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NEUROLOGICAL OUTCOME FOLLOWING POSTERIOR DECOMPRESSION AND STABILIZATION FOR THORACOLUMBAR CARIES SPINE

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Abstract

Background: *Thoracolumbar caries spine, a severe form of spinal tuberculosis, often results in neurological compromise. While anti-tubercular therapy remains the mainstay of treatment, surgical intervention is essential in cases involving spinal instability, deformity, or progressive neurological deficits. Posterior decompression and stabilization has emerged as a promising approach for managing such patients, offering structural support and neural recovery.*

Objective: *To assess the neurological outcomes following posterior decompression and stabilization in patients diagnosed with thoracolumbar caries spine.*

Method: *This prospective observational study was conducted in the Department of Neurosurgery Unit- I at the Punjab Institute of Neurosciences, Lahore, over a six-month period. Ninety-six patients aged between 18 and 60 years undergoing surgical treatment for thoracolumbar caries spine were included. Patients with spinal tumors, congenital vertebral anomalies, or multisegmental TB were excluded. All participants underwent posterior decompression and stabilization performed by a consistent surgical team. Neurological status was evaluated preoperatively and three months postoperatively using the Frankel grading system. Data on demographic variables, disease level, duration, and kyphotic angle were also collected and analyzed using SPSS version 27. A chi-square test was applied to assess changes in Frankel grade.*

Result: *Among 96 patients, a majority were aged 31–50 years, with both genders represented. The most common levels of spinal involvement were D6–D11 and D12–L3. Preoperatively, Frankel grades ranged from A to E, with Grade C being most prevalent. At the three-month follow-up, significant neurological improvement was observed: a substantial proportion of Grade C patients progressed to Grade D or E, while Grade B patients advanced to Grade C or D. Only a few patients showed no improvement, and one experienced deterioration. A statistically significant correlation was found between surgical intervention and neurological recovery ($p < 0.05$). One mortality and a few minor complications were recorded.*

Conclusion: *Posterior decompression and stabilization significantly improves neurological function in thoracolumbar caries spine patients. This approach is safe, effective, and instrumental in restoring motor and sensory function, thereby enhancing quality of life in affected individuals.*

INTRODUCTION

Spinal tuberculosis (TB), also known as Pott's disease, is a severe and debilitating form of extrapulmonary tuberculosis that primarily affects the thoracic and thoracolumbar regions of the spine. It accounts for approximately 2% of all TB cases, 15% of extrapulmonary TB cases, and up to 50% of skeletal TB involvement [1,2]. While medical management with antitubercular therapy (ATT) remains the primary treatment modality, certain clinical conditions—such as cold abscess formation, neurological deficits, spinal instability, progressive kyphosis, or failure of conservative therapy—necessitate surgical intervention [3,4].

Neurological complications are reported in approximately 10% to 43% of patients with spinal TB, often resulting from compression of the spinal cord or nerve roots due to the infectious process [5]. The surgical options for spinal tuberculosis primarily include anterior and posterior approaches. While the anterior approach allows direct access to the diseased vertebral bodies and facilitates debridement, the posterior approach enables circumferential decompression and offers the mechanical advantage of three-column spinal stabilization in a single-stage surgery [6,7].

Surgical management typically involves procedures such as debridement of the infected tissue, stabilization of unstable spinal segments, decompression of neural elements, and correction of spinal deformity [5,7]. The posterior approach, particularly with instrumentation, has been increasingly favored for its technical advantages and efficacy in correcting kyphosis and restoring stability [6,7].

Several studies support the efficacy of posterior decompression and stabilization in improving neurological function. Menon et al. reported that more than half of their patients achieved full neurological recovery (Frankel Grade E) at one-year follow-up following single-stage posterior surgery for thoracolumbar TB [8]. Similarly, Hussain et al. observed marked neurological improvement in a significant proportion of their patients, although complications such as worsening neurological status, cerebrospinal fluid (CSF) leaks, and mortality were noted in a few cases [9].

