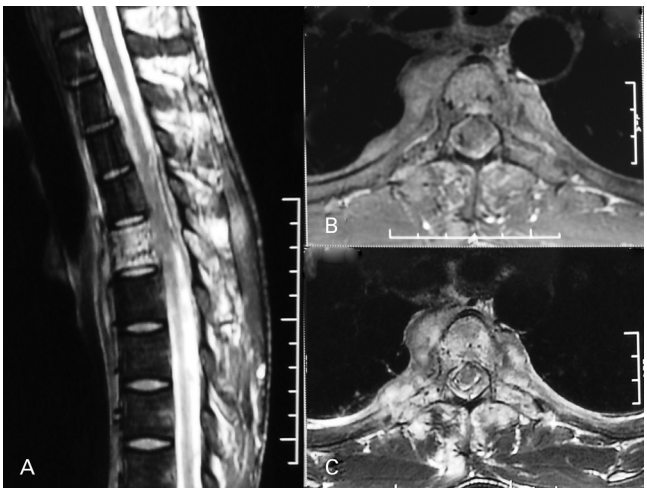


Fig. 1

Mid sagittal T2-weighted MR scan showing a) a hyperintense T6 vertebra with prevertebral and intraspinal collection compressing the cord and b) axial T1-weighted and c) T2-weighted scans showing panvertebral involvement with cord compression.

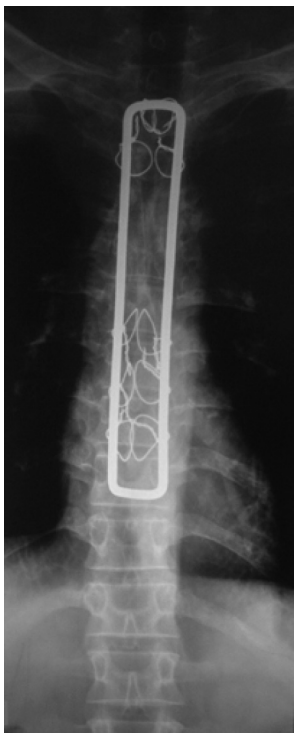

Fig. 2a

Fig. 2b

Anteroposterior (a) and lateral (b) radiographs 16 months after anterior decompression and posterior stabilisation with a Hartshill rectangle using an extrapleural anterolateral approach showing bony fusion at the site of disease and a well-maintained dorsal kyphosis.

if a posterior-column shortening has been performed as well as anterior column resection, to correct the kyphosis.[5,6] In long-segment disease with a neural deficit, anterior decompression is required over several levels and a long graft is needed to bridge the defect. This leaves a grossly unstable spine which needs formal stabilisation.

Tuberculosis of the spine involves the vertebral body in 98% of cases and is usually treated by anterior decompression, fusion and posterior stabilisation.[6-9] In order to achieve this the vertebral body needs to be approached from both front and the back. This can be undertaken in one or two stages. If posterior stabilisation is undertaken without previous anterior decompression the kyphosis cannot be corrected. If anterior decompression and fusion are performed first without instrumentation, the spine is rendered grossly unstable increasing the risk of further neurological injury until second-stage instrumentation is undertaken.[10] To carry out both approaches in one procedure can also cause significant morbidity.[11] The ideal procedure would allow an anterior decompression and fusion, posterior instrumentation with or without posterior-column shortening and fusion to be carried out in one stage through a single approach.

We present a series of 38 cases of tuberculosis of the spine treated by single-stage anterior decompression and fusion, posterior instrumentation with or without posterior-column shortening and posterior fusion for specific indications in a single stage using an extrapleural anterolateral approach.

## Patients and Methods

Between 1998 and 2006 we treated 38 consecutive patients with tuberculosis of the spine from T1-L2. Each underwent a single-stage anterior decompression, posterior Hartshill instrumentation and circumferential autogenous bone grafting through an extrapleural anterolateral approach.

There were nine males and 29 females, with a mean age of 20.4 years (2 to 57). Of these, 27 had a neural deficit and 11 had none. Eight had panvertebral disease (Figs 1 and 2) of whom two had a pathological subluxation and 13 had long-segment disease involving four or more segments while the rest had three-segment disease.

The first indication for surgery was panvertebral disease. There were eight patients in this group of whom two had a neural defect and six did not. The second was neurological deficit with loss of more than one and a half vertebrae or involvement of more than three. There were 27 patients in this group of whom 20 required correction of their kyphosis. In the third group were children with active or partially-treated disease and two or more radiological signs of progressive kyphosis who had undergone surgery for correction of the kyphus.

