Surgery for thoracolumbar junction (T12-L1) tuberculosis a multicentre, retrospective study

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Abstract

Purpose A multicentre, retrospective study was conducted to evaluate the safety and efficacy of different surgical techniques for thoracolumbar junction (T12-L1) tuberculosis. Methods The medical records of thoracolumbar junction tuberculosis patients (n = 257) from January 2005 to January 2015 were collected and reviewed. A total of 45 patients were operated on by an anterior approach (Group A), 52 by a combined anterior and posterior approach (Group B) and 160 by a posterior approach (Group C). Anti-tuberculosis therapy was performed both before and after surgery. Clinical outcomes, laboratory indexes and radiological results of the three groups were compared. Results All three surgical approaches achieved bone fusion, pain relief and neurological recovery. The mean loss of correction in group A at last follow-up was higher than in groups B and C ($P < 0.05$), and the difference between groups B and C was not significant ($P > 0.05$). The mean operation time and blood loss in group B were greater than in groups A and C. Conclusions For patients with thoracolumbar junction (T12-L1) tuberculosis, the posterior-only approach is superior to the anterior-only approach in the correction of kyphosis and maintenance of spinal stability. The posterior-only approach is recommended because it achieves the same efficacy as the anterior-only or combined approach but with shorter operation times, less trauma and less blood loss. Keywords Spinal tuberculosis; Thoracolumbar junction; Three approaches.

Introduction

Tuberculosis (TB) has a serious impact on human health, particularly in developing countries[1–3]. China still has the second largest TB-infected population in the world[4]. It is estimated that 2 million people suffer from spinal TB[5]. The thoracolumbar spine is one of the major targets of metastatic TB of the musculoskeletal system[6]. It most commonly affects the thoracolumbar junction[7]and about 10%–43% of patients with spinal TB have associated neurological complications. Spinal TB may result in spinal instability, kyphotic deformities, and compression of the spinal cord, causing neurological deficits. Chemotherapy and surgery can achieve satisfactory results with both timely diagnosis and long-term treatment[4]. Mild spinal TB can be treated with standard chemotherapy alone[8]. Surgical intervention is recommended for cases of spinal TB with spinal instability, neurological deficit and a severe and/or progressive kyphotic deformity, as well as for patients who are resistant to chemotherapy or those with a large paraspinal abscess[9]. However, the optimum surgical approach remains uncertain amongst surgeons. Traditionally, the anterior approach to the spine has been preferred for vertebral bodies, and disc spaces are the main sites affected by TB. These can provide direct access to the infection foci, which is convenient for debridement and reconstruction[10, 11]. However, persistent maintenance of spinal stability is outside the scope of such therapy[12, 13]. Therefore, anterior debridement combined with posterior instrumentation is recommended by some scholars and has excellent clinical results except for some inconvenient complications[14]. In recent years, posterior-only surgery has gained popularity because it can be used to debride the lesion, decompress the nerves and correct kyphosis in a single-stage procedure with less trauma, fewer complications, lower costs and shorter recovery times[15, 16]. To our knowledge, there is no study comparing the therapeutic efficacy between posterior-only, anterior-only and combined anterior and posterior approaches for monosegmental spinal TB focusing on the thoracolumbar junction (T12-L1). Furthermore, there is no study comparing the three surgical methods in multiple centres and on large samples. Therefore, we conducted a multicentre, retrospective study to observe the safety and efficacy of three different surgical methods of treating thoracolumbar junction TB and to provide a reference for its surgical treatment.

Materials And Methods

General information

Between January 2005 and January 2015, 302 patients with thoracolumbar junction (T12-L1) TB from six hospitals across China were hospitalized; 125 were excluded because of conservative therapy, complicated spinal tumours or active pulmonary TB, poor tolerance or compliance and lost to follow-up. The remaining 177 patients were included in the study, comprising 88 men and 89 women with a mean age of 35.2 ± 10.0 years (range 14–62). A total of 45 patients were treated by an anterior-only approach (Group A), 52 by a combined anterior and posterior approach (Group B) and 80 by a posterior-only approach (Group C) (Table 1). In this study, we did not include patients with HIV co-infection.