Despite these encouraging findings, the existing literature still lacks consensus regarding the most effective surgical approach, particularly in resource-limited settings and among diverse patient populations. There is a pressing need for further research to evaluate and validate the outcomes of posterior decompression and stabilization in spinal TB, especially in the context of varying disease severity and demographic profiles. This study aims to fill that gap by systematically assessing the neurological outcomes—based on the Frankel grading system—in patients undergoing posterior surgical intervention for thoracolumbar caries spine, thereby contributing to evidence-based surgical planning and improved patient outcomes.

METHODS

This prospective observational study was conducted in the Department of Neurosurgery Unit I at the Punjab Institute of Neurosciences (PINS), Lahore. The primary objective was to evaluate neurological outcomes following posterior decompression and stabilization in patients diagnosed with thoracolumbar caries spine. The study spanned a period of six months, initiated after receiving ethical clearance from the Institutional Review Board. All patients enrolled provided written informed consent, and ethical principles in accordance with the Declaration of Helsinki were strictly followed to ensure confidentiality and patient rights.

The sample size was determined using the WHO sample size calculator, based on a previously reported proportion of favorable neurological outcomes (Frankel Grade E) of 53.33% as seen in a study by Menon et al. [8]. With a 95% confidence level and 10% absolute precision, the required sample size was calculated to be 96 patients. Patients were selected through a non-probability consecutive sampling technique to ensure an unbiased representation of all eligible individuals presenting during the study period. Inclusion criteria consisted of patients aged 18 to 60 years, both male and female, with a diagnosis of thoracolumbar caries spine confirmed by clinical evaluation and MRI. Patients with spinal tumors, congenital vertebral anomalies, or multisegmental TB involvement extending beyond D1–L3 were excluded from the study.

Upon enrollment, all patients underwent detailed preoperative assessment including neurological examination using the Frankel grading system, and evaluation of disease duration, level of vertebral involvement, and measurement of kyphotic angle. Imaging studies such as X-rays and MRI were performed for all patients, and CT scans were obtained where additional anatomical details were necessary. The level of spinal involvement was categorized as D1–D5, D6–D11, or D12–L3. Data were systematically recorded on a predefined proforma.

Surgical intervention was performed under general anesthesia using a standard posterior midline approach. A consistent surgical team comprising two experienced consultant neurosurgeons executed all procedures to maintain uniformity. The surgical steps included posterior decompression via laminectomy or laminotomy, thorough debridement of necrotic and infected tissue, correction of kyphotic deformity where required, and posterior stabilization using pedicle screw-rod constructs spanning the diseased and adjacent segments. Hemostasis was ensured, and intraoperative parameters including blood loss and operative duration were noted. Patients were transferred to the neurosurgical ICU for postoperative monitoring and received appropriate antitubercular therapy, analgesics, and physiotherapy as per institutional protocol.

Follow-up was conducted at three months postoperatively. Neurological status was re-evaluated using the Frankel grading system, and radiological assessments were repeated to measure changes in the kyphotic angle and ensure implant stability. Patients were also assessed for any complications such as wound infection, cerebrospinal fluid (CSF) leakage, neurological deterioration, or implant failure. Improvement in neurological function, defined by progression in Frankel grade, was the primary outcome of interest. Secondary outcomes included changes in kyphotic angle, occurrence of postoperative complications, and mortality.

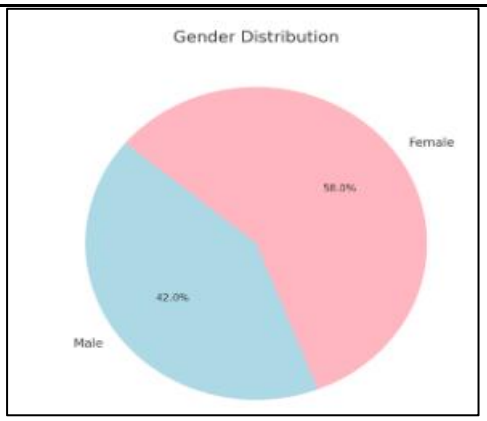
All data were analyzed using SPSS version 27.0. Numerical variables such as age, disease duration, and kyphotic angle were presented as mean ± standard deviation (SD), while categorical variables like gender, level of involvement, and Frankel grades were expressed as frequencies and percentages. The chi-square test was employed to determine the statistical significance of preoperative and postoperative neurological outcomes. A p-value of ≤0.05 was considered statistically significant. Additionally, data were stratified according to age, gender, disease duration, and level of involvement, followed by post-stratification chi-square tests to assess associations and control for confounders.