The indications for correction of the kyphus were as follows: an adult with loss of more than one and a half vertebral bodies, loss with an anticipated final kyphosis angle of 60° or more[4] and in a child more than two radiological signs of progressive kyphosis. In all, 23 patients underwent simultaneous correction of the kyphus.

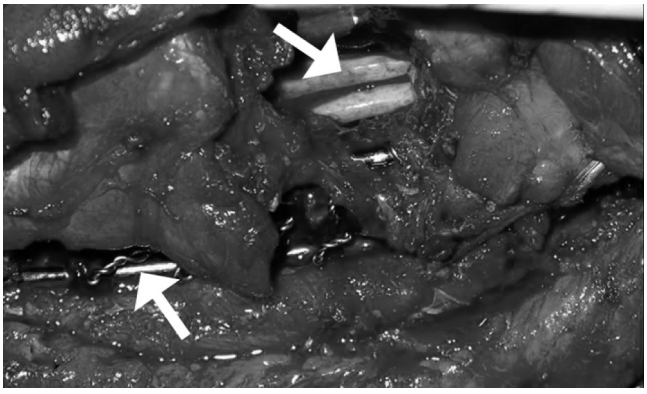

Fig. 3a

Fig. 3b

a) Peri-operative photograph showing the anterior rib graft (upper arrow), and posterior Hartshill rectangle (lower arrow), and b) photograph at follow-up showing a well-healed posterior T-shaped incision.

The neural deficit was staged using Tuli's method as modified by Jain and Sinha[12] as follows:

Stage 1. The patient is not aware of neural deficit but the clinician detects signs of deficit.

Stage 2. The patient has spasticity with a motor deficit but is able to lift the upper limbs against gravity or is a walker. The anticipated motor score in tetraparesis is between 60 and 100 and in paraparesis between 80 and 100. There is sensory impairment of the lateral column at all the root levels below the involvement of the cord.

Stage 3. A bedridden spastic patient. The anticipated motor score for paraplegia is between 50 and 80 and for quadriplegia between 0 and 30.

Stage 4. A bedridden patient with severe sensory loss. The anticipated motor score in paraplegia is 50 and in quadriplegia 0. There is impairment of both lateral and posterior columns.

Stage 5. As in stage 4 with bladder and bowel involvement and/or flexor spasm/flaccid paraplegia/quadriplegia.

The upper thoracic spine (T1-6) was involved in 11 cases, the lower (T7-12) in 22 cases and the thoracolumbar junction (T10-L2) in five. There was no single vertebral lesion but two, three, four or more than four vertebral bodies were affected in 15, ten, nine and four patients, respectively. The mean number of vertebrae involved as judged by CT, was 3.24 (2 to 9). In only two patients were more than six vertebral bodies involved. The mean initial vertebral body loss was 1.2 (0.4 to 3.1). Active pulmonary tuberculosis was identified in eight patients, six of whom had a neural defect and two did not.

Of the 38 patients, 23 had a haemoglobin level of 9 g/dl or less. None tested positive for HIV.

**Operative approach**. The technique has been described previously.[13] A parenteral third-generation cephalosporin (Ceftriaxone; 1 gm BD) was given six hours before surgery and was continued for three days after surgery. The patient was placed in a right lateral decubitus position. A T-shaped posterior incision 14 cm to 15 cm long was made with the central incision over the spinous process at the apex of the kyphosis, and the transverse incision about 8 cm from the midline and perpendicular to it at the apex of kyphosis on the left side. The subcutaneous tissues and deep fascia were incised in the line of incision, creating a full-thickness fasciocutaneous flap. The trapezius, latissimus dorsi and periscapular muscles were divided along the same line. The skin and muscle flaps were reflected and held by stay sutures. The three ribs at the apex of the kyphosis were identified and marked and their posterior 6 cm to 8 cm, up to the angle of the ribs, were resected. The diseased vertebral bodies were sufficiently debrided or resected to decompress the spinal cord which was exposed over the whole length of the diseased segment.

In the thoracolumbar spine the skin incision was similar to that in the thoracic spine. The transverse process of the diseased level, either L1 or L2, was identified and its tip defined by diathermy. Subperiosteal blunt dissection was carried out in front of the transverse process. The lumbar nerve roots were identified and protected with an infant feeding tube. A spatula was placed under the reflected psoas muscle exposing the anterolateral surface of the vertebral body which was removed to decompress the spinal cord.

