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Original Article

Efficacy evaluation of posterior internal fixation combined with percutaneous endoscopic debridement for spinal tuberculosis

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Abstract: Objective: To study the efficacy of posterior internal fixation combined with percutaneous endoscopic debridement in the treatment of spinal tuberculosis. (TB). Methods: Fifty-seven patients with mono-segmental lumbar TB were retrospectively analyzed. Thirty patients who received surgery through posterior internal fixation combined with percutaneous endoscopic debridement were included in the observation group, and 27 patients who received surgery through the combined anterior-posterior approach were included in the control group. The length of the operation, the intraoperative bleeding volume, the postoperative length of stay, the postoperative change in the Cobb angle, the abscess absorption time, the bone fusion time, the erythrocyte sedimentation rate (ESR), the C-reactive protein (CRP) levels, the postoperative neurological function recovery, and the postoperative pain were evaluated and compared between the two groups. Results: The observation group had significantly shorter operations and lengths of stay and smaller intraoperative bleeding volumes than the control group (all $P<0.05$). After surgery, The Cobb angle improved significantly in the two groups (both $P<0.05$) but was not significantly different between them ($P>0.05$). There were no significant differences in bone fusion or abscess absorption time between the two groups (both $P>0.05$). After surgery, the CRP levels and ESR were significantly decreased in both groups (both $P<0.05$) but were not significantly different between them (both $P>0.05$). There were no differences in the preoperative and postoperative neurological functions between the two groups (both $P>0.05$). After surgery, the neurological functions significantly improved in both groups (both $P<0.05$). The VAS scores were significantly decreased in both groups at 1 week and 1 month after surgery, and the decrease was more significant in the observation group (all $P<0.05$). Conclusion: Posterior internal fixation combined with percutaneous endoscopic debridement is effective in the treatment of mono-segmental lumbar TB, as it is characterized by short operations, minor bleeding, a quick recovery, and marked postoperative pain relief. Therefore, this surgical approach is worthy of promotion in clinical practice.

Keywords: Spinal tuberculosis, posterior internal fixation, combined anterior-posterior approach, efficacy observation

Introduction

Tuberculosis (TB) is a chronic, consumptive, and infectious disease caused by tubercle bacillus invasion. At present, half of the new TB patients appear in low-income countries, where the incidence of TB is 10 times higher than it is in high-income countries [1]. Therefore, WHO still declares it as a global health emergency [2]. TB infection at different sites will lead to different clinical manifestations. This, coupled with TB's increasing drug resistance, makes TB treatment more complicated [3, 4]. More than 10% of patients infected with tubercle bacillus may have secondary skeletal TB, of which spinal TB accounts for more than half of the cases [5]. If not treated quickly, spinal TB's progression will cause the oppression of nerves due to spinal deformity and may even cause paralysis, which increases the economic burden on the individual and society [6]. The use of anti-TB drugs is still the basic approach for the treatment of spinal TB, and the early diagnosis and treatment with anti-TB drugs is significant in the prevention of spinal deformity [7]. However, a study in China showed that 77.1% of spinal TB patients are cured by surgical intervention [8]. With the development of technology, there is a

growing awareness that surgical intervention is important for the removal of lesions and the recovery of nerves in spinal TB patients [9]. However, there is still controversy regarding the surgical intervention approach. The most common surgical approaches are posterior, anterior, and combined anterior-posterior [10]. The anterior approach allows for the exposure of the lesions, which helps the removal, but it also increases the risk of vascular and organ injuries, and the spine's stability is relatively poor after the bone graft [11]. The combined anterior-posterior approach is beneficial for the removal of lesions, spinal deformity and restabilization but leaves large surgical trauma and results in various postoperative complications that are slow to recover, which makes this approach unsuitable for those in a poor physical condition [12]. Given the advantages and disadvantages of the above two surgical approaches, the posterior approach is applied in the clinical setting as it reduces the size of surgical trauma and benefits the correction of kyphosis and bone graft stability [13]. Though the lesions cannot be completely removed through the posterior approach, the local residual lesions can be fully absorbed by the long-term use of anti-TB drugs [14]. With these advantages, the posterior approach is more widely used for the treatment of spinal TB. This retrospective study analyzed the clinical efficacy of posterior internal fixation combined with percutaneous endoscopic debridement in patients with lumbar TB.

