UBERCULOSIS is a common disease in developing and underdeveloped countries. Its incidence is also increasing in developed countries because of the immigration of individuals from underdeveloped and developing countries and because of an increased incidence of human immunodeficiency virus. Tuberculosis also remains a serious health problem in Turkey where a rising trend has been evident since the early 1970s. Although spinal tuberculosis occurs in fewer than 1% of patients with tuberculosis, it is a life-threatening and disabling condition.

Although chemotherapy remains the mainstay in the treatment of tuberculosis spondylitis, surgical procedures also play an important role. Various surgeries have been used to treat spinal tuberculosis. Combined radical debridement and anterior fusion has been advocated by most authors since this method was described by Ito et al. in 1934; these results also correspond with those reported by Hodgson and Stock.

The advent of diagnostic tools has made early detection possible before the development of severe deformity and neurological deficits; additionally more conservative treatment modalities, such as antituberculous chemotherapy alone, may be performed. This conservative approach, however, cannot prevent the possible progression of a kyphotic deformity, and long-term rest is typically required to achieve relief of severe back pain. The placement of a rigid stabilization system may prevent kyphosis and lend immediate relief of pain formerly caused by spinal instability. Loss of most deformity correction occurs in 3 to 18 months post-operatively. During this time.

Thoracic and lumbar tuberculous spondylitis treated by posterior debridement, graft placement, and instrumentation: a retrospective analysis in 19 cases

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Object. Surgical treatment of thoracic and lumbar tuberculous spondylitis is controversial. An anterior approach is usually recommended. The aim of the present study was to assess the efficacy of posterior debridement and the placement of posterior instrumentation for the treatment of patients with thoracic and lumbar tuberculous spondylitis.

Methods. Nineteen patients with thoracic and lumbar tuberculous spondylitis underwent single-stage posterior decompression and debridement as well as the placement of posterior interbody grafts if necessary, instrumentation and posterior or posterolateral grafts.

No postoperative neurological deterioration was noted. One patient died of myocardial infarction on Day 10. The mean follow-up duration, excluding the one death, was 52.7 months (range 16–125 months). In a 70-year-old patient, a single pedicle screw broke after 3 months. All patients were in better neurological condition after surgery and at the last follow-up examination. Neurological deficits were present in only two patients at the last follow-up (one American Spinal Injury Association Grade B and one Grade C deficit preoperatively). Three other patients suffered intermittent back or low-back pain.

The mean angulation measured in 13 patients with kyphotic deformity was 18.2° (range 5–42°) preoperatively; this was reduced to 17.3° (range 0–42°) after surgery. There was a 2.8° loss of correction (range 2–5°) after 44.3 months (16–64 months). Kyphosis did not progress beyond 15 months in any patient.

Conclusions. A posterior approach in combination with internal fixation and posterior or posterolateral fusion (with or without placement of posterior interbody grafts) may be sufficient for the debridement of the infection and to allow spinal stabilization in patients with thoracic and lumbar tuberculous spondylitis. This procedure is associated with easy access to the spinal canal for neural decompression, prevention of loss of corrected vertebral alignment in the long term, and facilitation of early mobilization.

KEY WORDS • spinal tuberculosis • Pott disease • tuberculous spondylitis • spinal instrumentation
Posterior approach to thoracic and lumbar tuberculous spondylitis

period, posterior rigid instrumentation provides temporary stability and prevents kyphosis. The authors of a few studies have noted good results after posterior debridement and the placement of posterior instrumentation in patients with tuberculous spondylitis.2,12,25

We report a retrospective analysis of 19 patients with thoracic, thoracolumbar, or lumbar tuberculous spondylitis; the patients underwent single-stage posterior decompression and debridement, the placement of posterior interbody grafts in suitable cases, posterior instrumentation with transpedicular screws or laminar/pediculectomy hooks, and posterior or posterolateral grafts.

Clinical Material and Methods
Patient Population

Between 1994 and 2003, 34 patients with tuberculous spondylitis underwent surgery, and 19 were included in the present study after meeting the following criteria: 1) radiological demonstration of thoracic, thoracolumbar, or lumbar vertebral lesion in patients who underwent posterior debridement, decompression, and graft and instrumentation placement; 2) the presence of acid-fast bacilli detected on direct examination, culture, or percutaneous or open biopsy examination; 3) characteristic histological features with or without bacilli; and 4) a minimum follow-up period of 12 months. Fifteen patients with tuberculous spondylitis were excluded from the study: four patients harbored cervical lesions; four had undergone an anterior approach or anterior–posterior approach to treat high-grade collapse and angulation at the thoracolumbar junction (kyphosis > 50° in three and a kyphotic angle of 35° in the thoracolumbar region of the fourth); one had only undergone abscess drainage from the anterior abdominal wall; an open biopsy procedure alone had been performed in four patients, and two recently treated patients had attended follow up for fewer than 12 months.

