

## Original Article

# Surgical treatment of selected patients with multilevel contiguous thoracolumbar spinal tuberculosis by only posterior instrumentation without any bone fusion

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**Abstract:** The retrospective clinical study is to determine the feasibility and efficacy of surgical management of multi-level contiguous thoracolumbar spinal tuberculosis (MCTLST) by only posterior instrumentation without posterior or anterior bone fusion and without anterior fixation in the study of eleven selected cases. Eleven selected cases with MCTLST were treated with combined posterior instrumentation and debridement and/or decompression without any bone fusion. The mean follow-up was 33.1 months (range 20-48 months). The kyphosis angle ranged from 9.2 to 40.4° before operation, 27.8° in average. The American Spinal Injury Association (ASIA) score system was used to evaluate the neurological deficits and erythrocytesedimentationrate (ESR) used to judge the activity of tuberculosis, which were collected at certain time. Spinal tuberculosis (STB) was completely cured in all eleven patients. There was no recurrent tuberculosis infection. The postoperative kyphosis angle was 7.1° to 12.5°, 9.6° in average and there was no significant loss of the correction at the final follow-up. Solid fusion was achieved in all cases. Neurological condition in all patients was improved after surgery. In conclusions, combined posterior instrumentation and debridement and/or decompression without any bone fusion can be a feasible and effective method in treatment of patients with MCTLST. However, the strict selection of patients was the critical of the surgery success.

**Keywords:** Multilevel, thoracolumbar, spinal tuberculosis, only posterior instrumentation, bone fusion

## Introduction

Tuberculosis (TB) remains a growing public health problem especially in developing countries, which has been attributed to a failure in detection of TB, lack of adequate health care facilities, poor sanitation, malnutrition, the presence of drug-resistant strains of mycobacterium tuberculosis and the effects of human immunodeficiency virus. Spinal tuberculosis (STB), which is a common extra-pulmonary, is the most commonly affected site in bone and joint (44.3%) [1] and it is found approximately 50% of all the affected TB patients will have TB of the spine [2]. However, multilevel contiguous thoracolumbar spinal tuberculosis (MCTLST) is described as atypical and case reports are published as rarities in the mainstream academic journals. Although the ant-TB chemotherapy and external immobilization still play an irre-

placeable role in treatment of MCTLST in most cases, MCTLST is characterized by involved multiple vertebrae, severe kyphosis deformity, large abscess and spinal cord compression, which usually beyond the chemotherapy function. Therefore, surgical invention will be necessary in this case. To our knowledge, surgical treatment of MCTLST has rarely been reported.

However, the advent of modern segmental spinal instrumentation systems have made posterior only surgery popular to surgeons during the past twenty years with the advantages of relatively minimal invasion, less complications but identical clinical results compared with anterior or combined surgeries [3-8]. Posterior fixation plays a significant party in correction of kyphosis deformity and prevention of the loss of correction in treatment of STB [9]. Moreover, some researchers had confirmed that the vertebra

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**Table 1.** Clinical data of involved levels in multi-level contiguous thoracolumbar tuberculosis

No. of involved levels	No. of patients	Percentage (%)
3	4	36.36
4	5	45.45
5	1	9.09
6	1	9.09
Total	11	100.00

body of lesion would heal spontaneously due to the regenerative capacity of the bone itself [3, 9, 10]. The aim of the study was to assess the clinical and radiological outcomes of only posterior instrumented fusion in adults with active STB.

