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Original Research Article

Management strategy of post-operative spinal infection

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ABSTRACT

Background: This study aims to evaluate the outcomes of different management strategies in PSIs, with a focus on infections caused by *S. epidermidis* and TB organisms. Specific emphasis is placed on the role of antimicrobial and anti-TB drug therapies, as well as revision surgical procedures.
Methods: Analysis was conducted on 31 patients diagnosed with PSI at Bangladesh Medical University between 2015 and 2023. 14 patients received targeted antimicrobial therapy for pyogenic infections 5 patients received anti-TB therapy for tubercular infections. Revision surgical management, 7 patients underwent debridement only, 3 patients underwent debridement with fusion and 2 patients underwent debridement with fixation. Assessment were done at 1st, 3rd, 6th and 12th monthly by VAS, Odom Criteria, Nurick's grading. Data were analyzed via the Statistical Package for Social Sciences (SPSS). A p value <0.05 was considered statistically significant.
Results: The mean VAS score significantly improved from 6.27±1.75 to 0.73±0.59 at 12 months ($p < 0.001$). According to the Modified Odom Criteria, 33.3% of patients had excellent outcomes, 60.0% had good outcomes and 6.7% had fair outcomes. Functional status measured by Nurick's grading improved significantly, with 93.3% of patients in Grade III preoperatively and 87% improving to either Grade 0 or I by 12th months ($p<0.001$).
Conclusions: Effective management of PSIs depends on early diagnosis, appropriate antimicrobial or anti-TB therapy and timely surgical intervention. *Staphylococcus epidermidis* infections respond well to targeted antimicrobial therapy and debridement, whereas TB infections require prolonged anti-TB regimens and often more extensive surgical stabilization.

Keywords: Anti-microbial and anti TB drug therapy, Debridement, Fusion and fixation, *Mycobacterium tuberculosis*, *Staphylococcus epidermidis*

INTRODUCTION

Postoperative spinal infections (PSIs) are recognized as one of the most serious complications following spinal surgeries, posing significant clinical and economic burdens on patients and healthcare systems worldwide. These infections are often associated with prolonged hospital stays, increased morbidity and substantial costs for both patients and institutions.[1,2] PSIs can present with a spectrum of clinical manifestations ranging from mild superficial wound infections to severe deep-seated infections involving vertebrae, intervertebral discs and implanted hardware, which may lead to devastating neurological outcomes if left untreated.[3] The incidence of PSIs varies widely, ranging from 0.7% to 12% depending on the type of spinal procedure, patient comorbidities and perioperative care protocols.[4] A range of pathogens has been implicated in these infections, with *Staphylococcus aureus* and *Staphylococcus epidermidis* being the most common culprits due to their strong biofilm-forming ability, which enables them to adhere to implants and resist antimicrobial treatment.[5] In endemic regions, *Mycobacterium tuberculosis* remains a notable etiological agent, complicating the clinical course of postoperative patients with spinal involvement.[6] Effective management of PSIs is challenging due to multiple factors, including

delayed diagnosis, antibiotic resistance and biofilm-related persistence of microorganisms on spinal hardware.[7] The management approach typically involves a combination of timely antimicrobial or anti-tubercular drug therapy and surgical interventions such as debridement, spinal fusion or fixation to eradicate infection and restore spinal stability.[8] Optimal treatment decisions must balance infection control with preservation of neurological function and structural integrity of the spine, making individualized patient-centered strategies crucial.

Despite advancements in surgical techniques, perioperative infection control measures and antimicrobial therapies, PSIs remain difficult to eradicate completely, with a risk of recurrent infections or long-term sequelae.[3,4] Therefore, early recognition, accurate pathogen identification and tailored management strategies are essential for improving clinical outcomes in affected patients.[5-8] This study evaluates the effectiveness of various pharmacological and surgical approaches in the treatment of PSIs, focusing particularly on infections caused by *S. epidermidis* and *M. tuberculosis*, which are highly relevant in both developed and resource-limited healthcare settings.

METHODS

This retrospective study was conducted at Bangladesh Medical University between January 2015 and December 2023 to evaluate different management strategies for postoperative spinal infections (PSIs). A total of 31 patients who developed clinically and microbiologically confirmed PSIs following spinal surgery were included. Diagnosis was established based on patient history, presenting symptoms such as wound pain, swelling, discharge and fever, supported by laboratory findings including elevated white blood cell counts, C-reactive protein and erythrocyte sedimentation rate.

