

Comparison between the antero-posterior and posterior only approaches for treating thoracolumbar tuberculosis (T10–L2) with kyphosis in children: a minimum 3-year follow-up

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Abstract

Purpose There are few papers in the literature comparing outcomes between antero-posterior and posterior-only approaches for treating thoracolumbar tuberculosis (T10–L2) in children

Methods We performed a retrospective review of 47 children who were diagnosed and treated as thoracolumbar tuberculosis (T10–L2) in our department from January 2005 to June 2009. Forty-seven cases of thoracolumbar tuberculosis were treated by two different surgical approaches. All the cases were divided into two groups: 25 cases in group A underwent one-stage posterior debridement, transforaminal fusion, and instrumentation, and 22 cases in group B underwent anterior debridement, bone graft, and posterior instrumentation in a single- or two-stage procedure. Two approaches were compared in terms of average operative time, blood loss, hospitalizations, bony fusion, intraoperative and postoperative complications, the Oswestry disability index score, neurological status, and the angle of kyphosis.

Results All 47 patients (24 M/23F), averaged 9.1 ± 2.6 years old (range 5 to 14 years), who were followed up for mean of 49.3 ± 8.6 months (range 36 to 65 months). Spinal tuberculosis (TB) was completely cured, and the grafted bones were fused in 9 months in all cases. It was obviously that the average operative time, blood loss, hospitalization, and complication

rate of group A was less than those of group B. Good clinical outcomes were achieved in both groups.

Conclusions Both the antero-posterior and posterior approaches can effectively heal T10–L2 vertebral tuberculosis, but the average surgical time, blood loss, complications, and hospital stay following the posterior approach are prominently less than those following the antero-posterior approach. It might be a better surgical treatment for thoracic spinal tuberculosis in children with poor health status, especially for cases in early phase of bone destruction and/or mild and moderate kyphosis.

Keywords Children · Thoracolumbar tuberculosis · Antero-posterior · Posterior-only

Introduction

The thoracolumbar junction (TLJ), which includes the T10–L2 region, is a common site for various spinal pathological processes including fracture, neoplasm, and infection. Thoracolumbar spinal lesions can result in neurological deficits, instability, and other adverse sequelae due to significant anterior compression of the neural tissue. Spinal tuberculosis (TB) is one of the most common severe spinal diseases that usually cause neurologic deficit, kyphotic deformity, and even spinal cord compression, especially in thoracolumbar, which is the most commonly affected site in spine (30 %) [1]. Thoracolumbar spinal tuberculosis in children—which is characterized as involving more vertebrae—causes severe kyphosis deformity, and spinal cord compression had the worst prognosis with the greatest deterioration during the active phase [2]. The aims of spinal tuberculosis treatment are to eradicate disease, to prevent the development of paraplegia and kyphotic deformity, to manage the existing deformity and neurological deficit, to allow early ambulation, and to

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return the patient back to daily life [3]. The therapeutic strategy for thoracolumbar tuberculosis in children includes conservative and operative treatments. Antituberculous chemotherapy is the mainstay of spinal TB treatment, but it has been found to be ineffective in preventing the progression of the deformity.

Various surgical treatments have been performed on children with spine tuberculosis: anterior, antero-posterior, and posterior approach [4–9]. Currently, posterior instrumentation has become popular as a technique to correct angular deformities and stabilize an unstable spine. However, the posterior-only approach remains controversial because it may affect posterior spinal column stability [10, 11], especially the skeletal immaturity of children. In addition, thoracolumbar lesions—the junction region of thoracic lesions and lumbar lesions—had the highest propensity to develop morphological changes likely to predispose to deformity progression in children with spinal tuberculosis [12]. Severe kyphosis is more often a complication of childhood spinal tuberculosis than of adult disease [2, 13]. We found that there is a lack of clinical studies comparing the antero-posterior approach (AP) with the one-stage posterior-only approach (P). Therefore, this study aimed to review and compare the efficacy of the two approaches. Our study may be of benefit to the field.

