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Comparative Study of Surgical vs. Non-Surgical Interventions in Patients with Vertebral Osteomyelitis and Discitis

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Abstract: ***Background:*** Vertebral osteomyelitis and discitis are serious infections of the spine that can lead to significant morbidity if not managed appropriately. The optimal treatment approach surgical versus non-surgical is still debated, with differing outcomes based on infection severity and patient characteristics. ***Objective:*** To compare the clinical outcomes of surgical versus non-surgical treatment in patients with vertebral osteomyelitis and discitis, focusing on infection resolution, pain relief, functional recovery, complications, and treatment duration. ***Methods:*** A prospective observational study was conducted over one year, involving 100 patients diagnosed with vertebral osteomyelitis and discitis at multicenter hospitals. Patients were randomly assigned to two treatment groups: 50 patients in the non-surgical group (Group A) received broad-spectrum antibiotics and supportive care, while 50 patients in the surgical group (Group B) underwent surgical debridement and stabilization (if necessary) along with antibiotics. Outcomes, including infection control (CRP, ESR), pain relief (VAS), functional recovery (ODI), complications, and duration of hospital stay and antibiotic therapy, were assessed at baseline, 2, 6, and 12 weeks, and at follow-up visits. ***Results:*** The surgical group demonstrated significantly better infection resolution (94% vs. 82%, p=0.04) and a greater reduction in pain (45% reduction in VAS vs. 18%, p=0.02). Functional recovery, measured by the Oswestry Disability Index (ODI), was also superior in the surgical group (50% improvement vs. 27%, p<0.05). However, the surgical group had a higher complication rate (26%) compared to the non-surgical group (18%), though this difference was not statistically significant. Patients in the surgical group had a longer hospital stay, but required a shorter duration of antibiotic therapy (6-8 weeks vs. 8-12 weeks in the non-surgical group). ***Conclusion:*** Surgical intervention in vertebral osteomyelitis and discitis results in better infection control, pain relief, and functional recovery compared to non-surgical management, though it carries a slightly higher complication rate. Surgical treatment should be considered for patients with severe disease, while conservative management remains an option for those with less severe presentations.

Keywords: Vertebral osteomyelitis, discitis, surgical treatment, non-surgical treatment, infection resolution.

INTRODUCTION

Vertebral osteomyelitis and discitis are serious infections that affect the spine, leading to significant morbidity if not promptly diagnosed and treated. These conditions are often caused by bacterial pathogens, with *Staphylococcus aureus* being the most common agent. Patients with vertebral osteomyelitis and discitis may present with back pain, fever, and neurological deficits, with potential long-term consequences, including chronic pain, spinal deformity, and permanent neurological impairment [1]. Treatment approaches vary widely, but they generally fall into two main categories: non-surgical (medical) management and surgical intervention [2].

Non-surgical treatment typically involves prolonged courses of intravenous and oral antibiotics aimed at controlling the infection, alongside supportive care to alleviate symptoms. Antibiotics are selected based on the identification of the pathogen, often through blood cultures, biopsy, or imaging-guided aspiration. The goal of this approach is to eradicate the infection without resorting to surgery, although it may take several months of antibiotic therapy to achieve infection resolution. While non-surgical management can be effective for many patients, it carries risks of prolonged hospitalization, antibiotic resistance, and incomplete infection resolution, especially in more severe or complicated cases [3].

Surgical treatment, on the other hand, is often considered when non-surgical approaches fail or in cases of severe disease, such as abscess formation, neurological compromise, or spinal instability. Surgical intervention may involve debridement of infected tissue, spinal decompression, and stabilization with hardware if necessary. The primary advantage of surgery is its potential for direct removal of the infected tissue, which may lead to quicker infection control and alleviation of symptoms. However, surgery carries its own set of risks, including wound infections, complications related to spinal hardware, and the need for post-operative care [4].

The decision between surgical and non-surgical treatment depends on several factors, including the severity of the infection, the presence of neurological deficits, patient comorbidities, and the response to initial medical therapy. There is no clear consensus on the optimal approach for managing these conditions, with outcomes varying based on individual patient factors. While studies have assessed the efficacy of surgical versus non-surgical interventions for vertebral osteomyelitis and discitis, there remains a need for more comprehensive comparative data to guide clinical decision-making [5].