The diagnosis of spinal TB was made on the basis of clinical symptoms, physical signs, laboratory findings and radiological evidence. In surgical patients, the diagnosis was confirmed histopathologically after debridement. The American Spinal Injury Association (ASIA) score was used to evaluate neurological function. Six patients were grade A, 14 were grade C, 47 were grade D and 108 were grade E. The visual analogue scale (VAS) was used to evaluate back pain for all patients. The Cobb technique was used to assess the local kyphotic angle.

Preoperative management

All patients were administered a chemotherapy regimen (isoniazid 300 mg/day, rifampicin 450 mg/day, ethambutol 750 mg/day and pyrazinamide 750 mg/day) for 2–4 weeks prior to the operation. Pre-operative haemoglobin levels and erythrocyte sedimentation rates (ESR) were higher than 100 g/L and not higher than 40 mm/L, respectively, before surgery.

Operation technique

Operations at each centre were performed by senior surgeons. All patients underwent general endotracheal anaesthesia, after which they were placed in the appropriate position on the spinal table. (1) The anterior-only approach was a thoracoabdominal approach. The exposure focus was complete debridement. The defect area in the vertebral body was packed with an appropriately sized allograft or autologous iliac bones or cage. The screw-plate or screw-rods were placed in the lateral anterior, then streptomycin (1.0 g) and isoniazid (0.3 g) were administered locally, before the incision was closed. (2) In the combined anterior–posterior approach, the patient was placed in a prone position, a standard dorsal midline incision was made, the lamina and articular process were exposed, a pedicle screw was implanted, the kyphosis angle was corrected, a bone graft was performed, and the incision was closed. Then, patients were transferred to the lateral position, and a correctly placed incision was made. The thoracoabdominal approach was used to complete debridement, spinal cord decompression and bone graft fusion. (3) In the posterior-only approach, patients were placed in the prone position on the spinal table. A standard dorsal midline incision was performed, and the posterior tissues were exposed. Abscesses, granulation tissue, sequestra, caseous necrosis, necrotic endplates and discs were debrided as thoroughly as possible via the transpedicular space. Then, two pre-bent rods were installed. A bone autograft of suitable size or a titanium cage containing cancellous bone from the iliac crest was placed within the intervertebral space. Compression and expansion of the internal fixation instrument was used to rectify the kyphosis and scoliosis gradually and carefully, then the contoured rods were tightened. Finally, streptomycin (1.0 g) and isoniazid (0.3 g) were administered locally, and a local drainage tube was placed in the operation site before the incision was closed.

Postoperative care

Preventive antibiotic treatment was used within 48 hours after the operation. All patients were advised to use a bracing apparatus until bony fusion was observed on radiography. Patients resumed oral HREZ chemotherapy postoperatively, then Pyrazinamide was discontinued at 6 months. Patients continued to receive 9–12 months regimens of HRE chemotherapy. If a drug sensitivity test suggested resistant TB, the chemotherapy regimen was adjusted. Patients' liver function and ESR rates were monitored carefully at regular intervals. Follow-up examinations were conducted at 1, 3, 6, 12 and 18 months. Subsequent follow-ups were performed at 12-month intervals.

Statistical analysis

Continuous data are expressed as $\bar{X}$ ± S.D. The LSD or Dunnett T3 test was used to evaluate differences in operation time, blood loss, kyphosis angle, ESR, VAS score. Statistical analyses were performed using SPSS version 22 (SPSS, Inc., Chicago, USA). Values of P less than 0.05 were considered to indicate significant differences.