Materials and methods

The study was approved by the ethics board committee of our hospital, and the written informed consent for participation in the study was obtained from children and their patients. This was a retrospective, clinical, comparative study. From February 2005 to July 2009, 47 children of the TLJ tuberculosis received surgical treatment. In group P ($n=25$), the posterior-only approach was combined with debridement, transforaminal fusion, and instrumentation. The remainder ($n=22$) received posterior internal fixation, anterior debridement, and fusion in a single- or two-stage procedure and were used as the control group (group AP). Detailed patient characteristics for the two groups were similar (Table 1). The diagnosis of TB spondylitis was based on clinical presentation, radiologic findings (plain radiograph, computed tomography, and magnetic resonance imaging), hematologic examination, and pathological examination. Erythrocyte sedimentation rate (ESR) was used to evaluate whether the lesion was active or the disease was healed. American Spinal Injury Association (ASIA) classification was used to assess the neurological compromise function. Clinical outcome was assessed preoperatively and at the last follow-up visit using the Oswestry disability index (ODI) questionnaire [14]. Kyphotic angle was measured by drawing two lines—one was along the top surface of the immediate upper normal vertebral body, and the other was away from the diseased segment. The bone fusion was assessed by the Moon standard

Preoperative management

Two to 4 weeks preoperatively, the most common antituberculous chemotherapy was a combination of isoniazid (5–10 mg/kg/day, with no more than 300 mg/day), rifampicin (5–10 mg/kg/day, with no more than 300 mg/day), and ethambutol (15 mg/kg/day, with no more than 500 mg/day). Chemotherapy was usually administered for 1 year after surgery on an outpatient basis. When the erythrocyte sedimentation rate (ESR) and temperature returned to normal or had significantly decreased and anemia and hypoproteinemia were rectified completely, surgery was performed. Children with progressive neurologic deficit received additional intravenous isoniazid (0.4 g/day) for 3 days preoperatively.

Surgical procedure

In group A, all patients were operated under general anesthesia in the prone position. Through posterior debridement, fusion and internal fixation were performed in a single stage [7]. The posterior spinal elements including lamina, facet joints, and transverse processes were exposed (extraperiosteal dissection) extending one vertebrae above and below the involved segments. Then, debridement and spinal cord decompression were performed (Fig. 1).

In group B, firstly, posterior internal fixation without fusion was performed; then, anterior debridement and titanium mesh fusion were applied in single- or two-stage procedure, as described by Huang et al. [8] (Fig. 2).

Postoperative procedure

The drainage tube was removed when the amount of drainage was less than 30 ml/day postoperatively. Patients were permitted to ambulate after remaining supine for 15 to 20 days postoperatively. We recommended that the bracing apparatus until bony fusion was observed on radiography. All children received antituberculous chemotherapy regimen for 12–18 months after the operation. Liver function and ESR rates were monitored carefully at regular intervals. Follow-up examinations were performed at 3 months, 6 months, 1 year, and last follow-up. Subsequent follow-ups were conducted at 12-month intervals. For the statistical analysis, chi-squared test and *t* tests were used, and a *p* value <0.05 was considered statistically significant.

Result

The mean duration of follow-up of all patients was 49.3 ± 8.6 months (range 36 to 65 months).

