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Treatment of Lumbar Tuberculosis by Mini-Open Anterior Approach Focal Cleaning Combined with Posterior Internal Fixation

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Background: The aim of this study was to evaluate the efficiency and clinical outcomes of mini-open anterior approach focal cleaning combined with posterior internal fixation compared to conventional anterior extraperitoneal approach focal cleaning combined with posterior internal fixation in the treatment of lumbar tuberculosis (TB).





Material/Methods: Medical records from 124 patients were collected from February 2010 to April 2015; patients were divided into two groups: group A (mini-open anterior approach focal cleaning combined with posterior internal fixation) and group B (conventional anterior extraperitoneal approach focal cleaning combined with posterior internal fixation in period I). The data on postoperative mechanical ventilation time, preoperative, postoperative, and last follow-up Cobb angle, visual analog scale (VAS), erythrocyte sedimentation rate (ESR), and Frankel classification were collected and analyzed. Operative complications, internal stability, and bone graft fusion were also observed.

Results: All patients were followed-up for 12 to 36 months (average 22.5 months). Seven cases (five in group A and two in group B) had side psoas abscess and were cured after secondary drainage surgery. The rest of the cases were all cured after primary surgery, with no formation of sinus, incisional hernia, cerebrospinal fluid leakage, or recurrence of spinal TB, with no TB symptoms. Bone graft fusion ranged from 3 to 8 months (average 4.7 months). Compared to group B, group A, which had less time on postoperative mechanical ventilation, had a higher VAS score. Both groups had distinct improvements in Cobb angle, ESR, and Frankel classification after surgery.

Conclusions: Treating lumbar TB by mini-open anterior approach focal cleaning combined with posterior internal fixation was safe and effective.

MeSH Keywords: **Internal Fixators • Lumbar Vertebrae • Surgery Department, Hospital**

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Background

Lumbar tuberculosis (TB) still occurs in both developing and developed countries including China and India; lumbar TB may cause kyphosis deformity, neurological deficits and complications, and paraplegia [1–3]. It can be difficult to diagnosis as it often occurs at an advanced stage, which causes a delay in establishing early diagnosis and good curative effect [4,5]. And at the same time, because there are no clear management strategies and the guidelines for lumbar TB, its treatment remains a challenge. Traditional treatment options [5–8] include anti-TB therapy, focal cleaning, and internal fixation at an earlier stage which may reconstruct the stability of spine and shorten the healing period. The best choice for internal fixation material of lumbar TB is a plate for the anterior and a pedicle screw for the posterior [9]. Furthermore, the method of pedicle screw fixation should be conducive to the patients' activities, and is more commonly used in thoracolumbar spinal TB as it is considered better and much more robust than plate fixation [10]. However, more segments are needed for posterior spinal fixation than for anterior fixation, which may impact the normal vertebral body. There is controversy over how to balance the use of these approaches in lumbar TB surgeries [11–13]. The objective of our study was to evaluate the efficiency and clinical outcomes of mini-open anterior approach focal cleaning combined with posterior internal fixation compared to conventional anterior extraperitoneal approach focal cleaning combined with posterior internal fixation.

Material and Methods

Clinical information

One hundred and twenty-four patients with lumbar TB, which was diagnosed by postoperative pathological examination and bacteriological culture, were analyzed in this study, including 76 male and 48 female aged from 20 to 85 years (average age 50.89 years). All of the patients had a paraspinal abscess initially, and were hospitalized at Integrated Chinese and Western Medicine Hospital of Zhejiang Province from February 2010 to April 2015. This work was approved by the Ethics Committee of Integrated Chinese and Western Medicine Hospital of Zhejiang Province. Written informed consent was obtained from all patients. The duration of follow-up was 5 to 22 month (average period 9.5). Patients had varying degrees of back pain, rigidity, and limitation in flexion and rotation. The patients were divided into two groups. Seventy-six patients were in group A, while 48 patients were in group B. The mini-open anterior approach focal cleaning combined with posterior internal fixation in period I was used in group A, and conventional anterior extraperitoneal approach focal cleaning combined with posterior internal fixation in period I was used in group B. Thirty-seven patients (22 patients in group A and 15 patients in group B) had nerve symptoms, such as lower limb numbness, asthenia, and sphincter disturbance. Nineteen patients (12 patients in group A and 7 patients in group B) had typical TB symptoms, such as low fever, night sweat, and hyperdynamic. There were no significant differences in sex, age, course of the disease, and segmental lesions between group A and group B ($p>0.05$) (Table 1).

