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Original Article

Posterior-only versus combined posterior-anterior approaches for thoracolumbar spinal tuberculosis with neurological deficit in the elderly

Zhenchao Xu, Xiyang Wang, Zhengquan Xu, Hao Zeng, Zheng Liu, Yupeng Zhang, Gongzhou Chen

Department of Spine Surgery, Xiangya Hospital of Central South University, Changsha 410008, Hunan, People's Republic of China

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Abstract: *Objectives:* This retrospective case-control study aimed to compare two surgical approaches (posterior-only versus combined posterior-anterior) for treating thoracolumbar (T11-L2) spinal tuberculosis with neurological deficits, and to evaluate the clinical effectiveness of posterior-only surgery in the elderly patients. *Patients and Methods:* We retrospectively reviewed 30 cases of thoracolumbar spinal tuberculosis with neurological deficits between October 2009 and May 2014, including 16 cases treated with single-stage posterior debridement, decompression, interbody fusion, and instrumentation (group A). The other 14 cases treated with single or two-stage anterior debridement, bone grafting, and posterior instrumentation (group B). The clinical and radiographic outcomes were analyzed and compared. *Results:* The mean operative durations were 153.1 ± 18.5 minutes and 276.4 ± 17.4 minutes in groups A and B, respectively ($p<0.05$). The average hospital stay time was 13.6 ± 1.5 days for group A and 18.6 ± 3.4 days for group B ($p<0.05$). Average intraoperative blood loss volume was 781.3 ± 155.9 mL and 1250.0 ± 174.3 mL for groups A and B, respectively ($p<0.05$). All patients were followed up for an average of 41.2 ± 4.4 months (range 36-48 months). Bony fusion occurred after an average of 8.5 ± 1.6 months and 8.1 ± 1.9 months in groups A and B, respectively. The Cobb angle was significantly decreased in both groups after surgical treatment, but loss of correction occurred in both groups. Neurological status was significantly improved post-operatively in all cases ($p<0.05$). *Conclusion:* Posterior-only approach may result in fewer complications and provide a better quality of life than combined posterior-anterior approaches for thoracolumbar spinal tuberculosis with neurological deficits in the elderly.

Keywords: Thoracolumbar spinal tuberculosis, elderly, neurological deficits, posterior, interbody fusion

Introduction

Spinal tuberculosis (TB) is the most common extra-pulmonary manifestation of TB, accounting for approximately 50% of bone and joint TB [1, 2]. Spinal TB is a critical spinal disease that frequently causes severe damage, such as kyphotic deformity, neurologic deficit, paralysis, and even death [3]. Recently, with increases in population age and migration, the incidence of spinal TB has been rising in the elderly [4]. Anti-TB chemotherapy has become the mainstay of TB treatment and a majority of cases can be cured [5]. However, kyphotic deformity caused by spinal instability cannot be arrested by conservative treatment, and neurological recovery has been generally unsatisfactory [6, 7]. Furthermore, the anti-TB treatment in aged patients requires long-term immobilization and its effects are limited [8]. Thus, surgery is recommended for spinal TB in the elderly.

The ideal surgical approach for thoracolumbar spinal TB is controversial. The aims of spinal surgery are debridement, correction of kyphotic deformity, improvement of neurological function, and reconstruction of spinal stability. Traditionally, the anterior approach has been preferred since TB pathology mainly affects vertebral bodies and disc space, and this approach provides direct access to the infected focus and pathological site. However, it is difficult to expose the affected segments (T11-L2) using the anterior approach because of their special anatomic characteristics and positions [9-12]. Another combined posterior-anterior approach

Table 1. Clinical data of patients

	Group A	Group B
Gender		
Male	10	7
Female	6	7
Age (years)	70.3 ± 3.9	69.4 ± 3.1
During of symptoms (months)	5.9 ± 1.4	5.2 ± 1.5
Diseased segments		
T11/T12	4	4
T12/L1	6	5
L1/L2	5	4
T11/T12/L1	1	1
Comorbidities		
Hypertension	5	3
Coronary hearts disease	3	1
Diabetes mellitus	3	3
Hepatitis B	3	4
COPD	6	4
None of the above disease	1	2

Abbreviation: COPD, chronic obstruction pulmonary disease.