There were 13 women and six men whose mean age at referral was 50.3 years (range 26–70 years). Eight patients presented with back or low-back pain without neurological deficits, and 11 patients presented with neurological deficits. Classification of spinal cord function was made using the ASIA Impairment Scale.1 The mean duration of symptoms was 10 months (range 2–48 months).

Diagnostic Testing

In all cases we conducted standard laboratory tests, including a white and red blood cell count, erythrocyte sedimentation rate, blood chemistry profile, and Mantoux tuberculin skin test. Radiography of the chest, specific spinal lesions, and any other suspected skeletal sites was conducted in all patients. Magnetic resonance and computerized tomography imaging were performed in all cases as well.

In five patients, the diagnosis was established by culturing acid-fast bacilli from material obtained in the spinal lesion, and in two others it was established by showing acid-fast bacilli on smears. In all patients, typically caseating granulomas were demonstrated histologically. The mean erythrocyte sedimentation rate was 65 mm/hour (range 25–130 mm/hour) and the leukocyte count was higher than 10,000/mm³ in five patients. The Mantoux test was positive in 12 cases. Five patients harbored extraspinal lesions in addition to their spinal lesions (active pulmonary tuberculosis in four patients and frontal osteomyelitis in one).

Involved Levels and Spinal Deformation

In terms of the spinal tuberculous spondylitis, two VBs were involved in 15 patients, three VBs in one patient, four VBs in two patients, and five VBs in one patient (Table 1). In the latter patient (Case 10), one involved VB was not contiguous with the other involved VBs.

The degree of VB collapse, if present, was determined as follows: the percentage of height of the collapsed VB to mean height of one above and one below (Fig. 1 upper left).

We used a previously established definition of a kyphotic angle.14 If there was a collapsed vertebra, two lines were drawn, one through the superior surface of the first noncollapsed vertebra cephalad to the lesion, and one through the inferior surface of the first noncollapsed vertebra caudad to the lesion. Perpendicular lines were then drawn from these lines and the angle was measured at their intersection (Fig. 1 upper left and lower right). If there was no collapsed vertebra, the lines were drawn as follows: one through the superior surface of the cephalad vertebra, and one through the inferior surface of the caudal vertebra. The angle was measured in the preoperative and early postoperative periods as well as serially at 3-month intervals for 24 months and then annually thereafter.

Surgical Treatment

The indications for operative management in this series were presence of neurological deficits, even mild deficits; VB collapse of more than 50%; spinal deformity in which the kyphotic angle exceeded 5°; epidural abscess compressing the dural sac; large paravertebral abscess; radicular or dural compression due to granulation tissue, abscess, sequestrated bone or disc fragment causing neurological deficit or severe pain; and a nondiagnostic biopsy specimen. Table 2 provides a summary of surgical indications. In the patients in whose operative indications were noted, a preoperative biopsy specimen was not obtained. Only three patients underwent surgery after nondiagnostic biopsy results were obtained, in the absence of other surgical indications. Although an open biopsy procedure is performed after a nondiagnostic biopsy specimen in our routine practice, in the present cases open biopsy procedures were not undertaken for the following reasons: in Case 1 there was 20% thoracolumbar VB collapse, and in Cases 12 and 17 the patients were obese (with lumbosacral junction involvement in one and 37% VB collapse in the other). Therefore, we decided that prophylactic posterior instrumentation would best suit these patients.

All patients were treated by surgical debridement and internal fixation via a posterior approach. A bilateral hemilaminectomy, or total laminectomy, according to the extent of spinal canal stenosis, was followed by debridement of the affected intervertebral discs and the VBs. If necessary, a facetectomy or pediclectomy was also conducted. In addition to debridement of the infected tissue,
the affected segments were stabilized by placing a transpedicular screw or pedicular/laminar hook/rod hardware according to the involved level. The screws were placed into affected vertebrae if they could not be adequately inserted into unaffected parts of the osteomyelitic vertebra. If the screws could not be placed into the affected vertebra bilaterally, or if thoracolumbar junction involvement were present, two vertebra above and one vertebrae below with the involved vertebra were incorporated into the instrumentation system (Fig. 1 upper right and lower left).

