

# Analysis of Risk Factors for Postoperative Complications of Thoracolumbar Brucella Spondylitis

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**Background:** This study aimed to identify risk factors for postoperative complications following a one-stage posterior approach for thoracolumbar Brucellosis spondylitis.

**Methods:** We retrospectively analyzed data from 61 patients with thoracolumbar Brucellosis spondylitis who underwent a one-stage posterior approach at this institution between January 2015 and January 2019. To compare clinical characteristics, patients were divided into two groups based on the presence of postoperative complications: a complication group (14 cases) and a control group (47 cases). Logistic regression analysis was then used to identify factors associated with postoperative complications.

**Results:** Disease duration, fever status, and hemoglobin levels differed significantly between groups (all  $P < 0.05$ ). Further, multivariate analysis identified diabetes, fever, and psoas muscle abscess as independent risk factors for postoperative complications (all  $P < 0.05$ ).

**Conclusion:** Having diabetes, fever, and psoas muscle abscess are independent risk factors for complications after a one-stage posterior approach for thoracolumbar Brucellosis spondylitis. Therefore, careful selection of surgical indications, strict surgical technique, proper blood glucose management in diabetic patients, and preoperative control of body temperature are essential to reduce complication rates.

**Keywords:** thoracolumbar spine, brucellosis spondylitis, postoperative complications, risk factors

## Introduction

Brucellosis is a zoonotic disease caused by *Brucella* species, with animals as the source of infection.<sup>1,2</sup> In China, brucellosis cases are mainly found in northern regions, such as Inner Mongolia.<sup>3,4</sup> The primary cause of human brucellosis is contact with livestock, such as cattle and sheep infected with *Brucella*, as well as their dairy and meat products. *Brucella* enters the body through the respiratory, skin, and digestive tracts, leading to fever and damage to multiple organs. Over time, the affected areas have shifted from localized to more scattered regions. Clinically, the most common symptom is lesions in the bone-joint and muscle systems, mainly affecting large joints, with the spine as the most frequently involved site. *Brucella* spondylitis, caused by *Brucella* invading the spine, has an incidence of up to 60% in patients with brucellosis.<sup>5,6</sup> Among these cases, the lumbar spine is most commonly affected, followed by the thoracic and, less commonly, the cervical spine.

Current treatments for brucella spondylitis are drug therapy and surgery.<sup>2,7</sup> Surgery is required when thoracolumbar pain persists or worsens after conservative care, when spinal nerves are compressed, or when spinal stability is compromised.<sup>8–10</sup> However, surgery for brucella spondylitis is challenging, with a high rate of complications and recurrence. Issues such as unclean incisions can result in poor wound healing and sinus tract formation, which may necessitate revision and debridement. Moreover, rates of wound infection and non-healing are reported to be higher than in other spinal surgeries.<sup>11,12</sup>

Despite these challenges, few studies have examined the risk factors for postoperative complications following surgical treatment of brucella spondylitis. This study analyzed such risk factors and aimed to provide a reference for reducing the probability of these complications.

## Materials and Methods

### Patient Population

From January 2015 to January 2019, 212 patients with brucella spondylitis were admitted to our department. Of these, 142 were discharged after improvement with conservative treatment, and 70 patients showed little or no relief after anti-brucellosis drug therapy and underwent surgery. Among them, 61 had thoracolumbar brucella spondylitis, all of whom were treated with one-stage posterior debridement, decompression, internal fixation, and interbody bone graft fusion (Figure 1).

Inclusion criteria were as follows: 1. fulfillment of the diagnostic criteria for brucellosis spondylitis,<sup>5,13</sup> completion of laboratory tests, X-ray, CT, and MRI examinations prior to surgery, and pathological confirmation of thoracolumbar brucella spondylitis during the operation; 2. fulfillment of the surgical indications for brucellosis spondylitis;<sup>5,10</sup> 3. absence of a history of spinal trauma; 4. adulthood without developmental spinal deformities; 5. absence of other etiological findings, such as *Mycobacterium tuberculosis*, *Staphylococcus aureus*, or fungi; and 6. availability of complete follow-up clinical imaging and laboratory examination data.