After this, the anterior wound was packed and the posterior midline paraspinal exposure completed. In patients with short-segment or partially-healed disease, the two adjacent healthy vertebrae on either side of the involved segment were exposed. In those with long-segment disease at least one healthy segment on each side was exposed. The sublaminar spaces were prepared for the introduction of the wires. A Hartshill loop of suitable length was prebent to allow correction of 30° to 40° in the sagittal plane. A series of 20-gauge sublaminar wires was then passed. Posterior-column shortening was carried out if correction of the kyphus was indicated, before tightening of the sublaminar wires. The sublaminar wires were tightened first on one

side of the diseased segment and then at the opposite end. A wake-up test was performed in neurologically intact patients. Next, the anterior wound was approached again. The gap created by the excision of the vertebral bodies was grafted with autogenous bone by creating a slot in the healthy proximal and distal vertebra (Fig. 3). Tricortical iliac-crest graft was used in eight patients and the ribs in 30. In children, the distal part of the Hartshill loop was cut to the open loop so that it did not become a posterior tether during growth.

In the post-operative period each patient was nursed in bed, with postural turning and exercises allowed on the first post-operative day after surgery. For the first week patients preferred to be on their right side. Standard anti-tubercular chemotherapy was continued for 12 months. No patient required intensive care. If any patient did not show signs of neural recovery in four weeks myelography was performed to assess the adequacy of the surgical decompression. Sitting and walking in a brace were allowed after six to eight weeks in patients who were neurologically intact. Sitting and walking in paralysed patients were allowed depending on the extent of the neurological recovery. Patients were followed up every three months for the first year, every six months for the next two years and then annually. At each visit we assessed the extent of neurological recovery, healing of the vertebral lesion and the degree of kyphosis.

## Results

The mean operating time was 3.5 hours (2.66 to 5.0) and the mean blood loss was 1175 ml (800 to 2600). Each patient needed a blood transfusion of at least two units. We had to remove three ribs in each of 34 patients and two in the other four. The mean number of segments stabilised was 7.83 (5 to 11). The mean pre-operative kyphus was 49.08° (30° to 72°). There were no peri-operative deaths. The surgical wounds healed uneventfully in 33 patients, and in five there was wound dehiscence and healing occurred by secondary intention. The mean follow-up was 32.9 months (11 to 74). Acid-fast bacilli were observed in five patients while the polymerase chain reaction was positive for *Mycobacterium tuberculosis* in all. Histological examination confirmed the diagnosis of tuberculosis in every case.

All except three patients showed some sign of neural recovery after a mean of ten days (1 to 48). Of the three who did not, one with a pathological dislocation at T9-10, miliary tuberculosis and bed sores died one month after surgery of disseminated tuberculosis. The second showed no evidence of neural recovery even at the final follow-up at one year and the third patient showed no sign of neural recovery for 48 days. A myelogram on the 48th day showed free flow of dye confirming an adequate surgical decompression. The next day he started to improve and after a week had recovered full neurological function.

There was radiological evidence of healing with remineralisation of the diseased segment and incorporation of bone graft in 37 patients. There was no difference in the graft-related outcome between patients treated with iliac crest or rib. Two patients stopped taking their anti-tuberculous drugs three months after surgery. They presented at eight and 12 months, respectively, with reactivation of their disease and progression of kyphosis. The mean kyphosis in the immediate post-operative period was 22.5° (10° to 50°) and at final follow-up it was 24° (11° to 54°). Thus the mean final correction achieved was 25° (6° to 42°). No junctional kyphosis was seen. One child had a prominent Hartshill rectangle under the skin, which necessitated removal at 18 months.

## Discussion

The aim of treatment in spinal tuberculosis is to eradicate the disease and to arrest and correct any kyphosis.[8] Decompression of the spinal cord may be required. This is usually undertaken from the front since it is the vertebral body which is affected.[14] Stabilisation of the spine is indicated for instability resulting from a panvertebral lesion[11] or in long-segment disease after cord decompression and correction of the kyphus.

The vertebral column is at its weakest immediately after debridement and bone grafting. The graft is able to provide sufficient stability and structural support in only 41% of patients with a short defect.[15] However, if the graft is more than 4 cm to 5 cm long, it needs to be protected to prevent graft-related complications such as fracture, or displacement of the graft with a consequent increase in kyphosis and/or increase in the neural deficit.[10,11,15] Stabilisation of the spine is indicated if there is a panvertebral lesion, if the post-debridement defect spans more than two discs (5 cm or more) or when correction of the kyphus is contemplated.

