Investigation of The Optimal Surgical Approach to Brucella Lumbar Spondylitis Treatment: A Comparative Study

Chenguang Jia
The Chest Hospital of Hebei Province
Jianguo Gao
The Chest Hospital of Hebei Province
Zhuo Li
The Chest Hospital of Hebei Province
Zhaoliang Dong
The Chest Hospital of Hebei Province
Liming Yao
The Chest Hospital of Hebei Province
Lianbo Wang
The Chest Hospital of Hebei Province
Xiaowei Yao (yaoxiaowei163@163.com)
The Chest Hospital of Hebei Province

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Abstract

Background: The optimal surgical approach in treating lumbar brucellosis (LBS) has not been determined. This study aims to compare the surgical efficacy of anterior approach and combined posterior and anterior approach in treating LBS.

Method: A retrospectively cohort study included LBS patients undergoing lumber surgery in the Department of Orthopedics, Department of Orthopedics, Hebei Province from June 2012 to June 2016. According surgical approach, patients were divided into two groups; patients with one-stage anterior approach were classified into group A, and the rest of patients with combined posterior and anterior approach were group B. The operative time, intraoperative blood loss and, hospitalization stay were recorded to compare the surgical risk of two groups. In terms of treatment efficacy, visual analogue scale (VAS), bone graft fusion, erythrocyte sedimentation rate (ESR) and Oswestry disability index (ODI) were assessed and compared before and after surgery.

Results: Eight-nine patients with LBS were included into the study. Fifty cases were males, and 39 patients were female. The mean age of this cohort was 61.9 ± 12 years, ranging from 23 to 78 years. Forty-nine patients were divided into group A, undergoing anterior debridement and bone graft fusion. Forty patients underwent posterior fixation combined with anterior approach (group B). The operation time of group A was 30 minutes shorter than that of group B. Group A had less intraoperative blood loss (800 vs. 900 ml; $P < 0.001$). Hospital stay was four days shorter in group A. At the last follow-up, all patients were in good condition with ASIA Level E and ESR returned to normal. The bone fusion rate of Bridwell bone was 89.29% (45/49) and 80.00% (38/40) of group A and group B, respectively. In terms of surgical efficacy, there was no significant difference in VAS score between the two groups before and after operation ($P > 0.05$).

Conclusions: One-stage anterior approach and combine posterior-anterior approach had no significant difference in terms of clinical efficacy. Individualized surgical treatment should be suggested in patients with complicated LBS and ineffective therapeutic treatment.

Trial registration: This study has been retrospectively registered in local ethical Institution Review Board(No:[2020]068).

Background

Brucellosis is a neglected zoonotic disease worldwide with high mortality(1), and approximately 500,000 cases are reported annually(2). There are an estimated 2.4 billion people at risk(2), and the disease prevalence ranges from 27% in low-risk countries including Europe and North American to 36% in high-risk regions, such as Middle East and South America(1). The incidence of human brucellosis in China has been increasing in each province across the whole country over the past decade, especially with a concentration in northern areas and a peak prevalence of 4.22/100,000 persons(3).

Brucellosis is caused by brucella through taking infected, unpasteurized animal-milk products, contacting with infected animals, and inhaling infected aerosolized particles(4). Brucella are taken up by local tissue lymphocytes, enter the circulation, and travel throughout the body to cause systemic clinical symptoms, such as fever, malaise, arthralgias, and organ impairments (e.g. hepatomegaly, splenomegaly and lymphadenopathy) (4, 5). Severe complications are not uncommon leading life burden in the long-term and death[4].

Osteoarticular disease is the most common complication of brucellosis, involving sacroiliac, knee and spine(1, 4, 6). Lumbar spine is commonly affected and the incidence of lumber brucellosis was approximately 68%(7). And up to 30% cases involve multiple vertebral bodies(8, 9). The combination of two or three antibiotics (e.g. doxycycline, rifampin, streptomycin) is suggested as the general approach to effectively control infection[1,](10), however for brucellosis-induced spondylitis, surgical interventions may be required in the setting of persistence or progression of deficits beyond adequate antimicrobial therapies[1]. The optimal surgical approach to treat brucella spondylitis (BS) is uncertain, and the current data is limited. This study aims to investigate the most optimal surgical decisions in BS by comparing the post-surgery clinical effectiveness of different surgical approaches on patients with lumbar BS.

