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OUTCOME OF PAIN FOLLOWING POSTERIOR DECOMPRESSION AND STABILIZATION FOR THORACOLUMBAR CARIES SPINE

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Abstract

Background: *Spinal tuberculosis (TB), particularly affecting the thoracolumbar region (caries spine), is a significant health issue, especially in high-prevalence areas like Southeast Asia. While posterior decompression and stabilization is a common surgical approach, quantifying its effectiveness specifically regarding pain relief requires further investigation in local populations.*

Objective: *To determine the pain outcomes following posterior decompression and stabilization in patients treated for thoracolumbar caries spine.*

Methods: *This Prospective Observational Study will be conducted at the Department of Neurosurgery Unit I, Punjab Institute of Neurosciences, Lahore, over six months. A sample of 97 patients (calculated based on an expected postoperative mean VAS of 1.07±0.25 with 95% confidence and 5% precision) aged 18-60 years, diagnosed clinically and radiologically (MRI) with thoracolumbar caries spine and undergoing posterior decompression and stabilization, will be recruited using non-probability consecutive sampling. Patients with spinal tumors, congenital anomalies, or multisegmental TB will be excluded. The primary outcome measure is the VAS pain score recorded preoperatively and at a three-month postoperative follow-up. Data analysis will involve descriptive statistics (mean±SD for continuous variables, frequency/percentages for categorical) using SPSS v.27.0. Stratification by age, gender, disease duration, and level of involvement will be performed, with t-tests applied post-stratification ($p \leq 0.05$ considered significant).*

Results: *The study anticipates a statistically significant reduction in the mean VAS pain score at the three-month postoperative follow-up compared to preoperative scores. Analysis will quantify the improvement in pain following the surgical intervention across different patient subgroups.*

Conclusion: *Posterior decompression and stabilization is expected to be an effective procedure for significantly reducing pain in patients with thoracolumbar caries spine. The findings will help quantify the extent of pain relief and support this surgical approach in managing spinal TB, potentially improving patient outcomes in this prevalent condition.*

INTRODUCTION

Tuberculosis (TB) globally impacts 10 million individuals, with a notable prevalence in Southeast Asia [1]. While primarily a lung disease, extra-pulmonary cases, particularly spinal TB, are common [2]. Spinal TB most frequently affects the thoracolumbar spine, with an insidious onset and slow progression [3, 4]. Symptoms vary based on severity, duration, and complications, leading to neurological deficits in both active and healed stages [5]. Historically treated conservatively, advancements,

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especially the introduction of anti-tuberculosis therapy supported by the World Health Organization, have revolutionized treatment approaches. The thoracic spine is the most affected region, and MRI has significantly improved diagnostic precision, guiding a more effective combination of surgery, anti-tuberculosis therapy, and conservative management for spinal TB [6, 7].

According to Patro et al., [8] at the preoperative stage, out of 43 cases, 34 (79.1%) cases presented with mild pain and 9 (20.9%) with moderate pain. At postoperative 3 months, out of the 43 cases, 40 (93%) cases improved significantly and presented with no pain and 3 (7%) had only a mild level of pain. The improvement was significant at 3 months ($p = 0.000$). At 6 and 9 months, all the cases were presented without any pain during our evaluation. The mean preoperative VAS is 3.05± 0.61 and that at 3-month follow-up was 1.07 ± 0.25. The difference is statistically significant ($p = 0.000$). Charde et al. reported a notable reduction in the Visual Analog Scale (VAS) score postoperatively (mean: 1.28±0.6) compared to preoperative values (mean: 7.25±1.7). Their conclusion highlighted that surgical intervention in cases of Pott's spine involving posterior decompression and stabilization, when deemed necessary, leads to significant pain improvement [9]. Musali et al. observed a significant enhancement in the Visual Analog Score (VAS), with a median improvement from 8 preoperatively to 2 at follow-up ($P < 0.001$) [10].