### Materials and methods

Written informed consent was obtained from all patients and the study protocol was approved by our hospital ethics committee. From January 2007 to January 2013, eleven patients with MCTLST were performed surgery therapy by the same surgeons in the same institution, of which, six were male and five were female, aged from 20 to 45 years old (with an average age of 32.2 years). Involved levels were observed at three vertebrae in four cases, accounting for 36.36% of all patients; four vertebrae in five cases, 45.45%; five vertebrae in one case, 9.09% and six vertebrae in one case, 9.09% (Table 1). Surgery was considered in the presence of following indication: 1) Persistent back pain unresponsive to chemotherapy for 2 months; 2) Progressive neurological deficit or early-onset para-paresis and angular deformity or instability likely to appear; 3) Radiologically, severe spinal cord decompression, significant vertebra destruction and paraspinal abscess with necrotic disc or inflammatory granulation tissue; 4) The elderly or the patients with poor health intolerant too much trauma. Compared to single lesion thoracolumbar STB, MCTLST had characteristic of complex clinical treatment, poor spinal stability, more complications and high morbidity. Consequently, surgical indication of MCTLST, especially for spinal internal fixation devices, should be lowered appropriately and the lesion leading to paraplegia should be treated with priority [7]. When the patients presented with following conditions were excluded: 1) Patients with severe kyphosis (more than 50°) or kyphosis with healed

lesion; 2) Patients with late-onset or complete paraplegia and spinal cord degeneration due to chronic decompression or inflammation; 3) The percentage of the involved lesion of the vertebra body more than 50%; 4) Large paraspinal abscess, like psoas abscess, far away from the focus and beyond the posterior pressure washing and postural drainage functioning; 5) Patients resistant to multi-drug since bone healing is prone to delayed. When these presentations appeared, combined posterior fixation and anterior decompression, debridement and bone grafting were mandatory. Diagnosis was based on clinical and hematological criteria. All patients had symptoms of tuberculosis, such as weight loss, low fever and fatigue. The preoperative kyphosis angle ranged from 9.2 to 40.4°, with an average of 27.8°. The classification of the American Spinal Injury Association (ASIA) was used to assess the neurological deficit and three patients with grade C, five patients with grade D and three patients with grade E. The erythrocyte sedimentation rate (ESR) of patients upon admission ranged from 30 to 83 mm/h, with an average of 51.7 mm/h. (Table 2).

### Preoperative procedure

Chemotherapy and thoracolumbar braces were administered soon after the clinical diagnosis was suspected. Anti-TB drugs with the HREZ chemotherapy regimen, consist of isoniazid (5-10 mg/kg/day with no more than 300 mg/day), rifampicin (5 to 10 mg/kg/day with no more than 300 mg/day), ethambutol (15 mg/kg/day with no more than 500 mg/day) and pyrazinamide (25 mg/kg/day with no more than 750 mg/day) 2-4 weeks before surgery. When progressive neurological deficits appear and severe back pain shows unresponsive to chemotherapy, we appropriately shorten the time of drug treatment. When the ESR and temperature returned to normal or had significantly decreased, and anemia and hypoproteinemia were rectified completely, we performed the surgical management.

### Operative technique

The patients were in the prone position after administration of general endotracheal anesthesia. Through a midline incision, the posterior spinal elements including lamina, facet joints, and transverse processes were exposed (extra-

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**Table 2.** Clinical data on all patients

Patient No	Age/Sex	Blood loss (ml)	Operation time (min)	Surgery procedures	Involved segments	Follow up (mon)	Kyphosis angle			ASIA			ESR	
							Pre	•Post	※FFU	Pre	#Post	.:FFU	Pre	*Post 3 mon
1	24/F	450	180	INS+DEB	T10-L1	24	28.2	10.3	13.1	E	E	E	43	8
2	37/M	950	225	INS+DEB	T9-L2	26	9.2	7.3	7.5	E	E	E	83	11
3	40/F	650	160	INS+DEB+DEC	T12-L3	28	25.8	7.9	11.5	D	E	E	66	7
4	20/F	590	120	INS+DEB+DEC	T9-T12	20	20.4	7.5	11.2	C	D	E	48	9
5	29/M	600	175	INS+DEB+DEC	T11-L1	40	30.1	11.4	15.1	D	E	E	48	8
6	30/M	750	160	INS+DEB+DEC	T10-L1	30	38.1	10.3	14.1	C	D	E	56	8
7	24/F	770	180	INS+DEB+DEC	T12-L2	48	31.2	11.3	15.0	D	E	E	40	8
8	30/M	580	175	INS+DEB+DEC	L1-L3	42	23.3	7.8	10.2	C	D	E	55	10
9	40/M	640	140	INS+DEB+DEC	T11-L1	36	30.6	12.2	14.5	D	E	E	45	9
10	45/F	590	115	INS+DEB	T12-L4	30	40.4	12.5	16.5	E	E	E	30	5
11	35/M	620	175	INS+DEB+DEC	T11-L2	40	27.1	7.1	10.5	D	E	E	55	9
Mean values	32.2	653.6	164.1			33.1	27.8	9.6	12.6				51.7	8.4