Table 1 Clinical data on the patients of two groups

	Group P (n=25)	Group AP (n=22)	p value
Gender			0.439
Male	11	13	
Female	14	9	
Age (years)	9.3±2.9	8.9±2.3	0.115
Average time to stand (days)	7.6±1.3	12.5±2.5	0.003
Operation time (min)	142.6±29.5	359.3±96.2	0.000
Amount of bleeding (ml)	520.0±180.3	877.3±123.2	0.04
Duration of follow-up (months)	47.3±8.4	51.7±8.5	0.082
Fusion time (months)	4.8±1.5	6.4±1.8	0.618
ASIA classification (preoperation)			0.561
B	3	2	
C	8	9	
D	11	10	
E	3	1	

Operative results

Average operative time, amount of bleeding, and average time to stand for groups AP and P were 142.6±29.5 vs 359.3±96.2 min, 520.0±180.3 vs 877.3±123.2 ml, and 7.6±1.3 vs 12.5±2.5 days, respectively. Group P were obviously less than those of group AP (Table 1). The operative complication rate of group P was obviously less than those of group AP (Table 2). Wounds healed without chronic infection or sinus formation.

Table 2 Outcomes of two different surgical treatments for lumbosacral tuberculosis

	Group P	Group AP	p value
Kyphosis angle			
Preoperative	38.1±5.1	41.2±4.3	0.624
Postoperative	7.4±1.3	8.2±1.4	0.066
Final follow-up	8.5±1.5	9.3±1.0	0.076
Loss of correction	1.2±0.7	1.0±1.2	0.534
ASIA classification			0.683
D	3	3	
E	22	19	
ODI			
Preoperative	45.2±2.9	43.4±3.5	0.064
Final follow-up	12.3±3.4	10.8±3.5	0.140
Complications			0.414
Intercostal nerve injury	0	1	
Water–electrolyte imbalance	2	1	
T12 dorsal ramus injury	0	2	
Tuberculous pleurisy	0	1	

Radiographic results and laboratory examination

Preoperative, postoperative, and last follow-up of Cobb angles for groups P and AP were 38.1±5.1° vs 41.2±4.3°, 7.4±1.3 vs 8.2±1.4°, and 8.5±1.5° vs 9.3±1.0°, respectively. Bony fusion was achieved in both groups, with an average fusion time of 5 and 4 months, respectively. The mean correction loss was 1.2±0.7° vs 1.0±1.2°, respectively (Table 2). The ESR decreased gradually after surgery and returned to normal in all patients within 3 months.

Recovery of neurological functions

No neurological deterioration was recorded in any children postoperatively. There were 43 cases who suffered neurologic insults before surgery, most recovered after surgery. There were no significant differences in improvement rates in the ASIA classification (Table 2).

Clinical outcome

Mean ODI scores were 45.2±2.9 vs 43.4±3.5 before and 12.3±3.4 vs 10.8±3.5 after the operation for groups P and AP, respectively.

Discussion

Thoracolumbar lesions—the junction region of thoracic lesions and lumbar lesions—had the highest propensity to develop morphological changes likely to predispose to deformity progression in children with spinal tuberculosis [12]. Chemotherapy remains the mainstay in the management of

children spinal TB, yet it cannot prevent the progression of kyphotic degeneration. Hence, timely and effective surgical intervention is essential. Indications for surgery are spinal instability, severe and/or progressive kyphosis, neurological deficit, no response to chemotherapy, and nondiagnostic and large paraspinous abscess [15]. In the clinic, however, there is still controversy over the strategy for thoracolumbar TB surgery. The thoracolumbar junction (T11–L2) poses an anatomical dilemma to spine surgeons during lateral approaches given the presence of the lower rib cage and the diaphragm, which is sandwiched between the pleura and peritoneum. Multiple surgical approaches have been described to access this area, from conventional anterior-only to more minimally invasive techniques: posterior-only as well as anterior-posterior approaches.