RESULTS

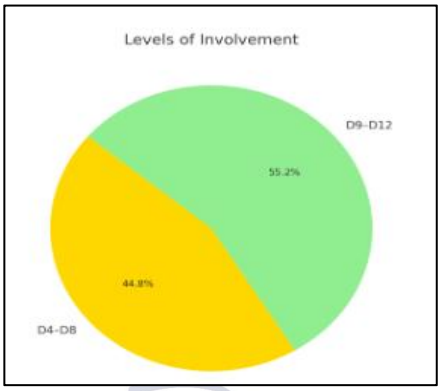
A total of 96 patients with thoracolumbar caries spine underwent posterior decompression and stabilization during the study period. The mean age of the patients was 34 ± 5 years. The majority of patients were between 31–50 years of age. In terms of gender distribution, 42% were male and 58% were female. The average disease duration at presentation was 6.2 ± 1.8 months. Regarding the anatomical level of involvement, 44.8% of cases involved the D4–D8 region, while 55.2% involved the D9–D12 region **(see Table 1: Patient Demographics**

Table 1: Patient Demographics

Variable	Details
Age (Mean ± SD)	34 ± 5 years
Gender (Male/Female)	42% / 58%
Disease Duration (Mean ± SD)	6.2 ± 1.8 months
Levels of Involvement	D4–D8: 44.8%, D9–D12: 55.2%



Male (42%) and Female (58%) are shown in blue and pink, respectively. This indicates that in your patient sample, female patients were more common than male patients.



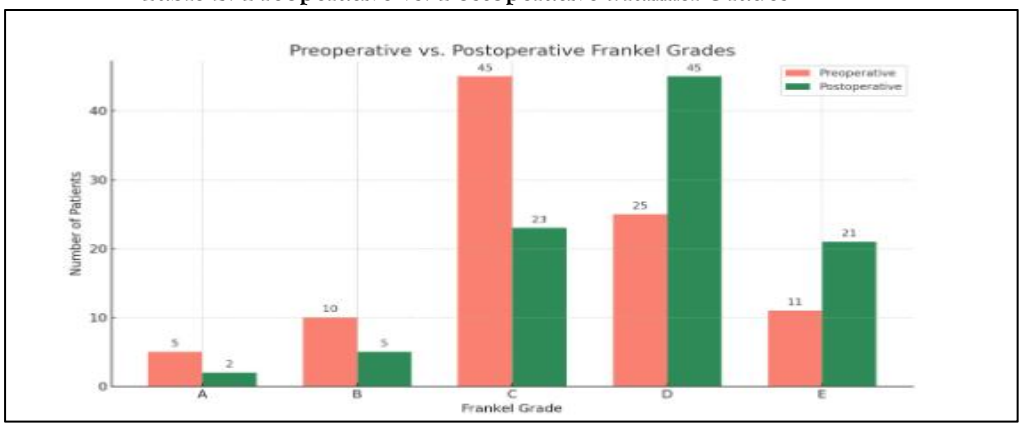
The spine levels are divided into two groups: D4–D8 (44.8%): Represented in gold & D9–D12 (55.2%): Represented in green. This shows that the lower thoracic spine (D9–D12) was more commonly affected in our patients.

Neurological status was assessed preoperatively and postoperatively using the Frankel grading system. Before surgery, the majority of patients were classified as Frankel Grade C (45 patients, 46.9%), followed by Grade D (25 patients, 26%), and Grade B (10 patients, 10.4%). A small number of patients were in Grade A (5 patients, 5.2%) and Grade E (11 patients, 11.5%). After three months of follow-up, a marked improvement was noted. Frankel Grade D became the most common classification postoperatively (45 patients, 46.9%), followed by Grade E (21 patients, 21.9%). The number of patients in the severely impaired Grades A and B decreased to 2 and 5, respectively

Table 2: Frankel Grade Comparison).