This retrospective study was approved by the ethical committee and performed in accordance with the ethical standards of the 1964 Declaration of Helsinki. All patients in this study voluntarily signed an informed consent form to join the scientific research and signed an informed consent form for surgical treatment.

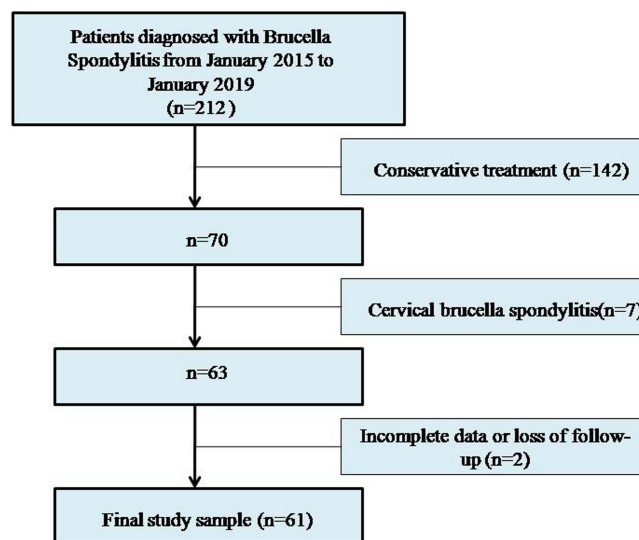
### Data Collection

Postoperative complications, such as incision infection, impaired wound healing, and recurrence, were systematically recorded.

The following variables were collected: patient age and gender at the time of surgery, preoperative clinical symptoms such as fever and lower-limb manifestations, imaging findings including intraspinal, paravertebral, and psoas abscesses, and laboratory indicators such as white blood cell count, lymphocyte count, hemoglobin, erythrocyte sedimentation rate, C-reactive protein, albumin, and globulin. Preoperative conditions, including anemia, malnutrition, and underlying diseases such as diabetes, were documented. The surgical segment, operative time, and intraoperative blood loss were recorded.

### Preoperative Preparation

All 61 patients underwent preoperative anti-Brucellosis drug therapy using either a triple or a quadruple regimen:<sup>2,7</sup> doxycycline 200 mg/d, rifampicin 600 mg/d, and levofloxacin 500 mg/d. Ceftriaxone sodium 2 g/d was included based on individual patient conditions. Each treatment course lasted 6 weeks, with a total of 2 to 3 courses administered. Throughout therapy, regular assessments of erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), liver function, and renal



**Figure 1** Flowchart showing study enrollment.

function were conducted. When the ESR shows a downward trend and is lower than 45 mm/h, and the CRP shows a downward trend and is lower than 15 mm/h, the surgery can be performed. If the patient has symptoms such as fever, the surgery should be postponed until the body temperature returns to normal.

## Surgical Techniques

The patient is placed in the prone position. Vertebral pedicles are identified and marked using C-arm fluoroscopy. The posterior median incision was made. Then, the skin, subcutaneous, and fascia layers were incised successively. Bilateral dissection along the spinous processes is performed until the lamina and facet joints are exposed. Under fluoroscopic guidance, a positioning needle is used to localize the pedicle, after which a pedicle screw system is inserted. For selected thoracic vertebrae, screw insertion is assisted by a computer navigation system. Unilateral or bilateral fenestration and decompression are then performed. With direct visualization and the use of a discectomy endoscope, inflammatory tissues and damaged bone within the spinal canal, intervertebral space, and paravertebral area are thoroughly removed. The intervertebral space is cleared until fresh blood is observed, and the area is repeatedly irrigated using an irrigation gun. Crushed autologous bone is implanted into the intervertebral bone defect, and an intervertebral fusion cage is inserted obliquely. Compression is applied, and fixation is tightened. The area is irrigated again with the irrigation gun. After confirming hemostasis, a drainage tube is routinely placed, and the incision is sutured in layers. The lesion tissue obtained during the procedure is sent for pathological examination (Figure 2).



