

The risk factors of the postoperative poor wound healing in spinal tuberculosis patients: A single centre retrospective cohort study

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Abstract

The purpose of this study is to find out the risk factors of poor wound healing (PWH) in spinal tuberculosis (STB) patients. A total of 232 STB patients who underwent debridement surgery between January 2012 to June 2020 were included in this retrospective study. The study cohort was divided into two groups according to the presence or absence of PWH. The clinical characteristics of STB patients who developed PWH were evaluated, and risk factors were found using logistic regression analysis. Of the 232 patients, 30 developed PWH. Multivariate binary logistic regression analysis showed that pulmonary tuberculosis, long operation time and low postoperative albumin level were independent risk factors for PWH in STB patients. Receiver operating characteristic curve analysis showed that the optimal cutoff value of PWH in operation time and postoperative albumin are 200 minutes and 30 g/L, respectively. Pulmonary tuberculosis, long operation time and low postoperative albumin level are independent risk factors for PWH following surgery for STB. Curing pulmonary tuberculosis, controlling operation time and supervising postoperative serum albumin may decrease the risk of PWH among STB patients.

KEYWORDS

poor wound healing, risk factors, spinal tuberculosis

Key Messages

- This study is focused on the independent risk factors of poor wound healing in spinal tuberculosis.
- Complicated with pulmonary tuberculosis, long operation time and low postoperative albumin level are independent risk factors of poor wound healing in spinal tuberculosis.
- Operation time more than 200 minutes and postoperative albumin less than 30 g/L are the cutoff value of poor wound healing in spinal tuberculosis.

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1 | INTRODUCTION

Spinal tuberculosis (STB) is a common extrapulmonary tuberculosis that accounts for approximately 50% of all osteoarticular tuberculosis cases.¹ At present, anti-tuberculosis drug therapy combined with surgical treatment is considered the gold standard for STB treatment.² The debridement of lesions is a key step in STB surgery as it enhances the control of tuberculosis changes, improves the efficacy of anti-tuberculosis drugs, promotes bone graft fusion and reduces the risk of recurrence of STB.^{3,4}

Poor wound healing (PWH) is an important surgical complication, which not only brings patients suffering and prolonged hospital stay, but also is a major cause of postoperative surgical site infections (SSIs).⁵⁻⁷ SSIs is also a common postoperative complication. The rate of surgical wound infection across Europe is variably reported to be between 2.1% and 7.1%.^{8,9} SSIs following spinal instrumented fusion combined debridement surgeries is a major postoperative concern in STB patients because it can lead to severe consequences such as failure of fixation, pseudoarthrosis, osteomyelitis, prolonged hospital stays, mortality, increased economic costs and even secondary revision surgery.¹⁰⁻¹² Therefore, high-risk wounds must be identified and monitored appropriately to decrease the occurrence of SSIs. However, wound surveillance is inadequate, leading to increased risk of SSIs. Although the previous studies demonstrated that risk factor identification reduces SSIs rates, but very few studies have focused on wound management at a junior level such as PWH.

PWH is a major cause of postoperative SSIs.^{5,6} The rate of SSIs in STB patients to be between 1.7% and 6.1% and the rate of postoperative PWH is much higher.¹³⁻¹⁶ Our study is focused on identifying the risk factors of postoperative PWH in STB patients for better wound surveillance to decrease the risk of SSIs.

2 | MATERIALS AND METHODS

All of the participants provided their written informed consent to participate in this study before their data were stored in the hospital database and used for research purposes. The work has been reported in line with the strengthening the reporting of cohort studies in surgery criteria.

2.1 | Patient selection

A total of 232 patients with STB who underwent lesion debridement in our hospital from January 2012 to June 2020 were retrospectively included in this study.

2.1.1 | Inclusion criteria

Patients were selected if they met the following inclusion criteria: (a) medical records were complete, including general information, perioperative laboratory examination, imaging results (including magnetic resonance imaging and computed tomography) and clinical data on postoperative clinical features; (b) patients who underwent surgery; and (c) patients' postoperative pathological diagnosis was confirmed as STB.

