Scientific Research Publishing

Open Journal of Modern Neurosurgery, 2025, 15(4), 272-279
https://www.scirp.org/journal/ojmn
ISSN Online: 2163-0585
ISSN Print: 2163-0569

Analysis of Risk Factors for Incisional Infection after Spinal Tumor Resection

Xiaoqiong Zheng, Hongying Zhang, Xinyi Liang*

Department of Musculoskeletal Oncology, Sun Yat-Sen University Cancer Center, Guangzhou China
Email: 1006803259@qq.com, 1617027870@qq.com, *Liangxy@sysucc.org.cn

How to cite this paper: Zheng, X.Q., Zhang, H.Y. and Liang, X.Y. (2025) Analysis of Risk Factors for Incisional Infection after Spinal Tumor Resection. *Open Journal of Modern Neurosurgery*, **15**, 272-279.
https://doi.org/10.4236/ojmn.2025.154028

Received: August 21, 2025
Accepted: September 20, 2025
Published: September 23, 2025

Abstract

Objective: To identify risk factors for postoperative incision infection in patients with spinal tumors, thereby providing a reference for reducing the incidence of postoperative wound infection. **Methods:** This study retrospectively analyzed 195 patients who underwent posterior open spinal tumor resection at our hospital from January 2024 to January 2025. Patients were divided into an observation group (20 cases with wound infection) and a control group (175 cases without wound infection) according to the presence of wound infection. The influence of eighteen variables on wound infection was comparatively assessed, including gender, age, BMI, history of diabetes, history of hypertension, smoking history, history of radiotherapy at the surgical site, preoperative hypoalbuminemia, disease duration, operative time, intraoperative blood loss, use of internal fixation, same-segment repeat surgery, surgical site, wound size, number of tumor resection segments, duration of wound drainage tube placement, and presence of postoperative cerebrospinal fluid leak. **Conclusion:** History of radiotherapy at the surgical site, preoperative hypoalbuminemia, and duration of wound drainage tube placement were identified as independent risk factors for the occurrence of wound infection ($P < 0.05$). Other variables including gender, age, BMI, history of diabetes, history of hypertension, smoking history, disease duration, operative time, intraoperative blood loss, internal fixation, same-segment repeat surgery, surgical site, wound size, number of tumor resection segments, and postoperative cerebrospinal fluid leak, did not significantly influence the occurrence of wound infection ($P > 0.05$). Comprehensive preoperative assessment of patients is essential, and risk factors should be carefully considered in surgical planning. Timely removal of the drainage tube after surgery is recommended to reduce the risk of wound infection.

Keywords

Incisional Infection, Risk Factors, Spinal Tumor Surgery

1. Introduction

With advances in tumor diagnosis and treatment, surgical resection has become the primary therapeutic approach for spinal tumors. By excising lesions and reconstructing spinal stability, this procedure can effectively alleviate pain and other symptoms, enhance neurological function, and extend patient survival. However, spinal tumor surgery is associated with complex anatomy, significant surgical trauma, prolonged operative time, and substantial intraoperative blood loss. These challenges are further compounded by the frequent presence of advanced age, malnutrition, underlying comorbidities, or a history of preoperative radiotherapy and chemotherapy among patients, resulting in a markedly higher risk of postoperative incision infection compared to standard spinal surgery [1]. According to domestic and international reports, the infection rate following conventional spinal surgery is approximately 1% - 3%, whereas the postoperative incision infection rate after spinal tumor resection may reach 5% - 18% [2] [3]. Should an incision infection occur, it not only prolongs postoperative recovery and significantly increases healthcare costs, but may also lead to severe complications such as spondylitis, epidural abscess, and nerve injury. This can further result in internal fixation loosening, surgical failure, and a marked decline in patient quality of life. In some instances, persistent infection may necessitate repeated surgical interventions, and in severe cases, can be life-threatening [4]. Currently, most research on risk factors for postoperative incision infection in spinal surgery focuses on general spinal procedures, with studies specific to the unique population of spinal tumor patients remaining limited. Therefore, this study aims to retrospectively analyze the clinical data of patients who have undergone spinal tumor resection, systematically identify factors that may influence postoperative incision infection, and determine their independent risk factors. These findings will provide data support for early clinical identification of high-risk patients and optimization of perioperative management, thereby reducing the incidence of postoperative incision infection.