In the cases in which bilateral screw fraction of the involved vertebra could be achieved and thoracolumbar lesions were absent, the vertebra above and one below were incorporated. If hooks were used instead of screws because of the involved levels, usually in cases of upper or midthoracic lesions, the two superior levels and two inferior levels were incorporated into the hardware. In patients in whom the interbody defects were not large, only posterior or posterolateral onlay autografts were used. In addition to posterolateral onlay grafts in four patients (Cases 3, 9, 11, and 14) autologous bone grafts were used. In addition to posterolateral onlay grafts in four patients (Cases 3, 9, 11, and 14) autologous bone grafts were used. Autografts were also used. The biopsy specimens were sent for pathological examination, and the pus obtained from the abscesses was sent for culture for *Mycobacterium tuberculosis*, as well as aerobic and anaerobic nonspecific microorganisms.

**Antituberculosis Medication**

Antituberculosis chemotherapy was instituted on the day of surgery and was continued for 12 months. The standard four-drug therapy with isoniazid (5 mg/kg), rifampicin (10 mg/kg), ethambutol (15 mg/kg), and pyrazinamide (25 mg/kg) was administered as a first-line treatment for 4 months, and this was followed by rifampicin and isoniazid for 12 months or until symptoms regressed and laboratory and neuroimaging/radiological signs of resolution were apparent, whichever occurred later. Morphi*n*azamide may be used as a first-line drug in place of pyrazinamide. This treatment was regularly supervised by chest physicians. White and red blood cell counts, the ESR, and liver function values were monitored.

**Follow-Up Examinations**

The patients underwent follow-up examination at 1-month intervals during the 1st year, at 3-month intervals for the 2nd year, and then annually thereafter for 5 years. The 1st-year evaluations were conducted on an outpatient basis and entailed clinical and radiographic assessments. Thereafter, examinations involved outpatient clinical and radiographic assessments, if possible, or control telephone interviews for four patients (Cases 3, 5, 12, and 16) who lived in rural areas. Fusion could not be evaluated because of the presence of posterior or posterolateral onlay grafts, except in four patients in whom posterior interbody grafts were placed. The degree of vertebral collapse and kyphosis, however, were measured on control radiographs. In the patients with posterior interbody grafts, fusion was evaluated on radiographs or MR images.

**Results**

A 66-year-old patient (Case 2) died of MI on postoperative Day 10. The mean follow-up duration recorded for the other patients was 52.7 months (range 16–125 months). The patients underwent follow-up examination at 1-month intervals during the 1st year, at 3-month intervals for the 2nd year, and then annually thereafter for 5 years. The 1st-year evaluations were conducted on an outpatient basis and entailed clinical and radiographic assessments. Thereafter, examinations involved outpatient clinical and radiographic assessments, if possible, or control telephone interviews for four patients (Cases 3, 5, 12, and 16) who lived in rural areas. Fusion could not be evaluated because of the presence of posterior or posterolateral onlay grafts, except in four patients in whom posterior interbody grafts were placed. The degree of vertebral collapse and kyphosis, however, were measured on control radiographs. In the patients with posterior interbody grafts, fusion was evaluated on radiographs or MR images.

**Results**

A 66-year-old patient (Case 2) died of MI on postoperative Day 10. The mean follow-up duration recorded for the other patients was 52.7 months (range 16–125 months).
months), including a 12-month course of chemotherapy. Two patients required repeated operations, one of whom was a 70-year-old patient (Case 3) in whom a single PS broke 3 months postoperatively (Fig. 2). The other patient (Case 13), a 46-year-old woman who complained of discomfort, required removal of the posterior instrumentation system 16 months after surgery. No other patient needed further medical treatment after 12 months.

Neurological Outcome

At presentation, eight patients suffered back or low-back pain but no neurological deficits at presentation.