Table 1. Comparison of clinical data between two groups with lumbar spinal tuberculosis.

	Group A	Group B	p Value
Cases	76	48	–
Sex (cases)			>0.05
Male	47	29	
Female	29	19	
Age ($\bar{x}\pm s$, year)	51.7 \pm 11.5	49.6 \pm 13.2	>0.05
Course ($\bar{x}\pm s$, month)	9.6 \pm 3.4	9.4 \pm 3.8	>0.05
Lesions segments (cases)			>0.05
L ₁₋₂	11	7	
L ₂₋₃	17	10	
L ₃₋₄	14	10	
L ₄₋₅	17	10	
L ₁₋₃	6	3	
L ₂₋₄	6	5	
L ₃₋₅	5	3	

Imaging examination showed that vertebral body and intervertebral disc were damaged and paravertebral abscess were observed. T2W1 scanning showed vertebral body compressed and distorted with the heterogeneous high signal. Stream high signal was seen in soft tissue space. The imaging diagnosis was in accordance with the manifestation of lumbar TB. There were 96 cases involving two vertebral bodies and 28 cases involving three vertebral bodies (shown in Table 1). Eleven cases (six in group A and five in group B) had sinus involvement. ERS, Cobb angle, Frankel classification [14] and VAS were evaluated on admission.

Inclusion and exclusion criteria

Inclusion criteria were as follows: spinal instability or kyphosis deformity; neurological impairment and paraspinal abscess; severe pain in the back or lumbar root pain; inefficacious conservative treatment.

Exclusion criteria were as follows: the destruction of L1 upper vertebral body and L5 lower vertebral body; thoracic vertebrae TB and sacral TB.

Anti-TB therapy

All patients had good compliance with TB medications. Isoniazid, rifampicin, pyrazinamide, and ethambutol were used for conventional anti-TB chemotherapy for two to four weeks. Individual anti-TB treatment was used for elderly patients who had abnormal liver functions and allergic reactions. Systemic nutritional support was strengthened. Blood transfusions were used to improve anemia if necessary. TB symptoms and erythrocyte sedimentation rate (ESR) changes were observed. The best operation time was considered to be when symptoms were alleviated, e.g., body temperature $\leq 37^{\circ}\text{C}$, hemoglobin $>100\text{ g/L}$ and ESR declined to 60 mm/hour.

Preparation for surgery

X-ray, CT scan, 2-D reconstruction, and MRI examinations were performed. Focal cleaning approach was chosen based on the range of vertebral destruction and location of the abscess. Individual fixation program was determined by unilateral or bilateral, upward or downward vertebral destruction, and whether there was interference from lesions for placed nail and focal cleaning.

Surgery assays

The blood test results and imaging performance determined the duration of the treatment. Patients were placed in the prone position. Posterior midline approach was done with affected vertebra as a center. Facet joints of both sides were exposed

by paraspinal muscle approach. Individual pedicle screws were placed into lesions according to the degree of preoperative vertebral damage.

Pedicle screws were 30–45 mm and placed in the upward or downward 1–2 normal vertebral. If there were two vertebral lesions, 2–3 pedicle screws were placed into vertebral, and pedicle screw was placed in the upward or downward 1 normal vertebral. If there were three vertebral lesions, 2–5 pedicle screws were placed into vertebral, and pedicle screw was placed in the upward or downward 1–2 normal vertebral. Distraction reduction and kyphosis correction were done by fixation system (Figure 1A–1G).