2. Materials and Methods

2.1. General Information

From January 2024 to January 2025, 195 patients who underwent posterior open spinal tumor resection at Sun Yat-sen University Cancer Center were included as study subjects. Based on the occurrence of incision infection, patients were categorized into an observation group (incision infection, n = 20) and a control group (no incision infection, n = 175). Inclusion criteria were as follows: ① All patients underwent posterior open spinal tumor resection surgery; ② Met the early postoperative incision infection diagnostic criteria established by the United States Centers for Disease Control and Prevention (centers for disease control and prevention, CDC) [5]; ③ Complete medical records; ④ Patient age greater than 18 years, with informed consent obtained from both patients and their families. Early incision infection was diagnosed if any one of the following criteria was met: ①

The incision displayed redness, swelling, heat, pain, with fluctuation, abscess, or purulent discharge; ② Bacterial culture of incision exudate or wound drainage fluid was positive; ③ Intraoperative irrigation or tissue bacterial culture during debridement surgery was positive; ④ Laboratory indicators—including routine blood tests, C reactive protein (C-reactive protein, CRP), procalcitonin—as well as imaging or histopathological examination, confirmed the presence of SSI; ⑤ Infection occurring within 30 days postoperatively. Exclusion criteria were: ① Preoperative traumatic brain injury or dysfunction of other organs; ② Coagulation dysfunction; ③ Age younger than 18 years; ④ Incomplete data; ⑤ Indeterminate wound infection.

2.2. Methods

Surgical procedure for spinal tumor resection: prophylactic antibiotic therapy is administered prior to surgery. If the operative duration exceeds 3 h, supplemental antibiotics are given. During surgery, patients are positioned laterally or supine, and a midline longitudinal incision is utilized. At the conclusion of surgery, prior to wound closure, the surgical cavity is irrigated with 100 ml of hydrogen peroxide. Following irrigation, one or two silicone drainage tubes are placed, and the incision is closed in layers with absorbable sutures, Simultaneously record the wound size. Postoperatively, routine antibiotics are administered to prevent wound infection. When the drainage volume is less than 30 ml/day, the drainage tube may be removed while simultaneously assessing the wound and characteristics of the drainage fluid. If the drainage fluid appears turbid or the patient exhibits signs of fever, wound secretions, drainage fluid, or blood samples should be sent for bacterial and fungal cultures.

2.3. Observational Indicators

This study analyzes the incidence and influencing factors of early surgical site infection following spinal tumor resection. A total of 18 variables were considered, including patient gender, age, BMI, history of diabetes, history of hypertension, smoking history, history of radiotherapy at the surgical site, presence of preoperative hypoalbuminemia (ALB < 35 g/l), disease duration, operation time, intraoperative blood loss, use of internal fixation, whether the procedure was a repeat surgery at the same segment, surgical site, wound size, number of tumor resection segments, duration of wound drainage tube placement, and postoperative cerebrospinal fluid leakage.

2.4. Statistical Analysis

All data were analyzed using SPSS version 27. Univariate analyses were conducted using t-tests or χ^2 tests, with statistical significance defined as $P < 0.05$. For multivariate analysis, logistic regression was performed, with a significance threshold of $\alpha = 0.05$; differences with $P < 0.05$ were considered statistically significant.

3. Results

3.1. Incidence of Incision Infection after Spinal Tumor Resection

Among 195 patients who underwent spinal tumor resection, a total of 20 cases of incision infection were observed, corresponding to an infection rate of 10.25%. The detailed distribution of infections was as follows: 6 cases of Staphylococcus epidermidis, 4 cases of Escherichia coli, 4 cases of Staphylococcus aureus, 2 cases of Pseudomonas aeruginosa, 2 cases of hemolytic staphylococcus, 1 case of Candida tropicalis, and 1 case of coagulase-negative staphylococcus infection.

3.2. Analysis of Clinically Related Indicators

Statistical analysis of all patient data revealed that a history of radiotherapy at the surgical site, preoperative hypoalbuminemia, operative time exceeding 3 hours, larger wound size, and drainage tube duration over 3 days are risk factors for surgical incision infection. The differences in were statistically significant ($P < 0.05$). Details are presented in Table 1.

3.3. Multivariate Analysis

Multivariate logistic regression analysis revealed that a history of radiotherapy at the surgical site, preoperative hypoalbuminemia, and a drainage tube duration of more than three days are independent risk factors for influencing early infection of the surgical incision following spinal tumor resection ($P<0.05$). Detailed results are provided in Table 2.

Table 1. Analysis of clinical relevant indicators in the two groups of patients.