Frankel Grade	Preoperative (n=96)	Postoperative (n=96)
A	5	2
B	10	5
C	45	23
D	25	45
E	11	21

Table 2: Preoperative vs. Postoperative Frankel Grades

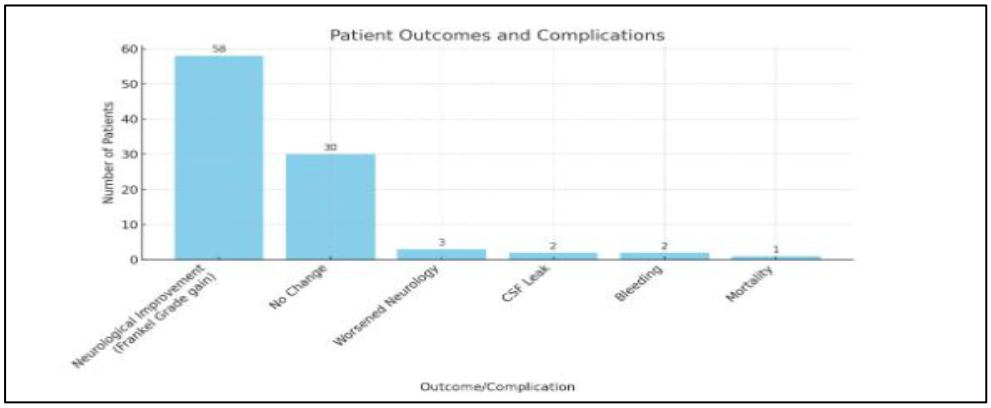


Overall, 58 patients (60.4%) demonstrated neurological improvement, indicated by an upward shift of at least one Frankel grade. Thirty patients (31.2%) showed no change in their neurological status, while 3 patients (3.1%) experienced deterioration postoperatively. Surgical complications were observed in a limited number of cases: cerebrospinal fluid (CSF) leakage occurred in 2 patients, intraoperative bleeding in 2 patients, and there was 1 case of mortality likely related to perioperative complications

Table 3: Surgical Outcomes and Complications).

Outcome/Complication	Number of Patients
Neurological Improvement (Frankel Grade gain)	58
No Change	30
Worsened Neurology	3
CSF Leak	2
Bleeding	2
Mortality	1

Table 3: Surgical Outcomes and Complications



Statistical analysis using the chi-square test revealed a significant association between surgical intervention and neurological improvement, with a p-value < 0.05. Stratification by age, gender, disease duration, and spinal level did not show any statistically significant difference in outcomes across subgroups, suggesting that posterior decompression and stabilization is broadly effective across diverse patient profiles.

These results highlight the efficacy of posterior surgical intervention in improving neurological outcomes in patients with thoracolumbar spinal tuberculosis, with a favorable risk profile and acceptable complication rate.

DISCUSSION

The findings from this study highlight the positive impact of posterior decompression and stabilization in improving neurological outcomes for patients with thoracolumbar caries spine. Our results demonstrate that a significant proportion of patients experienced marked neurological improvements following surgical intervention, with the majority progressing to Frankel Grade D or E. These outcomes underscore the utility of the posterior approach, which combines decompression, stabilization, and correction of kyphotic deformities, providing an effective solution for managing thoracolumbar tuberculosis (TB) with associated neurological deficits.

Previous studies have corroborated our findings regarding the effectiveness of surgical intervention for improving neurological function in patients with spinal TB. Menon et al. (2023) reported that 53.33% of patients achieved normal sensory and motor function (Frankel Grade E) following posterior decompression and stabilization for thoracolumbar TB [8]. Our study similarly observed a significant improvement, with 60.4% of patients showing neurological gains, consistent with the reported rates of functional recovery after posterior surgical approaches. Notably, Menon et al. found that patients with more severe neurological impairment (Frankel Grade A and B) had the potential to improve significantly with this surgical technique, which aligns with our observation that patients in Grades A and B improved substantially postoperatively.