Patients were in right lateral position in group A. Anterior retroperitoneal approach was used in this study, an approach which is also called inverted “eight” incision. The procedures were as follows: skin incisions for lumbar vertebrae; incision of fibers of external oblique muscle; incision into fibers of internal oblique muscle; exposure of spine before ligation of segmental vessels. The specific method has been described previously [15]. The vertebra with TB was chiseled to show normal bone of the vertebra, with oozing of blood and without caseous material and sequestrum at the surface. Proper iliac bone autograft was cut out for the bone graft. Autologous bone graft was advocated as first-line treatment as it is easier to heal and has good histocompatibility, which can reduce infection. The donor site of the autologous bone graft was usually the ipsilateral ilium. Aseptic technique was used during surgery. When we harvested the bone grafts, disinfection was applied again around the donor site. Gelatin sponge wrapped with streptomycin was applied into the surgical area to kill any remaining mycobacterium TB. Finally, a drainage tube was placed and wounds were sutured.

Patients were in right lateral position in group B. Conventional extraperitoneal approach was chosen and the incision was 12–18 cm. After incision with an electro-tome, obliquus external abdominis, the internal oblique muscle of abdomen, and the transversus abdominis were separated. The posterior peritoneum was separated, too. The subsequent operations were like group A.

Postoperative treatment

Postoperative drainage tubes were removed 48–72 hours after surgery. Antibiotics were used for 2–3 days. All patients receive braces, and were encouraged to get up and moved around. Most patients could get up and move around after one week post surgery. Few patients had severe preoperative nerve compression. After patients with Frankel grade B or C recovered to grade D or E, they were encouraged to get up and moved around. Systemic nutritional support and anti-TB treatment were continued after surgery (3 HRZE/9-15 HRE).

Routine blood tests, ESR, and hepatic and renal function were reviewed every 2–4 weeks during anti-TB treatment. If streptomycin was used, urine was routinely tested. Lumbar CT and MRI were reviewed every 3–6 months after surgery to inform the status of lesion healing, bone graft fusion, and whether there were loosening in the pedicle screw and/or fractures. After TB was controlled and bone graft fusion occurred, the fixation materials were removed (after 1.5–2.5 years).

Observation indexes

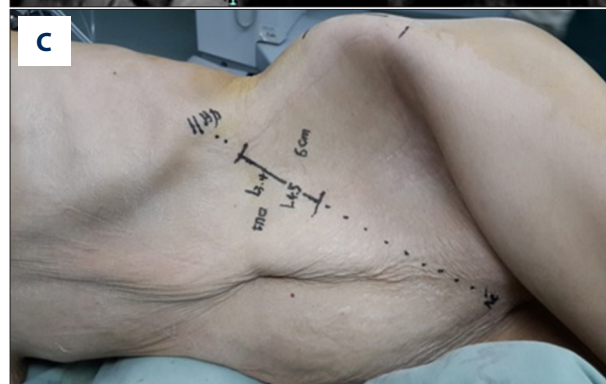
General information (operation time, blood loss, hospitalization days, and anal exsufflation time), clinical symptoms, radiological measurement, laboratory examination (VAS scores, Cobb angle, and ESR one week before surgery, after surgery, and at last follow-up), and Frankel classification was observed.

Statistical analysis

SPSS 19.0 was used for the data analysis. The data of sex and the structure of lesions segments were analyzed by the χ^2 test. Age, course, operation time, blood loss, postoperative hospital stay, VAS score, Cobb angle, and ESR were analyzed by *t*-test. Frankel classification was analyzed by Wilcoxon signed-rank test. A *p* value <0.05 was considered statistically significance.

Results

All patients were followed-up for 12 to 36 months (average 22.5 months). Seven patients (five in group A and two in group B) had side psoas abscess that were healed after secondary drainage surgery. The rest of the cases healed after primary surgery, with no formation of sinus, incisional hernia, cerebrospinal fluid leakage, or recurrence of spinal TB. All TB symptoms disappeared. The time of bone graft fusion was between 3–7 months (average 4.7 months). Five patients had drug-induced liver damage after taking anti-TB drugs. After the adjustment