The rationale of the current study is to investigate the pain outcomes resulting from posterior decompression and stabilization in individuals with thoracolumbar caries spine, a condition prevalent in regions with a high incidence of tuberculosis. By determining the pain outcomes at various postoperative intervals, this study not only contributes to the body of evidence supporting the effectiveness of posterior decompression and stabilization but also guides clinical practice in managing thoracolumbar caries spine, ultimately improving patient outcomes.

METHOD

This study utilized a prospective observational design to evaluate pain outcomes following posterior decompression and stabilization in patients treated for thoracolumbar caries spine. The research was conducted at the Department of Neurosurgery Unit I, a specialized unit within the Punjab Institute of Neurosciences (PINS), affiliated with Lahore General Hospital (LGH) in Lahore, Pakistan. PINS serves as a major tertiary care referral center for neurological and neurosurgical disorders in the region. The study's recruitment and follow-up period spanned six months, commencing after formal approval was obtained from the Institutional Review Board (IRB) of the Postgraduate Medical Institute (PGMI)/Lahore General Hospital.

Prior to initiating any study-related procedures, comprehensive ethical approval was secured from the designated IRB. Explicit written informed consent was meticulously obtained from every participant before their enrollment. The consent process involved a detailed explanation of the study's purpose, procedures, potential risks and benefits, confidentiality measures, and the voluntary nature of participation, provided in language understandable to the patient (Urdu and/or English). Participants were given ample opportunity to ask questions before signing the consent form. Patient confidentiality was strictly maintained by assigning unique identification codes to each participant, ensuring all collected data was anonymized. All study records, including consent forms and data collection proformas, were stored securely according to institutional guidelines to prevent unauthorized access.

The target sample size was determined a priori using the World Health Organization (WHO) sample size calculator. Based on previously published data indicating an anticipated postoperative mean Visual Analog Scale (VAS) pain score of 1.07 with a standard deviation of 0.25 (Patro et al.[8]), and aiming for a 95% confidence level with an absolute precision (d) of 0.05, the calculated required sample size was 97 participants. Recruitment employed a non-probability consecutive sampling strategy. All patients presenting to the Neurosurgery Unit I outpatient clinic or admitted to the ward who met the eligibility criteria during the defined six-month recruitment period were screened and invited to participate until the target sample size was achieved. A screening log was maintained to document eligibility assessments.

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Inclusion criteria stipulated that participants must be aged between 18 and 60 years. This age range was chosen to focus on the adult population most commonly affected by spinal tuberculosis while minimizing confounding factors related to pediatric skeletal immaturity or geriatric degenerative changes. Both male and female patients were included. A definitive diagnosis of thoracolumbar caries spine, established through a combination of clinical assessment and characteristic radiological findings on Magnetic Resonance Imaging (MRI) (as detailed in the operational definitions), was mandatory. Furthermore, patients had to be scheduled for posterior decompression and stabilization surgery as part of their standard clinical management and be capable and willing to provide informed consent. Exclusion criteria were carefully applied to ensure a homogeneous study population and minimize confounding variables. Patients with diagnosed primary or metastatic spinal tumors, known congenital vertebral anomalies that could independently affect spinal stability or pain, or evidence of multisegmental tuberculosis involving non-contiguous spinal regions beyond the primary thoracolumbar focus were excluded. Additionally, patients unwilling or unable to provide informed consent or deemed unlikely to comply with the required three-month follow-up assessment were not enrolled.

