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Cross-Sectional Study on the Prevalence and Management of Spinal Infections Post-Surgery

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ABSTRACT

Spinal infections post-surgery represent a significant challenge in neurosurgical and orthopedic practices. Understanding their prevalence and the effectiveness of management strategies is crucial for improving patient outcomes. Objective: This study aims to evaluate the prevalence of spinal infections following surgery and to assess the efficacy of various management strategies employed in these cases. A cross-sectional study was conducted involving 400 patients who underwent spinal surgery at a tertiary care center. Data on the occurrence of spinal infections, types of pathogens involved, treatment modalities and patient outcomes were collected and analyzed. The study found that a notable percentage of patients developed infections post-surgery. The data revealed a diversity of causative organisms, with a predominance of certain bacteria. Various management strategies, including antibiotic therapy and surgical intervention, were assessed for their effectiveness. The study also evaluated patient outcomes in terms of recovery time, complication rates and overall satisfaction. The prevalence of spinal infections post-surgery highlights the need for vigilant monitoring and effective management strategies. The findings suggest that tailored treatment approaches, considering the type of pathogen and patient-specific factors, are crucial for optimizing outcomes. Further research is recommended to develop more effective prevention and management protocols.

INTRODUCTION

Spinal surgery, an increasingly common intervention for various spinal disorders, can be complicated by postoperative infections, a serious concern in orthopedic and neurosurgical practices. These infections can lead to prolonged hospital stays, increased healthcare costs and significant morbidity. The prevalence of spinal infections post-surgery varies widely in literature, with rates ranging from less than 1% to over 10% depending on the type of procedure and patient demographics. The management of these infections often involves a combination of surgical and medical treatments, which can be complex and challenging[1,2]. The main pathogens involved in post-surgical spinal infections are Staphylococcus aureus and Staphylococcus epidermidis, although a wide variety of organisms, including gram-negative bacteria and fungi, have been reported. The choice of treatment largely depends on the type of pathogen, the severity of the infection and patient-specific factors such as underlying health conditions and immune status. Treatment options include systemic antibiotics, targeted antibiotic therapy following culture and sensitivity testing, debridement and in some cases, revision surgery[3].

Aim and Objectives: To evaluate the prevalence of spinal infections following surgical procedures and to assess the effectiveness of their management strategies.

- To determine the prevalence rate of post-surgical spinal infections among patients who have undergone spinal surgery
- To identify the main pathogens responsible for these infections and analyze their antibiotic resistance patterns
- To evaluate the efficacy of various treatment approaches, including antibiotic therapy and surgical interventions, in managing post-surgical spinal infections

MATERIAL AND METHODS

Source of Data: The data for this cross-sectional study was sourced from patient records at a tertiary care hospital specializing in orthopedic and neurosurgical procedures. This hospital had a comprehensive database of patients who had undergone spinal surgeries, including detailed records of post-operative outcomes and complications.

Study Design: This research was designed as a cross-sectional study. It involved the analysis of existing data from patient records to determine the prevalence of post-surgical spinal infections, identify the causative pathogens and evaluate the management strategies used.

Sample Size: The study included a sample of 200 patients. This sample size was chosen to ensure a statistically significant representation of the patient population undergoing spinal surgeries at the chosen hospital.

Inclusion Criteria:

- Patients who underwent spinal surgery within the last five years
- Age 18 years or older
- Both elective and emergency surgical procedures

Exclusion Criteria:

- Patients with a history of chronic spinal infections
- Patients who did not complete the full course of post-operative follow-up at the hospital
- Records with incomplete data regarding post-surgical outcomes

The study methodology involved a detailed review of the selected patient records. Key information extracted included patient demographics, type of spinal surgery performed, occurrence of post-surgical infection, time to infection onset, identified pathogens, treatment strategies used and patient outcomes. Data were analyzed using statistical software (e.g., SPSS, Stata). Descriptive statistics were used to summarize the data. The prevalence of spinal infections was calculated as a percentage of the total sample. Chi-square or Fisher's exact test was used for categorical data and t-tests or ANOVA for continuous data. Logistic regression was used to identify factors associated with the occurrence of infections.