Imaging modalities such as MRI and CT scans were used to assess the depth of infection, involvement of spinal structures and presence of abscesses. Microbiological cultures were obtained from wound swabs, pus aspirates or intraoperative samples to identify causative pathogens, while suspected tubercular infections were further confirmed using molecular diagnostic techniques and histopathology. Management strategies included both pharmacological and surgical interventions. Patients with pyogenic infections received targeted intravenous antimicrobial therapy tailored according to culture sensitivity reports, whereas those with tubercular infections were treated with standard multi-drug anti-tubercular regimens.

Surgical treatment was indicated in patients with persistent or worsening infection, neurological deficits or spinal instability and involved procedures such as debridement alone, debridement with spinal fusion or debridement with fixation depending on individual case requirements. Follow-up assessments were performed at 1, 3, 6 and 12 months' post-treatment to evaluate pain relief, clinical improvement and neurological recovery using the Visual Analogue Scale, Modified Odom Criteria and Nurick's grading system. Data were recorded and analyzed using SPSS version 25, with significance set at $p<0.05$ for outcome measures.

Data analysis

Data were analyzed using SPSS version 25 (IBM®, Armonk, USA). Descriptive statistics, including mean, standard deviation and percentage, were calculated for demographic variables, infection types and treatment modalities. Paired t-tests were used to compare pre- and post-treatment Visual Analogue Scale (VAS) scores, while changes in Nurick's grading and Modified Odom Criteria outcomes were evaluated using chi-square tests. A p-value of less than 0.05 was considered statistically significant. Results were presented in tables and figures to demonstrate demographic profiles, pathogen distribution, treatment approaches and clinical outcomes over different follow-up intervals.

Surgical technique

All patients received detailed counselling regarding the surgical procedure, including the available treatment options along with their respective merits and demerits. Possible postoperative sequelae were also discussed thoroughly. Preoperative CBC, ESR, CRP, MRI and X-rays (anterior-posterior and lateral views) were reviewed to confirm infection.

Operative procedure

After full pre-anesthetic check-up and Informed written consent was obtained. The operative field was cleaned and shaved. All patients were catheterized preoperatively. Intravenous administration of antibiotics was given. Under general anesthesia, patients were positioned prone on a radiolucent table with reverse knee chest position. Chest pads and 60°–90° flexion at the knees were used to reduce epidural venous bleeding. A midline longitudinal skin incision was made over the posterior spine from L1 to S1 or as per involved levels. Subperiosteal dissection exposed the spinous processes, laminae and facet joint bilaterally typically from L1 to S1 level. Wound debridement and surgical toileting was done. Then total discectomy was done. Fixation was done by pedicle screw and rod and fusion was done by banana cage and autogenous cancellous bone graft in infected level. Bleeding was controlled by electrocautery and gel foam.

RESULTS

Table 1 presents the demographic characteristics of the study population. The mean age was 57.13±6.14 years (range 40–65), with the majority of patients (60%) aged between 51–60 years. Males were predominantly affected (73.3%), while females accounted for 26.7% of the cases.

As shown in Table 2, *S. epidermidis* (46.7%) was the most common pathogen isolated, followed by Mycobacterium tuberculosis (16.7%), reflecting the prevalence of tubercular infections in endemic regions. The remaining 36.6% of cases had either unidentified or mixed bacterial isolates.

Figure 1 illustrates the treatment strategies employed. Conservative management with targeted antimicrobial therapy (46.7%) was the most common approach, followed by surgical debridement (23.3%). Anti-TB therapy accounted for 16.7% of cases, while fusion and fixation were performed in select patients requiring additional spinal stabilization.