Results

General patient characteristics

The mean patient age, operative time, blood loss and duration of follow-up were 34.3 ± 10.1 years (range 18–62 years), 330.2 ± 45.4 minutes (range 200–400 min), 744.0 ± 193.8 ml (range 500–1500 mL) and 30.0±7.3 months (range 24–50 months), respectively, in group A. In group B, these were 34.4 ± 10.4 years (range 14–61 years), 408.0 ± 54.3 minutes (range 295–540 min), 1134.6 ± 328.2 ml (range 400–2000 mL) and 29.7 ± 6.6 months (range 24–50 months), respectively. In group C, they were 35.6 ± 9.9 years (range 14–62 years), 227.9 ± 58.5 minutes (range 123–600 min), 349.8 ± 289.4 ml (range 200–2200 mL) and 28.9 ± 6.1 months (range 24–52 months), respectively (Table 1).

Laboratory evaluation

The average preoperative ESR values were 34.7 ± 27.0 mm/h (range 2–99 mm/h) in group A, 38.9 ± 30.2 mm/h (range 2 to 99 mm/h) in group B and 36.3±25.0 mm/h (range 2–99mm/h) in group C. The postoperative ESR values returned to normal in all three groups at 3 months (Table 2).

Function scores

Neurologic functions were evaluated by the ASIA classification, and the results are tabulated in Table 3. All patients with neurological deficits had different degrees of recovery after surgery. The postoperative VAS of the three groups were decreased significantly as of the last follow-up.

Radiological evaluation

The preoperative average Cobb angle was 22.7 ± 7.9° in group A, 18.1 ± 6.8° in group B and 20.8 ± 8.3° in group C. The postoperative Cobb angle decreased significantly to 11.2 ± 5.4° in group A, 8.4 ± 4.2° in group B and 8.7 ± 3.8° in group C. At the last follow-up, the kyphosis angle was 16.7 ± 7.0°, 10.1 ± 4.4°, 10.3 ± 4.0°, in groups A, B and C respectively. Compared with the preoperative Cobb angle, the postoperative and last follow-up Cobb angle in three groups had improved significantly (Table 2). By comparison of kyphosis angle loss, the results showed that the combined anterior–posterior approach and posterior-only approach were superior to the anterior-only approach in maintaining a corrective effect.

Complications

In group A, there was one case of superficial wound infection, one case of cerebrospinal fluid leakage and one case of water-electrolyte imbalance. In group B, there were three cases of cerebrospinal fluid leakage, five cases of water-electrolyte imbalance, one case of urinary infection and one case of pectoralgia. In group C, there were one case of superficial wound infection, five cases of cerebrospinal fluid leakage, one case of water-electrolyte imbalance and one case of refractory intercostal neuralgia. All of these complications were treated successfully or relieved after symptomatic treatment.

Discussion

The thoracolumbar junction (T12-L1) is one of the major targets of metastatic TB of the musculoskeletal system[6, 7]. Although standard anti-TB chemotherapy, strict bed rest and supportive therapy are the fundamental methods of treating spinal TB, suitable and timely surgical intervention for thoracolumbar spinal TB patients can improve spinal stability, eliminate compression on the spinal cord and prevent further development of deformity and paralysis or death.

The thoracolumbar junction (T12–L1) is sandwiched between the pleura and peritoneum, and various surgical approaches have been used to access this area: anterior only, anterior–posterior and posterior only. Tuberculosis mainly affects the anterior column of the spine[17], and in the most common form, a single motion segment is involved. Therefore, early scholars thought the anterior approach[9], which can allow direct access to the lesion site, radical debridement, adequate decompression and less muscle trauma, would be the first choice for decompression and debridement in spinal TB. However, it cannot correct or prevent deformity to any appreciable extent[18]. In our study, the degree of kyphosis correction was similar in group A to that in groups B and C, yet the Cobb angle losses were larger in group A than in groups B and C. Anterior instrumentation in spinal TB is becoming increasingly popular, because a bone graft alone does not provide initial stability. It can be very effective at correcting a deformity and maintaining the correction[19]. However, the value of an implant in an infected area is a matter of debate because it may undermine efforts to eradicate the infection[20]. Some scholars thought the use of metallic implants for stabilization would lead to biofilm formation and adherence of Mycobacterium tuberculosis to the metal surface, making them susceptible to host defence mechanisms and anti-tuberculous drugs[21]. Furthermore, some experts concluded that the use of biomaterial is safe because the M. tuberculosis are dividing slowly, produce little adhesion or biofilm and are present in sessile form in most cases[22].