Methods

Study population and study design

Consecutive LBS patients undergoing surgical treatment between June 2012 and June 2016 at the Department of Orthopedics, the Chest Hospital of Hebei Province, Hebei Province were retrospectively included into the study. LBS was diagnosed by experienced clinicians based on the results of the comprehensive clinical profiles, including epidemic history, clinical manifestations, laboratory tests, pathological reports, and radiological findings. The diagnosis was made if the patient fulfilled with three criteria as follows(7):1) A clinical picture compatible with spondylodiscitis or spondylitis;2) Absence of any aetiology other than brucellosis that can explain spinal involvement; 3)Microbiological evidence of brucellosis.

The surgical plan was determined based on the number, location, and destruction severity of diseased vertebrae and the presence of paraspinal abscess. If the patients having less or equal to two affected vertebrae and the diseases was limited withing the spinal, the one-stage anterior debridement and bone graft fusion with internal instrumentation was preferred. If the patients with more than two diseased vertebrae and the paraspinal abscess involving multiple levels with or without spinal deformity, the posterior approach combined with anterior method was then applied.

According to different surgical approaches, LBS patients were divided into group A with anterior approach and group B with combined posterior and anterior approach. Perioperation situation including Bleeding volume, operation time, hospitalization stay and bone fusion outcomes and surgical efficacy such as patients' recovery were compared between two groups.

Radiological findings and laboratory tests

Lumbar X radiography and spine magnetic resonance imaging (MRI) were performed before operation on all the subjects. T1-weighted, T2-weighted and short time inversion recovery (STIR) sequences were acquired to observe the spinal abnormalities. For laboratory tests, the rose bengal test (RBT) and the serum tube agglutination test (SAT) were performed. The erythrocyte sedimentation rate (ESR) were tested in all patients before and after surgery.

Perioperative preparation and surgical approaches

Oral doxycycline, intravenous rifampicin and levofloxacin mesylate were administrated for 7–14 days in average before surgery. If the patient with persistent fever, fatigue, anemia, hypoproteinemia, high ESR level, and other surgery-intolerant conditions were not proceeded with surgery.

Surgical procedure

Group A with anterior approach

Group A underwent the one-stage anterior debridement and bone graft fusion with instrumentation. Anterior access to the spine was achieved through the right retroperitoneal flank incision. After exposure, granulomatous tissues and necrotic contents were debrided. The lumbar spinal canal was then exposed, and all diseased disc material was resected down to healthy bleeding bone. After sufficient washout of saline and iodophor, adjacent normal vertebrae distraction was performed if necessary. The allogeneic bone was then implanted with lateral fixation by pedicle screw. Finally, anterior instrumentation was performed, and the position was verified by intraoperative imaging (Figure 1A-B). Drainage tube was accomplished when necessary.

Group B with combined posterior and anterior approach

The patient was taken in a prone position, and the involved lumbar disc was verified fluoroscopically. A midline skin incision was made to expose the facet join. Positioning needles were inserted, verified by intraoperative imaging. Then, the patient was turned over to expose the affected spinal lesion via the left retroperitoneal incision. The diseased vertebrae and all the connected neurotic tissues were removed until normal vertebrae were exposed. The following bone graft fusion and instrumentation were performed as mentioned in the anterior approach section (Figure 2A-B).

Postoperative management and follow-up

Post-operative vital signs, drainage volume and flow, the sense and motion function of both lower extremities were monitored. A drainage tube was removed after 24-48 hours. Patients were allowed to get out of bed under the protection of braces in 14 days after surgery. Besides, all the patients received first line therapy for brucellosis; Meanwhile, blood routine examination, ESR, and liver and renal functions were monitored. During this period, X-ray imaging was applied for following up and CT exam was performed for the last time. After discharge, all the patients were followed up every three months for the first year and every six months afterwards. Physical examination, liver function, ESR and imaging were tested.

Surgical efficacy assessment

In terms of surgical efficacy assessment, general condition and disease-related conditions were evaluated. Temperature and ESR level were assessed for general condition. Bridwell criteria was applied to estimate the presence of bone fusion based on CT imaging performance(11). Grade I was defined as solid fusion with trabeculae present. Grade II was an intact graft without complete remodeling and present lucency.

Grade III was an intact graft with lucency present, and grade IV was as an absent fusion with collapse or resorption of graft bone. Grade I-II was defined as effective bone fusion. Additionally, visual analogue scale (VAS) was used to assess the pain degree of lower extremities(12). Oswestry disability index (ODI) was to determine the recovery degree of spine after operation(13). Besides, the neurological function was classified as five levels from A to E based on American Spinal Injury Association (ASIA) Impairment Scale in 2011 version(14); Level E was assigned as 5 indicating normal active movement.

Statistical analysis

All the statistical analyses were performed on SPSS (version 24.0). The continuous-variable comparisons between groups were assessed by t test and one-way Analysis of variance (ANOVA). Categorical comparisons were analyzed by using Wilcoxon rank sum test. *P*<0.05 was considered as statistically significant.