2.1.2 | Exclusion criteria

Patients were excluded if they presented with the following: (a) suspected STB not confirmed by pathological examination, (b) preliminary and pathological diagnosis of diseases other than STB, (c) a previous history of STB or (d) SSIs.

2.2 | Measures and outcomes

2.2.1 | Measures

The PWH is defined as the obvious stagnation or delay in the incision healing process, resulting in prolonged non-healing status which can be complicated with the exudate, incision haematoma even incision dehiscence. Based on previous studies and our experience, the following possible predictors for the occurrence of postoperative PWH in STB patients were assessed: patient's general conditions, laboratory examination indexes and surgery-related indexes. Measures of general patient conditions included age, gender, body mass index, comorbidities, history of drinking, history of smoking and course of disease. Laboratory examination indexes included preoperative haemoglobin, preoperative serum albumin, preoperative lymphocytes, preoperative erythrocyte sedimentation rate, preoperative C-reactive protein, postoperative haemoglobin and postoperative serum albumin. Surgery-related indexes included the number of diseased vertebrae, the number of fixation segments, the number of pedicle screws, surgical approach, operation time and operation blood loss.

2.2.2 | Statistical analysis

Univariate analyses using Student's *t* test and chi-square test were used to compare continuous and categorical variables, respectively. The receiver operating characteristic (ROC) curves analysis determined the threshold values for continuous variables. The prevalence of the included clinical characteristics was evaluated by

calculating the sensitivity and specificity for each factor. The clinical characteristics were also subjected to univariate logistic regression analysis, and the significant factors were evaluated by multivariate logistic regression analysis. $P < .05$ was considered statistically significant. The SPSS version 26.0 software was used for statistical analyses.

3 | RESULTS

3.1 | Patient population

Among the 232 patients enrolled in the study, 30 presented with PWH (18 men and 12 women). The remaining 202 patients (111 men and 91 women) did not develop PWH (Figure 1). The mean age of patients with PWH was 51.97 ± 17.23 and that of patients without PWH was 46.71 ± 16.05 years (Figure 1). The independent sample t test and chi-square test showed that pulmonary tuberculosis ($P = .004$), operation time ($P = .001$), postoperative haemoglobin ($P = .007$) and postoperative serum albumin ($P < .001$) are significantly different between the patients with PWH and without PWH (Figures 1-3).

3.2 | Results of univariate logistic regression analyses

Univariate logistic regression analyses revealed that pulmonary tuberculosis, operation time, number of fixation

segments, number of pedicle screws, number of fixation segments, postoperative haemoglobin and postoperative serum albumin were risk factors for PWH (Table 1).

3.3 | Results of multivariate logistic regression analyses

Multivariate logistic regression analyses of the identified significant risk factors revealed that pulmonary tuberculosis, operation time and postoperative serum albumin were independent risk factors for the occurrence of PWH (Table 2). ROC curves showed that the diagnostic threshold of postoperative serum albumin was 30 g/L (sensitivity, 0.530; specificity, 0.900), and the threshold of operation time was 200 minutes (sensitivity, 0.800; specificity, 0.540) (Figure 4).

4 | DISCUSSION

In the present study, logistic regression analysis revealed that pulmonary tuberculosis, operation time and preoperative albumin level were independent risk factors for PWH in patients with STB.

4.1 | Pulmonary tuberculosis

STB patients are prone to be complicated with pulmonary tuberculosis simultaneously, another epidemiological study