**Figure 2** Imaging manifestations of a typical patient before and after surgery. (a and b) Pre-operative X-rays demonstrate lumbar scoliosis, kyphotic deformity, and reduced intervertebral space between the first and second lumbar vertebrae. (c and d) Pre-operative CT scans identify multiple foci of destruction at the superior and inferior margins of the first and second lumbar vertebral bodies. (e and h) Pre-operative MRI scans indicate inhomogeneous and abnormal signal changes in the vertebral bodies and intervertebral discs, as well as the presence of intraspinal and paravertebral abscesses. (i and j) Postoperative X-rays obtained two days after surgery demonstrate correction of scoliosis and restoration of intervertebral space height between the first and second lumbar vertebrae. (k and l) CT scans performed one year postoperatively confirm bony fusion between the vertebrae and substantial repair of previously damaged areas.

## Postoperative Management

Supportive care, including enhanced nutrition, should be administered following surgery. The drainage tube is to be removed within 2 to 3 days, contingent upon drainage status. Patients should wear a thoracolumbar brace and begin ambulation as tolerated. Postoperative anti-brucellosis pharmacotherapy must be continued.

## Statistical Analysis

All statistical analyses were performed using the SPSS software (version 25.0; IBM SPSS, New York). Continuous variables were presented as mean  $\pm$  standard deviation or medians with interquartile ranges, while categorical variables were presented as the frequencies or percentages of events. The Mann–Whitney *U*-test was used for non-normally distributed continuous variables, and a *t*-test was used for normally distributed continuous variables. Variables with  $P < 0.05$  in univariate logistic regression were included in the multivariate model to identify risk factors for complications. Relative risks and corresponding 95% confidence intervals were calculated. Statistical significance was defined as  $\alpha = 0.05$  (two-sided).

## Results

### Comparison of Clinical Data Between the Two Groups

A total of 61 patients were enrolled and categorized into a complication group or a control group based on the presence or absence of postoperative complications (Table 1).

The complication group comprised 14 patients, with 12 cases of delayed wound healing and 2 cases of recurrence. Of these patients, 11 were male, and 3 were female. Ages ranged from 26 to 68 years, with a mean age of  $60.07 \pm 12.71$  years. Seven patients had comorbid diabetes. Disease duration ranged from 30 to 260 days, with a median of 135 (90, 245) days. Clinical symptoms included fever in 9 patients and lower-limb symptoms in 6 patients. Imaging revealed intraspinal abscesses in 9 patients, paravertebral abscesses in 11 patients, and psoas abscesses in 6 patients.

The control group included 47 patients, of whom 33 were male and 14 were female. Ages ranged from 38 to 72 years, with a mean age of  $55.40 \pm 7.26$  years. Twelve patients had comorbid diabetes. Disease duration ranged from 30 to 720 days, with a median of 90 (60, 180) days. Clinical symptoms included fever in 16 patients and lower-limb symptoms in 24 patients. Imaging revealed intraspinal abscesses in 20 patients, paravertebral abscesses in 31 patients, and psoas abscesses in 11 patients.

There were statistically significant differences between the two patient groups in disease duration, fever status, and hemoglobin levels (all  $P < 0.05$ ; Table 1). In contrast, no statistically significant differences were observed between the

**Table 1** Comparison of Clinical Characteristic Data Between the Complication Group and the Control Group

Characteristic	Complication Group (n=14)	Control Group (n=47)	P	t
Age (year)	60.07 $\pm$ 12.71	55.40 $\pm$ 7.26	0.194	-1.358
Sex (male/female)	11/3	33/14	0.785	0.074
Diabetes	7/7	12/35	0.160	1.978
Disease duration (d)	135(90,245)	90(60,180)	0.041	-1.875
Fever	9/5	16/31	0.043	4.079
Lower limb symptoms	6/8	24/23	0.590	0.291
Intraspinal abscess	9/5	20/27	0.153	2.043
Paravertebral abscess	11/3	31/16	0.571	0.320
Psoas muscle abscesses	6/8	11/36	0.114	2.501
Albumin level (g/L)	37.84 $\pm$ 3.37	38.09 $\pm$ 4.11	0.836	-0.208
Globulin level (g/L)	32.40 $\pm$ 4.63	29.94 $\pm$ 4.77	0.094	1.703
White blood cell count ( $\times 10^9/L$ )	6.36 $\pm$ 2.15	5.38 $\pm$ 1.83	0.098	1.683
Lymphocyte count ( $\times 10^9/L$ )	1.61(1.38,2.08)	1.81(1.34,2.32)	0.512	0.655
Hemoglobin level (g/L)	118.64 $\pm$ 17.84	131.11 $\pm$ 12.51	0.026	-2.441
Surgical segment	2.0(1.0, 2.25)	2.0(1.0, 3.0)	0.294	1.050
Operation time (h)	3.0(2.88, 3.25)	3.0(2.8, 3.5)	0.908	0.116
Blood loss (mL)	370(300, 400)	380(300, 400)	0.683	0.409