Result

Demographics and clinical characteristics

Eight-nine patients with lumbar BS were enrolled into the study. Overall, they were characterized as having intermittent fever (≤ 38.5°C), fatigue, lumbar back pain accompanied with activity limitations and neurological symptoms of lower extremities, and percussed pain of lumbar spinous process. 89.9% (80/89) patients had two diseased vertebrae, and 7 patients had three involved vertebrae, where only 2 patients had single diseased vertebra. According to the clinical manifestations and patient preference, 49 patients were enrolled into group A administrated with anterior approach, whereas 40 patients received posterior approach procedures as group B. There was no difference regarding age, gender distribution between two groups(P>0.05). The data was shown in Table 1.

Table 1.
Demographics and clinical characteristics

	Group A N=49	Group B N=40	P
Gender			> 0.05
Male	20	22	
Female	29	18	
Age, yrs	58.2 ± 14.4	60.1 ± 12.3	> 0.05

Radiological features and laboratory results

The preoperative MRI showed that the heterogenous signal was observed within the vertebral body and intervertebral space was narrowed. Intervertebral disc had inflammatory changes given by low T1-weight signal and high T2-wight signal, and heterogenous high signal was presented in STIR. Patients had various degrees of vertebrae destruction. Abscesses was presented in an irregular shape with ring enhancement and showed low T1 signal and high T2 signal. The dural sac was then compressed. SAT test showed that the antibody titers was larger than 1:160 in all patients, which was considered as positive. Forty-nine cases were tested with +++, forty patients were tested with ++ in RBT. ESR was 80 ± 16 mm/L in average, ranging from 46 to 105 mm/L.

Perioperative comparisons: bleeding, operation time, hospitalization and bone fusion outcomes

The results were summarized in Table 2. The amount of bleeding during operation and operation time of group A were significantly less than these of group B (*P*<0.001; *P*<0001, respectively). The length of hospital stay of group A was four days shorter than group B (A vs. B=20 vs. 24 days; *P*=0.018). However, the time of bone fusion between two groups had no significant difference (A vs. B=7.2 vs. 6.8 days; *P*=0.286).

Table 2.
Comparisons of Bleeding, operation time, hospitalization days, bone fusion

Group	N	Bleeding volume (mL)	Operation time (min)	Length of hospital stay (days)	Bone fusion (months)
A	49	800±40	130±40	20±9	7.2±1.4
B	40	900±50	160±50	24±6	6.8±2.1
t		10.484	7.339	2.407	1.073
P		<0.001	<0.001	0.018	0.286

Surgical efficacy

VAS, ODI and ASIA assessment before and after operation

VAS, ODI and ASIA were assessed at baseline, one month after operation and last time of follow-up. VAS and ODI score showed a progressive decrease following time, and ASIA score increased reversely, indicating the positive effect of the surgical procedures. However, the trend showed no difference between two groups, may suggesting the similar therapeutic effect of two approaches. The results were displayed in Table 3.

Table 3.
Comparisons of VAS, ODI, ASIA scores before and after operation between two groups

Group	N	VAS Score			ODI score			ASIA score		
		Before operation	One month after operation	Last time follow-up	Before operation	One month after operation	Last time follow-up	Before operation	One month after operation	Last time follow-up
A	49	3.4±0.9	3.0±0.6	2.1±0.1	4.1±0.3	3.5±0.4	3.1±0.7	62.33±13.12	82.88±11.43	97.55±3.65
B	40	4.1±1.2	3.1±0.2	2.4±0.3	4.5±0.4	3.8±0.2	3.5±0.6	76.71±15.56	84.97±10.09	96.46±5.04
Difference between two groups	*P* = 0.051			*P* = 0.060			*P* = 0.061			
Difference among time periods	*P* =0.022			*P* <0.001			*P* =0.002			
Comparisons between two groups at different time points	*P* =0.051			*P* =0.060			*P* =0.056			
Data was presented as mean ± standard deviation.										

ESR and Cobb angle before and after operation

The baseline ESR of group A was higher than it of group B (81.8 vs. 77.2 mm/h). After operation, ESR significantly decreased at both groups, whereas ESR of group A was lower than the counterpart(*P*<0.001). Identically, Cobb angel decreased significantly after operation, and group A with anterior approach had more effective impact(*P*=0.001). But there was no significant difference at each time point between two groups(*P*>0.05). The results were shown in Table 4.