Generally, the lesion is usually located in anterior column; thus, anterior approach is considered better in view of decompression and fusion. However, the procedure may result in progression of kyphosis as a consequence of failure of the bone graft [16–19]. In children with spinal tuberculosis, anterior radical debridement destroys the anterior growth and limits the capacity for spinal remodeling, which leads to progressive kyphosis [20]. Also, this procedure has not been

successful in preventing the progression of kyphosis or correcting the preexisting kyphosis [16, 18]. In view of this, an additional posterior instrumentation was applied by some surgeons [8, 10, 21–23] who have advocated this procedure. Its advantage lies in keeping the TB focus away from the instrument and fusion region, thus reducing the incidence of intraspinal infection. Also anterior abscess formation or multilevel involvement is essential, where an anterior debridement is mandatory. Even in cases of failure of union or reoccurrence in the tubercular focus region, the posterior fusion is not influenced, and the second stage revision surgery is comparatively easier [24]. Disadvantage of the AP approach are also obvious. The results of the present study demonstrate that with two positions and two incisions being used in the procedure, a longer operation time (359.3 ± 96.2 min), larger amount of bleeding (877.3 ± 123.2 ml), larger wounds, and prolonged bed rest (12.5 ± 2.5 days), the AP approach may not be tolerated by children <5 years who have a poor general state of health.

Currently, literatures on treating spinal tuberculosis in children by posterior procedure have been reported [7, 25–28]. However, Jain and Tuli [10, 11] consider that posterior approaches are unsafe because the posterior approach may destroy the healthy posterior spinal column, which may lead to

