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Original Article

Experience of Short Segment Fixation in Thoracolumbar Spine Traumatic Fractures at Tertiary Care Hospital

Burhan Ul Haq, Shahzad Ahmad Qasmi, Abdul Rehman Arshad, Farhat Ijaz*, Akbar Shah, Saadia Ziaulhaque**

Department of Neurosurgery, Combined Military Hospital Lahore/National University of Medical Sciences (NUMS) Pakistan,
*Department of Physiology, Combined Military Hospital Lahore/National University of Medical Sciences (NUMS) Pakistan,
**Department of Neurosurgery, Akhtar Saeed Medical and Dental College (ASMDC), Lahore Pakistan

ABSTRACT

Objective: To assess the outcome of short-segment posterior fixation in thoracolumbar fractures in terms of reducing kyphosis, the mean hospital stay, pain, intraoperative blood loss, surgical time, and improvement in functional outcome.
Study Design: Prospective observational study.
Place and Duration of Study: Department of Neurosurgery, Combined Military Hospital, Lahore Pakistan, from Apr to Dec 2023.
Methodology: A total of 40 patients with mono-segmental thoracolumbar fractures were operated on for Short segment posterior fixation (SSPF) between April 2023 to December 2023 at Combined Military Hospital, Lahore. Various clinical and radiological indices were obtained pre-operatively, postoperatively, and outdoor follow-up till six months; including Cobb angle/Kyphotic Angle (KA), Local kyphotic angle (LKA), Oswestry Disability Index (ODI), Anterior vertebral body height ratio (AVBHR%), and pain score (Visual analog scale). Data was analyzed using SPSS.
Results: Out of 40 patients, with male preponderance and a mean age of 41.82 years, the mean pre-operative, post-operative, and 06-month follow-up kyphotic angles were 15.72 degrees, 6.72±3.74 degrees, and 8.25±2.48 degrees, respectively. The mean preoperative ODI was 65.7±8.90 which reduced to 20.7±3.44 at six months follow-ups, while the VAS improved from 7.10±1.05 to 3.90±1.40, and 2.70±1.22, at 3 and 6 months follow-up, respectively. The mean operative time was 120.50±36.60 minutes, and the mean surgical blood loss was 349.10±109.00 milliliters. The average hospitalization period was 9.50± 4.00 while Twelve patients lost to follow-up.
Conclusion: SSPF is an effective surgical option for thoracolumbar fractures; allows for a shorter hospital stay, reduced post-operative pain, early patient mobilization, and functional improvement, with remarkable restoration of vertebral height loss.

Keywords: Spinal Injury, Thoracolumbar, Oswestry Disability Index, Visual Analog Scale.

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INTRODUCTION

Thoracolumbar fractures are caused by substantial axial and flexion forces acting upon a vertebra, resulting in anterior vertebral body compression. The T10-L2 region is more susceptible to fracture, due to intermediate positioning between the rigid kyphotic thoracic spine and the more adaptable lordotic lumbar segment.[1] Surgical intervention is recommended in cases of neurological deficits or marked instability.[2] Cahueque *et al.*, further delineated criteria for surgical consideration, advocating for intervention in fractures manifesting a kyphosis angle of 25°–30°, progressive neurological deterioration, and vertebral height loss exceeding 50%.[3]

Operative management focuses on neural decompression, spinal stabilization, and kyphotic correction.[4] Surgical strategy selection aims to rectify segmental kyphotic deformity, restoration of vertebral height, and the fusion of the vertebral segments to prevent instability and facilitate prompt mobilization and functional recovery.[5] Several techniques, including posterior pedicle screw fixation, short and long segment fixation, anterior decompression coupled with arthrodesis and instrumentation, and combined anterior-posterior approaches, have been documented.[5] Short-segment fixation is a preferred fixation method among surgeons, owing to fewer involved vertebral levels (fractured vertebral level included in fixation), and consequently, lesser implant use, surgical cost, the amount of dissection, and superior functional outcomes as have been examined in this study.[4] Conversely, a meta-analysis hints at potentially superior radiographic outcomes and reduced implant failure rates with long-segment fixation, although clinical equivalence between modalities is observed.[6]

Correspondence: Dr Farhat Ijaz, Department of Physiology, Combined Military Hospital Lahore, Rawalpindi Pakistan
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Despite documented cases of kyphotic correction loss and implant failure in the long-term, the utilization of transpedicular screws at the fracture site offers advantageous attributes including augmented construct rigidity, enhanced bio-mechanical stability, and a three-point fixation mechanism guarding against construct failure.[7] Biomechanical investigations underscore the efficacy of incorporating a screw at the fracture site in short-segment fixation, bolstering construct stiffness, and safeguarding the anterior column during loading.[8-9] Despite occasional setbacks, short-segment instrumentation maintains its preeminence for most thoracolumbar injuries owing to its cost-effectiveness, procedural simplicity, and superior clinical outcomes.[5] This study prospectively examines the feasibility of employing SSPF in treating TL fractures in 40 patients.