Anterior instrumentation[16-22] has been described in the past when 51.5% cases had only one vertebra affected and the rest had two or more vertebrae affected. The mean correction of the kyphus achieved was 25.35° to 12.35° by anterior surgery. It was primarily carried out to prevent deterioration of the kyphus during treatment and is probably only appropriate for this indication. Posterior instrumentation in spinal tuberculosis has been reported using Harrington rods,[23] and with sublaminar segmental wiring to prevent graft-related complications and progression of kyphosis.[7-9,24-26] The advantage of posterior instrumentation is that good fixation can be achieved in healthy posterior vertebrae even when the anterior vertebral body is diseased. The instrumentation only needs to extend one healthy segment above and one below.[6] However, most series have used posterior instrumentation in short-segment disease in which the kyphosis has initially ranged from 30° to 35° and has been corrected to 15° to 18°, post-operatively.[5] Hence, posterior instrumentation is of value in the treatment of tuberculosis of the spine.

The ideal procedure is a single-stage anterior decompression followed by posterior instrumented stabilisation and anterior grafting. Transpedicular decompression and instrumentation through a posterior midline approach have

been described;[27] but the objective was not to correct a kyphosis but to prevent its progression and hence surgery was only carried out over one or two levels. Moon[8] and Moon et al[9] have described two-stage surgery in which the spine was stabilised by posterior instrumentation first followed by transthoracic anterior decompression and bone grafting two to three weeks later. In later cases they performed both procedures in one stage. The surgery again was primarily undertaken not to correct the kyphosis but to prevent its progression. The mean pre-operative kyphosis of 37° was improved to 15° and settled at 18°. Laheri et al[7] performed a single-stage decompression, anterior interbody fusion and posterior instrumentation through a posterolateral retroperitoneal approach in the prone position. Louw[28] performed a two-stage anterior and posterior procedure in 13 of 19 patients and a single-stage procedure in the rest. All patients needed intensive care post-operatively until their general condition was stable. We performed both the anterior decompression and posterior instrumentation through a single incision which allowed us to decompress the spinal cord anteriorly under direct vision. The surgical approach is that as described by Jain et al.[13]

The risk of cord injury was minimised by placing the patient in the lateral position thereby avoiding uncontrolled correction of the kyphus which may be encountered after anterior decompression in the prone position. Once the spine had been stabilised posteriorly it was still possible to inspect the spinal cord anteriorly for any remaining cord compression from granulation tissue or residual sequestrum. The tricortical graft could then be inserted in the anterior defect. The resected ribs were used as graft for the posterior fusion.[13] The mean pre-operative kyphus of 49° was corrected to 24° at the final follow-up. Since the approach to the vertebral body was extrapleural, respiratory function was not compromised. This is of considerable importance and the approach can be used in patients with concomitant pulmonary tuberculosis and compromised pulmonary reserve.[20]

No benefits in any form have been received or will be received from any commercial party related directly or indirectly to the subject of this article.