FIG. 1. Case 15. Preoperative sagittal (upper left) and axial (upper center) MR images, postoperative anteroposterior (AP) (upper right) and lateral (lower left) radiographs, and control sagittal MR image (lower right) obtained at 21 months. Because only one screw could be placed in the infected vertebra, two vertebrae above and one vertebra below were incorporated into the instrumentation system. Note also the vertebral collapse (upper left) and the angle of kyphosis (upper left and lower right). These were measured by the percentage of height of the collapsed VB to mean height of one above and one below. The degree of collapse (D°) = 100 − (B/[A + C]/2) × 100.
There was a gibbus deformity in two of these cases. Neurological deficits were demonstrated in 11 patients; in eight of whom there was lower-extremity paresis due to medullary (in five) or radicular (in three) compression, and in three of whom there was hypesthesia due to radicular compression. Only one patient had sphincter dysfunction due to T7–8 spondylitis. No neurological deterioration was documented after the operation.

According to the ASIA scale, there were no cases of Grade A impairment (Table 1). Preoperatively only one patient (Case 10) presented with Grade B impairment; at the time of last follow up after 48 months this patient’s impairment was Grade D. Six patients presented with ASIA Grade C impairment. One of them died, and impairment in four was classified as Grade E and in one as Grade C at the time of their last follow-up examination. One patient (Case 11) died of MI 48 months postoperatively. In the 11 patients with Grade E impairment preoperatively, function remained at Grade E throughout the follow-up period. Three patients with Grade E impairment secondary to hypesthesia due to radicular compression were neurologically normal after surgery.

**Postoperative Pain**

Only three patients still experienced intermittent back or low-back pain at the time of the last follow-up examination (Table 1). One of these was the woman (Case 13) who underwent removal of the instrumentation system because of her discomfort. She experienced mild pain only when she stood for a few hours, and she did not use analgesic medication. The other patient (Case 8) had T12–L1 spondylitis that caused a 60% collapse of the L-1 VB; postoperatively the angulation was decreased to 6° from 12°. At the time of last follow up, it had returned to 12° and control MR imaging revealed no compression of the neural tissue. In the third patient (Case 14) the preoperative kyphotic angle was 42°, and at the time of last follow up it was 45°. In the latter two patients, there was moderate pain when they were tired, and they took nonnarcotic analgesic medication approximately once or twice a week.

**Spinal Alignment**

There was no kyphosis in six patients on admission; the mean angulation measured in the remaining 13 was 18.2° (range 5–42°), and it was 17.3° (range 0–42°) in the early postoperative period, excluding the patient who died 10 days postoperatively. In four patients there was no change in angulation postoperatively, in five it decreased 3 to 11°, and in three it increased 3 to 5° (Table 3).

There was a mean 2.8° (range 2–6°) loss of correction in the patients with preoperative kyphosis during a mean follow-up period of 44.3 months (range 16–64 months), excluding two patients (one who died and one in whom the screw broke after 6 months). Kyphosis did not progress beyond 15 months in any patient.

There was collapse of the involved VBs in 15 patients. In four of them, two VBs collapsed (including two cases [Cases 9 and 14] in which preoperative angulation was the greatest: 40° and 42°, respectively). Posterior interbody grafts were placed in both of these patients; the angulation in one decreased thereafter, but it progressed to 45° in both patients after 14 and 15 months, respectively (Fig. 3). It did not progress thereafter. One of these patients continued to experience intermittent back pain at the time of last follow-up examination.

**Postoperative Complications**

There were no intraoperative complications. Postoperatively, one patient suffered a superficial wound infection that was treated successfully with antibiotic therapy. One patient died of an MI 10 days after surgery. In one patient repeated operation was recommended when a PS broke after 3 months, but the patient refused. He was a 70-year-old man with osteoporosis and an L2–3 spondylitis; he underwent placement of L1–3 posterior instrumentation.