Several studies have demonstrated the advantages of surgery in terms of faster infection resolution and symptom relief. A study found that patients treated with surgery had faster normalization of inflammatory markers (such as CRP and ESR) compared to those managed medically [6]. Furthermore, surgical intervention has been shown to lead to better functional outcomes, with patients experiencing quicker pain relief and returning to daily activities faster than those treated conservatively [7]. However, these advantages come at the cost of an increased risk of surgical complications, such as wound infections and hardware-related issues [8].

In contrast, non-surgical management remains a valuable approach for patients without severe complications or who are not suitable candidates for surgery. For these patients, long-term antibiotic therapy can control the infection effectively, although it may require extended hospital stays and prolonged follow-up. The literature suggests that while non-surgical treatments can be successful in many cases, the risk of persistent infection and neurological deficits may be higher compared to surgical approaches [9].

This study aims to compare the outcomes of surgical versus non-surgical interventions for patients with vertebral osteomyelitis and discitis. We evaluate the effectiveness of both treatments in terms of infection resolution, pain relief, functional recovery, and complication rates. Additionally, we assess the impact of each treatment on hospital stay duration and antibiotic use. By providing a detailed comparison of these two approaches, we hope to contribute valuable insights into the optimal management strategies for this challenging clinical condition.

METHODS

Study Design and Setting

This study was a prospective observational study conducted over a one-year period across multicenter hospitals, designed to compare the outcomes of surgical and non-surgical management in patients diagnosed with vertebral osteomyelitis and discitis. A total of 100 patients were included in the study, who were diagnosed with these conditions based on clinical evaluation, imaging studies, and laboratory tests. Patients were randomly assigned to one of two treatment groups: the non-surgical group (Group A) and the surgical group (Group B).

Study Population

The study included adults aged 18-70 years who were diagnosed with vertebral osteomyelitis or discitis confirmed by imaging (such as MRI or CT scans) and laboratory tests (such as blood cultures and inflammatory markers). Patients who met the inclusion criteria and were willing to adhere to the follow-up protocol for a minimum of 6 months were eligible for participation.

Inclusion Criteria:

- Adults aged 18-70 years with a confirmed diagnosis of vertebral osteomyelitis or discitis, based on imaging (MRI or CT) and laboratory tests (blood cultures, CRP, ESR).
- Patients who were able and willing to follow up for at least 6 months after treatment initiation.

Exclusion Criteria:

- Patients with infections involving multiple regions of the body or complicating conditions that would require a different therapeutic approach.
- Patients with severe comorbidities that would contraindicate surgery (e.g., severe cardiac or renal disease, immunocompromised states).

- Patients with incomplete follow-up data or who were lost to follow-up before the 6-month assessment.

Treatment Protocols

Patients were randomly assigned to one of two treatment groups:

1. Group A (Non-Surgical Group):
- A total of 50 patients were treated conservatively with a regimen consisting of broad-spectrum intravenous antibiotics, tailored based on blood culture sensitivity results. The duration of antibiotic therapy varied from 8 to 12 weeks depending on the infection's response and culture results.
- Supportive care was also a critical part of the management plan, including bed rest, spinal bracing for immobilization (if required), and a gradual mobilization protocol under medical supervision.
- Pain control was achieved using analgesics, including nonsteroidal anti-inflammatory drugs (NSAIDs), and in more severe cases, opioids.
- The decision to continue non-surgical management was based on clinical progress and lack of neurological deficits or spinal instability.

2. Group B (Surgical Group):
- A total of 50 patients in this group underwent surgical debridement of infected tissues. Surgery was indicated for patients with significant spinal instability, neurological deterioration, abscess formation, or failure of non-surgical management.
- In cases requiring spinal instability correction, spinal stabilization procedures such as decompressive laminectomy, fusion, or instrumentation were performed.
- After the surgical procedure, antibiotic therapy was continued based on blood culture sensitivity results, with adjustments made as necessary. The duration of antibiotic therapy was typically 6 to 8 weeks post-surgery, depending on the infection's resolution and inflammatory marker trends.
- Post-operative care included monitoring for complications such as wound infections, neurological deterioration, and ensuring pain management. Early mobilization was encouraged, with physical therapy support.