Table 4.
Comparisons of ESR, Cobb angle before and after operation between two groups

Group	N	ESR (mm/1h)			Cobb angle (°)		
		Before operation	One month after operation	Last time follow-up	Before operation	One month after operation	Last time follow-up
A	49	81.8±15.4	18.5±7.4	7.6±1.9	34.55±4.47	20.67±1.32	5.50±3.25
B	40	77.2±16.9	20.8±6.9	8.5±2.0	33.98±4.51	20.51±3.31	5.61±3.42
Difference between two groups	P<0.001				P= 0.001		
Difference among time periods	P<0.001				P=0.002		
Comparisons between two groups at different time points	P= 0.057				P=0.060		
Data was presented as mean ± standard deviation; ESR= erythrocyte sedimentation rate							

Bone graft fusion

At the end of follow-up, positive bone fusion rate of patients with posterior approach was 91.83% (45/49), and the rate of another group with one-stage anterior approach was 92.50% (37/40). No looseness, breakage, and shift of internal fixation occurred. There was no difference of bone graft fusion between two groups (*P*>0.05). The results of Bridwell grading were summarized in Table 5.

Table 5.
Bone graft fusion between two groups at the last follow-up.

		Bridwell grading				
Group	N	I	II	III	IV	*P*
A	49	31	14	3	1	0.972
B	40	27	10	2	1	

Complications

The follow-up range of group A and group B was 13-35 and 15-37 months, respectively. For patients with posterior approach, vascular injuries happened in three cases, and cerebrospinal leak occurred in two cases during operation. One patient had wound infection. For these patients with anterior approach, two patients had vascular injuries, and two more patients had cerebrospinal leak. Only one patient had sinus tract in the abdominal incision. ESR of all the patients returned to normalcy at the end of follow-up. No clinical abnormalities were observed during the follow-up.

Discussion

The role of surgical treatment for spinal brucellosis remains poorly understood. It has been commonly perceived as the last resort in the complicated cases when the patients had persistent symptoms despite adequate antimicrobial therapy, septal abscess(15), vertebral collapse(8, 15), progressive neurological deficits(8) and spinal instability(8, 16). Moreover, few research studies investigated the surgical procedures in detail for treating spinal BS beyond therapeutic antibiotic regimens. Therefore, the surgical management has not been standardized. To provide the evidence to advance the clinical management of BS patients, this retrospective study compared the clinical efficacy of two different surgical approaches in patients with lumbar BS. The results showed that patients treated with one-stage anterior approach had less bleeding volume, shorter operation time and hospital stays, however, there were no distinct difference regarding clinical efficacy. Either method could achieve the postoperative outcome, and a personalized surgical plan should be recommended in real clinical practice.

The anterior approach has the advantage in lesion identification and differentiation from other adjacent tissues especially in the case of abscess. It enables the direct visualization of infected lesions and therefore can clear the lesion by using less time, especially in the removal of necrotic disc tissue and destroyed vertebrae to relieve the compression from the front of the spinal canal(17). The restoration of the anterior

column through intervertebral bone grafting increased the spinal stability and repaired bone defects. More than 95% cases occurred in anterior or central column, and abscess happened predominately in the anterior part of the spine. In the present study, patients with one-stage anterior approach had less operating time and bleeding volume and shorter hospitalization days, compared to these with combined posterior and anterior approach, which indicated a relatively low surgical risk in anterior approach. One-stage approach therefore should be recommended in most of the LBS cases, especially in elder population, compared with combined posterior and anterior method.

However, anterior approach has been reported to have disadvantages including the possibility of vascular injury, the difficulty of dura repair, relatively high risks of intercostal muscle atrophy, pneumothorax, pneumonia, pleural effusion, chylothorax(18). Besides, in the cases with multi-level lesions, inaccessible anterior reconstruction and poor spinal stability, anterior approach only was not suitable. The combined posterior and anterior was therefore introduced. For example, Khaled Hassan et al, group has compared the anterior approach to posterior approach in patients with lumbar Pott's disease and found that the anterior approach was less effective in kyphotic angel correction(19). Another study also showed the good agreement that posterior approach allowed better correction in patients with severe kyphosis (Cobb angle > 30°) (20). It also can be seen in this study that the Cobb angle in group B was more significantly improved than that in group A, and the present study had relatively larger sample size.

Although having more operative time and blood loss, posterior approach had the advantage in correcting kyphotic deformity through posterior pedicle screw fixation, maintaining the spinal stability and improving back pain(19), compared to anterior approach. Moreover, the posterior approach prevented the direct contact of internal fixation with infected lesions to avoid further inflammation. Each procedure has its own advantages and disadvantages. Although both methods caused damage to the spine structure, the immediate stability of the lumbar spine structure can be achieved by pedicle screw fixation, and the long-term anatomical stability can be achieved by the fusion of bone graft.

