


Surgical Outcomes of Complicated Spinal Tuberculosis: A Prospective Observational Study of 56 Operated Cases at NITOR

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ABSTRACT

Background: Spinal tuberculosis remains a major cause of neurological disability in endemic regions, with complicated cases frequently requiring surgical intervention. Prospective outcome data from high-burden, resource-limited settings remain limited. **Objective:** To evaluate surgical outcomes in patients with complicated spinal tuberculosis treated at a national tertiary orthopedic referral center. **Methods & Materials:** This prospective observational study included 56 surgically treated patients with complicated spinal tuberculosis managed between January 2020 and June 2025. Neurological status was assessed using the Kumar et al. grading system. Outcomes evaluated included pain severity using the visual analog scale, neurological recovery, deformity correction, bony fusion, and perioperative and postoperative complications. **Results:** The mean age was 38.4 ± 12.8 years, with a near-equal sex distribution. Thoracolumbar and thoracic involvement predominated. Preoperatively, 71.4% of patients had Grade 3 or 4 neurological deficits. Postoperatively, pain scores improved from 8.2 ± 1.02 to 3.5 ± 0.9 , and higher neurological grades markedly decreased. Deformity correction and bony fusion were achieved in 89.2% of patients, with no implant failure. Complications were acceptable, and 14.2% of patients showed no neurological improvement. **Conclusion:** Surgical management of complicated spinal tuberculosis provides significant pain relief, neurological improvement, and durable spinal stabilization, supporting its role as an effective treatment option in endemic, resource-constrained settings.

Keywords: spinal tuberculosis, surgical outcomes, neurological recovery, spinal fusion, deformity correction

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INTRODUCTION

Tuberculosis (TB) remains a major global public health problem, with a substantial proportion of cases occurring as extrapulmonary disease, which is often associated with delayed diagnosis and increased morbidity. Among extrapulmonary manifestations, skeletal tuberculosis represents a clinically important subset, and involvement of the spine accounts for nearly half of all musculoskeletal TB cases, making it the most common and most disabling form of skeletal tuberculosis [1,2]. Despite advances in diagnostic imaging, microbiological techniques, and antitubercular chemotherapy, spinal tuberculosis continues to pose significant challenges, particularly in low- and middle-income countries where disease burden remains high and access to timely specialist care is often limited [3,4]. Spinal tuberculosis is characterized by a heterogeneous and frequently insidious clinical presentation, ranging from localized back pain and constitutional symptoms to severe neurological deficit, spinal deformity, and mechanical instability. The disease predominantly affects the anterior column of the spine, leading to progressive vertebral body destruction, collapse, kyphotic deformity, and abscess formation, which together contribute to spinal cord or nerve root compression and neurological impairment [2,4]. Delayed presentation

remains common in endemic regions, resulting in advanced disease at first clinical contact and a higher likelihood of complications that adversely affect functional outcome [5,6]. The term “complicated spinal tuberculosis” is generally used to describe cases associated with neurological deficit, significant or progressive deformity, mechanical instability, persistent pain, or failure to respond to conservative antitubercular therapy. These features have been consistently identified as key determinants of poor outcome when managed with chemotherapy alone [2,6]. While antitubercular therapy remains the cornerstone of treatment for spinal TB, surgical intervention is widely accepted as necessary in complicated cases to prevent irreversible neurological damage, halt progression of deformity, and restore spinal stability [4,7]. The objectives of surgical management in spinal tuberculosis are well established and include adequate neural decompression, thorough debridement of diseased tissue, reconstruction and stabilization of the spinal column, correction or prevention of progressive deformity, and facilitation of neurological recovery and early mobilization. However, considerable variability exists in surgical strategies across published studies, including differences in timing of intervention, choice of anterior, posterior, or combined approaches, methods of

reconstruction, and outcome assessment tools [2,7]. This heterogeneity reflects ongoing debate and the absence of universally accepted guidelines, particularly for patients presenting with advanced disease. Most of the existing literature on surgical outcomes in spinal tuberculosis consists of retrospective series, heterogeneous cohorts, or data derived from non-endemic or high-resource settings, which may not accurately reflect the disease spectrum and clinical challenges encountered in high-burden regions [8,9]. Large cohort studies from endemic areas have highlighted prolonged symptom duration, high rates of neurological involvement, and frequent need for surgical intervention, underscoring the importance of context-specific data [6,10]. Despite South Asia bearing a disproportionate share of the global TB burden, prospective observational studies reporting surgical outcomes of complicated spinal tuberculosis from Bangladesh remain scarce, particularly from national referral orthopedic centers managing advanced presentations. Documenting neurological recovery and functional outcomes following surgery is of critical clinical importance, as preoperative neurological status and postoperative improvement are among the strongest predictors of long-term quality of life and independence in patients with spinal tuberculosis [2,4]. In this context, prospective evaluation of surgically treated complicated

spinal TB can provide valuable evidence to inform clinical practice in endemic, resource-constrained settings. The present study was therefore designed to prospectively assess the demographic profile, disease characteristics, surgical management, and postoperative outcomes, with particular emphasis on neurological recovery, in patients undergoing surgery for complicated spinal tuberculosis at a national tertiary orthopedic referral center.