Outcome Measures

The study primarily aimed to assess the following outcome measures:

1. Infection Control:
- The success of infection control was measured by the normalization of inflammatory markers (C-reactive protein [CRP] and erythrocyte sedimentation rate [ESR]) and the resolution of symptoms. A significant reduction in CRP and ESR levels, as well as clinical improvement in symptoms such as fever and back pain, was considered indicative of successful infection control.

2. Pain Relief:
- Pain was evaluated using the Visual Analog Scale (VAS), which ranges from 0 (no pain) to 10 (worst pain imaginable). Pain levels were recorded at baseline, and subsequently at 2-week intervals during the follow-up period.

3. Functional Recovery:
- The Oswestry Disability Index (ODI) was used to assess functional recovery. The ODI is a widely used tool that measures the degree of disability caused by spinal conditions, with scores ranging from 0% (no disability) to 100% (maximum disability). A higher percentage indicates greater disability. Changes in the ODI score were tracked throughout the study to evaluate functional improvements.

4. Complications:
- Complications were carefully documented and included wound infections, neurological deterioration, reoperation rates, and other surgery-related issues in the surgical group. For the non-surgical group, complications primarily focused on persistent pain or incomplete resolution of infection.

5. Length of Hospital Stay and Duration of Antibiotic Therapy:
- The total length of hospital stay was recorded for each patient, reflecting the need for inpatient care, monitoring, and any potential complications.
- The duration of antibiotic therapy was also documented, comparing the two groups to evaluate whether surgical intervention leads to shorter or longer antibiotic courses, as well as its impact on infection resolution.

Data Collection and Analysis

Data collection was conducted prospectively, with patient demographics, clinical characteristics, and outcomes systematically recorded at baseline and throughout the follow-up period. Clinical data, including infection markers (CRP, ESR), pain scores (VAS), functional recovery (ODI), and complications, were gathered at regular intervals during hospital stays and at follow-up visits at 2, 6, and 12 weeks, and subsequently every 3 months. The length of hospital stay and duration of antibiotic therapy were also tracked. Data analysis was performed using SPSS v.26. Descriptive statistics (mean, standard deviation) were calculated for continuous variables, while categorical variables were compared using Chi-square tests. Independent t-tests were used to compare continuous outcomes between the two groups, with statistical

significance set at $p < 0.05$. All results were analyzed to determine the relative effectiveness of surgical versus non-surgical treatments in managing vertebral osteomyelitis and discitis, focusing on infection control, pain relief, functional recovery, and complication rates.

Ethical Considerations

This study was approved by the institutional review board (IRB) at each participating center. Informed consent was obtained from all patients before enrollment in the study. The study adhered to ethical guidelines and patient confidentiality was maintained throughout the research process**.**

RESULTS

The baseline characteristics of the study participants provide a foundation for understanding the patient demographics and clinical features before treatment initiation. Below is a summary of the baseline profile of the 100 patients enrolled in the study, divided into two groups: Non-Surgical (Group A) and Surgical (Group B).

The baseline characteristics of patients in both the non-surgical and surgical groups were closely matched, ensuring a fair comparison between the two treatment approaches. Key demographic factors like age, gender distribution, body mass index (BMI), and common comorbidities such as diabetes and hypertension showed no significant differences between the groups. This similarity in baseline factors indicates that both groups were comparable in terms of general health and risk factors.

However, a notable distinction was observed in the presence of neurological deficits. The surgical group had a higher percentage of patients presenting with neurological symptoms (40% compared to 22% in the non-surgical group), reaching borderline statistical significance ($p=0.05$). This suggests that patients undergoing surgery had, on average, more severe initial presentations, potentially warranting more aggressive treatment.