METHODOLOGY

The ethics committee of the Combined Military Hospital (CMH) Lahore, Pakistan approved the final study in April 2022. (ERB number 489/2023). From April 2023 to December 2023, a cohort comprising 40 patients diagnosed with single-level thoracolumbar fracture underwent surgical intervention utilizing short segment posterior fixation (SSPF). The sample size was calculated using the WHO Sample size calculator using the study by Karam *et al,* as the parent study by using level of significance 0.5, power of the test 90%, P1=0.484 and P2= .1285. The sample size(n) came out to be 40 patients who were selected through a non-probability consecutive sampling technique.[10] Written informed consent was obtained from all patients included in the study. All patients underwent surgical intervention within a timeframe of two weeks post-injury. The thoracolumbar AO Spine injury score (TL AOSIS) was utilized for preoperative selection. Patients with a score of <03 were managed conservatively, while those with a score of >04 were operated on. Surgical indications included neurological involvement caused by the fracture causing canal compromise, kyphosis, and more than 50% loss of the vertebral body's height.

Inclusion Criteria: The inclusion criteria for the study comprised individuals of all ages above 20 years, with single-level thoracolumbar spine fractures, presenting within two weeks of injury, absence of an ankylosed or osteoporotic spine having under-went SSPF including the fractured vertebra.

Exclusion Criteria: Patients with severely osteoporotic and ankylosed spines, and pathologic fractures caused by metastatic disease and/ or infection were excluded from the study.

All the patients underwent radiographs of the TL Spine in AP and lateral views initially during emergency room assessment, followed by a CT scan and MRI of the TL spine prior to the surgery. Radiographic indices such as the local kyphotic angle (LKA), Kyphotic angle (KA) or Cobb, anterior vertebral height (AVH) both for fractured and adjacent vertebra, vertebral body loss (%), and anterior vertebral body height ratio % (AVBHR%) were calculated. AVHR% was calculated as per the formula: AVHR%= AVH/ [(AVHa + AVHb)/ 2] x 100 %. AVH represents the anterior vertebral height of the fractured or collapsed vertebra, which is divided by the mean of the anterior vertebral height of the proximal (AVHa) and distal vertebrae (AVHb), immediately adjacent to the fractured vertebra. The sum obtained is represented as a percentage. Another measurement, AVBHL (Anterior vertebral body height loss %) was calculated by the formula: {1-B/[(A+C)/2]}×100%.[11] The LKA was calculated by first drawing two lines; one across the superior border and the other across the inferior border of the involved vertebra. The angle produced by the intersection of the two lines was measured, and this was the LKA.[11,12] The Visual analog scale (VAS), and Oswestry disability index (ODI) were also determined in every patient to assess pain and functional disability, respectively; using patient-filled questionnaire proformas. Operative indices included in the study were operative time measured (in minutes), mean blood loss (milliliters), and post-operative duration of hospitalization (days).

Patients were followed up within one month post-operatively, and six months follow-up, with post-operative radiographs of the TL spine in AP and Lateral views. A formal consent was sought from every patient, before including them into the study. Any postoperative complications including any segmental kyphosis, surgical site infections, and implant failure were noted. The postoperative and follow-up radiographs were studied to measure AVH, AVHR%, Cobb angle, and LKA. The ODI and VAS scales were evaluated for all patients.

All the procedures were undertaken under General anesthesia, with the patient positioned prone and a posterior midline approach. Further dissection was then performed in the subperiosteal plane, exposing the fractured vertebrae and its adjacent

nonfractured vertebrae on either side. Confirmation of the vertebral levels was done using an image intensifier.

Next, by ascertaining the confluence of the line connecting the mid-transverse process with a line along the lateral border of the superior articular facet, the introduction point of the mono-axial pedicle screw was marked. Both crania-caudal and mediolateral trajectories were then established.[8] Pedicle screws were then introduced first in the non-fractured vertebrae, followed by the insertion of pedicle screws in the involved fractured vertebrae.

Transpedicular fixation of the desired levels followed by decompression of the neural canal. We utilized two types of decompressions: direct and indirect.[13] Indirect decompression, utilizing distraction and lording maneuvers was performed in patients without neurological deficits, and without any radiological evidence of canal compromise by bony fragments. Conversely, patients with neurological deficits, and evidence of canal compromise, underwent direct decompression, involving laminectomy.[13]

After pre-contouring the rods into lordosis, bilateral rods were introduced into the screw heads and properly braced, followed by distraction maneuvers. Ultimately, all screws were securely locked after achieving satisfactory reduction and reinstating the sagittal and coronal alignment of the fractured vertebra, confirmed on the image intensifier. This restoration aimed at returning the anterior height of the fractured vertebra to approximately 80-90% of the adjacent vertebral height. Drains were placed as needed. Early mobilization with an extension brace was allowed at an average of the fifth post-operative day.