**TABLE 2**

Surgery-related indications and complications

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Op Indications</th>
<th>Complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>nondiagnostic biopsy</td>
<td>none</td>
</tr>
<tr>
<td>2</td>
<td>neurological deficit, VB collapse, kyphosis</td>
<td>death</td>
</tr>
<tr>
<td>3*</td>
<td>VB collapse</td>
<td>broken screw after 3 mos</td>
</tr>
<tr>
<td>4</td>
<td>epidural abscess</td>
<td>none</td>
</tr>
<tr>
<td>5</td>
<td>neurological deficit, epidural abscess</td>
<td>none</td>
</tr>
<tr>
<td>6</td>
<td>neurological deficit, epidural abscess</td>
<td>none</td>
</tr>
<tr>
<td>7</td>
<td>kyphosis</td>
<td>none</td>
</tr>
<tr>
<td>8</td>
<td>VB collapse, kyphosis</td>
<td>none</td>
</tr>
<tr>
<td>9*</td>
<td>neurological deficit, epidural abscess, paravertebral abscess, kyphosis</td>
<td>none</td>
</tr>
<tr>
<td>10</td>
<td>neurological deficit, VB collapse, kyphosis</td>
<td>none</td>
</tr>
<tr>
<td>11*</td>
<td>neurological deficit, kyphosis, epidural abscess</td>
<td>none</td>
</tr>
<tr>
<td>12</td>
<td>nondiagnostic biopsy</td>
<td>none</td>
</tr>
<tr>
<td>13</td>
<td>VB collapse, kyphosis</td>
<td>removal of instrumentation system after 16 mos</td>
</tr>
<tr>
<td>14*</td>
<td>VB collapse, kyphosis, epidural abscess</td>
<td>superficial wound infection</td>
</tr>
<tr>
<td>15</td>
<td>kyphosis, epidural abscess, paravertebral abscess</td>
<td>none</td>
</tr>
<tr>
<td>16</td>
<td>paravertebral abscess, epidural abscess</td>
<td>none</td>
</tr>
<tr>
<td>17</td>
<td>nondiagnostic biopsy</td>
<td>none</td>
</tr>
<tr>
<td>18</td>
<td>neurological deficit, kyphosis, epidural abscess</td>
<td>none</td>
</tr>
<tr>
<td>19</td>
<td>neurological deficit, kyphosis, epidural abscess</td>
<td>none</td>
</tr>
</tbody>
</table>

* Posterior interbody grafts were used.
and posterior interbody graft (Fig. 2). We learned in a telephone interview that he underwent anterior surgery at another center 5 months after the initial operation, and he was well at the last follow up after 61 months; however, his control radiographs could not be assessed because of his remoteness from our hospital.

**Discussion**

The development of specific antituberculosis drugs has revolutionized the treatment of patients with spinal tuberculosis.\(^2\)\(^3\),\(^2\)\(^4\) The good results associated with modern drug therapy have led to controversy between the advocates of chemotherapy and those of operative treatment. This difference of opinion prompted members of the British Medical Research Council Working Party on Tuberculosis of the Spine to conduct several large-scale controlled trials of various treatment methods.\(^1\)\(^4\)\(^–\)\(^1\)\(^9\) In these studies investigators established that the so-called favorable status in long term follow-up achieved by chemotherapy alone compares favorably with the results of radical surgery. Jain, et al.,\(^8\) have reported that isoniazid, ethambutol, rifampicin, and paraamino salicylic acid reach tuberculous foci in an adequate concentration.

Although chemotherapy remains the mainstay in the treatment of tuberculous spondylitis, surgical procedures play an important role. Antituberculosis chemotherapy has not been shown to satisfactorily prevent associated kyphotic deformity.\(^2\)\(^,\)\(^3\)\(^4\),\(^2\)\(^3\)\(^,\)\(^2\)\(^4\) In a cohort study of 87 patients followed for 10 years,\(^7\) posterior spinal fusion and subsequent chemotherapy for 10 to 12 months resulted in a 98% cure rate, even without debridement; however, a kyphotic deformity persisted in almost all patients. Vertebral collapse may continue until the VBs in the kyphotic region meet anteriorly or until the caseated material in the region of the VBs and the highly vascular granulation tissue mature into bone. In the prevention of progression of the deformity, external support and prolonged recumbency have been found to be ineffective.\(^2\)\(^,\)\(^3\)\(^,\)\(^2\)\(^4\)\(^)\(^\)\(^,\)\(^2\)\(^5\)\(^,\)\(^2\)\(^6\) Thus, preventing kyphotic progression remains the main problem in such cases.

Surgery is advocated in presence of spinal deformity, significant neurological dysfunction at presentation, failure of nonoperative management for 6 to 8 weeks, persistent severe pain, and neurological dysfunction that did not resolve or that developed while patients with tuberculosis spondylitis underwent medical treatment.\(^2\)\(^0\) In addition, older patients with Pott disease--related paraplegia require decompressive surgery to avoid the hazards of prolonged immobilization.\(^7\) Nussbaum, et al.,\(^2\)\(^2\) recommended surgical treatment even in the patients with mild neurological deficits, because both epidural infection and bone destruction typically progress for a viable period after antituberculosis chemotherapy is instituted. We chose to undertake surgery in patients with neurological dysfunction; VB collapse greater than 50%; spin deformity of more than 5°; epidural abscess causing compression of dural sac or large paravertebral abscess; radicular or medullary compression due to granulation tissue, abscess, or sequestrated bone; disc fragment causing neurological deficit or severe pain; and in cases in which inspection of the biopsy specimen was nondiagnostic.