Materials and methods

General information

We recruited 57 patients with lumbar TB admitted to the Shanghai Kaiyuan Orthopedic Hospital from July 2016 to July 2018. Of these patients, 30 were males and 27 females, aged 34-68 years with a mean age of 52.0±7.8 years. Thirty patients who received surgery through the posterior approach were included in the observation group, including 16 males and 14 females with a mean age of 52.0±8.5 years. Twenty-seven patients who received surgery through combined anterior-posterior approach were recruited in the control group, including 14 males and 13 females with a mean age of 51.9±7.2 years. The study was approved by the Ethics Committee of Shanghai Kaiyuan Orthopedic Hospital.

Inclusion and exclusion criteria

Inclusion criteria: patients who met the criteria of mono-segmental lumbar TB presented at The 4th Symposium on the Progress and Standardization of Clinical Diagnosis and Treatment of Skeletal Tuberculosis [15]; patients who had limited infections in the lesioned intervertebral space with local formations of abscess, sequestrum, and cavity; patients who had a nerve compression injury (classified as A, B, C, D or E according to the American Spinal Injury Association (ASIA) Impairment Scale) [16]; patients who had complete clinical data and complied with the follow-up. Exclusion criteria: patients with no evidence of TB infection in intervertebral space; patients who had lesions involving two or more segments of vertebrae; patients whose condition could not be improved by anti-TB drugs; patients with severe heart, liver, or kidney diseases; patients who had difficulty or inconvenience with follow-up.

Preoperative preparations and timing of surgery

Before surgery, four anti-TB drugs were administered to the patients, i.e. isoniazid (Shanghai Xinyi Huanghe Pharmaceutical Co., Ltd.) 0.3 g, once per day; rifampicin (Guangdong Hengjian Pharmaceutical Co., Ltd.) 0.6 g, once per day; pyrazinamide (Shenyang Hongqi Pharmaceutical Co., Ltd.) 0.75 g, once per day; ethambutol (Shanghai Xinyi Pharmaceutical Co., Ltd.) 0.75 g, once per day. The patients' erythrocyte sedimentation rate (ESR) and hemoglobin (Hb) were examined preoperatively and the surgery was performed when ESR<60 mm/h and Hb>100 g/h [17].

Surgical methods

For the observation group, general anesthesia was performed on the patients. First, the patient was given mask ventilation at 6-8 L/min. According to the patient's body weight (kg), intravenous injections of midazolam (0.05-0.10 mg/kg), propofol (1-1.5 mg/kg), sufentanil citrate (0.2-0.3 μg/kg), and cis-atracurium (0.15-0.2 mg/kg) were administered. Assisted ventilation was given for 3 min before tracheal intubation was performed to induce general anesthesia. Five minutes before the surgical incision was made, 10-20 μg of sufentanil citrate was administered intravenously. After the anesthesia induction, a midline longitudinal

skin incision was made at the lesioned intervertebral space with a length of 1.5 cm. According to the position of the lesion confirmed by the X-ray, pedicle screws were placed in 1-2 vertebrae adjacent to the lesion, and the unilateral or bilateral articular process joints were removed based upon the lesion. The abscess was drained, and the local necrotic tissue and sequestrum were removed from the intervertebral space. Then, under percutaneous endoscopy, lavage fluid was used to clean the deeper part of the abscess until the pus was fully removed under percutaneous endoscopy. Allogeneic or autologous bone grafting is performed at the site of the bone defect. After implantation, titanium compression rods were used for the fixation of bone graft. The incision was washed, and then 2-4 g of streptomycin powder was placed in through the incision and the drainage tube was left in place before the incision was sutured.