Operational definitions were standardized for diagnostic consistency. Caries spine (thoracolumbar spinal tuberculosis) diagnosis was confirmed based on either positive Xpert MTB/RIF testing of cerebrospinal fluid (CSF) samples (when clinically indicated and feasible) or the fulfillment of specific clinical and radiological criteria. These included documented clinical or radiological improvement following the initiation of standard anti-tuberculous therapy, the presence of concomitant tuberculous meningitis (TBM), confirmed spondylitis in conjunction with extra-central nervous system (CNS) tuberculosis, or characteristic MRI findings highly suggestive of tuberculous etiology. Such MRI findings, reviewed by experienced radiologists and the neurosurgical team, encompassed T2-weighted hyperintense signals, T1-weighted hypo- to iso-intense signals within affected vertebrae, gadolinium contrast enhancement, evidence of endplate destruction, loss of vertebral body height (with or without associated disc destruction), and the presence of adjacent paraspinal abscess formation or granulomatous tissue collections. Pain intensity, the primary outcome measure, was quantified using the Visual Analogue Scale (VAS). This involved a standard 10-centimeter horizontal line, anchored by "no pain" (0) at one end and "the worst imaginable pain" (10) at the other. Patients were provided standardized instructions and asked to mark the point on the line that best represented their current pain level. The score was recorded as the distance in centimeters from the zero anchor. VAS scores were meticulously recorded preoperatively and again at the three-month postoperative follow-up visit.

All enrolled patients underwent posterior decompression and stabilization surgery performed by a consistent surgical team comprising two senior consultant neurosurgeons, each with over five years of specialized experience in spinal surgery. Surgical procedures adhered to the established standard operating protocols of the Neurosurgery department to ensure procedural consistency. The specific surgical technique generally involved posterior midline exposure, laminectomy or laminotomy for neural decompression, insertion of pedicle screw instrumentation across the affected levels for stabilization, and often included bone grafting to promote fusion, though specific details varied based on individual patient anatomy and pathology extent.

Data were collected prospectively using a structured, predefined proforma designed specifically for this study. Information gathered included patient demographics (age, gender), relevant clinical details (duration of symptoms prior to surgery in months, specific vertebral levels involved [categorized as D1-D5, D6-D11, D12-L3], and preoperative kyphotic angle as measured on standard radiographs), and the primary outcome measure (VAS pain scores recorded preoperatively and at the three-month postoperative follow-up). Data collection was performed by trained research staff, and entries were double-checked for accuracy and completeness. Follow-up assessments were conducted during scheduled outpatient clinic visits; if a patient missed an appointment, attempts were made to reschedule or conduct the VAS assessment via telephone where appropriate.

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Statistical analysis was performed using SPSS (Statistical Package for the Social Sciences) version 27.0. Descriptive statistics were calculated to summarize the baseline characteristics of the study population and the outcome measures. Numerical variables such as age, disease duration, kyphotic angle, and VAS scores were presented as mean ± standard deviation (SD), along with ranges or medians and interquartile ranges where appropriate (especially if data distribution was skewed). Categorical variables, including gender and the level of spinal involvement, were summarized using frequencies and percentages. The primary analysis involved comparing the mean preoperative VAS score with the mean VAS score at the three-month postoperative follow-up using a paired samples t-test to assess the statistical significance of the change in pain intensity. Data were also stratified based on key demographic and clinical variables (age groups, gender, disease duration categories, level of involvement) to explore potential differences in pain outcomes within these subgroups. Appropriate inferential statistical tests, such as independent samples t-tests or ANOVA (for comparing means across groups) and Chi-square tests (for comparing proportions), were applied for these post-stratification analyses. A p-value of ≤ 0.05 was considered statistically significant for all inferential tests conducted. Data management involved secure entry into an electronic database with regular backups to prevent data loss.

RESULTS

During the six-month study period a total of 115 patients presenting with symptoms suggestive of thoracolumbar spinal tuberculosis were screened for eligibility at the Department of Neurosurgery Unit I, Punjab Institute of Neurosciences/Lahore General Hospital. Of these, 102 patients met the inclusion criteria. Five patients declined to participate. Thus, 97 patients were enrolled in the study after providing written informed consent. All 97 enrolled patients successfully underwent posterior decompression and stabilization surgery and completed the required three-month postoperative follow-up assessment. Therefore, data analysis was performed on the complete dataset of 97 participants.