overcomes the stability-related drawbacks of the anterior-only approach [13], but is often associated with prolonged surgical times, increased blood loss, and more frequent complications, making it unsuitable for elderly patients with poor health [14, 15]. Recently, a single-stage posterior-only approach for spinal TB has been reported to obtain outcomes equally as good as anterior debridement and bone grafting [16, 17]. However, few studies have compared the effectiveness of the posterior-only approach and combined posterior-anterior approach for the treatment of thoracolumbar spinal TB with neurological deficits in the aged. In this study, we compared the clinical outcomes of these two methods in a group of elderly patients suffering from thoracolumbar spinal TB with neurological deficits, and evaluated the effectiveness of the posterior-only approach.

Material and methods

Basic characteristics of patients

Thirty patients diagnosed with thoracolumbar TB without active pulmonary TB and HIV between October 2009 and May 2014 were enrolled in this study. Written informed consent was obtained from each patient and this study was approved by the Xiangya Hospital Ethic Committee. We included 17 males and 13 females and the average age of patients was 69.9 ± 3.5 years (range, 65-78 years).

All patients presented with constitutional symptoms, including weight loss, fatigue, moderate fever, back pain, and variable degrees of neurological dysfunction. The average symptom duration was 5.6 ± 1.5 months (range 3-8 months). The preliminary diagnosis of TB was based on manifestations, laboratory examinations, X-ray, computed tomography (CT), and magnetic resonance imaging (MRI) findings. TB diagnoses were later confirmed by pathological examination and TB culture after percutaneous interventional puncture. Neurological status was evaluated according to American Spinal Injury Association (AISA) guidelines. Initial and preoperative pain was assessed using a visual analog scale (VAS). Comorbidities are summarized in **Table 1**.

The inclusion criteria were as follows: (1) Age over 65 years; (2) Progressive neurological deficit; (3) Persistent pain and bone destruction with limited paravertebral abscess; (4) Lesions confined to one segment or two adjacent segments and (5) Unsatisfactory response to conservative anti-TB treatment and ambulation.

The exclusion criteria were (1) Age under 65 years; (2) Congenital scoliosis or ankylosing spondylitis; (3) Lesions confined anterior column; (4) A wide range of prevertebral abscesses and (5) The destruction of multi-segmental vertebrae.

Preoperative procedure

Patients were administrated anti-TB chemotherapy, including isoniazid (300 mg/day), rifampicin (450 mg/day), ethambutol (750 mg/day), and pyrazinamide (750 mg/day) for at least 2 weeks before surgery and concurrent diseases were routinely controlled. The liver and renal function, erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP) levels were assessed to monitor drug complications and efficiency. Surgery was performed when anemia and hypoproteinemia were resolved, and body temperature returned to normal and ESR had significantly decreased.

Operative procedure

Patients who conformed to the surgical criteria were divided into two groups: groups A and B.

Group A (n=16) underwent surgery using one-stage posterior debridement, decompression, interbody fusion and instrumentation. Group B (n=14) underwent anterior debridement, bone grafting, and posterior instrumentation in a single-or two-stage procedures. The same team of surgeons reviewed the surgical indications and performed surgeries.

In group A, surgery was performed under general endotracheal anesthesia with patients in a prone position. With the assistance of c-arm fluoroscopy, pedicle screws were placed. The instrumentation extended one or two levels superior and inferior to the level of the affected vertebrae. Screws were also inserted in the affected vertebrae if the upper part of the vertebrae body was not destroyed. The screws were fixed to a temporary rod on the side of lesser neurological and radiological manifestation to avoid spinal cord injury during decompression and focal debridement. Various sizes and angles of curette were used to remove lesions through the healthy, bleeding bone from the posterolateral approach. Necrotic tissues were eliminated by intraoperative pressurized washing and negative pressure suction. The temporary rod was switched to the other side, and the same decompression and debridement were performed if the bilateral vertebral body was severely destroyed. The block-sized allogeneic bone with an appropriate shape was imbedded in the interbody. Autograft particulate bone obtained from cancellous bone which removed from spinous processes during decompression, mixing with allograft particulate bone, was implanted in the posterolateral vertebral body to promote bone fusion. Pedicle screws were connected by rods and compression was applied to correct the local kyphosis. Streptomycin (1.0 g) and isoniazid (0.3 g) were administered locally. The incision was drained and sutured as previously described.