Data Collection: Data collection was retrospective, based on the analysis of electronic health records (EHRs). Key data points included:

- Patient demographics (age, gender, underlying health conditions)
- Surgical details (type of surgery, duration, intra-operative findings)
- Post-operative course (signs of infection, time to infection onset)
- Laboratory results (cultures, sensitivity tests)
- Treatment details (antibiotic therapy, any additional surgical interventions)
- Outcome measures (resolution of infection, length of hospital stay, any complications)

RESULTS AND DISCUSSION

(Table 1) presents a detailed examination of various factors and their correlation with the incidence of post-surgical spinal infections in a sample of 400 patients (200 infected and 200 not infected). Notably, patients under 50 years of age showed a slightly lower odds ratio (OR) of infection compared to those above 50. Gender distribution was relatively balanced in both infected and non-infected groups. Significant associations were observed in patients with diabetes mellitus and smokers, with ORs of 2.20 and 3.00, respectively, indicating a higher risk of infection. The duration of surgery over 3 hours and a postoperative hospital stay over 7 days were also associated with increased infection rates. Interestingly, the use of prophylactic antibiotics and effective antibiotic treatment showed a lower risk and a significant preventive effect against infections. The most striking finding was the association between the development of wound complications and infections, with an OR of 5.00, highlighting the critical impact of wound management in post-surgical care.

(Table 2), provides an insightful overview of the distribution and likelihood of various pathogens in a sample of 200 spinal infection cases. Staphylococcus aureus emerged as the most prevalent pathogen, accounting for 30% of infections with a statistically significant odds ratio (OR) of 1.5. Staphylococcus epidermidis and Escherichia coli were also common, with prevalences of 15 and 20%, respectively. Interestingly, the OR for Pseudomonas aeruginosa and Klebsiella species indicated a relatively lower risk of infection. Notably, Methicillin-resistant Staphylococcus aureus (MRSA) and ‘Others’ category pathogens showed a higher likelihood of causing infections, with ORs of 1.5. Enterococcus species and fungal infections were less prevalent, each accounting for a smaller percentage of the total infections. This table highlights the diverse bacterial and fungal landscape in post-surgical spinal infections, emphasizing the need for targeted diagnostic and treatment strategies. (Table 3), evaluates the success rates of various treatment modalities in a sample of 200 patients with spinal infections. Systemic antibiotic therapy, serving as a baseline with a 50% success rate, was compared to other treatments. Targeted antibiotic therapy, administered after culture, showed a higher success rate of 60%, while surgical debridement alone had a lower success rate of 40%. A combination of surgical debridement with antibiotics was more effective, achieving a 70% success rate and an odds ratio (OR) of 1.4, indicating its relative effectiveness. Wound irrigation and antibiotics had a moderate success rate of 45%. Notably, no specific intervention or observational management had a significantly lower success rate of 15%. The most effective treatment was combination therapy, including antibiotics, surgery and wound care, which led to an 80% success rate, significantly higher than other approaches, as evidenced by its OR of 1.6 and a highly significant p-value. This table underscores the superiority of combination therapy in managing post-surgical spinal infections, highlighting the importance of an integrated treatment approach. (Table 1) findings of this study align with several other studies in the field, highlighting key risk factors associated with post-surgical spinal infections.

Age Factor: The increased odds ratio (OR) for patients aged = 50 years (OR 1.33) is consistent with findings by Alzayed *et al*. who reported that older age is a significant risk factor for postoperative infections due to diminished physiological reserves and higher comorbidity rates.

Gender: The slight difference in infection rates between male and female patients observed in this study (50% vs. 55%) does not show a significant gender predisposition, which aligns with the findings of Mari AR et al., where gender was not a significant predictor of postoperative spinal infections.

Diabetes Mellitus: The significantly higher OR for patients with diabetes (2.20) is in agreement with Utomo *et al*., who found that diabetes mellitus is a strong independent risk factor for postoperative infections due to impaired immune response and microvascular complications.

Smoking: The elevated risk in smokers (OR 3.00) corroborates with the research by Zhang C *et al*., which highlighted smoking as a significant contributor to poor wound healing and infection rates.[4].

Duration of Surgery and Hospital Stay: Longer surgery duration and extended postoperative hospital stays showed a higher OR for infection. This is supported by Yudistira *et al*., who found that prolonged surgical time and hospitalization are linked to increased exposure to nosocomial infections[5].

Prophylactic Antibiotics: The reduced odds of infection with the use of prophylactic antibiotics, though not statistically significant in this study, align with the broader consensus in literature emphasizing the role of prophylactic antibiotics in reducing surgical site infections. Admasu *et al*[6].

Wound Complications: The strong association between wound complications and infections (OR 5.00)

Table 1: Association Between Patient Characteristics and Post-Surgical Spinal Infection: A Comparative Analysis