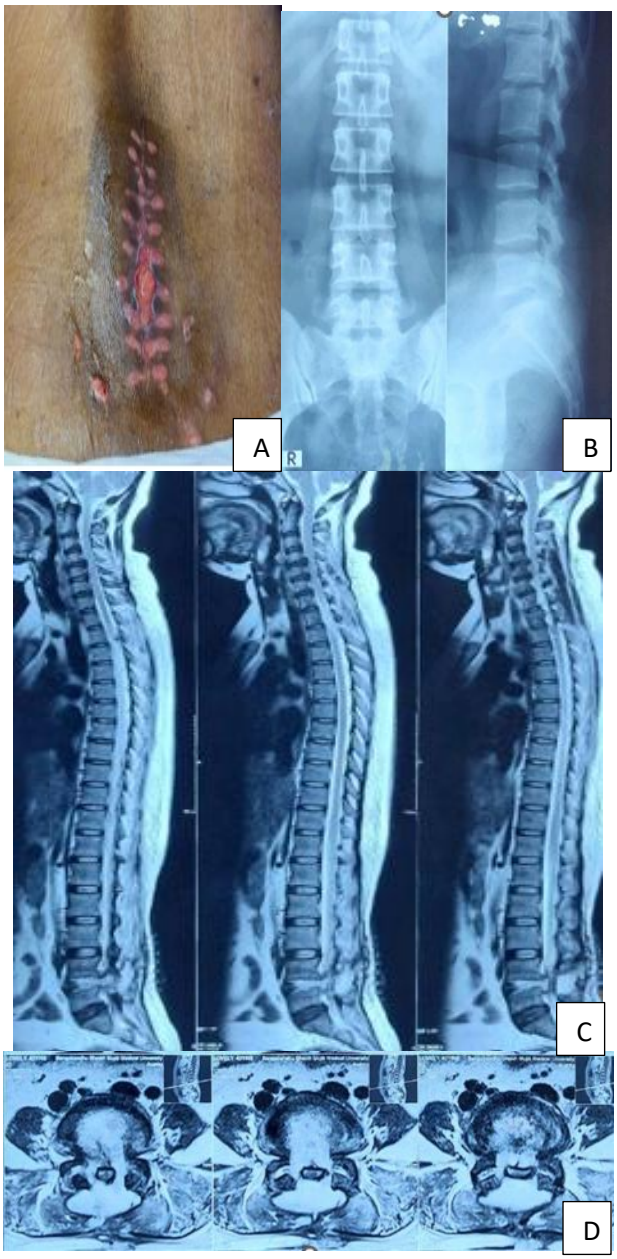

Figure 1 (A-D): Pre-operative wound, X-ray and MRI.

Figure 2 (A and B): Wound debridement and surgical toileting and post-operative X-ray.

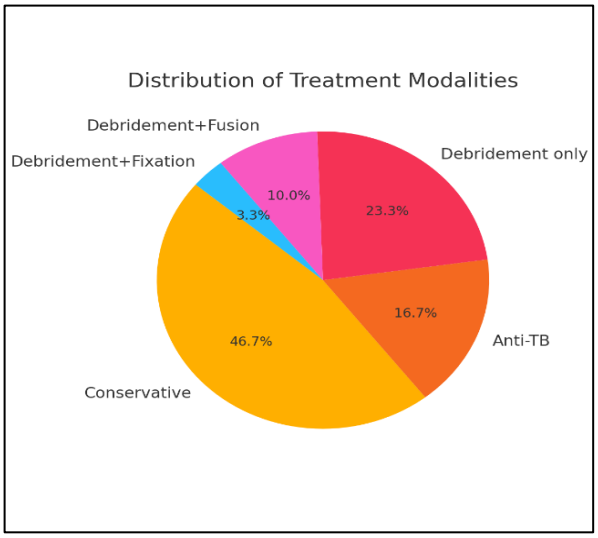

Figure 3: Treatment modalities used.

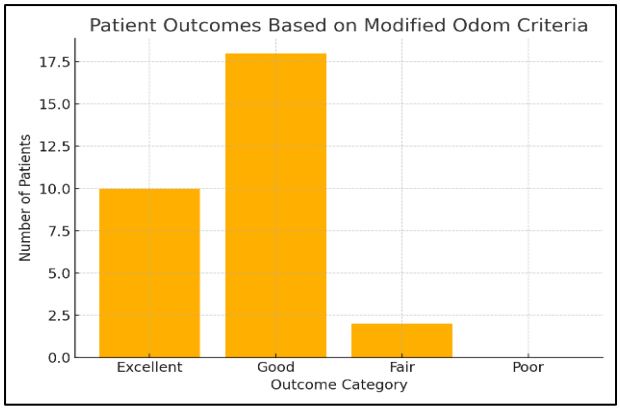

Figure 4: Outcome according to modified odom criteria.

Pain levels improved significantly over time (Table 3). The mean VAS score decreased from 6.27±1.75 pre-treatment to 0.73±0.59 at 12 months ($p<0.001$). Substantial reductions were observed as early as the first month, with progressive improvement at each follow-up interval.