In group B, posterior instrument without fusion was performed first, followed by anterior debridement and allograft in a single- or two-stage procedure. The anterior approach was performed with patients in a lateral decubitus positions with the more severely involved side upward, and an incision was made parallel to the posterior midline, 7-8 cm lateral to the spinous process, according to the tuberculosis lesion segment. The chest cavity or abdominal cavity was exposed according to the location of the lesion. The spinal TB lesions including paravertebral abscess, collapsed vertebrae, intervertebral discs were removed until healthy bleeding bone for spinal cord decompression. Suitable block-sized allogeneic bone was embedded in the thoracolumbar interbody to complete interbody fusion and restore normal height.

The debrided tissue from group A and group B were sent for mycobacterial culture and histopathological examination.

Postoperative management

Typically, the drainage tube was removed when drainage fell below 30 ml/24 h. Nutritional support and intravenous antibiotic therapy were regularly administered. Patients underwent anti-TB chemotherapy for 12-18 months postoperatively until an outpatient visit confirmed clinical recovery and bone graft fusion, and ESR and CRP returned to normal. With the assistance of a plastic orthosis, patients were allowed to gradually start walking four weeks post-operatively, according to the recovery of their lower limb muscle strength. Early rehabilitation training and physical treatments were performed to improve nerve function and prevent blood clots.

Follow-up evaluation

After surgery, routine blood ESR, CRP, hepatic and renal function tests were performed. X-ray (lateral and anteroposterior) or CT was performed to assess the extent of decompression and the position of the implant; CT was also used to classify the degree of bone healing. The following indices were obtained preoperatively and postoperatively and during follow up: (1) Cobb angle; (2) Angle loss rate, [(cobb angle at the last visit)-(postoperative Cobb angle)/(postoperative Cobb angle)] ×100%; (3) Neurological status (Frankel classification); (4) ESR and (5) VAS pain score.

Statistical analysis

Statistical analyses were performed using SPSS 17.0. Changes in laboratory and physical parameters in the two groups were compared using the Student-Newman-Keuls test. Any discrepancy in normal distribution was analyzed using the rank-sum test. A *P* value under 0.05