Additionally, laboratory markers of infection severity, including C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR), were similar across both groups. The distribution of common infectious agents, such as *Staphylococcus aureus*, *Escherichia coli*, and *Streptococcus* species, was also comparable. This indicates that the initial severity of infection was similar in both groups, allowing for a balanced assessment of the effectiveness of surgical and non-surgical interventions. (Table1)

Table 1: Baseline Profile of Patients

Baseline Characteristics	Non-Surgical (n=50)	Surgical (n=50)	p-Value
Mean Age (years)	56.8 ± 10.2	57.6 ± 9.8	0.63
Gender (Male/Female)	30/20	32/18	0.72
Average BMI (kg/m²)	26.4 ± 3.1	27.0 ± 3.0	0.44
Diabetes (%)	40% (20/50)	38% (19/50)	0.85
Hypertension (%)	50% (25/50)	52% (26/50)	0.82
Smoking History (%)	28% (14/50)	32% (16/50)	0.68
Duration of Symptoms (weeks)	10.2 ± 3.6	9.8 ± 3.9	0.54
Neurological Deficit (%)	22% (11/50)	40% (20/50)	0.05
CRP Level (mg/L)	68.5 ± 12.4	70.3 ± 13.1	0.48
ESR (mm/hr)	78.2 ± 14.5	79.6 ± 15.0	0.66
White Blood Cell Count (x10⁹/L)	11.4 ± 2.5	11.9 ± 2.7	0.31
Common Infectious Agent (%):			
- *Staphylococcus aureus*	60% (30/50)	62% (31/50)	0.81
- *Escherichia coli*	18% (9/50)	16% (8/50)	0.78
- *Streptococcus spp.*	12% (6/50)	10% (5/50)	0.75
Initial Pain Score (VAS)	7.6 ± 1.2	7.8 ± 1.3	0.52
Oswestry Disability Index (ODI)	58 ± 12	60 ± 13	0.47

Below is a comparative analysis of infection control between the Non-Surgical and Surgical groups, focusing on the success of eradicating the infection and normalization of inflammatory markers. The surgical group demonstrated a notably higher success rate in resolving infections, with 94% of patients achieving complete resolution compared to 82% in the non-surgical group ($p=0.04$). This statistically significant difference highlights the effectiveness of surgical intervention in controlling infection. Additionally,

patients in the surgical group experienced a quicker reduction in inflammation, as indicated by the faster normalization of inflammatory markers like C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR).

While the rate of persistent infection at the 6-month follow-up was higher in the non-surgical group, this difference did not reach statistical significance. However, the trend suggests that surgical intervention may offer superior infection control, potentially reducing the risk of long-term or recurring infection compared to non-surgical approaches. This indicates that surgery could be a more reliable option for achieving lasting infection clearance in patients with vertebral osteomyelitis and discitis. (Table 2)

Table 2: Infection Control Outcomes

Infection Control Metrics	Non-Surgical (n=50)	Surgical (n=50)	p-Value
Successful Infection Resolution (%)	82% (41/50)	94% (47/50)	0.04
Time to Normalization of CRP (weeks)	6.4 ± 1.5	4.8 ± 1.3	0.02
Time to Normalization of ESR (weeks)	7.2 ± 1.6	5.5 ± 1.4	0.01
Persistent Infection at 6 Months (%)	10% (5/50)	4% (2/50)	0.22

The following table summarizes the pain relief outcomes and functional recovery between the two groups, highlighting improvements in pain scores and physical functioning. The surgical group experienced significantly better pain relief compared to the non-surgical group. Pain scores were reduced by 45% from baseline in the surgical group, while the non-surgical group showed only an 18% reduction (p=0.02). This substantial difference underscores the effectiveness of surgery in providing more rapid and substantial pain relief for patients with vertebral osteomyelitis and discitis. In terms of functional recovery, the surgical group also outperformed the non-surgical group, with a 50% improvement in the Oswestry Disability Index (ODI) compared to just 27% in the non-surgical group. This indicates that surgical treatment not only alleviates pain but also contributes to greater improvement in patients' overall mobility and daily functioning. Additionally, patients in the surgical group returned to work more frequently and more quickly than those in the non-surgical group. This suggests that the surgical approach leads to faster recovery, enabling patients to resume normal activities sooner, which is a key indicator of effective functional rehabilitation. (Table 3)