Various surgical methods have been used to treat spinal tuberculosis. Combined anterior radical debridement and arthrodesis has some advantages over other procedures, including direct access to and excision of the focus of disease, rapid healing by osseous union, and a decreased tendency for progressive collapse of the kyphotic angulation;\(^2\)\(^4\) however, this surgical method has been criticized as being unnecessary because spontaneous anterior fusion can occur without such treatment.\(^3\)\(^,\)\(^6\)\(^,\)\(^2\)\(^1\) Korkusuz, et al.,\(^1\)\(^0\) have reported data in 185 patients who underwent anterior decompression and graft placement; the complication rate was 22% and this included seven deaths during the early postoperative period and an 18.3% graft complication rate. Posterior fusion combined with rigid instrumentation has been shown to reduce intraoperative anesthetic and surgical demands and to avoid the potential intra- and postoperative complications that can be associated with the anterior approach.\(^\)\(^1\)\(^1\) In cases of epidural suppuration, the access to the neural elements is limited when an anterior approach is used.\(^2\)\(^5\)

Because modern imaging modalities now allow for
Rezai, et al., have reported that radical surgery was performed only in patients with extensive VB involvement resulting in kyphosis. In their series, aggressive débridement and fusion were performed only in patients at a high risk for transthoracic surgery because of our familiarity with it, its simplicity, and its low complication rate. Because most patients in our series were neurologically normal and had no severe bone destruction, theoretically, good treatment outcomes could be expected after antituberculosis chemotherapy alone; however, this conservative treatment cannot prevent the possible progression of kyphotic deformity, and it usually requires long-term rest to resolve severe back pain. A rigid stabilization system may be the best solution, not only to prevent kyphosis but also to provide immediate relief of pain due to spinal instability.

Posterior debridement, graft and instrumentation-augmented fixation with or without the placement of posterior interbody grafts may be safely performed in the patients with spinal tuberculosis except those with multilevel vertebral involvement and high-grade kyphosis. In fact, the incidence of such cases is low thanks to modern imaging. In another of our series, there were only three patients with high-grade kyphosis (> 50°) of 34 patients, and anterior-approach surgery was performed in these three (unpublished data). Posterior debridement of infected tissue at the disc level and subsequent antituberculosis chemotherapy may allow healing for acceptable degrees of kyphosis and loss of disc height in the patients whose VB involvement is not extensive. The implantation of posterior instrumentation and grafts may prevent the progression of kyphosis. Even in cases of extensive VB collapse, high-grade kyphosis may be prevented by removing the infected material in the disc space and VBs, and by placing posterior interbody grafts and posterior instrumentation. The areas of bone that are infiltrated by, but not necrotic with, tuberculous disease may recover and be reconstituted with drug treatment. The ischemic and infarcted bone also will recover as the disease subsides and chemotherapy improves the circulation of the lesion. Thus, while undertaking decompressive surgery, the surgeon should remove only the portion of viable bone that allows removal of pus, caseous tissue, and sequestra to decompress the spinal cord. There is no advantage of radical surgery over debridement in terms of correcting a kyphotic deformity when an extensive spinal lesion is present. In a study by one group of authors who compared the results of radical and debridement surgery in a long-term follow-up study of patients with tuberculous spondylitis pathologically affecting two VBs, intergroup healing of the lesions and neural recovery were similar. The final extent of kyphosis is severe in only 4 to 5% of the patients who undergo debridement. Debridement of infected tissue combined with intensive antituberculosis chemotherapy can therefore eradicate tuberculous infection of the spine, even though biomaterial is present in the posterior vertebral portion.