For the control group, general anesthesia was also performed on the patients the same way that it was in the control group. The same midline longitudinal skin incision was made at the lesioned intervertebral space. Pedicle screws were then placed in the specific vertebrae as required. After placement, normal saline was used to repeatedly rinse the abscess until the deeper part of the abscess was cleaned of pus. The incision was sutured. The patient was then placed in a lateral position. The abscess was drained and the local necrotic tissue and sequestrum were removed from the intervertebral space using the anterior approach. Allogeneic or autologous bone grafting was performed on the site of bone defect. After implantation, the implanted bone was fixed using a titanium rod, the incision was washed, and about 2-4 g of the streptomycin powder was inserted. The drainage tube was indwelled and the incision was finally sutured layer by layer. After implantation, titanium compression rods were used for the fixation of the bone graft. The incision was washed, then 2-4 g of streptomycin powder was placed in through the incision and the drainage tube was left in place before the incision was sutured.

Outcome measures

The primary outcome measures included the length of the operation, the intraoperative bleeding volume, the postoperative length of stay, the change in the Cobb angle, and the abscess absorption and bone fusion times. The length of the operation was calculated as the time from when the skin incision was made to when the suture was completed. The intraoperative bleeding volume was recorded as the bleeding volume from the beginning of the surgery to the completion of the suture. The postoperative length of stay was defined as the days since the completion of the surgery to discharge. The change in the Cobb angle was an indicator used to evaluate the efficacy by comparing the preoperative Cobb angle with the angle 1 month after the surgery [18]. Abscess absorption time and bone fusion time were defined as the time from the completion of the surgery to the absorption of the abscess and to bone fusion, respectively, and were determined using X-rays.

The secondary outcome measures included the changes in the erythrocyte sedimentation rate (ESR) and the C-reactive protein (CRP) level, postoperative neurological function recovery, and postoperative pain. Changes in the ESR and CRP levels were based on the differences between the preoperative and postoperative levels. Postoperative neurological function recovery was evaluated according to the ASIA Impairment Scale. Postoperative pain was assessed using the Visual Analogue Scale (VAS) to quantify the subjective feeling of pain. The VAS for pain is a scale with a 10-cm straight line at one end meaning no pain and the other end meaning the worst pain imaginable. Patients were asked to mark a point on the straight line that shows how he or she feels, which is the VAS score. The intensity of the pain was measured before the surgery, 1 week after the surgery, and 1 month after the surgery.

Follow-up

The patients were followed up at 1 week and 1 month after the surgery to observe their recovery. The abscess absorption and bone fusion were also assessed at each follow-up to determine the abscess absorption and bone fusion times, respectively.

Statistical analysis

All statistical data were processed using the SPSS 17.0 software package. The continuous variables were expressed as the means ± standard deviations ($\bar{x}$ ± sd). All data were normally distributed and equal in variances. The comparison between groups were based on independent *t*-tests. The comparison within the

Table 1. Comparison of the general data between the two groups of patients

	The observation group (n=30)	The control group (n=27)	X^2/F	P
Sex (Male/Female)	16:14	14:13	0.013	0.911
Age (Years)	52.4±8.6	51.6±7.0	0.388	0.699
Lesion site			0.065	0.799
Lumbar vertebrae	26	24		
Lumbosacral vertebrae	4	3		
Kyphosis				
Yes	13	14	0.414	0.520
No	17	13		
ASIA			1.012	0.908
A	1	2		
B	3	3		
C	5	3		
D	7	5		
E	14	14		
Hypertension				
Yes	14	12	0.028	0.866
No	16	15		
Diabetes				
Yes	7	5	0.198	0.656
No	23	22		

groups were based on paired *t*-tests. Categorical variables were expressed as %. A *P* value of <0.05 was considered statistically significant.

Results

Comparison of baseline characteristics

There were no significant differences between the two groups in terms of sex, age, lesion site, or the presence of kyphosis and concomitant diseases (all P>0.05). See **Table 1**.

Comparison of intraoperative data and postoperative length of stay

The length of the operation, the intraoperative bleeding volume, and the postoperative length of stay in the observation group were significantly lower than they were in the control group (all P<0.001). See **Table 2** and **Figure 1**.