Data analysis was performed by Statistical Package for Social Sciences (SPSS) Version 25. Quantitative variables were presented as Mean±SD while qualitative were presented as frequency and percentages. Comparison between mean values was done by ANOVA and paired t-test. A p-value of less than 0.05 was considered significant.

RESULTS

A total of 40 patients with single-level thoracolumbar fractures underwent short-segment posterior fixation (SSPF) surgery between April 2023 to December 2023. The sample had a male preponderance with 35 males (87.5%) and 5 females (12.5%). The mean age of the patients was 41.82±12.23, with the ages ranging between 22 and 74 years. The most involved fractured vertebra was L2 (37.5%), followed by L1 (27.5%). Other fracture levels included in the study were T12, T11, and L3 accounting for 15%, 10%, and 10%, respectively. All patients underwent surgery within two weeks of the injury; (6.7±2.7) days. Most of these patients had a complete burst fracture (60%), classified as AO3 on the AO Scale. Only 01 patient was ASIA B on the impairment scale, whilst 02 patients, one each were ASIA A, and ASIA C, respectively. The remaining 37 patients (97.5%) were ASIA E (Table-I).

Table-I: Distribution of Study Participants According to Vertebral Levels Fractured and ASIA Impairment Scale (n=40)

Parameter(s)	Value
Age*	41.82±12.23
Gender**	
Male	35 (87.5%)
Female	5 (12.5%)
Fracture level**	
T11	4 (10.0%)
T12	6 (15.0%)
L1	11 (27.5%)
L2	15 (37.5%)
L3	4 (10.0%)
Neurological Deficit**	
ASIA E	37(92.5%)
ASIA C,A, and B	3 (7.5%)

**Data presented as Mean ± SD; ** data presented as %*

Figure-1 shows the measurement of radiographic indices for a patient who suffered an L2 fracture and was offered Short-segment posterior fixation. Pre-Operative radiograph (Left) illustrates the calculation of Cobb and Local Kyphotic angle on a lateral film. post-Operative radiograph (Right) illustrates the calculation of AVHR%(Anterior vertebral height ratio%) as per the formula AVHR%= AVH/ [(AVHa + AVHb)/ 2] x 100 %. Note the correction of Cobb angle from 22^{o} to 10^{o}, post-operatively.

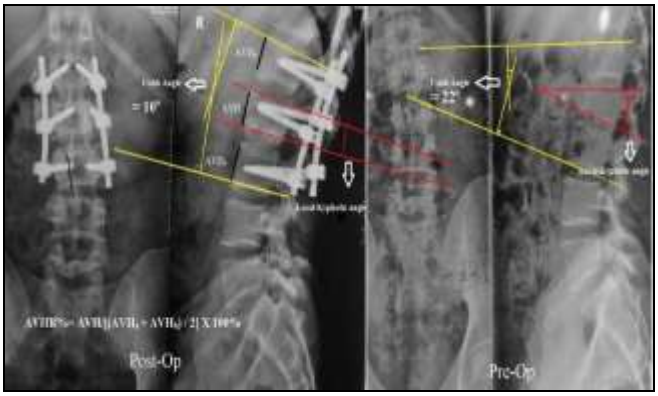

Figure 1: Radiographic indices of patient

The mean duration of the surgery was 120.6±36.6 minutes. The mean blood loss was 349.1±109.1 minutes. The average duration of stay in the hospital was 9.4±3.9 days. The mean pre-operative VAS was 7.1±1.05. VAS at 03-month follow-up and 06-month follow-up were 3.7±1.42 and 2.7±1.31, respectively. Both improvements were statistically significant (p<0.001). The pre-operative ODI was 65.7±8.90. ODI at the most recent follow-up of 06 months was noted to be 20.7±3.44. (p<0.001) (Table-II). 12 patients lost to follow up.