two groups for the following variables: age, gender, diabetes mellitus, lower-limb symptoms, intraspinal abscess, paravertebral abscess, psoas abscess, white blood cell count, lymphocyte count, albumin level, globulin level, surgical segment, operation time, and blood loss (all  $P > 0.05$ ; Table 1).

## Risk Factors of Postoperative Complications

### Univariate analysis

Variables such as age, gender, disease duration, comorbid diabetes, comorbid intraspinal abscess, paravertebral abscess, psoas major muscle abscess, surgical segments, operation time, blood loss, white blood cell count, lymphocyte count, hemoglobin, albumin, globulin, erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP) were initially identified based on their potential clinical relevance as risk factors for postoperative complications in patients with thoracolumbar brucella spondylitis. These variables were subsequently included in the logistic regression analysis. Statistically significant factors were diabetes ( $P = 0.040$ ), fever ( $P = 0.049$ ), ESR ( $P = 0.018$ ), CRP ( $P = 0.046$ ), hemoglobin (HB) ( $P = 0.010$ ), and psoas major muscle abscess ( $P = 0.042$ ) (Table 2).

### Multivariate logistic regression

Six indicators—diabetes, fever, ESR, CRP, HB, and psoas major muscle abscess—were identified in the univariate logistic analysis and included as independent variables in the multivariate model using the full-model regression method. Regression results: Diabetes, fever, and psoas major muscle abscess were significant predictors of postoperative complications in patients with thoracolumbar brucella spondylitis (Table 3).

**Table 2** Univariate Logistic Regression Analysis of Postoperative Complications

Factor	B	SE	Wald $\chi^2$	P	OR	OR 95% CI
Age	-0.060	0.035	2.980	0.084	1.062	0.992~1.138
Sex	-0.442	0.725	0.371	0.542	0.643	0.155~2.663
Disease duration	-0.002	0.003	0.689	0.406	0.998	0.993~1.003
Surgical segment	0.417	0.399	1.091	0.296	1.517	0.694~3.314
Operation time	0.159	0.598	0.071	0.791	1.172	0.363~3.781
Blood loss	0.001	0.003	0.230	0.632	1.001	0.996~1.007
ESR	-0.028	0.012	5.577	0.018	1.972	0.950~2.995
CRP	-0.040	0.020	3.978	0.046	1.961	0.924~2.999
Albumin level	0.016	0.078	0.045	0.833	1.017	0.872~1.185
Globulin level	-0.109	0.066	2.730	0.098	0.896	0.787~1.021
White blood cell count	-0.246	0.153	2.576	0.109	0.782	0.579~1.056
Lymphocyte count	0.053	0.470	0.013	0.911	1.054	0.419~2.649
Hemoglobin level	0.061	0.023	6.657	0.010	1.063	1.015~1.113
Diabetes	-1.070	0.631	2.882	0.040	2.343	0.100~3.180
Fever	-1.249	0.637	3.845	0.049	2.287	0.082~2.999
Intraspinal abscess	-0.888	0.631	1.980	0.159	0.412	0.119~1.417
Paravertebral abscess	-0.638	0.720	0.784	0.376	0.528	0.129~2.169
Psoas muscle abscesses	-1.186	0.636	3.476	0.042	1.306	0.088~2.063