Comparison of Cobb angle in the kyphosis patients before and after surgery

A total of 27 patients in the two groups developed kyphosis, of which 14 were in the observation group and 13 in the control group. There was no significant difference between the two groups in the preoperative Cobb angle (P>0.05). The patients were significantly improved in their Cobb angles after surgery (P<0.05), but there was no significant difference between the two groups in their postoperative Cobb angles (P>0.05). See **Table 3**.

Comparison of bone fusion and abscess absorption time

There were no significant differences between the two groups in bone fusion or abscess absorption time (P> 0.05). See **Table 4**.

Comparison of the CRP levels and ESR before and after surgery

Before the surgery, the CRP levels and the ESR were high in the two groups, with no significant differences (both P>0.05). After surgery, the CRP levels and the ESR were significantly lower in both groups (both P<0.05). However, for the differences in the CRP levels and ESR before and after surgery, there were no significant differences between the two groups (P>0.05). See **Table 5**.

Comparison of the ASIA classifications before and after surgery

There were no significant differences between the two groups in terms of preoperative and postoperative neurological functions (both P> 0.05). The neurological functions of the two groups were significantly improved after surgery (both P<0.05). See **Table 6**.

Comparison of VAS score before and after surgery

There was no significant difference between the two groups in their preoperative VAS scores (P>0.05). The VAS scores of the two groups at 1 week after surgery were significantly lower

Table 2. Comparison of the intraoperative data and length of stay

	The observation group (n=30)	The control group (n=27)	t	P
Operative time (min)	213.83±38.60	375.92±39.10	15.733	<0.001
Intraoperative bleeding volume (mL)	404.80±125.81	567.44±110.25	5.165	<0.001
Length of stay (day)	14.40±1.07	16.37±1.33	6.178	<0.001

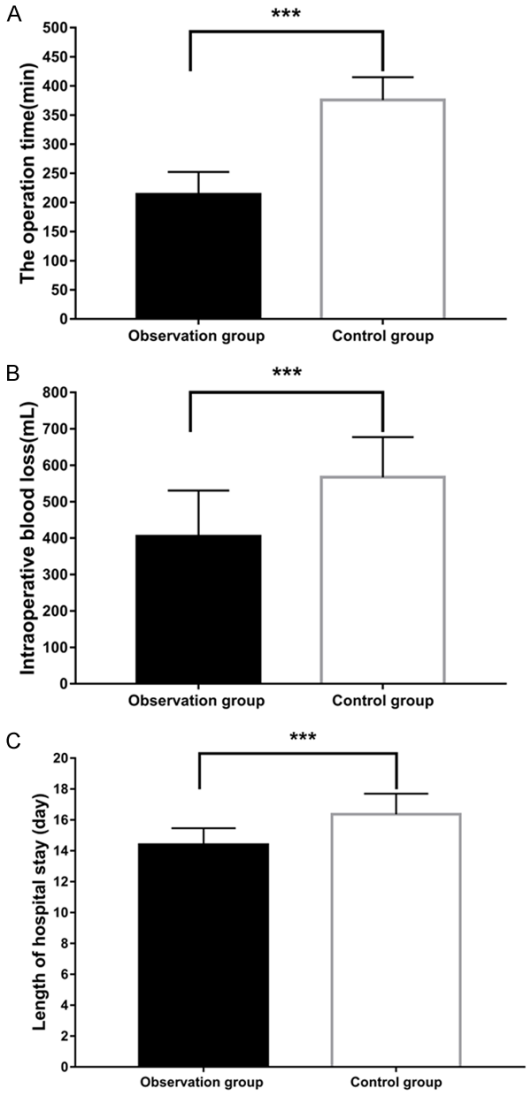

Figure 1. Comparison of the intraoperative data and length of stay. A. Comparison of the lengths of the operation; B. Comparison of the intraoperative bleeding loss; C. Comparison of the lengths of stay. ***P<0.001.

than they were before surgery, and the decrease was more significant in the observation group (all P<0.05). The VAS scores of the two groups at 1 month after surgery were significantly lower than they were before surgery and at one week after surgery, and the decrease was more significant in the observation group (all P<0.05). See **Table 7**.