The combined anterior–posterior approach is an advanced surgical technique that not only achieves complete debridement of the abscess and neural decompression, satisfactory outcomes for deformity correction and long-term maintenance spinal stability but also separates the debridement area from the area of internal fixation to decrease the spread of TB[19]. The disadvantage of the combined approach is longer operative times, increased blood loss, more serious trauma and higher complication rates. In our study, the operative time, blood loss, and complication rate were much greater with this approach than with the other approaches.

Advantages of the posterior approach include less bleeding and shorter hospitalization and operation times. Other advantages are the relief of spinal nerve compression, correction of spinal kyphosis, reconstruction of spinal stability and improvement of patients' quality of life. Moreover, the posterior approach may be a better surgical procedure in patients with less involved spinal TB for the anterior column, which is almost always achieving spontaneous fusion[23, 24]. Additionally, posterior pedicle screw fixation may be able to improve neurological recovery for rigid stabilization, enhancing neurological improvement in patients with traumatic spinal cord injury[14]. There is a potential risk of TB spreading to the posterior healthy regions with posterior debridement, resulting in infection diffusion and fistulas. The stability of the spine would be affected in theory because the normal posterior spinal column would be destroyed with debridement and decompression in this procedure. In our study, the operation time, blood loss and complication rates were better than in other groups, and during the follow-up period, group C achieved the same satisfactory kyphosis correction as group B; moreover, clinical symptoms and neurological functions postoperatively were improved significantly.

Our research has some limitations. First, it was a retrospective rather than a prospective study. Second, operations were performed by the respective surgical teams of the six teaching hospitals, which may cause a certain degree of bias due to differences in their surgical proficiency.

Conclusions

Our multicentre, retrospective study demonstrated that the posterior-only approach can be an effective treatment method for thoracolumbar junction (T12-L1) TB patients, with good neurologic recovery, avoidance of kyphosis progression and few complications. For thoracolumbar junction (T12-L1) TB patients with large migrating abscesses, masses of dead bone and severe neurological deficits, posterior-only surgery is not suitable. In this case, a combined anterior–posterior approach is recommended, which can achieve satisfactory kyphosis correction and long-term maintenance of spinal stability. The use of the anterior-only approach should be limited.

Abbreviations

TB: Tuberculosis; ASIA: American Spinal Injury Association; ESR: Erythrocyte sedimentation rate; HREZ: Isoniazid, rifampicin, ethambutol, and pyrazinamide; VAS: Visual analogue score.

Declarations

Funding

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Compliance with Ethical Standards

This research was approved by the Ethics Committee of the First Affiliated Hospital of the Third Military Medical University, People's Liberation Army (PLA).

Consent for publication

Written informed consent was obtained from the patients for publication of their clinical details and clinical images.

Availability of data and material

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Conflict of Interest

All the authors declare that they have no potential conflicts of interest.

