

## COMPARATIVE STUDY OF SHORT SEGMENT FIXATION WITH OR WITHOUT TRANSPEDICULAR BONE GRAFT FOR SURGICAL TREATMENT OF BURST FRACTURES OF THORACIC & LUMBAR SPINE IN ADULTS AFTER TRAUMA

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### ABSTRACT

**Background And Objective:** Thoracolumbar fractures are among the most common fractures of the spine because of high energy trauma. A short segment fixation with two proximal & two distal screw fixation including the fractured vertebra at single level thoracolumbar fracture with or without transpedicular intracorporeal bone graft provides the adequate support & stability. The objective of this study was to assess the clinical effectiveness of short segment fixation with or without transpedicular bone grafting substitutes in patients with single level Thoracolumbar spine Burst fracture.

**Methods:** This Randomized Controlled Trial was conducted from December 2016 to December 2019 in the Department of Orthopedic & Spine Surgery at Lahore General Hospital, Lahore. After approval from Hospital Ethical Review Board, 64 patients having single level burst fractures of thoracolumbar Spine were divided into two equal groups A & B. In Group A, all patients were treated with short segment trans pedicle screw fixation with bone graft while in group B patients, only short segment fixation was done. All the patients were followed for one year to assess the Kyphotic angle, vertebral body height and visual analogue score (VAS) and was noted in a predesigned proforma.

**Results:** Group A and Group B demonstrated statistically significant differences in various measured outcomes. For the kyphotic angle, Group A recorded a mean of  $18.5^\circ \pm 4.0^\circ$ , while Group B had a slightly higher mean of  $19.5^\circ \pm 4.2^\circ$  ( $p = 0.03$ ). Vertebral height measurements revealed that Group A maintained a mean height of  $23.1 \pm 2.8$  mm, whereas Group B exhibited a lower mean height of  $21.3 \pm 3.3$  mm ( $p = 0.02$ ). Lastly, the VAS score, reflecting pain intensity, showed Group A with a mean score of  $2.0 \pm 0.8$ , slightly lower than Group B's  $2.05 \pm 0.7$  ( $p = 0.01$ ), indicating a statistically significant improvement in pain levels in both groups but more significant in Group A over the year.

**Conclusion:** Short Segment Fixation is an effective treatment option for maintaining the anterior vertebral height and prevention of loss of kyphotic angle at single level thoracolumbar fracture of the spine. Moreover, the VAS score was also improved where the short segment fixation with transpedicular bone graft was done.

**Key Words:** Anterior vertebral height, Kyphotic Angle, Short segment fixation, Trans pedicle graft substitutes, Trans pedicle screw fixation, Thoracolumbar Burst fractures,

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One fractures involving different body parts as a result of high energy trauma are a global health issue that has existed millennia.<sup>1</sup> Spine fracture are cause of disability & are major burden on socio-economic status of the society. The most commonly affected people are young generation in between age of 15-40 years.<sup>2</sup> Thoracolumbar burst fractures result from axial compression with retropulsion of bone fragments into vertebral canal, fracture of anterior & middle column

of vertebral body with an increase in inter pedicular distance. It has been reported that 25% fractures of thoracolumbar spine present with neurological deficit. Among these, 45% are neurological compromised, 25% with incomplete & 19% with complete cord injury. High energy trauma like road traffic accidents are responsible for these injuries (50%) followed by work related injuries and sports injuries.<sup>3</sup> Mostly thoracolumbar fractures involve one or more thoracic vertebra (T10-T12) with one or more lumbar vertebra (L1-L2). The junction between thoracic and lumbar spine forms a transition zone that predisposes it to injury.<sup>4</sup> Spinal segment behave in a different way during motion in certain dimensions.<sup>5</sup> Thoracolumbar injuries remain a controversial subject in modern Orthopaedics & Neurosurgery with regards to classification & in terms of treatment.<sup>6</sup> Up till now no single ideal classification system exist to standardize the treatment and management options for these injuries.<sup>7</sup> The most acceptable classification is AO Thoracolumbar injury Classification and severity score (TLICS).<sup>8</sup> Still another four column classification is also gaining popularity. It is based upon the relationship of movements and forces acting on the spine with advantages of practicality and simplicity for better understanding of fracture pattern. Here the four columns are incorporated into thoracic spine through direct & indirect mechanism.<sup>9</sup> The knowledge about spine anatomy with its biomechanics is vital for preventing mechanical damage to the thoracolumbar spine.<sup>10</sup> The compressive forces acting on the thoracic spine are more as compared to cervical spine because of greater body weight & natural kyphosis in this region. The line of gravity falls anterior to thoracic spine. This produces a flexion movement at this level which is counteracted by posterior ligaments and extensor muscles of spine with resultant wedge shaped deformity of vertebral body radio logically. Lumbar spine provides support in dynamic as well as static situations of upper body. It has been observed that compressive forces acting in this region are mainly from back muscles tension. Moreover the shear forces causes the spine to undergo translation. The electromyographic studies also suggest that shear forces up