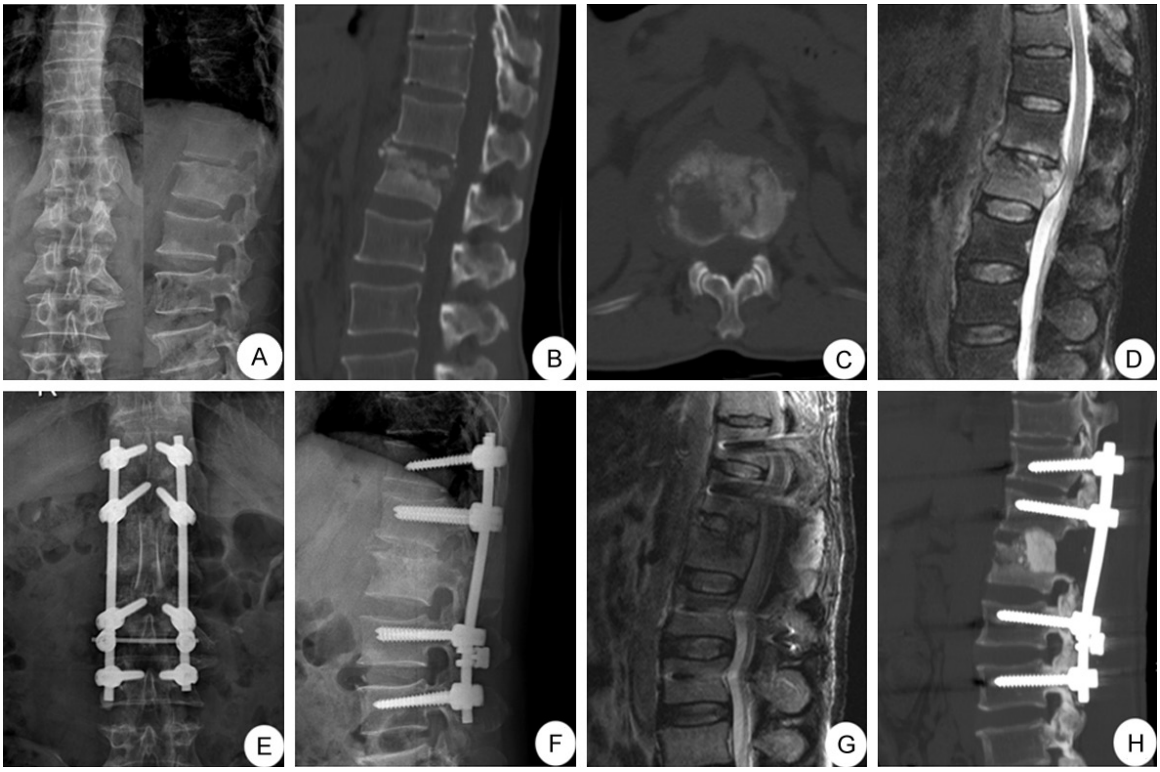

Figure 1. A 65-year-old male demonstrated lesions and received single-stage posterior decompression, debridement, bone grafting, and instrumentation. Preoperative images ((A) plain frontal and lateral, (B) CT lateral, (C) CT cross section, (D) T_2 MRI lateral) showed T12/L1 vertebral bodies' destruction with kyphosis deformity and spinal cord compression. Postoperative radiography ((E) plain antero-posterior, (F) plain lateral) showed that fixation was in good position and the kyphosis was improved. MRI ((G) T_2 MRI lateral) showed satisfied decompression of spinal cord without paravertebral abscess or relapse of spinal tuberculosis at the final follow-up. CT-scan ((H) CT lateral) showed satisfied bone fusion at the final follow-up.

was considered to indicate statistical significance.

Results

The clinical characteristics of patients did not differ significantly between the two groups (**Table 1**). The neurological status according to the American Spinal Injury Association (AISA) was grade B in 4 patients, grade C in 21, and grade D in 5 patients. The comorbidities included hypertension, coronary heart disease, hepatitis B, diabetes mellitus, and chronic obstructive pulmonary disease (COPD) (**Table 1**).

The mean surgical time, intraoperative bleeding volume and length of hospital stay in group A were significantly less than those in group B ($P<0.05$). The ESR and CRP returned to normal within 3 months in both groups. All grafted bones in group B patients achieved fusion at an average of 8.1 ± 1.9 months (range 6-12 months) (**Figure 2**). In group A, one case had delayed fusion but was cured by anterior debridement and catheter drainage. Patients ultimately obtained interbody fusion at 8.5 ± 1.6 months (6-12 months) (**Figure 1**). All patients were followed up for an average of 41.2 ± 4.4 months (range 36-48 months).

Pre- and post-operative neurological status is summarized in **Table 2**. At the final follow-up, the ASIA score of 11 patients in group A and 10 in group B returned to grade E. The remaining cases achieved grade D. Pre- and post-operative neurological status differed significantly between results in each group, but neither differed significantly between the two groups ($P<0.05$).

To evaluate these two surgical approaches for thoracolumbar spinal TB treatment, outcomes including surgical duration, blood loss, mean hospital stay, ESR, Cobb angle VAS score and fusion time were included in **Table 3**. Preoperatively, the average Cobb angles in groups

Figure 2. A 68-year-old female with T12/L1 lesions recevived combined posterior and anterior approaches. The pre-operative imaging data ((A) plain antero-posterior and lateral, (B) CT lateral, (C) CT cross section, (D) T_2 MRI lateral, (E) T_2 MRI cross section) presented with severe bone destruction, paravertebral abscess formation, and severe compression of spinal cord at T12/L1. The postoperative radiography ((F) plain antero-posterior and lateral) indicated that the kyphosis was improved. MRI ((G) T_2 MRI lateral) showed satisfied decompression of spinal cord without paravertebral abscess or relapse of Pott's disease at the final follow-up. CT-scan ((H) CT lateral) showed satisfied bone fusion at the final follow-up.