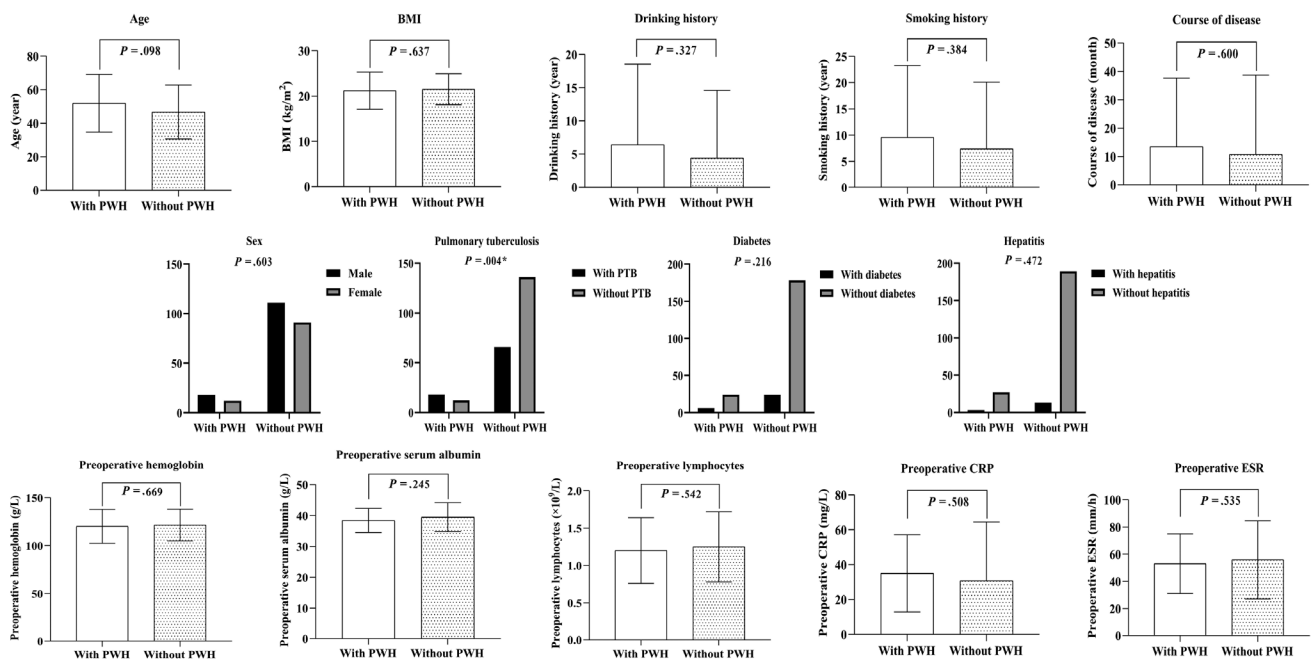


FIGURE 1 Preoperative clinical characteristics of 232 spinal tuberculosis patients