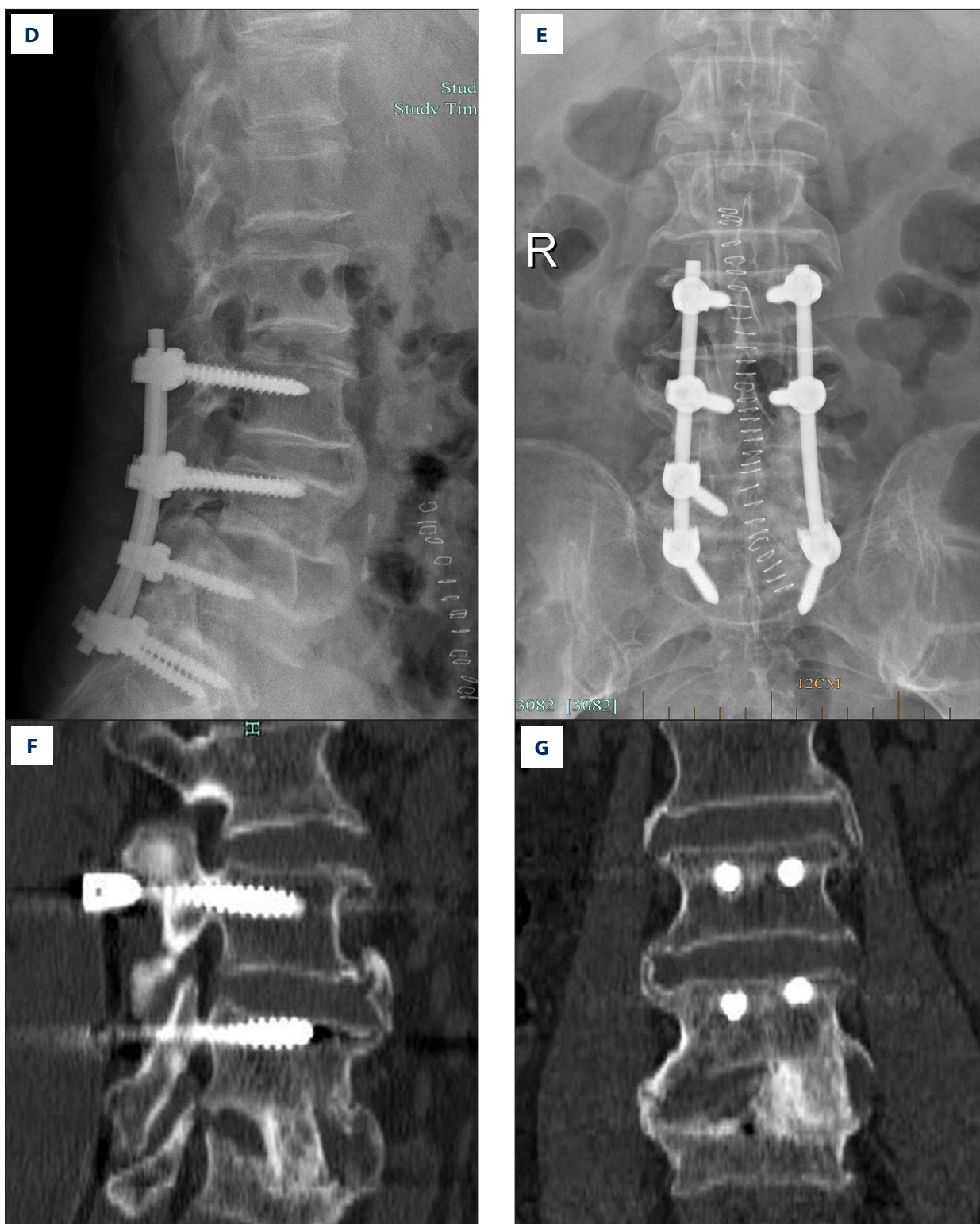


Figure 1. Mini-open anterior approach focal cleaning combined with posterior internal fixation in period I was used in 66-year-old man for treating L₄-L₅ vertebral tuberculosis with incomplete paralysis. (A, B) Preoperative CT and MRI of lumbar vertebrae showed the destruction of vertebral bodies on L₄-L₅ and spinal canal occupation. (C) Vision on the location of the incision and focal cleaning. (D, E) Postoperative x-ray showed pedicle screw toward upside in L₄, and L₅ was performed single fixation toward downward and outside. (F, G) CT at six months after surgery showed good graft fusion.