## References


1. **Luk KD.** Tuberculosis of the spine in the new millennium. *Eur Spine J* 1999;8:338-45.
2. **Tuli SM.** Severe kyphotic deformity in tuberculosis of the spine. *Int Orthop* 1995;19:327-31.
3. **Rajasekaran S.** The natural history of post-tubercular kyphosis in children: radiological signs which predict late increase in deformity. *J Bone Joint Surg [Br]* 2001;83-B:954-62.
4. **Rajasekaran S, Shanmugasundaram TK.** Prediction of the angle of gibbus deformity in tuberculosis of the spine. *J Bone Joint Surg [Am]* 1987;69-A:503-9.
5. **Jain AK, Dhammi IK.** Tuberculosis of the spine: a review. *Clin Orthop* 2007;460:39-49.
6. **Jain AK, Maheshwari AV, Jena S.** Kyphus correction in spinal tuberculosis. *Clin Orthop* 2007;460:117-23.
7. **Laheri VJ, Badhe NP, Dewnany GT.** Single stage decompression, anterior interbody fusion and posterior instrumentation for tuberculous kyphosis of the dorso-lumbar spine. *Spinal Cord* 2001;39:429-36.
8. **Moon M-S.** Combined posterior instrumentation and anterior interbody fusion for active tuberculous kyphosis of the thoraco-lumbar spine. *Curr Orthopaedics* 1991;5:177-9.
9. **Moon MS, Woo YK, Lee KS, et al.** Posterior instrumentation and anterior interbody fusion for tuberculous kyphosis of dorsal and lumbar spines. *Spine* 1995;20:1910-16.
10. **Altman GT, Altman DT, Frankovitch KF.** Anterior and posterior fusion for children with tuberculosis of the spine. *Clin Orthop* 1996;325:225-31.
11. **Mehta JS, Bhojraj SY.** Tuberculosis of the thoracic spine: a classification based on the selection of surgical strategies. *J Bone Joint Surg [Br]* 2001;83-B:859-63.
12. **Jain AK, Sinha S.** Evaluation of systems of grading of neurological deficit in tuberculosis of spine. *Spinal Cord* 2005;43:375-80.
13. **Jain AK, Aggarwal A, Dhammi IK, Aggarwal PK, Singh S.** Extrapleural anterolateral decompression in tuberculosis of the dorsal spine. *J Bone Joint Surg [Br]* 2004;86-B:1027-31.
14. **Hodgson AR, Stock FE, Fang HS, Ong GB.** Anterior spinal fusion: the operative approach and pathological findings in 412 patients with Pott's disease of the spine. *Br J Surg* 1960;48:172-8.
15. **Rajasekaran S, Soundarapandian S.** Progression of kyphosis in tuberculosis of the spine treated by anterior arthrodesis. *J Bone Joint Surg [Am]* 1989;71-A:1314-23.
16. **Ozdemir HM, Us AK, Ogün T.** The role of anterior spinal instrumentation and allograft fibula for the treatment of pott disease. *Spine* 2003;28:474-9.
17. **Christodoulou AG, Givissis P, Karataglis D, Symeonidis PD, Pournaras J.** Treatment of tuberulosis spondylitis with anterior stabilization and titanium cage. *Clin Orthop* 2006;444:60-5.
18. **Korkusuz F, Islam C, Korkusuz Z.** Prevention of postoperative late kyphosis in Pott's disease by anterior decompression and intervertebral grafting. *World J Surg* 1997;21:524-8.
19. **Korkusuz Z, Binnet MS, Isiklar ZU.** Pott's disease and extrapleural anterior decompression: results of 108 consecutive cases. *Arch Orthop Trauma Surg* 1989;108:349-52.
20. **Dai LY, Jiang LS, Wang W, Cui YM.** Single-stage anterior autogenous bone grafting and instrumentation in the surgical management of thoracolumbar spinal tuberculosis. *Spine* 2005;30:2342-9.
21. **Yilmaz C, Selek HY, Gürkan I, Erdemli B, Korkusuz Z.** Anterior instrumentation for the treatment of spinal tuberculosis. *J Bone Joint Surg [Am]* 1999;81-B:1261-7.
22. **Jin D, Qu D, Chen J, Zhang H.** One-stage anterior interbody autografting and instrumentation in primary surgical management of thoracolumbar spinal tuberculosis. *Eur Spine J* 2004;13:114-21.
23. **Rezai AR, Lee M, Cooper PR, Errico TJ, Koslow M.** Modern management of spinal tuberculosis. *J Neurosurgery* 1995;36:87-97.
24. **Güven O, Kumano K, Yalçin S, Karaham M, Tsuji S.** A single stage posterior approach and rigid fixation for preventing kyphosis in the treatment of spinal tuberculosis. *Spine* 1994;19:1039-43.
25. **Sundararaj GD, Behera S, Ravi V, et al.** Role of posterior stabilisation in the management of tuberculosis of the dorsal and lumbar spine. *J Bone Joint Surg [Br]* 2003;85-B:100-6.
26. **Chen WJ, Chen CH, Shih CH.** Surgical treatment of tuberculous spondylitis: 50 patients followed for 2-8 years. *Acta Orthop Scand* 1995;66:137-42.
27. **Lee TC, Lu K, Yang LC, Huang HY, Liang CL.** Transpedicular instrumentation as an adjunct in the treatment of thoracolumbar and lumbar spine tuberculosis with early state bone destruction. *J Neurosurg* 1999;91(2 Suppl):163-9.
28. **Louw JA.** Spinal tuberculosis with neurological deficit: treatment with anterior vascularised rib grafts, posterior osteotomies and fusion. *J Bone Joint Surg [Br]* 1990;72-B:686-93.