Table 3: Pain Relief and Functional Recovery

Pain and Functional Outcomes	Non-Surgical (n=50)	Surgical (n=50)	p-Value
Mean Pain Score (VAS) at 6 Months	6.2 ± 1.5	4.3 ± 1.2	0.01
% Pain Reduction from Baseline	18%	45%	0.02
Mean ODI at 6 Months	42 ± 10	30 ± 8	0.02
Improvement in ODI (%)	27%	50%	0.03
Return to Work Rate (%)	60% (30/50)	78% (39/50)	0.04
Average Time to Return to Work (weeks)	14.5 ± 2.8	9.7 ± 2.5	0.01

The table below presents the rates and types of complications encountered in both groups during the follow-up period. The surgical group experienced significantly better pain relief compared to the non-surgical group. Pain scores were reduced by 45% from baseline in the surgical group, while the non-surgical group showed only an 18% reduction (p=0.02). This substantial difference underscores the effectiveness of surgery in providing more rapid and substantial pain relief for patients with vertebral osteomyelitis and discitis.

In terms of functional recovery, the surgical group also outperformed the non-surgical group, with a 50% improvement in the Oswestry Disability Index (ODI) compared to just 27% in the non-surgical group. This indicates that surgical treatment not only alleviates pain but also contributes to greater improvement in patients' overall mobility and daily functioning.

Additionally, patients in the surgical group returned to work more frequently and more quickly than those in the non-surgical group. This suggests that the surgical approach leads to faster recovery, enabling patients to resume normal activities sooner, which is a key indicator of effective functional rehabilitation. (Table 4).

Table 4: Complications and Adverse Events

Complications	Non-Surgical (n=50)	Surgical (n=50)	p-Value
Overall Complication Rate (%)	18% (9/50)	26% (13/50)	0.19
Wound Infection (%)	N/A	10% (5/50)	-
Persistent Neurological Symptoms (%)	12% (6/50)	8% (4/50)	0.49
Hardware-Related Issues (%)	N/A	6% (3/50)	-
Reoperation Rate (%)	N/A	6% (3/50)	-
Readmission Rate (%)	6% (3/50)	10% (5/50)	0.43

The duration of hospital stays and the length of antibiotic treatment for both groups are summarized in the table below. The surgical group had a significantly longer hospital stay compared to the non-surgical group, primarily due to the need for post-operative care, monitoring, and recovery. This extended stay is typical for patients undergoing surgery, as they require time for wound healing, pain management, and addressing any potential complications associated with the procedure. On the other hand, the surgical group benefited from a shorter duration of antibiotic therapy. This reflects the effectiveness of surgery in directly removing the source of infection, thereby reducing the need for prolonged antibiotic treatment. In contrast, the non-surgical group required longer courses of antibiotics as the infection was managed medically without the option of direct surgical intervention to eliminate the infection. This suggests that surgical treatment not only accelerates infection resolution but also reduces the reliance on long-term antibiotic use, which can help mitigate the risks of antibiotic resistance and other medication-related complications. (Table 5).

Table 5: Hospital Stay and Antibiotic Use

Treatment Duration Metrics	Non-Surgical (n=50)	Surgical (n=50)	p-Value
Mean Length of Hospital Stay (days)	12.4 ± 3.2	18.5 ± 4.1	0.03
Total Antibiotic Duration (weeks)	12 ± 2.5	8 ± 2.0	0.05
IV Antibiotic Duration (weeks)	6.8 ± 1.4	5.2 ± 1.3	0.02
Oral Antibiotic Duration (weeks)	5.2 ± 1.5	2.8 ± 1.1	0.01

DISCUSSION

This prospective observational study aimed to compare the clinical outcomes of surgical versus non-surgical treatment for patients with vertebral osteomyelitis and discitis. Our findings suggest that surgical management offers several advantages over conservative treatment in terms of infection resolution, pain relief, functional recovery, and quicker return to work, despite a higher complication rate.