Table 2. Neurological recovery according to ASIA (Group A and Group B)

Preoperative	Group A/B	Final follow-up in group A					Final follow-up in group B				
		A	B	C	D	E	A	B	C	D	E
A	0/0										
B	2/2				2					2	
C	11/10				3	8				2	8
D	3/2					3					2
E	0/0										

A and B were 40.8° ± 7.3° and 39.7° ± 8.6°, respectively (P>0.05). And the Cobb angle decreased to 11.1° ± 2.2° and 10.8° ± 2.4° (P>0.05) postoperatively, respectively in these two groups. The preoperative and postoperative Cobb angles differed significantly in each group (P<0.05). Also, the postoperative Cobb angle, angle correction, loss of correct and angle loss rate did not differ significantly between the two groups (P>0.05, **Table 3**).

In this study, no loosening or breakage of internal fixations was observed. In group A, a unilateral psoas abscess possibly caused by irregular anti-TB treatment was observed in one patient who had delayed interbody fusion at 6-month follow up. The abscess was successfully treated by anterior debridement, catheter drainage and regular chemotherapy. At the 12-month follow up, solid fusion was achieved.

Four patients in group B experienced surgical complications. One incision was superficially infected with *Escherichia coli*, which was successfully cured with antibiotics. Another patient with chronic obstruction pulmonary disease suffered from lung infection was cured with antibiotics. One case with hepatitis experienced anti-TB drugs-induced liver damage was recovered after modified anti-TB drugs and hepatoprotective treatment. One patient had paralytic ileus, which was relieved by gastrointestinal decompression and nutrition support treatment. No infection in the spinal canal or

Table 3. Summary of treatment outcomes

	Group A	Group B	*P*-valve
Operation time (min)	153.1 ± 18.5	276.4 ± 17.4	<0.05
Blood loss (ml)	781.3 ± 155.9	1250.0 ± 174.3	<0.05
Hospitalization (days)	13.6 ± 1.5	18.6 ± 3.4	<0.05
Duration of follow-up (months)	40.4 ± 4.0	42.1+4.7	0.295
Cobb angle			
Preoperative	40.8 ± 7.3	39.7 ± 8.6	0.695
Postoperative	11.1 ± 2.2	10.8 ± 2.4	0.746
Angle correction	29.8 ± 6.2	29.1 ± 8.3	0.801
Final follow-up	13.1 ± 2.0	12.7 ± 2.6	0.630
Loss of correction	2.1 ± 0.6	1.9 ± 0.8	0.539
Angle loss rate (%)	19.6 ± 7.5	18.1 ± 7.7	0.598
Fusion time	8.5 ± 1.6	8.1 ± 1.9	0.577
ESR			
Preoperative	68.4 ± 15.6	72.7 ± 9.3	0.371
3-momth postoperative	9.7 ± 2.8	9.1 ± 2.7	0.544
VAS			
Preoperative	6.6 ± 1.1	6.6 ± 1.0	0.837
Final follow-up	1.5 ± 0.6	1.4 ± 0.5	0.502

development of severe neurological complication was observed in either group.

Discussion

Spinal TB can lead to permanent neurological deficits and kyphotic deformities [3, 18]. Despite the emergence of anti-TB drugs and implementation of public health policies to reduce transmission, spinal TB still remains prevalent and pervasive in some developing countries. TB affects susceptible individuals due to malnutrition and high population density, particularly elderly patients in poor health [5, 19, 20]. Diagnosis of TB in the elderly can be difficult because their symptoms are generally mild and concealed in the early stage, which delays accurate diagnosis and treatment (17). Due to the declining rate of tissue regeneration and immune function in this population, TB can present atypically in elders, and they may first treated for other diseases, such as intervertebral disc herniation, osteoporosis, spinal stenosis, and neoplasia [21]. Therefore, neurological deficits and even paraplegia from spinal TB are more common in elderly patients than other groups [22].

A large-scale prospective study carried out by The British Medical Research Council Working Party on the Spine TB treatment concluded that chemotherapy was sufficient to treat a majority of patients [23]. Most patients with spinal TB treated conservatively achieve good curative effects, particularly elderly patients who often suffer from multiple chronic diseases and poor health status, to avoid surgical risk and associated complications. However, on the one hand, chemotherapy generally achieves a low rate of fusion and high disease recurrence [5, 24]. On the other hand, for cases in which the vertebral body is destroyed and nerves are compressed, conservative treatment requires prolonged bed rest, which can cause severe complications and strongly affects patient quality of life. Moreover, a higher percentage of older adults die during conservative treatment [25]. Thus, surgical management is still necessary for focal TB debridement, neural decompression, spinal stability reconstruction and deformity correction. However, surgical approaches for treatment of thoracolumbar spinal TB with neurological deficits in the aged remains controversial [26].