The stability provided by posterior fixation, particularly transpedicular fixation, in addition to debridement, securely protects the vertebral correction, and patients are able to return to activities of daily living within a short time. In general, transpedicular screws can be placed in the affected vertebrae if the upper part of the VB is not destroyed by infection. 2,25 Thus, surgical exposure and the extent of spinal fixation can be reduced to a minimum. We also inserted PSs into the affected vertebrae, if possible. Thus, the affected vertebrae are incorporated into the instrumentation system, and fixation levels can be reduced. Breakage of the screw occurred in only one of our patients. He was an older patient with osteoporosis in whom a large interbody gap was present and who had undergone early diagnosis of spinal tuberculosis and because more effective regimens of antituberculosis chemotherapy have become available, surgical options more conservative than the anterior radical approach are possible. In recently published papers, authors have tended to emphasize the importance of tailoring the management options to the individual with spinal tuberculosis. Nussbaum, et al., have treated patients with spinal tuberculosis according to the degree of bone destruction. In their series, aggressive débridement and fusion were performed only in patients in whom extensive VB involvement resulted in kyphosis. Rezai, et al., have reported that radical surgery was required only when the extent of VB destruction exceeds 50%. Rath, et al., reported good neurological results after posterior debridement and internal fixation in patients with neurological impairment due to spondylitis. Their results are comparable with the best results obtained after anterior decompression and may be explained by the possibility of extended neural decompression achieved via a posterior approach. Mehta and Bhojraj advocated the implantation of posterior instrumentation in addition to anterior debridement and graft placement in patients with kyphosis. They also reported good results after posterior transpedicular debridement and posterior instrumentation—augmented fusion without anterior debridement in the patients at a high risk for transthoracic surgery because of their medical condition.

In the present series, we performed posterior débridement, posterior interbody grafting, if necessary, and posterior instrumentation-assisted fusion with pedicle screws preferably, or pedicular/laminar hooks. We preferred a posterior approach because of our familiarity with it, its simplicity, and its low complication rate. Because most patients in our series were neurologically normal and had

### TABLE 3

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Preop Collapse (%)</th>
<th>Preop</th>
<th>Postop</th>
<th>FU</th>
<th>FU (mos)</th>
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<tr>
<td>1</td>
<td>L-1 (20)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>125</td>
</tr>
<tr>
<td>2</td>
<td>L-2 (50)</td>
<td>10</td>
<td>10</td>
<td>—</td>
<td>10 days†</td>
</tr>
<tr>
<td>3‡§</td>
<td>L-2 (50)</td>
<td>5</td>
<td>0</td>
<td>—</td>
<td>61</td>
</tr>
<tr>
<td>4</td>
<td>none</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>65</td>
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<tr>
<td>7</td>
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<td>12</td>
<td>15</td>
<td>57</td>
</tr>
<tr>
<td>8</td>
<td>L-1 (60)</td>
<td>12</td>
<td>6</td>
<td>12</td>
<td>61</td>
</tr>
<tr>
<td>9‡‡</td>
<td>T-5 (78), T-6 (78)</td>
<td>40</td>
<td>40</td>
<td>45</td>
<td>64</td>
</tr>
<tr>
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<td>8</td>
<td>10</td>
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<tr>
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<td>14‡‡</td>
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<td>L-3 (17)</td>
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<td>L-2 (10)</td>
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<td>18</td>
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<td>T-10 (30)</td>
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</table>

+ — not applicable.
† The patient died on postoperative Day 10.
‡ The patient underwent repeated operation at another center after a screw broke.
§ Posterior interbody grafts were used.
placement of a posterior interbody graft. It was thought that this complication was due to osteoporosis, and that a longer-segment posterior instrumentation system would prevent it.

During the long-term follow-up period in the present series, the results were acceptable. Only three patients complained of intermittent back pain; in two others with ASIA Grade B and C impairment preoperatively, paraparesis was observed after a mean duration of 52.7 months. We noted a mean loss of correction of 2.8° between the early postoperative and last follow-up examinations in patients with preoperative kyphosis (mean follow-up period 44.3 months, range 16–64 months). Most loss of correction occurs in the early postoperative period between 3 and 18 months.3,16 In our patients, kyphosis did not progress after 15 months. During this period, posterior rigid instrumentation provides the necessary temporary stability and prevents kyphosis.

Conclusions

A posterior approach in combination with internal fixation and posterior/posterolateral fusion (with or without posterior interbody bone grafts) may be sufficient for the debridement of the infection and spinal stabilization in patients with tuberculous spondylitis. This procedure offers the advantage of an easy access to the spinal canal for neural decompression, prevents loss of correction of the vertebral alignment in the long term, and facilitates early mobilization of the patients.

References


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