**Table 3** Multivariate Logistic Regression Analysis of Postoperative Complications

Factor	B	SE	Wald $\chi^2$	P	OR	OR 95% CI
ESR	-0.033	0.048	0.462	0.496	0.968	0.881~1.063
CRP	0.027	0.05	0.285	0.594	1.027	0.931~1.134
Hemoglobin level	-0.086	0.063	1.875	0.171	0.917	0.811~1.038
Diabetes	-2.166	1.106	3.834	0.046	1.886	0.013~3.002
Fever	-0.127	1.007	0.016	0.039	2.338	0.122~6.344
Psoas muscle abscesses	-1.83	1.104	2.744	0.048	1.032	0.018~1.398

## Discussion

*Brucella* spondylitis is caused by *Brucella* infecting the spine. Current treatments are mainly drugs or surgery. Surgery is necessary when drugs do not relieve symptoms, when there are large paravertebral or psoas abscesses, or when vertebrae are unstable. Because incisions are contaminated and patients' immune systems are weak, wound healing is often poor, and the risks of infection and recurrence are higher. This study found that diabetes, fever, and psoas muscle abscess independently increase the risk of postoperative complications in thoracolumbar brucella spondylitis and should be addressed during perioperative management.

### The Relationship Between Diabetes and Postoperative Complications

Diabetes is the most prevalent endocrine disorder worldwide, with China reporting the highest number of diabetic patients.<sup>14,15</sup> Previous studies have identified diabetes as an independent risk factor for postoperative wound infection following spinal surgery.<sup>16–18</sup> The co-occurrence of brucella spondylitis and diabetes necessitates the simultaneous management of a specific infection and a complex systemic metabolic disorder. These conditions can interact, substantially increasing the complexity and risk associated with diagnosis and treatment. Diabetes impairs leukocyte function and causes circulatory disorders, thereby reducing the body's ability to eliminate *Brucella* and complicating infection control. Additionally, diabetic patients often exhibit a chronic low-grade inflammatory state. Following *Brucella* infection, these patients may experience a heightened inflammatory response, resulting in more severe and extensive bone destruction, an increased risk of abscess formation—particularly paravertebral or psoas abscesses that are difficult to resolve—and a greater likelihood of nerve damage due to inflammation and abscesses compressing the spinal cord or nerve roots.

In this study, 50.00% (7/14) of patients in the complication group had diabetes. In patients with both brucella spondylitis and diabetes, the use of hypoglycemic drugs can cause subcutaneous fat thickening. Intraoperative traction may damage this fat, leading to fat liquefaction, poor wound healing, or infection. Diabetic patients are also prone to microvascular lesions. The use of electrocoagulation during surgery may damage blood vessels, resulting in ischemia and hypoxia of the incision tissue, which can further contribute to poor wound healing or infection.<sup>12</sup> Furthermore, hyperglycemia in diabetic patients can reduce the synthesis of substances such as collagen fibers that promote wound healing, leading to delayed postoperative recovery.

Currently, there is a paucity of studies, both domestically and internationally, that examine brucellosis complicated by diabetes. Yumuk et al<sup>19</sup> infected diabetic rats with *Brucella* and observed a worsening of their condition following infection. Additionally, Widdrington et al<sup>20</sup> identified diabetes as a risk factor for mortality in spondylitis in a large-scale retrospective study.

For patients with brucella spondylitis complicated by diabetes, it is essential to maintain strict blood glucose control during the perioperative period. Timely adjustment of the hypoglycemic regimen is recommended to minimize the risk of complications.

### The Relationship Between Fever and Postoperative Complications

In brucellosis spondylitis, fever often occurs in the afternoon, typically exceeding 38°C, and is accompanied by profuse sweating.<sup>2,10</sup> In this study, 64.29% (9/14) of patients in the complication group had concurrent fever. During the febrile period, a large number of bacteria are present in the vertebral lesions, and tissues are in a state of acute or sub-acute suppurative inflammation and edema, with abundant blood supply but fragile structure. Although the lesion is located in the spine, fever indicates bacteria may enter the bloodstream, posing a risk of bacteremia or septicemia, and the immune system is under stress.<sup>21–24</sup> If the fever is not controlled before surgery, many viable bacteria remain in the surgical area. Although most lesions are removed during surgery, remaining bacteria may proliferate due to low post-operative immunity or local hematoma, leading to poor wound healing or recurrence.