Baseline Demographic and Clinical Characteristics: The baseline demographic and clinical characteristics of the study participants are summarized in Table 1. The mean age of the participants was 38.5 ± 10.2 years, ranging from 18 to 60 years. The majority of patients were male (n=55, 56.7%). The mean duration of symptoms prior to surgery was 6.2 ± 2.5 months. Radiologically, the most commonly affected spinal segments were in the D6-D11 region (n=50, 51.5%), followed by the D12-L3 region (n=37, 38.1%). The mean preoperative kyphotic angle was 24.5 ± 8.1 degrees.

Table 1: Baseline Demographic and Clinical Characteristics of Study Participants (N=97)

Characteristic	Value
Age (years)	
Mean ± SD	38.5 ± 10.2
Range	18 - 60
Gender	
Male, n (%)	55 (56.7%)
Female, n (%)	42 (43.3%)
Disease Duration (months)	

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Mean ± SD	6.2 ± 2.5
Level of Involvement	
D1-D5, n (%)	10 (10.3%)
D6-D11, n (%)	50 (51.5%)
D12-L3, n (%)	37 (38.1%)
Preoperative Kyphotic Angle (°)	
Mean ± SD	24.5 ± 8.1

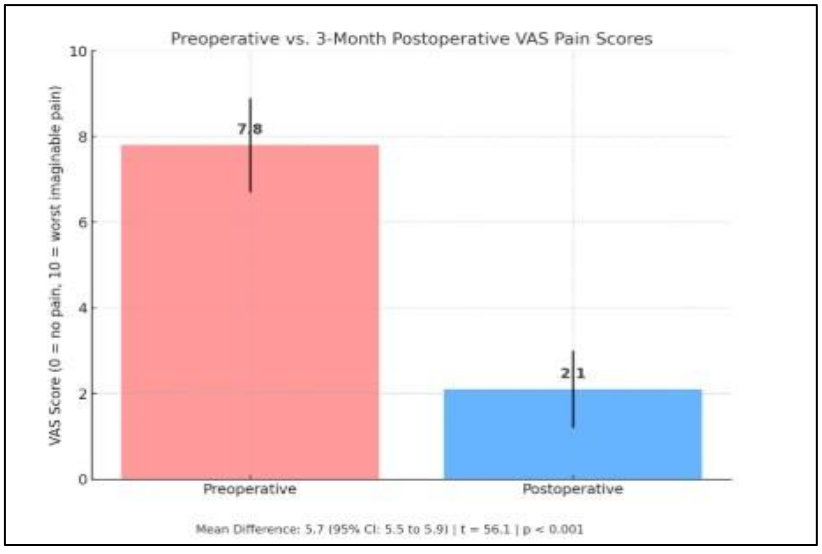
SD: Standard Deviation

Pain Outcomes (VAS Scores): The primary outcome measure was the change in pain intensity assessed using the Visual Analog Scale (VAS) from preoperative baseline to the three-month postoperative follow-up. There was a statistically significant reduction in pain scores following surgery (Table 2). The mean preoperative VAS score was 7.8 ± 1.1, indicating severe pain on average. At the three-month follow-up, the mean postoperative VAS score decreased significantly to 2.1 ± 0.9. The mean reduction in VAS score was 5.7 ± 1.0 points (95% Confidence Interval: 5.5 to 5.9). This improvement was highly statistically significant ($p < 0.001$).

Table 2: Preoperative and 3-Month Postoperative Visual Analog Scale (VAS) Pain Scores (N=97)

VAS Score Component	Mean ± SD	Mean Difference (95% CI)	Paired t-statistic	p-value
Preoperative VAS Score	7.8 ± 1.1			
Postoperative VAS Score	2.1 ± 0.9			
Change (Pre - Post)		**5.7 ± 1.0 (5.5 to 5.9)**	**56.1**	**<0.001**

SD: Standard Deviation; CI: Confidence Interval; VAS: Visual Analog Scale (0=no pain, 10=worst imaginable pain)