INS Instrumentation; DEB Debridement; DEC Decompression; ASIA the American Spinal Injury Association score system; ESR Erythrocyte sedimentation rate, Pre pre-operation; Post post-operation 4 weeks; FFU Final follow-up; Post 3mon post-operation 3 months. #Wilcoxon signed rank test, compare post-operation 4 weeks with pre-operation in ASIA, P<0.05; .: Wilcoxon signed rank test, compare final follow-up with post-operation 4 week in ASIA, P<0.05; • Analyzed by pairedt test, compare post-operation 4 weeks with pre-operation in kyphosis angle, t=8.530, P=0.000; ※Analyzed by pairedt test, compare final follow-up with post-operation 4 weeks in kyphosis angle, t=-9.125, P=0.000; \*Analyzed by pairedt test, compare post-operation 4 weeks with pre-operation in ESR, t=10.977 P=0.000.

periosteal dissection), extending one vertebrae above and below the involved segments. Transpedicular screws were allowed to use in the side of vertebral lamina based on preoperative symptoms and imaging. Transpedicular screws were also placed in the affected vertebrae if the upper part of the vertebrae was not destroyed by infection. When screws were not inserted into the involved vertebrae, two healthy vertebrae above and below the involved segments were instrumented to ensure rigid fixation. Generally, we preferred longer segmental fixation, at least two levels superior and inferior to the level of decompression. Following transpedicular screws being implanted and C-arm X-ray confirming their accuracy, installed a temporary pre-bent rod on the mild side of the lesion to avoid spinal cord injury induced by instability of the spine during decompression and focal debridement and then selected the severe side of the lesion, which caused clinical symptoms or presented with paraspinal abscess as the decompression side. A unilateral facetectomy and a laminectomy up to the medial pedicle edge were performed. We cut off adjacent rib 1.0-1.5 cm beside the thoracic spine, if necessary. Thoracic nerve roots on the focal side were satisfied for better exposure. It should be noticed that the spinal cord was not stretched and distracted. Generally, the decompression range was based on the extent of spinal canal stenosis and the scope of paraspinal abscess. And then, a suitable flush tube was

plunged in paravertebral abscess to wash with appropriate pressure until no pus outflow following the removing the necrotic disc and the collapsed vertebrae by curettes through to healthy bleeding bone. When the abscess was beyond the flush tube extension, we controlled the patient's position by changing operating table to facilitate the abscess into the focus (postural drainage). Sequentially, the rods were tightened and the kyphosis slowly and carefully rectified with the help of the compression and stretch of the internal fixation instrument. No posterolateral or anterior inter-body or posterior bone grafting or cage applying was done. If necessary, the other side was treated in the same way. Afterwards, administered locally with 1.0 g streptomycin and 0.2 g isoniazid and negative pressure drainage and incision sutures were performed postoperatively and resected specimens were collected for bacterial culture and pathological diagnosis (**Figures 1, 2**).