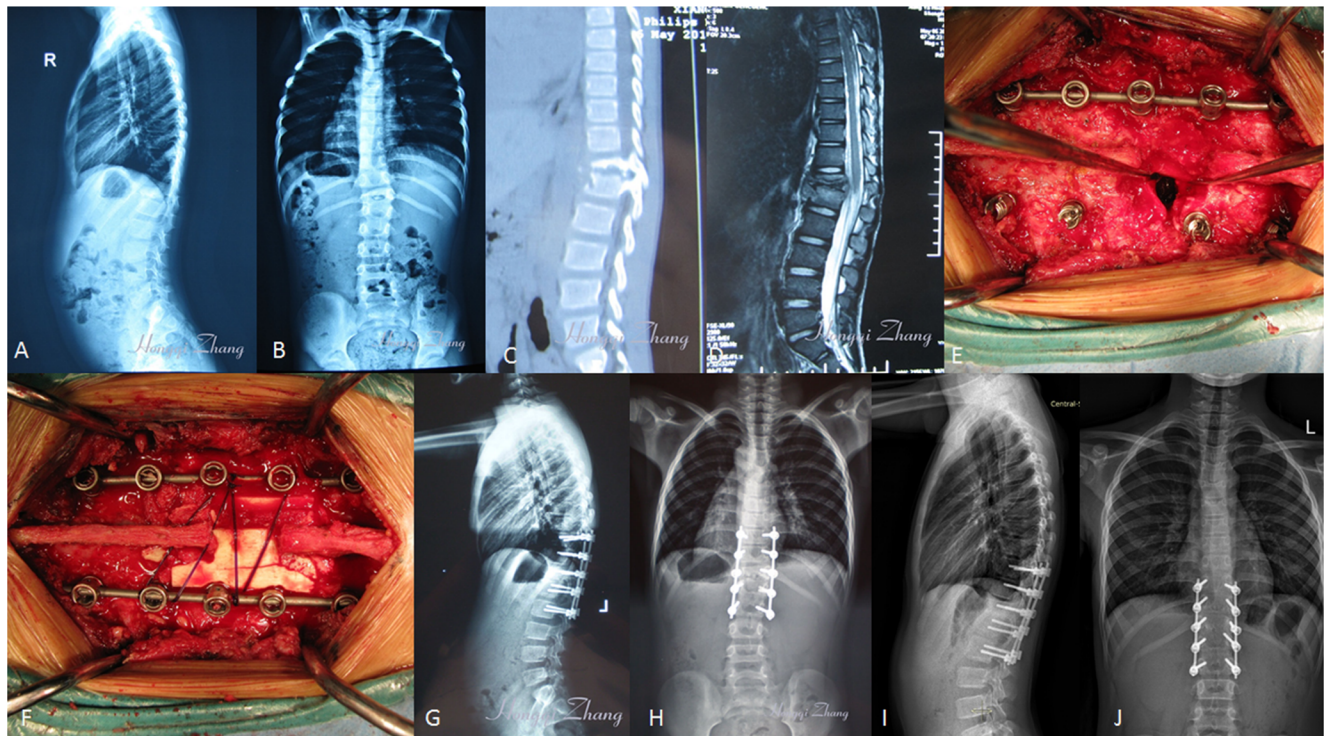


Fig. 1 An 11-year-old boy was diagnosed as having tuberculous spondylitis after a 7-month history of severe back pain. The infection has been resistant to chemotherapy for 3 months. The destructive changes seen at L1–L2 on plain radiographs were progressive, and the lumbar kyphotic angle was 49.6° (a–d). The lesion around the vertebral body of L1–L2 developed a great abscess with marked bony destruction. The abscess involved into the spinal canal with cord compromise resulted

in neurologic deficit. We performed one-stage posterior debridement, transforaminal lumbar interbody fusion, and instrumentation (e, f) from T11 to L3, the postoperative lumbar kyphotic angle became 8.0° (e, f). Follow-up MRI showing complete resolution of epidural abscess and decompression of neural component (g). Forty months after surgery, lateral radiographs show good bone fusion and maintenance of the correction (h, i)