METHODS & MATERIALS

This prospective observational study was conducted at the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh, from January 2020 to June 2025. A total of 56 surgically treated patients with complicated spinal tuberculosis were included. Complicated disease was defined by clinical indications for surgery, including neurological deficit, spinal instability, refractory pain, significant deformity, and nonresponsiveness to conservative treatment. The cohort included patients aged 16–68 years, with follow-up ranging from 3 months to 3 years. Preoperative neurological status was documented using the Kumar et al. grading system. The anatomical level of involvement was categorized as cervical, thoracic, thoracolumbar, lumbar, or lumbosacral. Surgical management was planned according to the level and indication. Cervical vertebral body involvement was treated using an anterior approach. Thoracic, thoracolumbar, lumbar, and lumbosacral cases were managed using a

posterior approach, with debridement, decompression, and transpedicular fixation performed in all cases; anterior reconstruction with cage and bone graft was performed in 40 cases, and anterior bone graft in 14 cases. Postoperative assessment included pain evaluation using the visual analog scale, neurological grading, radiological assessment of maintained deformity correction and bony fusion, and documentation of perioperative and postoperative complications.

RESULTS

Table I summarizes the baseline characteristics of the 56 operated cases. The patients were aged 16–68 years, with a mean age of 38.4 ± 12.8 years. Sex distribution was nearly balanced, with 30 males (53.6%) and 26 females (46.4%). The follow-up duration ranged from 3 months to 3 years.

Table I
Baseline Demographic Characteristics of the Study Population (n = 56).

Variable	Value
Age, years, range	16–68
Age, years, mean ± SD	38.4 ± 12.8
Sex, n (%)	
Male	30 (53.6)
Female	26 (46.4)
Follow-up duration	3 months to 3 years

Table II shows the anatomical distribution of spinal tuberculosis lesions in the cohort. Thoracolumbar involvement was most frequent, observed in 24 patients (42.85%), followed by thoracic involvement in 20

patients (35.71%). Lumbar lesions were present in 8 patients (14.28%), while cervical and lumbosacral involvement were least common, each occurring in 2 patients (3.57%).

Table II
Anatomical Distribution of Spinal Tuberculosis Lesions (n = 56).

Spinal Level	n (%)
Cervical	2 (3.57)
Thoracic	20 (35.71)
Thoracolumbar	24 (42.85)
Lumbar	8 (14.28)
Lumbosacral	2 (3.57)

Table III presents the preoperative neurological status of the 56 patients using the Kumar et al. grading system. Most patients had advanced neurological involvement at presentation, with Grade 4 deficits in 24 cases (42.85%) and Grade 3 deficits in 16 cases (28.57%). Lower-grade involvement was less frequent, with Grade 2 in 5 patients (8.92%) and Grade 1 in 3 patients (5.35%), while 8 patients (14.28%) had Grade 0 neurological status preoperatively.

Table III
Preoperative Neurological Status According to Kumar et al. Grading (N = 56).

Neurological Grade	n (%)
Grade 0	8 (14.28)
Grade 1	3 (5.35)
Grade 2	5 (8.92)
Grade 3	16 (28.57)
Grade 4	24 (42.85)

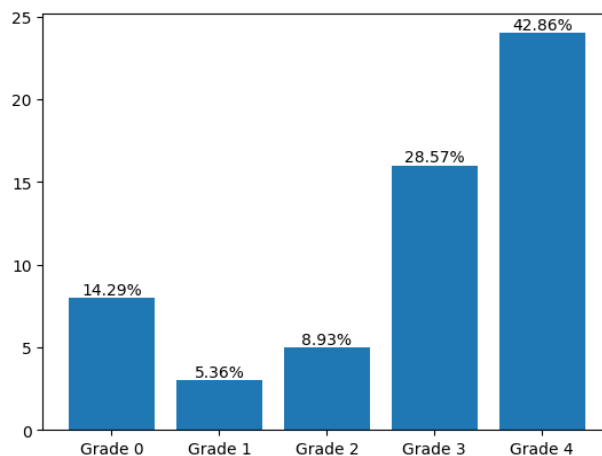


Figure 1 Preoperative Neurological Status.