### *Post-operative care and standard of cure*

The drainage tube was pulled out when the volume of drainage was less 30 ml. Patients continued with the oral HREZ chemotherapy postoperatively. Six months later, pyrazinamide was discontinued. Patients then received nine- to twelve-month regimens of the HRE chemotherapy (6HREZ/9-12HRE) [11]. Ambulation was allowed six to eight weeks after surgery with a

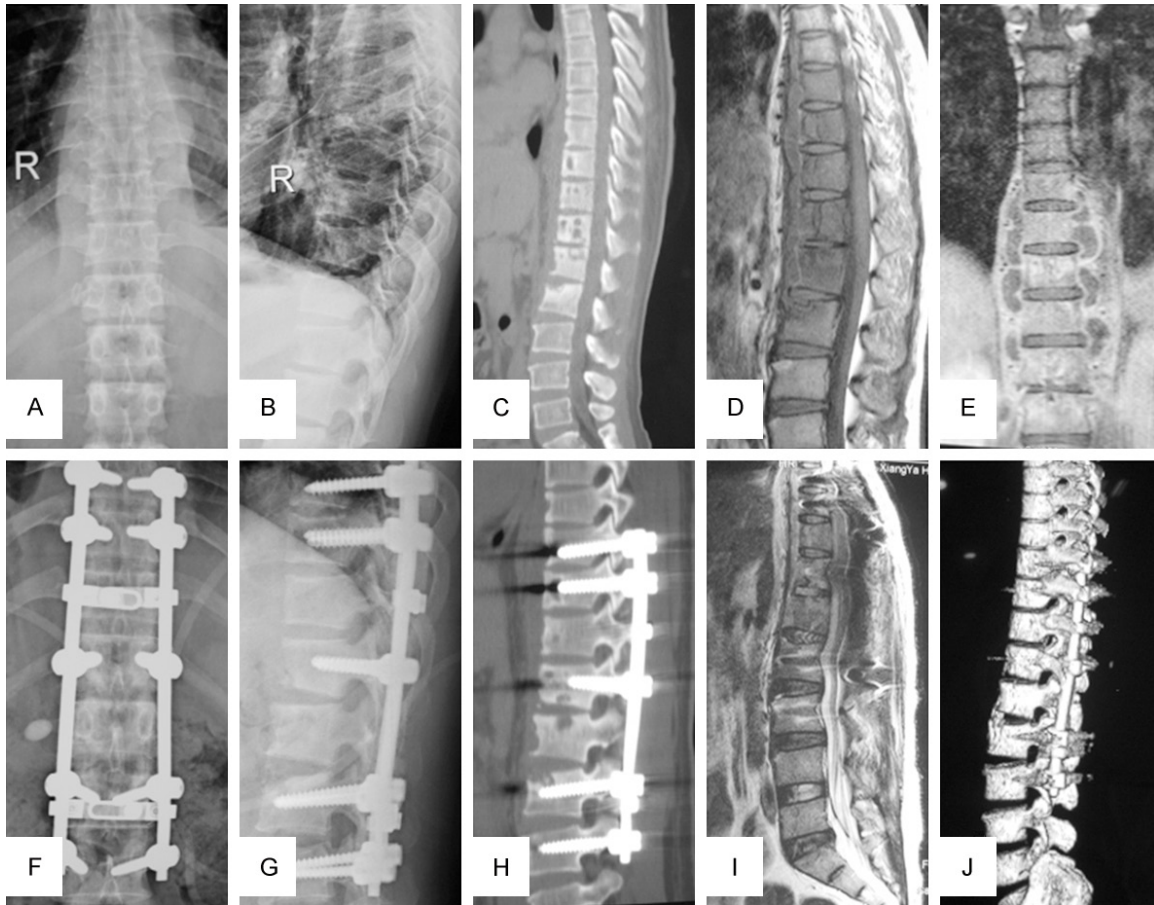


**Figure 1.** A 24-year-old female T12-L2 lesions with bone destruction and formation of epidural cold abscess and kyphotic deformity. We performed single-stage posterior instrumentation, transforaminal thoracic debridement and decompression without any bone fusion. A. Sagittal T2 weighted MR image showing tubercular spondylitis involving the thoracolumbar junction and the degree of spinal canal compromise; B-D. 3D CT image showing the amount of destruction of the T12, L1 and L2 vertebrae, lesions primarily sited in central and posterior column of the spine; E, F. Plain radiograph (A-P and lateral view) showing pedicle screw instrumentation of L2 and L3 proximally and T11 vertebrae distally (early postoperative 3months); G, H. Plain radiograph (A-P and lateral view) showing rigid fixation and solid intervertebral bone fusion with acceptable sagittal profile during the final follow-up.

brace [12]. All of the patients were examined clinically and radiologically at 3, 6 and 12 months after surgery and then once a year and reviewed liver function on a regular basis. The STB was considered as cured when patients presented no back pain and no fever, clinical examinations showed no tenderness or spasm, laboratory tests indicated that ESR and CRP returned to normal and no anaemia and hypoproteinemia and definitive bone fusion was obvious on the follow-up radiographs.