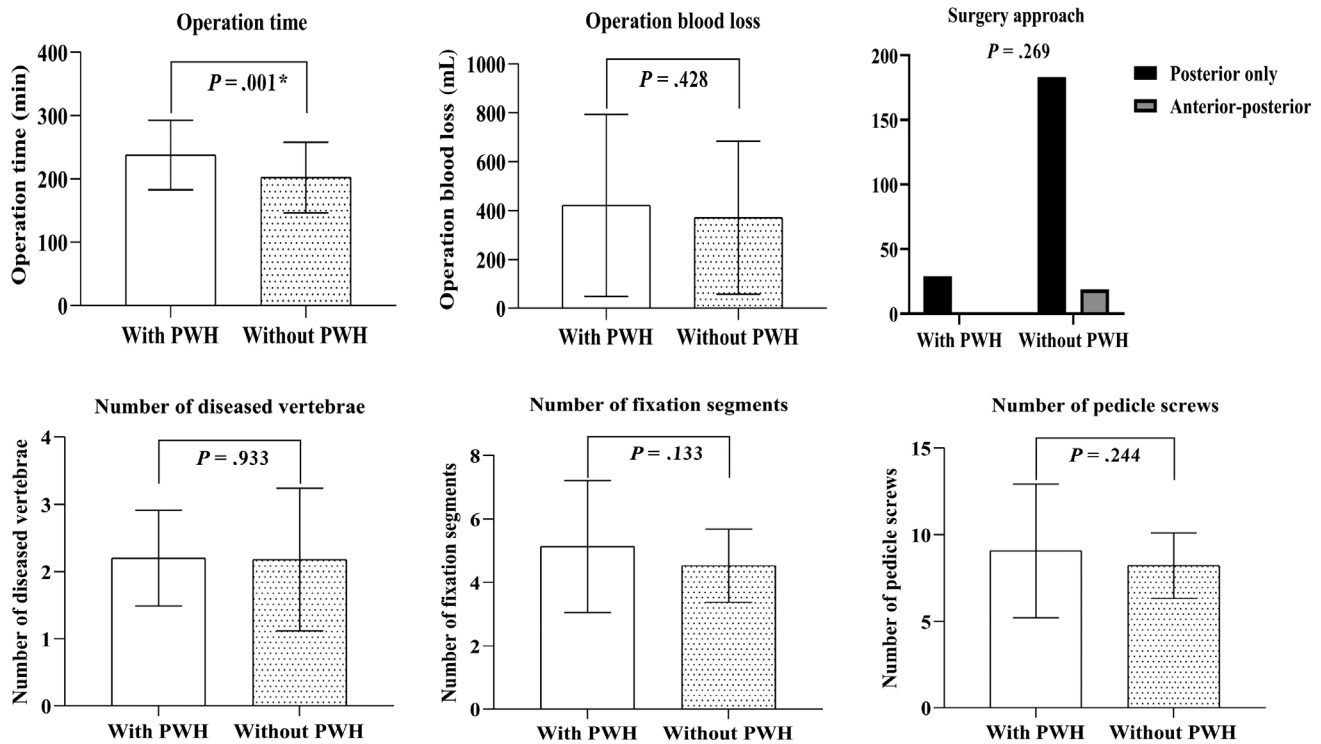


FIGURE 2 Operation-related clinical characteristics of 232 spinal tuberculosis patients

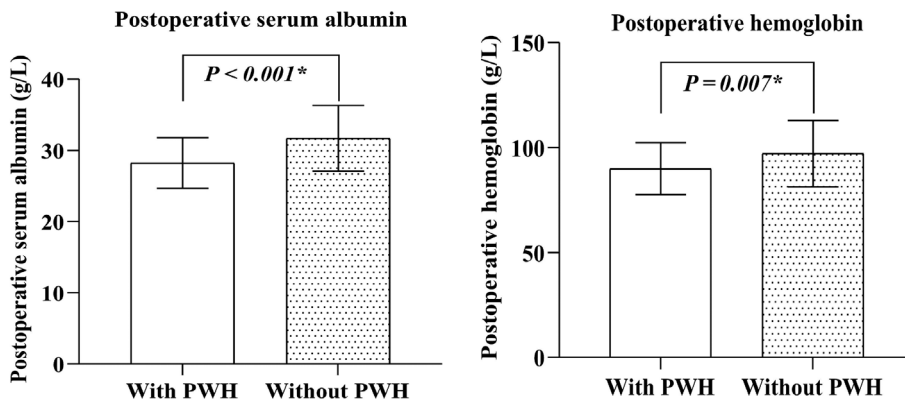


FIGURE 3 Postoperative clinical characteristics of 232 spinal tuberculosis patients

in STB patients based on the same province demographic characteristics reported that 25.7% of 284 STB patients are complicated with pulmonary tuberculosis.¹⁷ Pulmonary tuberculosis is closely related to malnutrition, pulmonary tuberculosis patients are easier to develop hypoalbuminemia that previous study had shown 24% tuberculosis patients complicated with hypoalbuminemia.^{18,19} Many studies have approved that serum albumin level is an independent risk factor of the SSIs in spinal surgeries.^{20,21} We believe that the PWH in STB patients caused by pulmonary tuberculosis may be due to the patient's malnutrition in serum albumin. Not only the serum albumin level, pulmonary tuberculosis patients' concentrations of blood haemoglobin, plasma retinol and plasma zinc are poorer than health people.²² Comprehensive malnutrition may be another vital factor that

pulmonary tuberculosis' adverse effect to STB patients' PWH. For STB patients complicated with pulmonary tuberculosis, we should pay more attention to their nutritional status.