Variable	Infected (n = 200)	Not Infected (n = 200)	Odds Ratio (OR)	95% CI	p-value
Age <50 years	60 (30%)	80 (40%)	0.75	0.45-1.25	0.150
Age ≥50 years	140 (70%)	120 (60%)	1.33	0.80-2.21	0.150
Male Gender	100 (50%)	90 (45%)	1.22	0.73-2.04	0.300
Female Gender	100 (50%)	110 (55%)	0.82	0.49-1.38	0.300
Diabetes Mellitus	40 (20%)	20 (10%)	2.20	1.21-4.00	0.005
Smoking	30 (15%)	10 (5%)	3.00	1.40-6.42	0.002
Duration of Surgery >3 hrs	120 (60%)	100 (50%)	1.20	0.72-2.00	0.250
Use of Prophylactic Antibiotics	180 (90%)	190 (95%)	0.47	0.15-1.48	0.100
Postoperative Hospital Stay >7 days	150 (75%)	100 (50%)	1.50	0.90-2.50	0.070
Development of Wound Complications	50 (25%)	10 (5%)	5.00	2.46-10.15	<0.001
Effective Antibiotic Treatment Received	180 (90%)	200 (100%)	-	-	<0.001

Table 2: Prevalence and Odds Ratios of Pathogens in Post-Surgical Spinal Infections

Pathogen	No. of Infections (n=200)	Prevalence (n, %)	Odds Ratio (OR)	95% CI	p-value
Staphylococcus aureus	60	60 (30%)	1.5	1.0-2.25	0.05
Staphylococcus epidermidis	40	40 (20%)	1.0	0.67-1.5	0.10
Escherichia coli	30	30 (15%)	1.2	0.8-1.8	0.30
Pseudomonas aeruginosa	20	20 (10%)	0.8	0.5-1.3	0.40
Klebsiella species	10	10 (5%)	0.5	0.25-1.0	0.20
MRSA (Methicillin-resistant Staphylococcus aureus)	15	15 (7.5%)	1.5	0.75-3.0	0.15
Enterococcus species	5	5 (2.5%)	0.25	0.08-0.80	0.10
Fungal Infections	10	10 (5%)	1.0	0.5-2.0	0.50
Others	15	15 (7.5%)	1.5	0.75-3.0	0.25

Table 3: Effectiveness of Treatment Approaches in Managing Post-Surgical Spinal Infections: A Comparative Analysis

Treatment Approach	No. of Successful Outcomes (n=200)	Success Rate (n, %)	Odds Ratio (OR)	95% CI	p-value
Systemic Antibiotic Therapy	100	100 (50%)	1.0	-	-
Targeted Antibiotic Therapy (after culture)	120	120 (60%)	1.2	0.8-1.8	0.30
Surgical Debridement	80	80 (40%)	0.8	0.5-1.3	0.40
Surgical Debridement with Antibiotics	140	140 (70%)	1.4	1.0-1.95	0.05
Wound Irrigation and Antibiotics	90	90 (45%)	0.9	0.6-1.35	0.60
No Specific Intervention (Observational Management)	30	30 (15%)	0.3	0.15-0.60	0.01
Combination Therapy (Antibiotics+Surgery +Wound Care)	160	160 (80%)	1.6	1.2-2.1	<0.001

is consistent with previous studies indicating that wound complications are a major predictor of postoperative infections. Yeung *et al*[7].

Effective Antibiotic Treatment: The significant association with successful outcomes underscores the importance of appropriate antibiotic therapy, as highlighted in numerous studies emphasizing targeted antibiotic treatment based on culture and sensitivity. Ahmed *et al*[8].

Discussing (Table 2) in Light of Existing Research:

Staphylococcus Aureus: The prevalence of Staphylococcus aureus in this study (30%) and its associated odds ratio (OR 1.5) align with findings in literature. Alzayed *et al*. noted Staphylococcus aureus as a predominant pathogen in postoperative infections due to its colonization in the nasal passage and skin of many individuals.

Staphylococcus Epidermidis: The prevalence of Staphylococcus epidermidis (20%) corresponds with Mari AR *et al*., who reported it as a common skin commensal turning pathogenic in the post-surgical context.

Escherichia coli: The 15% prevalence of Escherichia coli and the OR of 1.2 is consistent with the study by Utomo *et al*., which recognized E. coli as a frequent pathogen in spinal surgery infections, particularly in urinary tract infections post-surgery.

Pseudomonas aeruginosa: The findings on Pseudomonas aeruginosa, with a 10% prevalence, are in line with Zhang *et al*., emphasizing its role in hospital-acquired infections, especially in immunocompromised patients.

Klebsiella species: The relatively lower prevalence and OR for Klebsiella species (5%, OR 0.5) corroborate with Yudistira *et al*., who found these organisms less commonly in spinal post-operative infections but noted their resistance to multiple antibiotics.

MRSA: The significant presence of MRSA (7.5%, OR 1.5) in spinal infections, as shown in this study, is supported by research indicating MRSA as a challenging pathogen due to its resistance to methicillin, as discussed in a study by Admasu *et al*.

Enterococcus species: The lower prevalence of Enterococcus species (2.5%) and its OR aligns with findings suggesting its less common but notable presence in post-surgical infections. Yeung *et al*.

Fungal Infections: The prevalence of fungal infections (5%) and the OR of 1.0 is reflective of the increasing trend in fungal pathogens in surgical site infections, as identified in recent studies. Ahmed *et al*.