Table 2. Comparison of operation time, blood loss and hospital stay between two groups with lumbar spinal tuberculosis ($\bar{x}\pm s$).

	Group A	Group B	p Value
Cases	76	48	–
Operation time(min)	235.7±33.6	229.3±31.4	>0.05
Blood loss (ml)	924.8±202.9	955.1±198.3	>0.05
Hospital stay (d)	14.3±4.3	15.1±3.8	>0.05

Table 3. Preoperative, postoperative and the last follow-up VAS, Cobb and ESR between two groups with lumbar spinal tuberculosis ($\bar{x}\pm s$).

Time	VAS score		Cobb angel (°)		ESR (mm/h)	
	A (76 cases)	B (48 cases)	A (76 cases)	B (48 cases)	A (76 cases)	B (48 cases)
Preoperative	6.89±1.25	6.71±1.12	16.54±3.27	16.03±3.11	16.47±3.24	18.13±3.42
Postoperative one week	4.62±0.92*	5.76±0.80	4.23±1.24**	4.31±1.21**	4.53±1.71**	4.56±1.25**
Final follow-up	1.87±0.78**	2.13±0.83**	4.56±1.73**	4.57±1.68**	4.22±1.32**	3.97±1.19**

Level of significance with * $p<0.05$; ** $p<0.01$ compare with before surgery.

Table 4. Frankel classification between two groups with lumbar spinal tuberculosis before and after surgery.

Before surgery	Group		Last follow-up in group A*					Last follow-up in group B*.#				
	A	B	Grade A	Grade B	Grade C	Grade D	Grade E	Grade A	Grade B	Grade C	Grade D	Grade E
Grade A	0	0										
Grade B	3	1			1	1	1				1	0
Grade C	7	4				2	5				1	3
Grade D	14	9				3	11				2	7
Grade E	52	34					52					34
Total	76	48			1	6	69				4	44

Comparison between last follow-up and preoperative data, * $P<0.01$. Comparison between two groups at last follow-up, # $P>0.05$.

of program and strengthening liver treatment, liver function was improved.

In group A, operation time was slightly extended, blood loss was reduced, and hospitalization time was shorter than for group B, but the data were not statistically significant (Table 2). Anal exsufflation time in group A and group B were 1.21 ± 0.48 day and 2.12 ± 0.82 day, respectively, and there were significant differences between the two groups ($p<0.05$).

The VAS scores, Cobb angle, and ESR before surgery, at one week after surgery, and at the time of the last follow-up are shown in Table 3. Compared with preoperative values, the Cobb angle and ESR were significantly lower at one week after surgery and last follow-up in both groups ($p<0.01$). The VAS scores had significant differences between one week after surgery and

before surgery in group A ($p<0.05$), but the difference was not significant in group B ($p>0.05$). The VAS scores at the last follow-up were significantly different from that before surgery in both groups A and B ($p<0.01$). After surgery, the VAS scores in group A were better than that in group B ($P<0.05$), while the Cobb angle and ESR of the two groups showed no difference.

Postoperative nerve compression symptoms were improved (Table 4). There were significant differences in Frankel classification between before surgery and last follow-up in both groups ($p<0.01$). But there were no significant differences between group A and group B ($p>0.05$).

Discussion

Lumbar TB is associated with abscess formation, the presence of the neurologic deficit, persistent or local kyphosis, and segmental instability [10]. Generally, the surgical treatment for spinal TB offer relief of severe pain and improved sagittal balance, which completely relieves the lesion, relieves spinal cord compression, rectifies the kyphosis, and reconstructs spinal stability [11]. Many methods for spinal TB have been reported, such as the anterior approach and staged or simultaneous anterior decompression combined with posterior stabilization [16–18]. Among them, one method, which has been recognized by scholars [19], focuses on the focal cleaning in period I and bone graft fusion internal fixation. As we all know, eliminating the TB lesions is the most important aim in the surgical approach, which may help TB recovery, reduce recurrence, and guarantee the internal fixation is robust. From this perspective, the ideal surgery for lumbar TB remains controversial. This study analyzed the clinical effects and advantages of mini-open anterior approach focal cleaning combined with posterior internal fixation compared to the conventional anterior extraperitoneal approach focal cleaning combined with posterior internal fixation.