Figure 1 presents the percentage distribution across five grade categories (Grade 0–Grade 4). Among the categories, Grade 4 has the highest proportion at 42.86%, indicating that nearly half of the observations fall into this category. The second highest proportion is Grade 3 with 28.57%. In contrast, the lower grades account for smaller percentages: Grade 0

represents 14.29%, Grade 2 accounts for 8.93%, and Grade 1 has the lowest proportion at 5.36%. Overall, the distribution shows a clear concentration of observations in the higher grades (Grades 3 and 4), while the lower grades occur less frequently.

Table IV compares preoperative and postoperative pain and neurological status in the 56 operated cases. Mean pain severity improved from a preoperative VAS score of 8.2 ± 1.02 to a postoperative score of 3.5 ± 0.9. Neurological grading shifted toward lower deficit grades postoperatively, with Grade 0 increasing from 8 patients (14.28%) to 20 patients (35.71%), Grade 1 increasing

from 3 (5.35%) to 10 (17.85%), and Grade 2 increasing from 5 (8.92%) to 10 (17.85%). Higher deficit grades decreased, with Grade 3 reducing from 16 (28.57%) to 8 (14.28%) and Grade 4 reducing from 24 (42.85%) to 8 (14.28%).

Table IV
Comparison of Preoperative and Postoperative Clinical Outcomes (*n* = 56).

Outcome Measure	Preoperative	Postoperative
VAS score, mean ± SD	8.2 ± 1.02	3.5 ± 0.9
Paraplegia Grade 0, n (%)	8 (14.28)	20 (35.71)
Paraplegia Grade 1, n (%)	3 (5.35)	10 (17.85)
Paraplegia Grade 2, n (%)	5 (8.92)	10 (17.85)
Paraplegia Grade 3, n (%)	16 (28.57)	8 (14.28)
Paraplegia Grade 4, n (%)	24 (42.85)	8 (14.28)

Table V summarizes postoperative outcomes and complications among the 56 operated cases. Deformity correction was maintained in 50 patients (89.2%), and bony fusion was achieved in 50 patients (89.2%), with no implant failure recorded. Complications included superficial infection in 6 patients (11.1%), deep infection in 2 patients (3.57%), screw malposition in 6 patients (10.71%), and perioperative bleeding in 2 patients (3.57%). No neurological improvement was documented in 8 patients (14.2%).

Table V
Postoperative Outcomes and Complications (*n* = 56).

Variable	n (%)
Maintained deformity correction	50 (89.2)
Achieved bony fusion	50 (89.2)
Implant failure	0 (0.0)
Superficial infection	6 (11.1)
Deep infection	2 (3.57)
Screw malposition	6 (10.71)
Perioperative bleeding	2 (3.57)
No neurological improvement	8 (14.2)

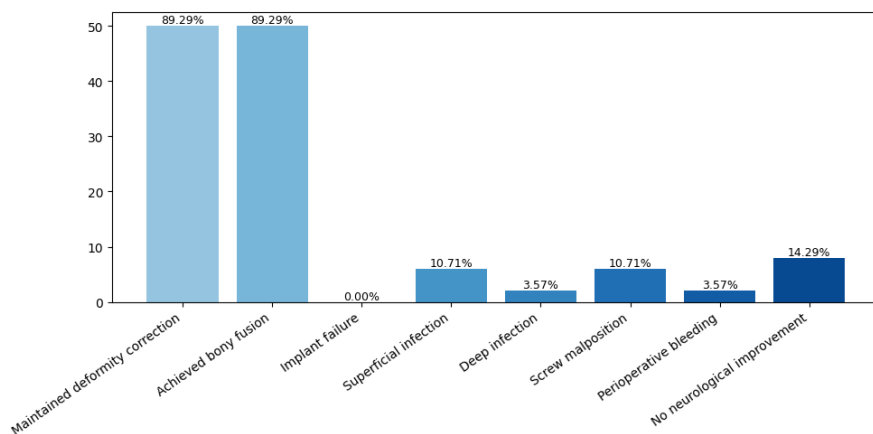


Figure 2 Postoperative Outcomes and Complications.

Figure 2 shows surgical outcomes and complications. Maintained deformity correction and achieved bony fusion were observed in 89.29% of cases each, while implant failure was not reported (0%). Minor complications included superficial infection and screw malposition (10.71% each), and deep infection and perioperative bleeding (3.57% each). No neurological improvement was seen in 14.29% of cases.