This study identifies preoperative active fever as an independent risk factor for postoperative complications in brucellosis spondylitis. Nonhealing of the surgical wound and recurrence are linked to this risk. Control fever and stabilize the disease before elective surgery to reduce complications.

## The Relationship Between Psoas Major Muscle Abscess and Postoperative Complications

Following spinal invasion by *Brucella*, granulomas proliferate beneath the cartilaginous endplate. Disease progression results in expansion of the affected area, bone destruction, and narrowing of the intervertebral space. Rupture of paravertebral lymph nodes may lead to paravertebral or psoas muscle abscesses.<sup>2,25,26</sup> Esmaeilnejad-Ganji et al<sup>27</sup> reported that thoracolumbar pain in brucella spondylitis is associated with epidural, paravertebral, and psoas muscle abscesses. Clinical outcomes remain poor in the presence of abscesses, even with rigorous treatment. Yang B<sup>28</sup> and others observed that, compared to spinal tuberculosis, brucella spondylitis is characterized by bone destruction with concurrent bone hyperplasia, and abscesses are typically limited to the vicinity of the affected vertebral bodies. Ulu-Kilic et al<sup>29</sup> analyzed clinical data from 293 patients with brucella spondylitis and identified psoas muscle abscesses in only 10 cases, indicating a relatively low incidence. They concluded that psoas muscle abscesses are uncommon in brucella spondylitis. In the present study, 42.85% (6/14) of patients in the complication group exhibited psoas muscle abscesses. Compared to spinal tuberculosis, brucella spondylitis is associated with fewer cases of psoas muscle abscesses. Consequently, inadequate perioperative attention and incomplete debridement of psoas muscle abscesses during surgery may increase the risk of postoperative complications.

This study utilized the posterior surgical approach. Traditionally, brucella spondylitis has been managed with a combined anterior-posterior approach, which is associated with significant surgical trauma, increased procedural risks, greater demands for spinal stability reconstruction, occasional insufficient fixation strength, the need for intraoperative repositioning, and higher physical requirements for patients.<sup>30–32</sup> In recent years, the posterior approach has gained preference among surgeons, as it mitigates these disadvantages and can significantly reduce recurrence rates.<sup>33,34</sup> Although multiple studies have demonstrated that posterior surgery for brucella spondylitis yields satisfactory clinical outcomes, REN et al<sup>35</sup> identified limitations of the posterior approach, including a restricted visual field. This limitation is particularly problematic in cases with paravertebral or psoas abscesses, where complete lesion removal is challenging and may compromise surgical efficacy.

Therefore, in clinical management of brucella spondylitis complicated by psoas muscle abscesses, careful preoperative assessment, meticulous surgical planning, and strict adherence to operative protocols are essential to minimize postoperative complications.

However, this study also has limitations, such as the interaction relationships among the three variables, a large temporal span of sample size, a small sample size, and the absence of multicenter data. So, future research should focus on larger, collaborative studies to validate and extend these findings.

## Conclusion

In conclusion, diabetes, fever, and psoas abscess are significant risk factors for postoperative complications in patients with thoracolumbar brucella spondylitis. To reduce these complications, surgical indications should be selected judiciously, surgical procedures must be rigorously followed, blood glucose in diabetic patients should be controlled, and preoperative body temperature must be managed appropriately.

## Abbreviations

ESR, erythrocyte sedimentation rate; CRP, C-reactive protein; CT, computed tomography; MRI, magnetic resonance imaging.

## Data Sharing Statement

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

## Ethics Approval and Consent to Participate

This retrospective study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Beijing Ditan Hospital, Capital Medical University, Beijing, China (No.2019-048-001). And all participants signed informed consent for publication.

## Acknowledgments

The authors thank the participants for making this study possible and the Department of Pathology for technical support. This paper has been uploaded to Research Square as a preprint: <https://www.researchsquare.com/article/rs-8435058/v1>.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

## Disclosure

The authors declare that they have no competing interests in this work.

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