4.2 | Operation time

Studies have shown that operation time is closely related to the rate of postoperative incision infections after spinal surgery.^{23,24} Analysis using the ROC curve determined that operation time of 200 minutes was the diagnostic threshold for the occurrence of postoperative PWH. In a study addressing the risk of spinal infections, Beiner et al suggested that an operation time longer than 180 minutes predisposes the patients to postoperative wound infections,

TABLE 1 Univariate binary logistic regression analysis of postoperative poor wound healing

Characteristics	Regression coefficient (β)	Odds ratio (OR)	95% CI	P
Age	.021	1.021	0.996–1.046	.101
Sex	.207	1.230	0.563–2.686	.604
BMI	–.027	0.973	0.869–1.089	.635
Pulmonary tuberculosis	–1.128	0.324	0.147–0.711	.005*
Diabetes mellitus	–.617	0.539	0.200–1.453	.222
Hepatitis	–.480	0.619	0.166–2.314	.476
Smoking history	.012	1.012	0.985–1.041	.384
Drinking history	.016	1.016	0.984–1.050	.329
Preoperative haemoglobin	–.005	0.995	0.973–1.018	.667
Preoperative lymphocytes	–.267	0.766	0.326–1.800	.541
Preoperative serum albumin	–.053	0.949	0.869–1.036	.238
Preoperative CRP	.004	1.004	0.993–1.014	.508
Preoperative ESR	–.004	0.996	0.983–1.010	.608
Course of disease	.003	1.003	0.992–1.014	.608
Operation time	.008	1.008	1.002–1.015	.011*
Operation blood loss	.000	1.000	0.999–1.001	.429
Surgery approach	–1.102	0.332	0.043–2.577	.292
Number of diseased vertebrae	.016	1.016	0.706–1.462	.932
Number of fixation segments	.301	1.351	1.039–1.757	.025*
Number of pedicle screws	.145	1.157	0.992–1.348	.063*
Postoperative haemoglobin	–.032	0.968	0.943–0.995	.020*
Postoperative serum albumin	–.182	0.834	0.757–0.918	<.001*

Abbreviations: BMI, body mass index; CRP, C-reactive protein; ESR, erythrocyte sedimentation rate. * statistical significance.

TABLE 2 Multivariate binary logistic regression analysis of postoperative poor wound healing

Characteristics	Regression coefficient (β)	Crude odds ratio (OR)	95% CI	P
Pulmonary tuberculosis	–.899	0.407	0.178–0.931	.033*
Operation time	.008	1.008	1.001–1.015	.030*
Number of fixation segments	–.019	0.981	0.521–1.850	.954
Number of pedicle screws	.068	1.071	0.901–1.273	.438
Postoperative haemoglobin	–.003	0.997	0.964–1.032	.873
Postoperative serum albumin	–.143	0.867	0.783–0.960	.006*

*statistical significance.

and antibiotics should be administered when operation costs longer than 180 minutes.²⁵ Therefore, Chinese surgeons will administer one more time antibiotics in surgeries when it reaches 180 minutes. However, there is no current study on the correlation between postoperative wound infections and operation time when the operation time over 180 minutes with antibiotics administered. Our findings suggest that operation time more than 200 minutes is a high risk factor for postoperative PWH in case of the antibiotics are administered additionally at 180 minutes in operation. Therefore, optimising operation time in STB patients

to 200 minutes or less may be a crucial step in minimising postoperative PWH.

4.3 | Postoperative albumin

Albumin is thought to predispose patients to SSIs by impairing wound healing and prolonging inflammation via several mechanisms, including impaired fibroblast proliferation and collagen synthesis.²⁶ Plenty of previous studies have approved the preoperative serum albumin is