The surgical group demonstrated a significantly higher rate of infection resolution, with 94% of patients showing successful infection control, compared to 82% in the non-surgical group (p=0.04). This finding aligns with previous studies that highlight the effectiveness of surgical intervention in controlling infection by directly removing the source of infection and preventing its spread. A study reported that surgical debridement led to quicker normalization of inflammatory markers and better infection resolution compared to non-surgical treatment, which often requires prolonged antibiotic courses [9]. The faster normalization of CRP and ESR in our surgical cohort further supports this conclusion, as both markers are commonly used to monitor the severity of infection and the effectiveness of treatment [10]. These findings suggest that surgery may be a more effective strategy for achieving long-term infection control, especially in patients with significant structural involvement or neurological compromise.

Patients in the surgical group experienced a significantly greater reduction in pain, with a 45% reduction in VAS scores compared to an 18% reduction in the non-surgical group (p=0.02). This is consistent with previous literature indicating that surgical treatment, by addressing the underlying structural issues and decompressing affected areas, can provide more substantial and rapid pain relief [11]. The more significant pain reduction in the surgical group may be due to the direct removal of infected tissue and stabilization of the spine, leading to reduced pressure and inflammation. The contrast in pain relief between the two groups highlights the benefit of surgical intervention in improving patient comfort, particularly in severe cases where conservative measures alone may not adequately control pain.

Functional recovery, as measured by the Oswestry Disability Index (ODI), was also superior in the surgical group, with a 50% improvement in ODI scores compared to 27% in the non-surgical group. This is consistent with the results of studies by other studies which demonstrated that surgical intervention often

leads to better functional outcomes. The ability to stabilize the spine and address structural deformities or instability likely contributed to the greater functional improvement observed in the surgical group [12]. Furthermore, patients in the surgical group returned to work more quickly, reinforcing the idea that surgery facilitates faster recovery and return to daily activities [13].

While the surgical group had a higher overall complication rate (26%) compared to the non-surgical group (18%), this difference was not statistically significant. Surgical complications were mainly related to wound infections, hardware-related issues, and a small percentage requiring reoperation. These findings are in line with the existing literature, which reports a higher complication rate in surgically treated patients, particularly concerning wound healing and surgical site infections [14]. However, it is important to note that despite these complications, the surgical group experienced superior infection control and functional recovery, which may outweigh the risks associated with surgery, especially in patients with severe disease.

In terms of length of hospital stay, patients in the surgical group required longer hospitalization due to post-operative care needs, which is typical for surgical procedures. However, the duration of antibiotic therapy was significantly shorter in the surgical group, reflecting the more direct approach to infection management through surgery. In contrast, the non-surgical group required prolonged antibiotic therapy (8-12 weeks), underscoring the challenges of achieving infection resolution with conservative treatment alone. The reduced duration of antibiotic use in the surgical group is consistent with the findings of another study, which noted that surgery may reduce the need for extended antibiotic regimens by directly addressing the infected tissue [15].

Limitations and Future Research

While our study provides valuable insights into the outcomes of surgical versus non-surgical treatments, there are several limitations. The study was conducted over one year, and longer-term follow-up would be beneficial to assess the durability of the outcomes. Additionally, the study was limited to a single cohort of patients from three tertiary care centers, which may not fully represent the broader population. Future research should focus on larger multicenter trials with longer follow-up periods and more diverse patient populations to confirm these findings. Additionally, exploring factors that may predict which patients are most likely to benefit from surgery versus conservative management could help guide treatment decisions more effectively.

CONCLUSION

In conclusion, our findings suggest that surgical intervention offers significant advantages over non-surgical treatment for patients with vertebral osteomyelitis and discitis, including better infection resolution, faster pain relief, and superior functional recovery. While the surgical group did experience a higher complication rate, these risks were offset by the overall improvement in clinical outcomes. Non-surgical management remains an important option for less severe cases or for patients who are not candidates for surgery, but surgery should be strongly considered in patients with severe disease or complications.

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