In our study, 16 patients in group A underwent a posterior-only approach, which obtained better outcomes than the combined anterior-posterior surgical method. In comparison to other surgical methods, the advantages of posterior-only approach are manifold. First, posterior instrumentation can provide long-segmental and three-column fixation. The pedicle screw provides the most powerful stabilization of the spine, achieving great anti-torsion and anti-bucking support, successfully solving correction lost postoperatively [27]. Meanwhile, interbody and posterolateral bone grafting fusion increases the bone grafting fusion rate and reconstructs spinal stability, which makes this approach especially suitable for elderly patients with varying degrees of osteoporosis. Furthermore, lesion debridement, decompression and instrumentation can be performed simultaneously with shorter surgical time, less blood loss, less surgical trauma and less risk of nerve injury, which is also beneficial for elderly

patients win poor health. Finally, the posterior-only approach also results fewer complications, shorter hospital stays and lower costs.

Spinal TB lesions are mainly concentrated in the anterior column, and the posterior-only approach for spinal TB remains controversial as whether it can completely achieve focal debridement, and whether reconstruction of spinal stability can be effectively obtained is poorly understood [28]. The posterior approach has no advantages in terms of debridement, however under the precondition of standard anti-TB therapy, TB lesions may heal through spontaneous fusion, and complete debridement is not overly emphasized [29]. In our study we observed no significant difference between group A and B in deformity correction and bone fusion. However, neurological function was clinically improved by at least one ASIA grade in both groups after surgery, and 21 cases returned to normal level. All patients ultimately achieved solid bone fusion. In group A, the Cobb angle correction was 29.8° ± 6.2°; and the correction was satisfactorily reserved with only 2.1° ± 0.6° angle loss, which is consistent with previous reports [30, 31], proving the effectiveness of the single posterior approach. Although the rate of recurrence and diffusion were not studied, the current relevant literature suggests that such phenomenon is rare, and that standard anti-TB therapy is still beneficial for the majority of patients [29, 32].

Although the posterior approach provides promising results, careful selection of the patients is essential for this procedure. Because the anterior part of the spine carries 80% of the total spinal load, according to the "load-sharing" principle, it is very important to promote bone healing anteriorly while maintaining spinal stability. The following limitations should be emphasized when adopting the posterior method: (1) Lesions with limited abscess formation or lesions that could be thoroughly debrided; (2) Lesions are confined mono-segment or two adjacent segments; (3) The lesion area does not need long segmental bone grafting after debridement to restore spinal height; and (4) Epidural spinal canal stenosis with serious infected nerve root, and the pathological site is mainly confined to the intervertebral disc and vertebral rear. Spinal TB cases not suitable for this type of intervention include severe kyphosis, old healed TB lesions with residual deformity, a late-onset neurological deficit and multi-segment involvement with destructed vertebral bodies and a wide range of TB abscess. Combined anterior-posterior decompression, interbody fusion, and instrumentation can obtain optimal outcomes for these patients.

Due to controversy regarding the treatment of spinal TB in the elderly, each case should be considered individually. Due to decreased body resistance and low immune function in elderly patients, detailed and thorough examination before surgery is essential, and active concurrent diseases should be treated. During surgery, ECG monitoring, blood gas analysis, blood and plasma transfusion should be performed in a timely manner. After surgery, nutrition support is crucial and water and electrolyte balance should be taken into account.

One limitation of this study is that we only obtained these preliminary results in a relatively small group of patients, and some patients received short follow-up. Further studies with larger samples and longer follow-up are necessary to validate our findings.

In conclusion, single-stage posterior debridement, decompression, interbody fusion, and instrumentation represent an effective approach to treat thoracolumbar spinal TB with neurological deficits in the aged. The procedure causes less trauma, fewer complications, and has a more positive effect on kyphosis correction, achieves satisfactory neurological recovery, and spinal stability reconstruction.

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Disclosure of conflict of interest

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Address correspondence to: Xiyang Wang, Department of Spine Surgery, Xiangya Hospital of Central South University, 87 Xiangya Road, Changsha 410008, Hunan, People's Republic of China. E-mail: 3289405626@qq.com

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