Clinical outcomes assessed using the Modified Odom Criteria demonstrated that 93.3% of patients achieved good-to-excellent outcomes, with 33.3% rated excellent and 60.0% rated good. Only 6.7% of patients had fair outcomes and no poor results were recorded.

Functional neurological status, assessed using Nurick's grading, improved markedly over the follow-up period (Table 4). Pre-treatment, 93.3% of patients were classified as Grade III, indicating significant impairment. At 3 months' post-treatment, 86.7% of patients had improved to Grade 0 or I, with only one patient remaining in Grade III.

Table 1: Demographic profile of patients.

Variable	Frequency (n=30)	%/ Mean±SD
Age (in years)	-	57.13±6.14 (40–65)
40–50	6	20.0
51–60	18	60.0
>60	6	20.0
Male	22	73.3
Female	8	26.7

Table 2: Types of infection and causative pathogens.

Pathogen Type	Number of patients (N)	%
***S. epidermidis* (Pyogenic)**	14	46.7
Mycobacterium tuberculosis (TB)	5	16.7
Other/Unidentified organisms	11	36.6

Table 3: Functional outcome based on VAS scores.

Follow-up time (in months)	Mean VAS Score±SD	P value
Pre-treatment	6.27±1.75	-
1 month	3.95±1.21	<0.05
3 months	2.20±0.97	<0.05
6 months	1.12±0.65	<0.05
12 months	0.73±0.59	<0.001

Table 4: Improvement in Nurick's grading over time.

Nurick's Grade	Pre-treatment (N, %)	Post-treatment (3 months) (N, %)
Grade 0	0 (0)	12 (40.0)
Grade I	0 (0)	14 (46.7)
Grade II	2 (6.7)	3 (10.0)
Grade III	28 (93.3)	1 (3.3)

DISCUSSION

Postoperative spinal infections (PSIs) remain a significant challenge in spine surgery, contributing to prolonged hospitalization, increased morbidity and, in severe cases, long-term neurological deficits. The current study highlights that early diagnosis, appropriate antimicrobial or anti-tubercular therapy and timely surgical intervention

can significantly improve clinical outcomes in patients affected by PSIs. The predominance of Staphylococcus epidermidis in this study aligns with previous literature emphasizing the organism's strong biofilm-forming ability, which enables it to colonize surgical implants and evade host immune defences, leading to persistent infections.[9,10] In regions endemic to tuberculosis, Mycobacterium tuberculosis continues to pose a considerable burden, often requiring longer treatment durations and more aggressive surgical strategies for adequate infection control.[11,12]

The findings of this study support the role of targeted antimicrobial therapy as an effective first-line treatment for pyogenic infections, demonstrating significant pain relief and improved neurological outcomes over time. Similar reports have shown that prompt initiation of culture-guided antibiotics can reduce the need for repeated surgeries and prevent chronic infection states.[13,14] For tubercular infections, a combination of prolonged anti-TB drug regimens and surgical stabilization has been shown to be crucial for achieving infection resolution and preventing spinal deformity.[15] Surgical intervention, particularly debridement with or without fusion or fixation, was essential in cases with severe neurological impairment or structural instability, echoing the results of earlier studies advocating for aggressive debridement to reduce bacterial load and enhance the efficacy of medical therapy.[16]

Post-treatment assessments revealed significant improvements in pain scores and neurological function, suggesting that a multidisciplinary approach integrating pharmacological therapy and surgical management offers the best chance for favourable outcomes in PSIs. These findings are consistent with other clinical investigations emphasizing early multidisciplinary intervention to minimize complications and improve quality of life.17 However, the small sample size and single-centre design limit the generalizability of this study's results. Future multi-centre, prospective studies with larger populations are needed to refine treatment protocols and develop standardized management guidelines for PSIs.[18]

This study was conducted at a single facility-based hospital, so the study population may not represent the whole community. Long-term outcome couldn't be assessed due to the short follow-up duration. Fusion was assessed by plain radiographs only, which may not detect pseudarthrosis accurately.

CONCLUSION

Postoperative spinal infections are serious complications that can lead to prolonged morbidity and neurological impairment. Early diagnosis, targeted antimicrobial or anti-tubercular therapy and timely surgical intervention significantly improve patient outcomes. Surgical debridement with or without stabilization plays a vital role in infection control. A multidisciplinary approach remains essential for effective management and prevention of long-term complications.

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