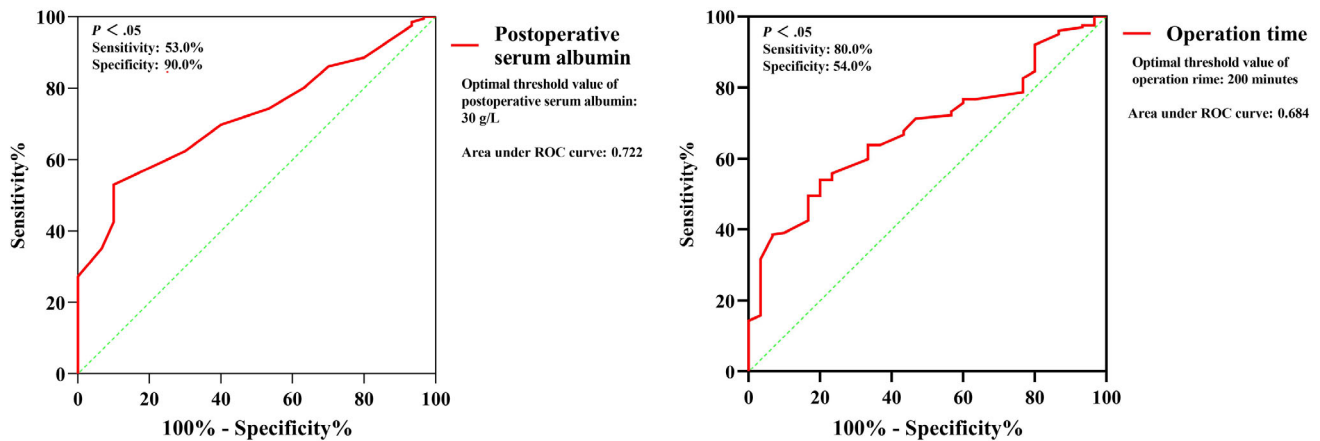


FIGURE 4 ROC curve of postoperative serum albumin and operation time

the independent risk factor of wound infection.²⁸⁻³⁰ However, we found that it is the postoperative serum albumin rather than preoperative serum albumin is the independent risk factor of the PWH in STB patients. The low postoperative albumin leads to the PWH by hindering fibroblast proliferation and collagen synthesis in the incision tissue, impairing the ability of the immune system and increasing tissue fluid leakage.²⁷ Postoperative albumin plays a vital role in the surveillance of postoperative wound recovery because it's more time-sensitive. When albumin level decreased less than 30 g/L, positive actions should be taken to prevent the PWH such as administer human serum albumin and enhanced enteral nutrition.

Some of the negative finding in our study also interesting, many studies have determined the diabetes is the independent risk factor of wound infection.²⁸⁻³⁰ However, our study suggested that complicated with diabetes is not the risk factor of PWH, which may due to the blood glucose control measurements. All the patients with diabetes included in our study had their blood glucose controlled below 10 mmol/L by active intervention such as insulin administration, we believe the blood glucose controlled intervention decrease the risk of PWH in STB patients. Furthermore, we think it is the blood glucose level rather than the existence of diabetes that determines PWH's occurrence, which indicates good perioperative blood glucose control can effectively reduce the occurrence of PWH.

This study had some limitations, there may be some risk factors that we did not consider and our sample number is not satisfying enough. Future studies addressing these issues are required to confirm our results.

5 | CONCLUSION

This study identified three independent risk factors for postoperative PWH in patients with STB. Clinicians can

decrease the occurrence of PWH in STB patients by curing pulmonary tuberculosis, control operation time and supervise postoperative serum albumin.

Informed consent was obtained from all individual participants included in the study. The participant has consented to the submission of the case report to the journal.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

ETHICS STATEMENT

This study was conducted in accordance with the Declaration of Helsinki (as revised in 2013) and was approved by the Institutional Ethics Board of The First Affiliated Hospital of Chongqing Medical University (No. ChiCTR1800019109).

AUTHORS CONTRIBUTIONS

Guanyin Jiang: Conceptualization, methodology, formal analysis, investigation, data curation, writing – original draft, writing – review & editing, visualization, project administration. **Yong Zhu:** Formal analysis, investigation, data curation, writing – original draft, writing – review & editing. **Muzi Zhang:** Formal analysis, investigation, data curation, writing – review & editing. **Wanyuan Qin:** formal analysis, investigation, data curation, writing – review & editing. **Tuotuo Xiong:** Formal analysis, investigation, data curation, writing – review & editing. **Yunsheng Ou:** Conceptualization, methodology, writing – review & editing, supervision, project administration, funding acquisition.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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