Table-II: Clinical and Operative indices (n=28)

Clinical Indices	Values	*p*-value
Visual analogue scale (VAS)		
Pre-Operative	7.1±1.05	<0.001
3 months follow-up	3.9±1.4	
6 months follow-up	2.7±1.22	
Average final follow-up	2.3±1.1	
Oswestry disability index (ODI)		
Pre-Operative	67.1±9.0	<0.001
3 months follow-up	25.7±5.2	
Average final follow-up	20.7±3.4	
Operative indices		
Mean operative time	120.5±36.6	-
Mean blood loss	349.1±109	
Hospitalization period	9.5±4.0	

Table-III: Radiographic Indices Obtained from Lateral Radiographs of Thoraco Lumber Spine (n=28)

Radiographic Indices	Values	*p*-value
Cobb		
Pre-Operative	16.6±6.1	0.01
Post-Operative	6.5±3.4	
Average final follow-up	8.2±2.5	
Local Kyphotic Angle (LKA)		
Pre-Operative	20.3±7.0	0.001
Post-Operative	6.4±3.0	
Average final follow-up	7.5±3.5	
Anterior vertebral height ratio (AVHR)%		
Pre-Operative	49±11.7	0.01
Post-Operative	83.4±7.4	
Average final follow-up	85.5±6.0	
Vertebral body loss %		
Pre-Operative	51±12	0.01
Post-Operative	16.5±7.4	
Average final follow-up	14.4±6.0	
Kyphotic Correction	-1.53±3.5	

The mean Cobb angle significantly (p<0.01) improved from 15.72±6.17 to 6.72±3.74 at 03 months follow up, with a Mauchly's Test of Sphericity of 0.690. This was, however, followed by a loss of kyphotic angulation of 2.3 degrees at 06 months follow-up. This loss of kyphotic correction was statistically significant (p-value <0.001). Similar trends in SKA were also observed with an initial improvement of 67 % at 03 months follow-up (from 20.3±7.75 to 6.64±3.32) followed by a loss of 1.3 degrees. However, 12.7 degrees of kyphotic correction still remained at 06 months follow-up compared to the pre-op kyphotic angle. The mean anterior vertebral body compression at both 03 and 06 months follow-ups were significantly lower (p<0.01) compared to the pre-operative index. No surgical complications were encountered. (Table-III).

DISCUSSION

The findings of our study indicate substantial improvements in various parameters such as disability markers, pain indices, kyphotic correction, and overall functional status, with minimal instances of perioperative and postoperative complications.

Spinal trauma, predominantly caused by road traffic accidents and falls from heights, often results in fractures occurring in the thoracolumbar region. Initially, there was a prevailing notion that short-segment fixation offered inferior stability and higher rates of implant failure compared to long-segment fixation.[14] However, pioneering research by Mahar *et al.*, introduced the concept of same-segment fixation, demonstrating superior biomechanical stability.[15] This concept was further supported by subsequent studies by Guven *et al.*, and Bolesta *et al.*, which highlighted comparable stability between short and long-segment fixation, alongside notable improvements in kyphotic angles and follow-up disability scores.[16,17]

In our study, an initial significant improvement in kyphotic angle correction was observed, although a loss of correction was noted at the 6-month follow-up. Nonetheless, a substantial degree of correction persisted despite this decline, a pattern also noted in similar studies on short same-segment fixation. Adawi *et al.*, reported a noteworthy decrease in Cobb Angle and a 48% improvement in kyphotic angulation at the one-year follow-up, albeit with a subsequent loss of 4.2 degrees.[18] Similarly, in a study with a longer mean follow-up duration, a loss of kyphotic angulation of 11.51 degrees was observed.[19]

Perna *et al.*, in their investigation of short-segment fixation utilizing percutaneous screws, found that the loss of kyphotic correction did not significantly impact clinical outcomes.[20] Furthermore, there were no substantial differences in outcomes between groups experiencing varying degrees of kyphotic correction loss.[21] These findings are corroborated by Phan *et al.*, who reported comparable

outcomes between groups undergoing percutaneous and open screw placement, suggesting that the poly-axial nature of pedicle screws might contribute to early correction loss.[20,22]

LIMITATION OF STUDY

Despite several positive outcomes reported in our study, there are limitations to consider. Our study was conducted solely at a single institution with a relatively modest sample size of forty patients, twelve of whom were lost to follow-up. Additionally, the six-month follow-up period may not be sufficient to definitively establish the long-term efficacy and stability of short-segment fixation. Objective measures of mobility and return to work were not evaluated. Nevertheless, notwithstanding these limitations, we maintain that our study demonstrates significant improvements in both preoperative and postoperative outcomes, thereby enhancing biomechanical stability and patient satisfaction.

CONCLUSION

Short segment fixation in TL spine fractures has been found to be efficacious with a lesser degree of intraoperative blood loss, fewer complications, shorter duration of hospital stay, early mobilization of patients, and increased biomechanical stability and cost-effectiveness. Moreover, postoperatively and on follow-up, there is a significant reduction in overall disability and pain. However long-term kyphosis correction is not maintained; with long segment constructs conferring more kyphotic correction.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

BUH & SAQ: Data acquisition, data analysis, critical review, approval of the final version to be published.

ARA & FI: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

AS & SZ: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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