In terms of the surgical efficacy, two methods got primary healing, and the satisfactory recovery of wounds was observed at different time points after operation. This study also compared the VAS score, ESR and ODI of two groups regarding surgical efficacy assessment and the data demonstrated that two groups achieved good recovery at the relatively early stage without distinct difference. Both methods can remove the granulomatous tissue and necrotic lesions. Of importance, surgical procedure breaks the barrier of infected lesions, so that effective drugs can reach the lesion area, which indicated that surgery is necessary to be preformed in complicated cases or patients with ineffective treatment(21). The result was concordance with the earlier studies (19),(22). A systematic review including 25 studies compared the clinical efficacy of anterior approach, posterior approach and posterior approach combined with anterior approach and found that there was no significant difference among three methods, but posterior approach alone had less surgical risk.

And, in the selection of surgical procedures, individualized surgery should be recommended(19). This study suggested anterior approach only can be applied when patients with ≤ 2 involved vertebrae. In the cases where there is abscess compression or inflammatory granulation tissue wrapped around the nerve roots and dura mater, one-stage anterior approach is recommended. However, combine posterior and anterior approach is more suitable for patients with lesions in focal anterior column accompanying with paravertebral and prevertebral abscess or granuloma.

This study had some limitations. First, the sample size of this study is small. Second, the follow-up time is not long. Third, due to the different degree of segment destruction, the comparison before and after surgery for surgical efficacy assessment may bias. The findings of the present study should be confirmed in a prospective, case-control study with larger sample size in the future.

List Of Abbreviations

ASIS American Spinal Injury Association

BS Brucella Spondylitis

ESR Erythrocyte Sedimentation Rate

LBS Lumbar Brucellosis

MRI Magnetic Resonance Imaging

ODI Oswestry Disability Index

RBT Rose Bengal Test

SAT Serum Tube Agglutination Test

STIR Short Time Inversion Recovery

VAS Visual Analogue Scale

Declarations

Ethics approval and consent to participate:

The study was approved by the ethical Institution Review Board of the Chest Hospital of Hebei Province(No:[2020]068). And the consent form was waived as it was a retrospective study.

Consent for publication:

As stated before, the consent form was waived which was granted as a retrospective study.

Availability of data and materials:

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests:

The authors declare that they have no competing interests.

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Authors' contributions:

Chengguang Jia and Jianguo Gao designed the study and wrote the manuscript. Shaoliang Dong and Mingli Yao collected the clinical data regarding surgical approaches, perioperation information and surgical efficacy. Chengguang Jia, Jianguo Gao and Lianbo Wang analyzed and interpreted the data. Chengguangjia and jianguo Gao contributed equally to the work acting as co-first authors. Xiaowei Yao, as the corresponding author supervised and helped with the whole project. All authors read and approved the final manuscript.

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Figures

Figure 1 A

Figure 1

A 50-year-old male patient with vertebral brucellosis at L3-4 in the A-approach group. MRI before operation, showed L3-4 vertebral body destruction and paravertebral abscess formation.

Figure 1B

Figure 2

Postoperative review of X-ray showed lumbar posterior fixation and lesions were cleared thoroughly.

Figure 2A

Figure 3

A 24-year-old male patient with vertebral brucellosis at L2-3 in the posterior combined anterior approach group.

Figure 2B

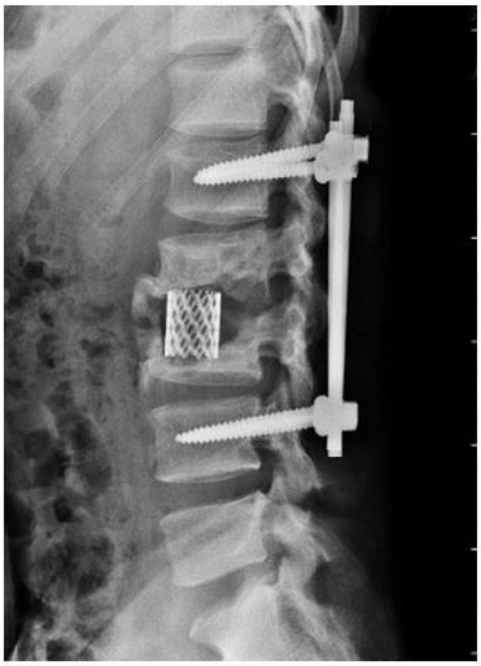

Figure 4

Postoperative review of X-ray showed lumbar posterior fixation and lesions cleared thoroughly.