Discussion

The spinal blood supply mainly comes from the terminal arteries. In elderly patients, tubercle bacilli stay and proliferate in the spine, mostly in the thoracolumbar spine, due to the slow blood flow caused by arteriosclerosis, resulting in a higher prevalence of spinal TB in elderly patients than in patients of other ages [20]. Surgery is often used on the basis of anti-TB drugs for the treatment of spinal TB. The common surgical approaches are the anterior, posterior, and combined anterior-posterior approaches. For the anterior approach, the stability of the spine is relatively poor and the bone fusion is slow after the bone graft; moreover, TB infection may occur in the pleuroperitoneal cavity [21, 22]. Some studies have found that the effect of the posterior approach for spinal TB is not different from that of the anterior approach as well as the combined anterior-posterior approach [23, 24]. Lesion removal under percutaneous endoscopy is conducive to lesion removal, blood supply around the lesion, and the formation of new bone crusts; it can provide a good foundation for reconstructing the stability of the anterior spinal path; furthermore, it can reduce the stimulus of the peritoneum and bowel during the operation, accelerate intestinal peristalsis and anal exhaust, reduce postoperative abdominal pain, abdominal distension, and other symptoms, and shorten the fasting time [25]. In this study, posterior internal fixation combined with percutaneous endoscopic debridement was compared with the combined anterior-posterior approach. The results showed that the observation group had a significantly shorter length of operation time, a shorter length of hospital stay, and a lower intraoperative bleeding volume than the control group. The disadvantage of combined anterior-posterior approach may be due to the

Table 3. Comparison of the Cobb angle in the kyphosis patients before and after surgery

	The observation group (n=14)	The control group (n=13)	t	P
Cobb angle before surgery (°)	16.43±3.52	17.11±4.00	0.680	0.499
Cobb angle after surgery (°)	4.92±1.70	5.15±1.90	0.477	0.635
t	34.693	29.643		
P	<0.001	<0.001		
Difference in Cobb angle before and after surgery (°)	11.51±1.82	11.96±2.10	0.867	0.390

Table 4. Comparison of the bone fusion and abscess absorption time

	The observation group (n=30)	The control group (n=27)	t	P
Bone fusion time (month)	9.70±4.62	8.56±2.96	1.127	0.265
Abscess absorption time (month)	4.41±1.71	4.26±1.6366	0.329	0.743

Table 5. Comparison of the CRP level and ESR before and after surgery

	The observation group (n=30)	The control group (n=27)	t	P
CRP level (mg/L)				
Before surgery	24.39±14.01	24.28±12.71	0.030	0.976
After surgery	6.75±2.48*	6.95±3.30*	0.263	0.793
Difference	17.64±11.53	17.33±9.67	0.108	0.914
ESR (mm/h)				
Before surgery	43.16±13.54	44.54±15.40	0.361	0.719
After surgery	7.80±2.98*	9.02±4.06*	1.298	0.200
Difference	33.36±10.57	33.52±11.34	0.058	0.954

Note: for the comparisons between the levels before and after surgery, *P<0.05. CRP: C-reactive protein; ESR: erythrocyte sedimentation rate.

large surgical trauma that increases the operation time and the intraoperative bleeding volume, which further extends the postoperative length of stay. The findings are consistent with previous studies [26].