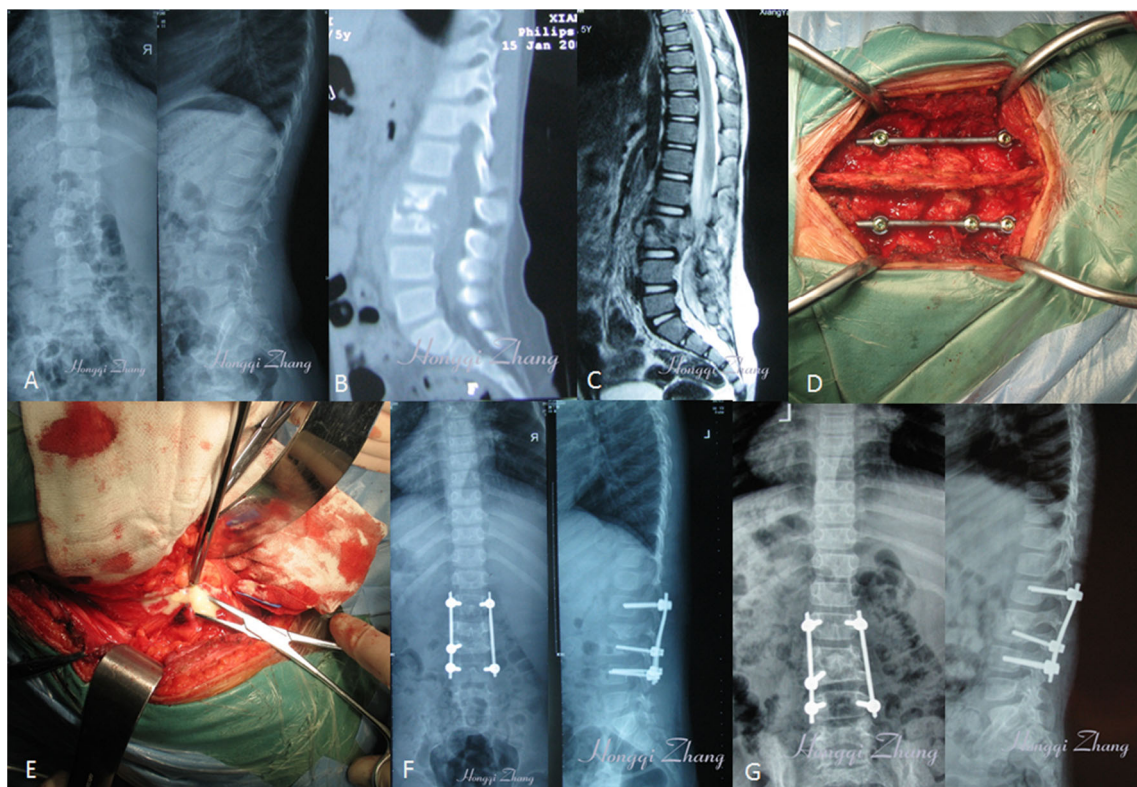


Fig. 2 An 5-year-old boy was diagnosed as having tuberculous spondylitis. The lesion around the vertebral body of L2–L3 developed a great abscess with marked bony destruction. We performed a posterior instrumentation from L1 to L4. Two weeks after the first operation, anterior debridement and allograft was performed on the patient (d, e).

Three months after surgery, lateral radiographs show good bone fusion and maintenance of the correction (f). The X-ray found that the anterior infected site had healed and bony union was achieved at the final follow-up (g)

spine instability. In addition, progression from thoracic kyphosis to lumbar lordosis at T12 leads to transfer of weight from the posterior aspect to the anterior aspect of the spinal column which results in increased stress at this level. Moreover, many studies have shown a direct correlation between sagittal spine imbalance and severity of back pain [29, 30]. Posterior long-segment instrumentation, which is a rigid stabilization system, can provide better kyphosis correction and is beneficial to the stress dispersion which effectively prevents implant failure. Also, it can achieve relief of pain due to spinal instability. Meanwhile, a supplementary posterior short-segment fusion was applied to inhibit the overgrowth of posterior elements, which can balance the growth ratio between anterior height of fusion mass and posterior height of fusion mass and to prevent an increase in kyphosis during the growth period [12, 18, 31]. Lastly, reconstruction of spinal stability is beneficial to heal spinal tuberculosis and avoid recurrence [8].

In our middle-term follow-up results, although there was loss of correction in group P, the segmental stability of the spine was unaffected by this approach, which is consistent with the other efforts reported [7, 25–28]. The majority of patients achieved pronounced improvement in daily activities and neurologic deficits. Some scholars hold that the posterior approach could lead to intraspinal infection and central

nervous system complications of TB infection, such as TB meningitis [25, 26]. In our research, this case did not happen, which is consistent with the other efforts reported [7, 25–28].

Posterior-only approach surgery provided adequate surgical space through resection of laminectomy, partial resection of the facet joints, and moderate stretch of nerve roots, at a 270° angle visualization for debridement, and the bony fusion 360° is also relatively fast. In this research, the rate and time of fusion in the two groups (4.8 ± 1.5 vs 6.4 ± 1.8 months) have no significant differences, which manifested that both groups achieved a reliable reconstruction of segmental stability.

In addition, minimally invasive surgery has become the direction of treatment for children's spinal tuberculosis. The surgery wasn't through thoracic cavity and mediastinum, as a result of the simple anatomical in the surgical approach. Through the posterior approach, debridement, fusion, and fixation can be accomplished simultaneously, and only one position and one incision are needed during operation. As a result, operation time is obviously reduced (142.6 ± 29.5 min), blood loss is decreased (520.0 ± 180.3 ml), and average time to stand is relatively short (7.6 ± 1.3 days). In our study, fewer complications happened in group P than in group AP, but this finding may be attributable to the small sample size. However, this approach can only be used with localized foci of no more than three levels and without

extensive formation of abscesses. It is difficult to remove complete antero-lateral debridement if the abscess is large and sticky [19].

Conclusion

Individualized treatment should be employed in treating TLJ tuberculosis. For carefully selected cases of thoracolumbar tuberculosis (T10–L2) in children, both approaches can successfully cure the disease. There were significant differences in operation time, blood loss, average time to stand, complications, or wound. Moreover, posterior-only approach alone cannot be used in cases of anterior abscess formation or multilevel involvement where an anterior debridement is mandatory.

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Compliance with ethical standards

Conflict of interests The authors declare that they have no conflict of interests concerning this paper.

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