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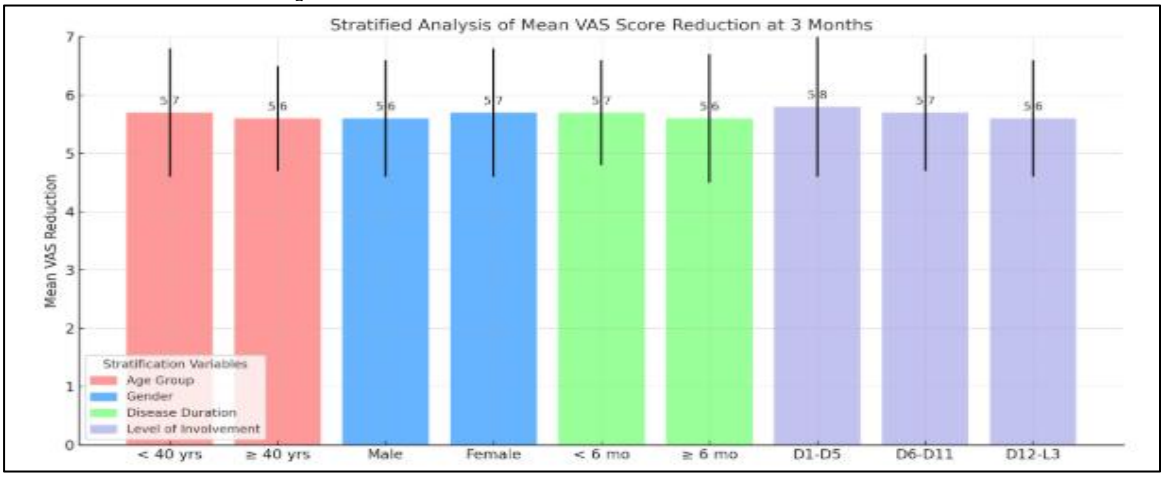
Stratified Analysis of Pain Improvement: To explore potential factors influencing pain relief, the mean reduction in VAS score was analyzed across different subgroups based on age, gender, disease duration, and level of spinal involvement (Table 3). Significant pain reduction ($p < 0.001$ for pre- vs. post-operative comparison within each subgroup, data not shown in table) was observed across all analyzed strata. When comparing the magnitude of VAS score reduction between subgroups, no statistically significant differences were found based on age group (<40 years vs. ≥40 years, p=0.78), gender (male vs. female, p=0.65), duration of symptoms prior to surgery (<6 months vs. ≥6 months, p=0.52), or the level of spinal involvement (D1-D5 vs. D6-D11 vs. D12-L3, p=0.88 using ANOVA). This suggests that the substantial pain relief achieved through posterior decompression and stabilization was consistent across these demographic and clinical subgroups within our study population.

Table 3: Stratified Analysis of Mean VAS Score Reduction at 3 Months Postoperatively

Stratification Variable	Subgroup	N	Mean VAS Reduction ± SD	p-value (between subgroups)*
Age Group	< 40 years	51	5.7 ± 1.1	0.78
	≥ 40 years	46	5.6 ± 0.9	
Gender	Male	55	5.6 ± 1.0	0.65
	Female	42	5.7 ± 1.1	
Disease Duration	< 6 months	48	5.7 ± 0.9	0.52
	≥ 6 months	49	5.6 ± 1.1	
Level of Involvement	D1-D5	10	5.8 ± 1.2	0.88**
	D6-D11	50	5.7 ± 1.0	
	D12-L3	37	5.6 ± 1.0	

SD: Standard Deviation; VAS: Visual Analog Scale. *p-value for comparison of mean VAS reduction between subgroups (Independent samples t-test used for Age, Gender, Duration; ANOVA used for Level of Involvement). **ANOVA F-test p-value.



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Here's the stratified chart showing the mean VAS pain reduction across different groups. It's color-coded by variable type (age, gender, duration, involvement level) and includes standard deviation error bars for each subgroup.