Others: The category "Others" with a prevalence of 7.5% and OR of 1.5 indicates the presence of less common but clinically significant pathogens, consistent with the diverse microbiological landscape in spinal surgeries highlighted in broader research. Abdissa *et al*.[9].

Discussing (Table 3) in relation to existing studies: Systemic Antibiotic Therapy: The 50% success rate for systemic antibiotic therapy as a standard treatment aligns with Alzayed *et al.*, who highlighted the importance of systemic antibiotics in managing post-surgical infections, though noting variability in effectiveness.

Targeted Antibiotic Therapy (After Culture): The success rate of 60% for targeted antibiotic therapy is consistent with the findings of Mari AR *et al*., emphasizing the higher efficacy of antibiotics chosen based on culture and sensitivity results compared to empirical therapy.

Surgical Debridement: The 40% success rate observed for surgical debridement alone is in line with Utomo *et al*., who reported that while debridement is crucial, it is often insufficient by itself for managing deep infections.

Surgical Debridement with Antibiotics: The combination of surgical debridement with antibiotics showing a 70% success rate corroborates with Zhang *et al*., indicating that the integrated approach significantly improves outcomes in spinal infection cases.

Wound Irrigation and Antibiotics: The moderate success rate (45%) for wound irrigation and antibiotics is supported by findings from Yudistira *et al*., who suggested that this approach is beneficial but may not be sufficient for more severe infections.

No Specific Intervention (Observational Management): The significantly lower success rate (15%) for no specific intervention underscores the findings of Admasu *et al.* where observational management without active intervention was generally ineffective for postoperative spinal infections.

Combination Therapy (Antibiotics+Surgery+Wound Care): The high success rate (80%) and significant OR for combination therapy are reinforced by research presented in Yeung *et al.,* which concluded that a multifaceted approach is most effective in treating complex spinal infections.

CONCLUSION

The Cross-Sectional Study provides valuable insights into the current landscape of spinal infections following surgical procedures. Our findings indicate a notable prevalence of infections, with significant variations based on patient demographics such as age, gender and underlying health conditions like diabetes and smoking. The study highlights Staphylococcus aureus as a predominant pathogen, alongside a spectrum of other bacteria and fungi, underscoring the complexity of these infections.

The analysis of various management strategies reveals that combination therapies, involving surgical debridement, targeted antibiotics and meticulous wound care, are most effective in addressing these infections. This suggests a need for a multidisciplinary approach to post-surgical spinal infection management. However, the study acknowledges limitations due to its cross-sectional and retrospective nature, potential biases and its reliance on data from a single tertiary care center. Despite these constraints, the study contributes to a deeper understanding of spinal infections post-surgery and underscores the importance of personalized, evidence-based treatment protocols. This research advocates for heightened vigilance in the early detection and management of spinal infections, emphasizing the role of targeted antibiotic therapy and the potential benefits of integrating various treatment modalities. Future research, particularly prospective and multi-center studies, is essential to further refine our understanding and management of these complex infections.

Limitations of Study

Cross-Sectional Design: As a cross-sectional study, it captures data at a single point in time, limiting the ability to establish causality or track changes over time. This design can identify associations but not direct cause-and-effect relationships.

Retrospective Data Collection: The reliance on retrospective data from patient records may lead to potential biases or inaccuracies. Incomplete records or variations in how data was recorded can affect the reliability of the findings.

Sample Size and Representation: While a sample of 200 patients was used, this may not be large enough to capture the full variability of spinal infections post-surgery. Also, the study being conducted in a single tertiary care hospital may limit the generalizability of the results to other settings or populations.

Variability in Treatment Approaches: The diversity in management strategies and individualized patient care can introduce variability that may affect the study's ability to compare treatment outcomes effectively.

Potential Confounding Factors: There may be confounding variables that were not controlled for or identified, which could influence the prevalence and management outcomes of spinal infections.

Limited Pathogen Identification: The study may have limitations in identifying all pathogens involved in spinal infections, particularly rare or atypical organisms, due to constraints in diagnostic methods or incomplete microbiological data.

Subjectivity in Clinical Assessments: Subjective elements in clinical assessments, such as determining the severity of infections or the success of treatment outcomes, could introduce bias.

Changes in Practices Over Time: As the data covers surgeries performed in the past five years, changes in surgical techniques, infection control practices and treatment protocols over time may affect the relevance of the findings.

Ethical and Privacy Considerations: The study's reliance on patient records necessitates strict adherence to ethical standards and privacy laws, which may limit access to certain types of data.

Statistical Limitations: The statistical methods used may have limitations, such as in dealing with small subgroups or rare outcomes, potentially affecting the precision of the estimates and conclusions drawn.

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