#### *Follow-up index and statistical analysis*

For all cases, the following indexes were recorded pre-, postoperatively, and during the follow-up: (1) kyphosis angle: observing the lateral X-ray, two lines are drawn, one through the superior surface of the first normal vertebra cephalic to the lesion and one through the inferior surface of the first normal vertebra caudal to the lesion. Perpendiculars are then drawn from these lines, and the angle is measured at



**Figure 2.** A 37-year-old male T9-L2 lesions with bone destruction and formation of bilateral paraspinous abscess. We performed posterior instrumentation and debridement without any bone grafting. A, B. Plain radiograph (A-P and lateral view) showing no obvious abnormalities as normal vertebral; C. 3D CT sagittal image showing the amount of destruction from T9 to L2 vertebrae, worm-eaten empty lesions primarily sited in anterior and central column of the spine; D. Sagittal T1 weighted MR image showing no obvious spinal compression; E. Coronal MR image showing bilateral paraspinous abscess from T9 to L2 vertebrae levels; F, G. Plain radiograph (A-P and lateral view) showing pedicle screw instrumentation of L2 and L3 proximally, T12 medially and T9 and T10 vertebrae distally (early post-operative 3 months); H-J. Twenty months postoperative MRI and CT showing internal fixation in good position, no obvious loss of kyphosis, and no paraspinous abscess.

their intersection; (2) neurological status; (3) erythrocyte sedimentation rate (ESR). Using SPSS 19.0 software, kyphosis angle and ESR were statistically analyzed by paired t test pre-, postoperatively and during the follow-up and neurological function was statistically analyzed by Wilcoxon signed rank test pre-, postoperatively and during the follow-up. Discrepancy of the normal distribution was analyzed by a rank-sum test with a significance level of 0.05 (**Table 2**).

## Results

### Basic condition

The blood loss was 450-950 ml, with mean blood loss of 653.6 ml; the operation time was

115-225 min, with mean operation time of 164.1 min; the hospitalization time was 15-22 days, with mean hospitalization time of 18.2 days. There are some complications, such as water-electrolyte imbalance in two cases, superficial infection in one case and bundle-like numbness of the chest and abdomen in nine cases after operation. No complication related to instrumentation was observed postoperatively; the symptoms disappeared after the patient was performed anti-inflammatory or symptomatic supportive treatment for 2-4 weeks.

### Neurologic function and pain

Neurologic deficits in all patients were improved at final follow-up examination. The results were

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evaluated by ASIA classification: three cases improved by two grades, five cases improved by one grade and all of them had reached E grade during the final follow-up. Statistical analysis demonstrated that there was significant difference between pre-operation and final follow-up ( $P < 0.05$ ) (**Table 2**). Ten patients had no recurrence of tuberculosis but one relapsed and all had pain relief.

### *Kyphosis deformity*

The kyphosis angle was  $9.2-40.4^\circ$ , with mean kyphosis angle of  $27.8^\circ$ , preoperatively; it significantly decreased to  $7.1-12.5^\circ$  with mean kyphosis angle of  $9.6^\circ$ , postoperatively ( $P < 0.05$ ). The kyphosis angle was  $7.5-16.5^\circ$  with mean kyphosis angle of  $12.6^\circ$  at final follow-up, whose loss of correction was mean  $3.1^\circ$  (range  $0.2-4^\circ$ ). It still significantly improved in comparison to the preoperative measurements ( $P < 0.05$ ) (**Table 2**).