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Tables

TABLE 1. Patients' Clinical Data				
	Group A	Group B	Group C	Statistical Value
Sex (male/female)	21/24	29/23	38/42	
Average age (years)	34.3±10.1	34.4±10.4	35.6±9.9	
Preoperative VAS score	5.7±1.6	6.0±1.9	6.1±1.6	P1>0.05/ P2>0.05/ P3>0.05
Operation time (min)	330.2±45.4	408.0±54.3	227.9±58.5	P1<0.05/ P2<0.05/ P3<0.05
Blood loss (mL)	744.0±193.8	1134.6±328.2	349.8±289.4	P1<0.05/ P2<0.05/ P3<0.05
Final follow-up VAS score	0.6±0.7	0.5±0.6	0.6±0.7	P1>0.05/ P2>0.05/ P3>0.05
Follow-up duration (months)	30.0±7.3	29.7±6.6	28.9±6.1	P1>0.05/ P2>0.05/ P3>0.05
P1：A vs B P2: A vs C P3：B vs C				

TABLE 2. Cobb Angle and ESR in Three Groups						
	Preoperative Cobb Angle (°)	Postoperative	Final Follow-Up		ESR (mm/h)	
		Cobb Angle (°)	Cobb Angle (°)	Angle Lost (°)	Preoperative	3 Months Postoperative
A	22.7±7.9	11.2±5.4	16.7±7.0	5.5±3.7	34.7±27.0	6.1±4.7
B	18.1±6.8	8.4±4.2	10.1±4.4	1.6±1.9	38.9±30.2	7.4±5.3
C	20.8±8.3	8.7±3.8	10.3±4.0	1.7±2.2	36.3±25.0	7.0±4.5
P1	<0.05	<0.05	<0.05	<0.05	>0.05	>0.05
P2	>0.05	<0.05	<0.05	<0.05	>0.05	>0.05
P3	<0.05	>0.05	>0.05	>0.05	>0.05	>0.05
P1：A vs B P2: A vs C P3：B vs C						

TABLE 3. ASIA Classification in Three Groups												
ASIA Classification	Group A (n)				Group B (n)				Group C (n)			
	Pre-operative	Post-operative	Final Follow-up	Improvement	Pre-operative	Post-operative	Final Follow-up	Improvement	Pre-operative	Post-operative	Final Follow-up	Improvement
A	0	0	0	0	3	0	0	3	3	0	0	3
B	0	0	0	0	0	0	0	0	0	0	0	0
C	2	0	0	2	6	3	3	3	8	3	2	6
D	8	3	2	6	14	3	1	13	25	8	4	21
E	35	43	45		29	46	48		44	69	71	
Spinal cord function improvement rate: Group A was 80%, Group B was 82.6% and Group C was 83.3%.												

Figures

Figure 1

The graph shows a case using one-stage anterior debridement, bone grafting and instrumentation Illustration: 25-year-old man with thoracolumbar junction tuberculosis (a, b) preoperative anteroposterior and lateral X-ray films; (c, d) preoperative computed tomography (CT); (e) preoperative 3D reconstruction of CT; (f) preoperative MRI; (g, h) X-ray 18 months after operation; (i) CT at 24 months after operation; (j) 3D reconstruction of CT at 24 months after operation; (k, l) MRI at 18 months after operation.