Influencing factors		Observation group (20)	Control group (175)	t/χ^2 value	P value
Gender	Male	14	95	1.798	0.180
	female	6	80		
Gender	<60	12	118	0.446	0.504
	≥60	8	57		
BMI	<18.4	2	13	0.177	0.915
	18.5 - 23.9	11	101		
	≥24	7	61		
Preoperative hypoalbuminemia	Yes	10	46	4.931	0.026
	No	10	129		
History of diabetes	Yes	0	12	0.515	0.473
	No	20	163		
History of hypertension	Yes	6	34	1.230	0.267
	No	14	141		
Smoking history	Yes	1	34	1.652	0.197
	No	19	141		

Continued

History of radiotherapy	Yes	11	23	21.844	<0.001
	No	9	159		
Course of disease	<1 year	9	105	1.663	0.197
	≥1 year	11	70		
Placement of internal fixation	Have	20	10	0.415	0.373
	None	0	165		
Surgery time	<3 h	7	103	4.155	0.042
	≥3 h	13	72		
Reoperation at the same spinal segment	Yes	18	161	0.095	0.758
	No	2	14		
Surgical site	Cervical vertebrae	1	10	14.349	0.002
	Thoracic vertebrae	3	99		
	Lumbar vertebrae	11	69		
	Sacrum	5	18		
Decompression segment	Single segment	11	106	0.232	0.630
	Multi-segment	9	69		
Duration of drainage tube placement	≤3 days	5	151	42.134	<0.001
	>3 days	15	24		
Is there cerebrospinal fluid leakage	Yes	3	16	0.193	0.661
	No	17	159		
Wound size		23.00 ± 5.477	17.98 ± 7.716	−2.825	0.005
Intraoperative blood loss		1060.00 ± 557.62	825.89 ± 713.94	−1.417	0.158

Table 2. Multivariate retrospective analysis of postoperative incision infection in the two groups.

Indicator	β value	OR value	95% CI	P value
Is it hypoalbuminemia	1.801	6.057	1.541 - 23.817	0.010
History of radiotherapy	2.023	7.562	1.975 - 28.955	0.003
Surgery duration	0.031	1.031	0.230 - 4.621	0.968
Surgical site	1.988	7.301	0.252 - 211.147	0.247
Wound size	0.026	1.026	0.948 - 1.111	0.521
Duration of drainage tube retention	2.737	15.433	2.997 - 79.471	0.001

4. Discussion

In the present study, the incidence of postoperative incision infection was found to be 10.25%. The identified risk factors included preoperative hypoalbuminemia,

a history of radiotherapy, and a drainage tube retention time exceeding 3 days. These findings are consistent with those reported in multiple studies both in China and abroad [6] [7].

The significant association between preoperative hypoalbuminemia and the risk of early postoperative incisional infection may be attributed to several pathophysiological mechanisms [8]: ① Impaired immune response and dysregulated inflammation. Albumin plays a crucial role in maintaining immune homeostasis, and spinal tumor surgery represents a profound physiological stressor that elicits a robust inflammatory reaction. In malnourished patients, the immune system is unable to effectively respond to surgical trauma and potential bacterial invasion, facilitating the breach of the body's defense barriers and consequently elevating the risk of infection. ② Compromised tissue repair and wound healing. Wound healing is a complex, energy-intensive biological process that requires substantial amounts of proteins and amino acids as substrates. In the context of spinal tumor surgery, the extensive and deep incisions, along with the presence of internal implants, demand robust healing capacity. Poor wound healing creates an ideal environment for bacterial colonization and proliferation, thereby establishing a vicious cycle from delayed healing to infection. Therefore, comprehensive preoperative screening and risk assessment should be implemented, and serum albumin measurement should be incorporated as a standard preoperative test for patients with spinal tumors. If hypoalbuminemia is detected, preoperative nutritional intervention should be initiated. Active nutritional support therapies, including oral nutritional supplements (ONS), enteral nutrition (EN), or even parenteral nutrition (PN), should be employed to correct albumin levels to a safe range.

Radiotherapy coordinates through multiple mechanisms to establish a local microenvironment that is highly susceptible to infection: ① immunosuppression results in reduced patient immunity; ② impaired cellular function leads to delayed wound healing; ③ local tissue fibrosis, diminished elasticity of soft tissues, complicating intraoperative suturing and increasing the risk of postoperative dead space formation, thereby providing a favorable environment for bacterial proliferation. Surgical procedures for spinal tumors inflict considerable trauma and significant intraoperative blood loss, substantially increasing the risk of infection. Consequently, regarding the application of adjuvant radiotherapy, Itshayek *et al.* [9] recommend that the optimal interval between preoperative or postoperative adjuvant radiotherapy and surgery should be at least one week to minimize the incidence of wound complications.

During closure and fascial suturing in open spinal surgery, substantial fluid exudation from deep tissues may persist. If not promptly evacuated, this accumulation can cause compression of the spinal cord and nerves within the spinal canal, potentially leading to severe functional deficits. Consequently, spinal surgeons typically place drainage tubes at wound closure to evacuate postoperative exudate, minimize hematoma formation, and manage dead space. Olsen *et al.* [10] conducted a study involving 2136 postoperative spinal surgery cases and found that a

postoperative drainage duration of >3 days is an independent risk factor for surgical site infection. Each additional day of drainage is associated with an increased risk of wound infection. This may be attributable to the drainage tube, as a foreign body, provoking a local inflammatory response, and to resident skin flora migrating retrogradely through the tube into deeper wound sites, thereby elevating infection risk. Therefore, for patients whose indications for tube removal are not met within an extended period, clinicians should closely monitor the wound, drainage fluid, and body temperature, ensure proper management of both incision and drainage tube, and adjust antibiotic use as appropriate [11].