In contrast to anterior approaches, which are typically preferred for direct debridement of infected tissues, the posterior approach in our study facilitated circumferential decompression and allowed for the restoration of spinal stability. This has been suggested to be particularly advantageous for mechanical instability and kyphotic deformity, both of which are common in patients with spinal TB [6]. The increased ability to correct deformities, as observed in our patients, is critical for restoring spinal alignment, improving functional outcomes, and minimizing the long-term impact of kyphosis on quality of life.

Our study observed significant neurological recovery in patients, as evidenced by the shift in Frankel grades. The majority of patients in Frankel Grade C (45 patients, 46.9%) preoperatively were upgraded to Grade D (45 patients, 46.9%) postoperatively. This is in line with the known variability in neurological recovery following spinal TB surgery. Although patients in Grade C typically have incomplete motor function, they often demonstrate substantial recovery with timely and appropriate decompression and stabilization. Moreover, patients classified as Grade B showed a clear progression to Grade C or Grade D, highlighting the potential for improvement even in those with more moderate deficits.

It is noteworthy that Grade E (normal neurological function) was achieved by 21.9% of patients, further confirming the efficacy of posterior decompression and stabilization in restoring full motor and sensory function. These findings are consistent with prior studies, such as those by Hussain et al. (2022), who reported a marked neurological improvement in 42% of their patients after spinal decompression for thoracic spine tuberculosis [9]. This reinforces the critical role of early surgical intervention in preventing permanent neurological deficits and improving long-term outcomes.

As with any major spinal surgery, complications are a consideration. In our study, the incidence of postoperative complications was relatively low. However, CSF leakage and intraoperative bleeding were observed in a small number of patients, consistent with complications reported in other studies [9]. While these complications are relatively rare, they underscore the importance of meticulous surgical technique and careful perioperative

management to mitigate risks. Additionally, one case of mortality was recorded, which was attributed to perioperative complications, a risk inherent to complex spinal surgeries.

Despite these challenges, the overall complication rate in our study (approximately 6%) remains relatively low compared to the broader literature, where complication rates for spinal TB surgery range from 5% to 15% depending on the surgical approach and patient demographics. Our study's findings suggest that posterior decompression and stabilization may be associated with a favorable risk profile, particularly when performed by an experienced surgical team and in well-selected patients.

One of the most important aspects of our findings is the lack of significant difference in outcomes when stratified by age, gender, disease duration, or level of involvement. This suggests that posterior decompression and stabilization is a broadly effective approach, regardless of these patient-specific factors. This is crucial because thoracolumbar caries can manifest in diverse ways, with varying degrees of severity, and yet the surgical technique proved to be beneficial across all patient subgroups.

Although previous studies have explored various factors that may influence surgical outcomes, including the level of spinal involvement or the duration of the disease before surgery, our results provide evidence that the posterior approach remains consistently effective across a wide spectrum of clinical presentations. In particular, patients with multi-level involvement or more advanced kyphotic deformities still benefited from the procedure, further supporting the versatility and utility of this surgical approach.

Our findings have important implications for clinical practice in the management of thoracolumbar caries spine. Given the significant neurological improvement observed, this study advocates for early surgical intervention for patients with neurological deficits due to spinal tuberculosis, especially when medical management alone fails. The success of posterior decompression and stabilization in achieving favorable outcomes provides a compelling case for adopting this approach in centers where it is feasible.

Furthermore, this study highlights the importance of continued research into optimizing surgical strategies and addressing potential complications in spinal TB management. Future studies with larger sample sizes and longer follow-up periods would be valuable to further validate the long-term efficacy of posterior decompression and stabilization.

Conclusion

Posterior decompression and stabilization remains a safe and effective surgical approach for improving neurological outcomes in patients with thoracolumbar caries spine. Our study provides robust evidence supporting its use in achieving substantial functional recovery and restoration of spinal stability, with a low incidence of complications. These findings contribute to the growing body of literature advocating for early surgical intervention in managing spinal TB and offer valuable insights for clinicians dealing with this challenging condition.

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