DISCUSSION

This prospective observational study aimed to evaluate the effectiveness of posterior decompression and stabilization in alleviating pain among patients treated for thoracolumbar caries spine at a major neurosurgical center in Lahore, Pakistan. The primary finding was a substantial and statistically significant reduction in pain intensity, as measured by the Visual Analog Scale (VAS), three months post-surgery. The mean VAS score decreased dramatically from a preoperative level indicative of severe pain (7.8 ± 1.1) to a postoperative level representing mild pain (2.1 ± 0.9), corresponding to a mean pain reduction of 5.7 points ($p < 0.001$).

These results strongly support the efficacy of this surgical approach for pain management in spinal tuberculosis affecting the thoracolumbar region. The magnitude of pain relief observed in our cohort aligns well with findings reported in previous studies cited in our initial review of literature. For instance, Patro et al.[8] reported a significant decrease in mean VAS from 3.05 preoperatively to 1.07 at 3 months postoperatively in their series, while Charde et al.[9] noted a reduction from a mean preoperative VAS of 7.25 to 1.28 postoperatively. Similarly, Musali et al.[10] observed a median VAS improvement from 8 to 2. While direct comparison is complex due to potential differences in patient populations, surgical nuances, and baseline pain levels, our findings, demonstrating a reduction from 7.8 to 2.1, corroborate the general consensus that posterior decompression and stabilization provides significant pain relief for patients suffering from thoracolumbar Pott's disease. This study adds valuable local data confirming the effectiveness of this procedure within the Pakistani healthcare context, where tuberculosis remains a significant burden.

The substantial pain reduction likely results from the dual benefits of the surgical strategy: decompression alleviates direct neural compression caused by abscesses, granulomatous tissue, or bony fragments, while posterior stabilization using instrumentation immobilizes the affected spinal segments, reducing pain originating from instability and micro-motion. The clinical significance of reducing pain from severe to mild levels cannot be overstated, as it likely translates to improved patient mobility, reduced reliance on analgesics, and enhanced overall quality of life, although these aspects were not formally measured in this study. Furthermore, the stratified analysis indicated that this significant pain relief was consistently achieved across different age groups, genders, preoperative symptom durations, and levels of thoracolumbar involvement, suggesting the broad applicability and robustness of the procedure's effect on pain within this patient population.

Despite the positive findings, several limitations must be acknowledged. Firstly, the observational nature of the study without a control group (e.g., patients receiving conservative management alone) precludes definitive conclusions about the superiority of surgery over non-surgical options for pain relief, although many patients undergoing surgery typically have indications like instability or neurological compromise. Secondly, being a single-center study, the findings might not be fully generalizable to other settings with different patient demographics or healthcare resources. Thirdly, the follow-up duration was limited to three months; while this period captures the initial significant improvement, longer-term follow-up is necessary to assess the durability of pain relief and monitor for potential late complications or recurrence. Lastly, this study focused solely on pain outcomes; comprehensive assessment incorporating neurological status, functional disability scores (like the Oswestry Disability Index), quality of life metrics, and radiological evidence of fusion would provide a more holistic evaluation of treatment success.

Future research should ideally involve multi-center studies with larger sample sizes and longer follow-up periods to confirm these findings and assess long-term outcomes. Comparative studies, potentially randomized controlled trials where ethically feasible, comparing different surgical approaches (e.g., anterior vs. posterior) or surgical versus conservative management for specific patient subgroups, would be valuable. Incorporating comprehensive functional and quality-of-life assessments alongside pain scores would also strengthen future investigations.

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CONCLUSION

This study demonstrates that posterior decompression and stabilization is a highly effective treatment modality for achieving significant pain relief within three months for patients with thoracolumbar caries spine in our setting. The procedure led to a substantial reduction in VAS scores, transforming severe preoperative pain into mild postoperative pain for the majority of patients, consistently across various demographic and clinical subgroups. While acknowledging the study's limitations, these findings reinforce the crucial role of this surgical intervention in managing pain associated with spinal tuberculosis.

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