### *Bone graft fusion*

Lateral X-ray or CT was used to assess the fusion and the formation of a bone bridge. The anterior vertebra lesion healed through sound bone fusion in all cases, which were confirmed by two different surgeons based on the modified criteria of Lee et al [13] for radiological fusion. Radiographically, fusion was considered as definitive when definitive bony trabecular bridging across the interface of adjacent vertebra, no movement (less than  $3^\circ$ ) on a flexion-extension radiograph and no gap at the interface.

### *Erythrocyte sedimentation rate*

The average pretreatment ESR was  $51.7$  mm/h ( $30$  to  $83$  mm/h), which got normal during the final follow-up in all patients. There was a statistical difference between preoperative ESR and during the final follow-up ESR ( $P < 0.05$ ) (**Table 2**).

## **Discussion**

To our best knowledge, MCTLST was characterized by following features compared with single-segment thoracolumbar STB: 1) Spread widely to involve multiple vertebral bodies and intervertebral disc tissues, which can form a larger paraspinal abscess or sinus; 2) The

extent of severity of lesions is different, the focal center of the vertebral body is severely damaged, where abscess or caseous necrotic tissue would compress the spinal dural sac and both ends of the lesions is the lighter, where frequently appears worm-eaten empty damage; 3) Poor spinal stability and focal or multi-lesion segments kyphosis deformity; 4) Longer course, more complications, higher morbidity and poorer general condition, such as hypoproteinemia, anemia, etc. While formal and sufficient anti-TB chemotherapy, strict bed rest and supportive therapy is the most basic methods of treatment of STB, when patients predisposed to bone destruction, sequestrum formation, paraspinal abscess and nerve compression, conservative regimes will yield to surgical approaches.

There is consensus on medical management of single segment STB; however, there are quite a few controversies on surgical management of multilevel STB. Some people recommend conservative treatment others focus on anterior, posterior or combined surgeries. Some researchers insisted that the anterior approaches allows direct access to the focus, thorough debridement and convenient bone grafting [14-17], however, poor spinal stability, low fusion rate, high frequent pseudarthrosis, easy recurrence of TB, ineffective correction of kyphosis and presentation of the correction and unsatisfactory neurological function after operation overwhelm its advantages, moreover, anterior exposure of the thoracolumbar spinal region which is blocked by major vessels and nerves presents a significant challenge to the spine surgeons, especially, when destruction by infection leads to kyphosis [7, 13, 14, 18]. The combined anterior and posterior surgery becomes popular due to its satisfactory clinical outcomes [14, 19], while the patients of MCTLST usually with poor condition and severe complication are difficult to tide over the terrible trauma, such as larger loss of blood, longer operation time and complications related to anterior approach [20-22]. Of course, the arguments above are mandatory in treatment of patients with severe kyphosis or kyphosis with healed lesion and patients with late-onset paraplegia or spinal cord degeneration. However, they are not necessarily suitable to management of early-onset paraplegia, mild angular deformity (less than  $50^\circ$ ) or light destruc-

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tion. There was quite few literature reported in surgical management of MCTLST via only posterior instrumentation combined with posterior debridement and/or decompression without anterior or posterior bone grafting.

The anterior column is prone to be affected by *mycobacterium tuberculosis* and controversies about applying the only posterior fixation combined debridement and/or decompression without any fusion in treatment of MCTLST may focus in whether isolated posterior instrument without any fusion can maintain long-term spinal stability; whether the surgeons can perform focal debridement and anterior decompression completely on the circumstance of limited visual field; whether it would destroy the spinal stability due to damaging posterior column of spine and so on. The following characteristics can solve the above doubts: 1) The pathology of early tubercular spondylitis involves the presence of granulation tissue, edema, and abscess formation which have been shown to regress following chemotherapy. With chemotherapy, spontaneous inter-body bony healing has been observed to occur without anterior surgery [3, 10]. Natural history studies have also shown that STB can lead to bony inter-body fusion once the intervertebral disk has been destroyed by infection [9]. While, healed intervertebral bone fusion is essential for effective load transferability. What's more, based on the scope of vertebral destruction and the extent of vertebral osteoporosis, the fixed segments can be extended to increase stability in axial compression, flexion, lateral bending, extension, and clockwise or anti-clockwise rotations; 2) This approach creates enough operating space through resection of both side of the facet joint and diapophysis allowing operation on the vertebral body at a 360 degree angle under direct visualization of the outside of the dura mater for thorough removal of the focal TB and complete spinal decompression without injuring the spinal cord, which have been shown to reduce the required amount of intraoperative anesthetic and it helps to avoid the possible intra and post-operative complications that maybe associated with the anterior exposed and debrided. We sacrificed nine patients' nerve roots on the focal side for better exposure and they would get a normal level in ASIA classification during the final follow-up by using gangliosides, acupuncture and moxibustion. To our