This study did not identify cerebrospinal fluid leakage as a risk factor for incision infection, which differs from previous research findings. The discrepancy may be attributed to the fact that patients in our hospital promptly adopted routine and standardized preventive measures against incision infection when cerebrospinal fluid leakage occurred. These measures include strict aseptic techniques and isolation, mandatory adherence to sterile procedures during dressing changes for leaking incisions, the use of waterproof dressings to isolate the incision from external contamination, and, when appropriate, extending the duration of prophylactic antibiotic administration. The discrepancy in results may also be attributed to an insufficient sample size.

5. Limitations and Prospects

This study has certain limitations. Despite efforts to maximize data integrity and objectivity, the collection of case information inevitably involved various uncertain factors. Furthermore, while some relevant risk factors for incisional infection were identified, the analysis did not yield precise indicators, such as hypoalbuminemia levels. Due to the limited sample size, further research on the risk factors for early postoperative incisional infection following spinal tumor surgery requires large-sample, multi-center, and prospective clinical trials for comprehensive elucidation.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Hu, H.Z., Yang, W.B., Deng, X.T., *et al.* (2021) Surgical Complications and Prevention Strategies of Metastatic Spinal Tumors. *Chinese Journal of Geriatric Orthopedics and Rehabilitation*, **7**, 52-59.

[2] Sebaaly, A., Shedid, D., Boubez, G., Zairi, F., Kanhonou, M., Yuh, S., *et al.* (2018) Surgical Site Infection in Spinal Metastasis: Incidence and Risk Factors. *The Spine Journal*, **18**, 1382-1387. https://doi.org/10.1016/j.spinee.2018.01.002

[3] Hayashi, H., Murakami, H., Demura, S., Kato, S., Yoshioka, K., Shinmura, K., *et al.* (2015) Surgical Site Infection after Total En Bloc Spondylectomy: Risk Factors and the Preventive New Technology. *The Spine Journal*, **15**, 132-137. https://doi.org/10.1016/j.spinee.2014.08.007

[4] Tan, W.G. (2016) Effects of Infection after Spinal Fusion Surgery on Patients' Psycho-Logical State and Physiological Function. Master's Thesis, Guangzhou University of Chinese Medicine.

[5] Pull ter Gunne, A.F., Hosman, A.J.F., Cohen, D.B., Schuetz, M., Habil, D., van Laarhoven, C.J.H.M., *et al.* (2012) A Methodological Systematic Review on Surgical Site Infections Following Spinal Surgery: Part 1: Risk Factors. *Spine*, **37**, 2017-2033. https://doi.org/10.1097/brs.0b013e31825bfca8

[6] Liu, G.Q. (2020) Analysis of Factors Related to Early Complications after Spinal Metastasis Surgery. Master's Thesis, Zhengzhou University.

[7] Zheng, Y., Tian, F.J., Wang, Y.J., *et al.* (2022) Related Influencing Factors of Surgical Wound Infection after Sacral Tumor Resection. *Practical Journal of Cancer*, **37**, 991-993.

[8] Fang, X.Y., Wang, S.J., Xu, H.W., *et al.* (2025) Research Progress on the Correlation between Perioperative Hypoalbuminemia and Adverse Events after Spinal Surgery. *Chinese Journal of Spine and Spinal Cord*, **35**, 91-95.

[9] Itshayek, E., Yamada, J., Bilsky, M., *et al.* (2010) Timing of Surgery and Radiotherapy in the Management of Metastatic Spine Disease: A Systematic Review. *International Journal of Oncology*, **36**, 533-544. https://doi.org/10.3892/ijo_00000527

[10] Olsen, M.A., Nepple, J.J., Riew, K.D., Lenke, L.G., Bridwell, K.H., Mayfield, J., *et al.* (2008) Risk Factors for Surgical Site Infection Following Orthopaedic Spinal Operations. *The Journal of Bone and Joint Surgery-American Volume*, **90**, 62-69. https://doi.org/10.2106/jbjs.f.01515

[11] Zhang, N., Wang, M., Zhang, P., *et al.* (2024) Effect of Intra-Incision Drainage Tube on Incision Healing and Infection Indicators in Patients after Posterior Lumbar Spinal Decompression and Internal Fixation. *Chinese Journal of General Practice*, **22**, 729-732.