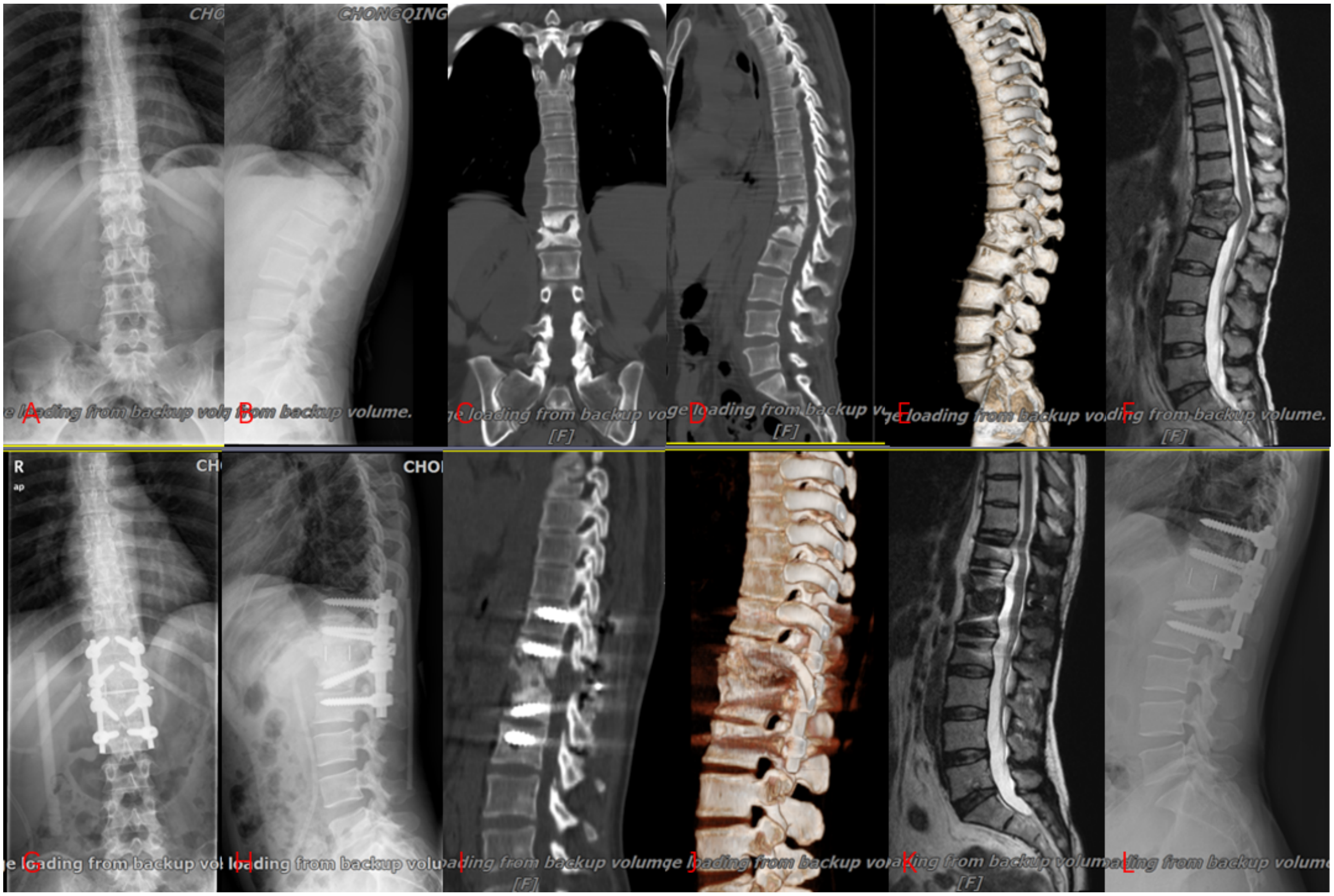

Figure 2

The graph shows a case using anterior debridement and bone grafting combined with posterior internal fixation instrumentation Illustration: 38-year-old woman with thoracolumbar junction tuberculosis (a, b) preoperative anteroposterior and lateral X-ray films; (c, d) preoperative computed tomography (CT); (e) preoperative 3D reconstruction of CT; (f) preoperative MRI; (g, h) X-ray at 1 month after operation; (i) CT at 6 month after operation; (j) 3D reconstruction of CT at 6 month after operation; (k) MRI at 13 months after operation; (l) lateral X-ray films at 56 month after operation.

Figure 3

The graph shows a case using one-stage posterior debridement with decompression and internal fixation instrumentation Illustration: 18-year-old man with thoracolumbar junction tuberculosis (a, b) preoperative anteroposterior and lateral X-ray films; (c, d) preoperative computed tomography (CT); (e) preoperative 3D reconstruction of CT; (f) preoperative MRI; (g, h) X-ray at 1 month after operation; (i, j) CT at 3 months after operation; (k) 3D reconstruction of CT at 12 months after operation; (l) MRI at 12 months after operation.