knowledge, mycobacterium tuberculosis cannot be completely cleared no matter which surgery [7, 23], but the removal of clinically relevant compression as much as possible is the key to treatment of STB. In our study, paraspinal abscess, if there is, will be conquered by appropriate pressure washing and postural drainage. 3) Healed bone fusion in anterior and central column of the spine can play a major role in resistance to the vertical compressive stress, torsional force, shear force from the spine and sharing the part load of the internal fixation system, which avoid too stress to focus on the internal fixation screws and prevent the emergence of kyphosis recurrence and late-onset paraplegia. Interactionally, some pressure from internal fixation at endplates interface will served as very relevant biomechanical indicators of biological phenomena, such as bone fusion [24], therefore, although the posterior column of spine was damaged, healed bone fusion combined with fixed instrumentation was in full compliance with the requirements of the biomechanics of the spine. Therefore, in our study, we kept viable bone tissue as much as possible and scraped the surface of the sclerotic bone to the bleeding sub-healthy bone tissue without complete resection during operation and all patients achieved bone fusion within 9-11 months after surgery. However, there was one case suffered from the recurrence of STB due to termination of administration of ant-TB drugs at the sixth month of follow-up and presented with relatively large loss of correction of kyphosis deformity. Under the right guidance, the patients continued oral anti-TB drugs and loss of correction terminated during one year of follow-up.

However, this surgical approach has three limitations. First, the cases in our study were relatively less and the range of indications for this surgery was relatively narrow; second, there are aggravated risks of spinal cord injury with decompression; third, anteriolateral debridement was difficult to complete. However, we suggest that posterior instrumented fusion alone is sufficient due to the following reasons: 1) Valid anti-TB drugs are available at present to sterilize mycobacterium tuberculosis without the need for aggressive anterior debridement or fusion; 2) Complications related to anterior approaches to thoracolumbar spine could be avoided; 3) The posterior instrumentation could

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fully serve to correct the angular deformity and minimize the loss of correction, combined posterior debridement and/or decompression, while anterior body lesion is healing spontaneously; 4) Paraspinal abscess, if there was, could be drained by skillfully performing pressurewashing and postural drainage.

The authors consider that the methods reported above are feasible; therefore, the following points should be emphasized when adopting it: a) Careful and strict selection of patients is essential; b) Application of the intraoperative electrophysiological monitoring, such as computer navigation monitoring system, so that the subjective factors can be ruled out and make sure the security for spinal cord during debridement, decompression; c) Master postural drainage technology during operation and place the drainage tube after operation in the treatment of abscess; d) Immobilization for 6-8 weeks and ambulation with a suitable brace for 6-8 weeks are necessary; e) Regular chemotherapy and supportive care are always the key to cure of STB.

### Conclusion

In our study, isolated posterior instrumented fusion was adequate in correction of angular kyphosis and prevention of correction. Without anterior or posterior or posterior-lateral bone fusion, our patients had achieved satisfactory spinal stability since the fact that the intervertebral fusion was spontaneously healed occurred. However, the cases in our study were relatively less and the range of indications for this surgery was relatively narrow, therefore, a large number of patients and longer follow-up will be required.

### Disclosure of conflict of interest

None.

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