DISCUSSION

The present prospective observational study describes the surgical outcomes of 56 patients with complicated spinal tuberculosis managed at a national tertiary orthopedic referral center in Bangladesh and provides context-specific data from an endemic, resource-constrained setting. The demographic profile of the cohort, with a mean age of 38.4 years and near-equal sex

distribution, is consistent with several large series from endemic regions, which report that spinal tuberculosis predominantly affects young to middle-aged adults without a strong gender predilection [2,5,6,11,12]. The predominance of thoracolumbar and thoracic involvement in this study mirrors established epidemiological patterns, as these regions are biomechanically vulnerable and most commonly affected in spinal tuberculosis across diverse geographic settings [2,9,10]. These similarities suggest that the study population is representative of advanced spinal tuberculosis encountered at tertiary centers in high-burden countries. A notable finding of this study was the high proportion of patients presenting with severe neurological deficits. More than two-thirds of patients had Grade 3 or Grade 4 neurological involvement preoperatively, reflecting

delayed presentation and advanced disease, a pattern frequently reported in endemic regions where socioeconomic factors and limited access to specialist care contribute to diagnostic delay [2,5,6]. Comparable studies from tertiary centers in South Asia and Africa have similarly documented a high prevalence of neurological compromise at presentation, reinforcing the clinical relevance of focusing on surgically treated complicated cases [6,9]. Postoperatively, a clear shift toward lower neurological deficit grades was observed, with a reduction in Grade 3 and Grade 4 deficits and corresponding increases in lower grades. This pattern of neurological recovery is consistent with prior reports demonstrating that timely decompression and stabilization can result in meaningful neurological improvement even in patients with advanced deficits [2,4,13-15]. However,

neurological recovery was incomplete in a subset of patients, with 14.2% showing no neurological improvement. Similar proportions of residual deficit have been reported in other series and are often attributed to prolonged duration of compression, severe preoperative deficits, and irreversible spinal cord damage [5,6]. These findings underscore the importance of early referral and intervention to optimize neurological outcomes. Pain relief following surgery was substantial in this cohort, with mean VAS scores decreasing from 8.2 preoperatively to 3.5 postoperatively. Significant postoperative pain reduction has been consistently reported in surgical series and is considered a reliable indicator of clinical improvement and stabilization of the disease process [4,16]. The observed pain improvement further supports the role of surgery in addressing mechanical instability and active disease burden in complicated spinal tuberculosis. Radiological outcomes in this study were favorable, with maintained deformity correction and bony fusion achieved in nearly 90% of patients. These results are comparable to fusion and deformity correction rates reported in large endemic-region cohorts, which typically range between 85% and 95% following surgical stabilization [6,10]. The absence of implant failure in the present study aligns with growing evidence that modern posterior instrumentation, when combined with adequate debridement and antitubercular therapy, is safe and durable even in infected spinal environments [2,7]. The overall complication profile observed in this study, including superficial and deep infections, screw malposition, and perioperative bleeding, was comparable to previously reported series and reflects the complexity of operating on advanced spinal tuberculosis in tertiary-care settings [5,9]. Importantly, complication rates remained acceptable and did not negate the overall benefits of surgical intervention. Taken together, the findings of this study support the role of surgery as an effective treatment modality for complicated spinal tuberculosis in endemic settings, with favorable neurological, pain, and radiological outcomes. The prospective design and focused inclusion of complicated cases add value to the existing literature, which is dominated by retrospective and heterogeneous cohorts. These results contribute region-specific evidence to inform clinical decision-making and highlight the continued need for early diagnosis, timely referral, and standardized outcome reporting in spinal tuberculosis management.

LIMITATIONS

This was a single-center observational study with a relatively limited sample size, which may restrict generalizability to other settings. The absence of a comparative non-surgical or alternative surgical approach group also limits causal inference regarding the superiority of specific techniques.

CONCLUSION

This prospective observational study demonstrates that surgical management of complicated spinal tuberculosis in a tertiary referral center setting results in favorable clinical, neurological, and radiological outcomes. Most patients presented with advanced disease, characterized by severe neurological deficits and thoracolumbar or thoracic involvement, reflecting delayed presentation typical of endemic regions. Surgical intervention led to significant pain reduction, improvement in neurological status, high rates of maintained deformity correction and bony fusion, and no implant failure. Although a subset of patients showed no neurological improvement, the overall outcomes support surgery as an effective and safe modality for managing complicated spinal tuberculosis in resource-constrained, high-burden settings.

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CONFLICT OF INTEREST

None declared

ETHICAL APPROVAL

The study was approved by the Institutional Ethics Committee

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