Currently, the main surgeries for lumbar TB are anterior, posterior, and anterior combined with a posterior. The cardinal pathological destruction of spinal TB is in vertebral body and intervertebral space and thus the anterior approach might access the lesions directly, which is convenient for focal cleaning and supporting bone autograft [20–22]. However, sometimes bad effects might occur, such as infection, or the strength of the anterior internal fixation might not be as strong as a posterior approach [23–25]. Meanwhile, the posterior approach could access the anterolateral column, which would not completely remove the lesions in the front of the vertebral body, and reconstruct the anterior spinal column [26]. So some surgeons have advocated for the anterior focal cleaning and strut graft combined with posterior fixation, which might compensate for the defects of simple anterior or posterior approach and be good for the postoperative rehabilitation of patients [27].

Short-segment pedicle fixation has become an important trend in spinal orthopedic surgery [28]. And pedicle screw internal fixation in pathologic vertebrae can reduce internal fixation segment in the normal vertebral body, which could shorten the fixed range, guarantee the reliability of fixation, reduce acceleration and degeneration of adjacent segment caused by long internal fixation segment, reduce spinal activities, and reduce medical cost [29,30]. Zhang et al. achieved a very nice clinical effect in treating multi-segmental spinal TB through posterior or internal fixation approach [30].

And individualized operation mode could be done according to the results of CT scan, x-ray, and MRI before surgery, which might show the true condition of the vertebral destruction. Whether the pathologic vertebrae should use pedicle screw internal fixation or not depends on the failure location of the vertebral column. Wang et al. [29] thought that if the normal tissue of anterior and middle vertebral column was >50%, pedicle screw internal fixation could be used in pathologic vertebrae after focal cleaning. According to our study, we concluded that individualized operation was indispensable on the basis of the range of vertebral lesions and the surgical approach. Pedicle screws might be done if one-third of the bone in pathologic vertebrae had no destruction. Pedicle screws were generally located in the contralateral approach of focal cleaning. If it did not impact the focal cleaning and bone graft, pedicle screw placed ipsilateral was acceptable. Whereas, if the three-column structure of pathologic vertebrae is damaged, internal fixation should not be attempted. In our study, there were seven cases that had severe damage in vertebral bodies, which needed no pedicle screw. For the rest of the cases, pedicle screws were placed in vertebral bodies. There were 11 screws exposed in eight cases, but no occurrence of fixation instability occurred in our study. Hence, effective preoperative imaging evaluation was indispensable, and can greatly lessen the incidence of screw exertion.

In our study, group A patients were placed in the right lateral position, and the inverted “eight” incision was chosen as a center, and the length of anterior incision was 6–8 cm; which was much shorter than conventional extraperitoneal approach [31]. As the obliquus external abdominis, the internal oblique muscle of the abdomen and transverse abdominis were separated bluntly; there was potential slight injury in soft tissue and abdominal muscle. During the surgery, only pathologic vertebrae that needed to be cleaned were exposed, which lessened the damage of the vertebrae, surrounding tissues, and segmental vessels. Meanwhile, after surgery, there was a benefit of lighter pain from incision and the recovery was faster. In this study, the degree of pain in group A was lower than that of group B, which was beneficial to the recovery of intestines peristalsis. And patients in group A had shorter anal exsufflation time than people in group B. Although using the small incision decreased visualization to some extent, the operation time and blood loss was not significantly different between the two groups. Blood vessels should be attended to during the surgery. In our study, there were no vascular injuries to injuries to important organs.

Conclusions

Compared with the conventional anterior extraperitoneal approach of focal cleaning combined with posterior internal

fixation in treating lumbar TB, mini-open anterior approach of focal cleaning combined with posterior internal fixation was safer, much more productive, and effective. This approach may

present an improvement to clinical treatment programs of spinal TB, especially lumbar TB.

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