This study used the change in the Cobb angle to evaluate the two approaches in terms of surgical efficacy and the correction of kyphosis. The Cobb angle is defined as the angle between intersecting lines drawn perpendicular to the top of the top vertebrae and the bottom of the bottom vertebrae [27]. Whether the use of the posterior approach can maximally correct kyphosis is still being studied [28]. Previous studies have found that the posterior approach and the combined anterior-posterior approach can both correct the kyphosis and maintain the effect [29]. In this study, both surgical approaches had a significantly positive effect on kyphosis, and there was no significant difference in the efficacy between the two approaches, which is consistent with the above studies. Previous studies indicated that surgery only through the posterior approach cannot completely remove the lesion, which is not conducive to the recovery of the disease, and that surgery through the combined anterior-posterior approach can remove tubercle bacilli and the lesion in a more thorough way [13, 14]. Therefore, in this study, using surgery through the posterior approach, we reached the goal of removing the residual lesion using percutaneous endoscopic irrigation. Studies have shown that the concentration of isoniazid can reach 1,000 times higher after local irrigation than the level of isoniazid reached through oral administration, which enables the rapid killing of tubercle bacilli [30]. The results of this study show that the two groups of patients were not significantly different in their bone fusion times, abscess absorption times, and indicators of TB activity, including their CRP levels and ESR, indicating a comparable disease prognosis and control.

Spinal TB can cause bone damage and spine deformity, which can lead to nerve compression and even paralysis, severely affecting a patient's quality of life [31, 32]. The purpose of the surgery is to remove TB lesions, relieve nerve compression, and reconstruct and stabilize damaged bone to maintain its function. A previous study reported that performing the surgery using the combined anterior-posterior

Table 6. Comparison of the ASIA classification before and after surgery

	Level A	Level B	Level C	Level D	Level E	χ^2	P
The observation group (n=30)						11.044	0.026
Before surgery	1	3	5	7	14		
After surgery	0	1	1	2	26		
The control group (n=27)						11.769	0.019
Before surgery	2	3	3	5	14		
After surgery	0	0	1	1	25		
Before surgery						1.012	0.908
The observation group (n=30)	1	3	5	7	14		
The control group (n=27)	2	3	3	5	14		
After surgery						1.198	0.753
The observation group (n=30)	0	1	1	2	26		
The control group (n=27)	0	0	1	1	25		
All patients (n=57)						22.268	<0.001
Before surgery	3	6	8	12	28		
After surgery	0	1	2	3	51		

Table 7. Comparison of the VAS score before and after surgery

	The observation group (n=30)	The control group (n=27)	t	P
VAS score				
Before surgery	6.76±1.50	7.11±1.10	1.001	0.321
1 week after surgery	4.59±0.78*	5.18±0.77*	2.880	0.006
1 month after surgery	1.93±0.65*,#	2.29±0.66*,#	2.045	0.046
Difference between the VAS scores before surgery and 1 week after surgery	2.27±0.79	1.92±0.55	2.145	0.034
Difference between VAS scores before surgery and 1 month after surgery	2.88±0.32	2.67±0.48	2.043	0.043

Note: compared with the VAS score before surgery, *P<0.05; compared with the VAS score 1 week after surgery, #P<0.05.

approach achieves satisfactory results with an improvement in neurological function [33]. Another study found that surgery using only the posterior approach can also improve neurological function [34]. The results of this study showed that surgery using both approaches can improve neurological function, which is consistent with the above studies. At present, postoperative pain has become an important topic in clinical studies, thereby serving as an indicator of surgical success [19]. This study found that due to the presence of vertebrae infection, bone damage, and nerve compression before surgery, the patients' preoperative pain scores were high. After surgery, the pain was significantly reduced, but compared with the posterior approach, the combined anterior-posterior approach caused increased surgical trauma, resulted in significant postoperative pain, a slower recovery, and longer duration of experiencing pain. Therefore, the patients experienced less pain at 1 week and 1 month after surgery with the surgery using the posterior approach than they did with the surgery using the combined anterior-posterior approach.

The sample size of this study was small. Therefore, an expansion of the sample size is warranted for future research. Moreover, the follow-up time was short in the study. It is necessary to further lengthen the follow-up time to study the efficacy of the surgery in the two groups.

In conclusion, posterior internal fixation combined with percutaneous endoscopic debridement has a significant effect on the treatment of mono-segmental lumbar TB because of its a short operation time, its small amount of intraoperative bleeding, and its quick postoperative recovery and pain relief. Therefore, it is worthy of promotion in clinical practice.

Disclosure of conflict of interest

None.

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