to 250N are exerted by back muscles activity while abdominal muscles co contraction increase it up to 70%.<sup>11</sup> Spinal movements like bending causes compression as well as tension of the spine. In forward flexion, the anterior structures are compressed while the posterior structures are failed in tension. The general resistance to extension is provided by the anterior outer fibers of annulus fibrosus, the zygapophyseal joint capsule and passive tension in the spinous process. Torsion forces are created during the axial rotation, the torsion stiffness in flexion and lateral bending of upper thoracic spine.<sup>12</sup>

The ideal surgical treatment of thoracolumbar spine burst fractures is still controversial. According to McAfee if there is loss of vertebral height up to 50%, progressive neurological deficit, neural canal compromise and kyphosis of more than 20degree, are indications for surgery. The short segment pedicle screw is still considered the ideal treatment of these fractures as it preserve the motion segment resulting in minimal blood loss.<sup>13</sup> However loss of anterior column support with resultant failure to correct kyphotic deformity and hardware failure are disadvantages of this fixation technique. Several different strategies have been devised to solve this problem including conservative management to surgical treatment in the form of transforaminal inter body fusion, arthrodesis and long segment fixation where inter body fusion is not required. In patients with single level thoracolumbar fractures, excessive compression of vertebra is linked to the loss of correction with kyphotic deformity.<sup>14</sup> The implant failure rate in short segment fixation ranges from 20-50% while loss of reduction ranges from 50-90%. In the present study, we performed the short segment fixation with or without bone graft substitutes for single level thoracolumbar burst fracture. In this technique we have also added an additional Trans pedicle screw in fractured vertebra. This study looks at prospectively collected data for 2 years. These treatment options will definitely result to improve the maximum recovery of neurological and functional deficit<sup>15</sup>. Moreover the addition of transpedicular intracorporeal bone grafting would further improve the fracture stability in terms

of reduction, loss of vertebral height and Kyphotic angle.<sup>16</sup> Thus this study was planned to compare the outcomes after short segment fixation with or without Transpedicular bone grafting substitutes in patients with single level Thoracolumbar spine Burst fracture.

## METHODS

After permission from Ethical Review Board of General Hospital Lahore, a total number of 64 patients having single level unstable Burst fractures with loss of anterior body height of more than 50% (Type A fractures According to AO Classification) of thoracolumbar spine as a result of trauma were included in the study after an informed consent through non-probability purposive sampling. Patients who were 20-60 years old with intact distal neurology were included while Patients with Polytrauma, Head and Multilevel Spinal Injury and open fractures were excluded from the study. They were divided into two equal groups A & B, each having 32 patients, randomly by Lottery method. After detailed clinical assessment, each patient underwent plain radiographs of thoracic & lumbar spine followed by CT scan & MRI of this region.

In group A, all patients were treated surgically with short segment posterior instrumentation and intra corporeal trans-pedicular bone grafting while in group B patients, we performed short segment posterior instrumentation only. In both groups, two intermediate pedicle screws were also inserted in the injured vertebra without any effort to decompress the dural sac directly. Active and passive range of movements were started on next day after the surgery. All patients were mobilized one week after the surgery with advice to wear the total contact underarm brace for 12 weeks post-operatively. All patients were followed for one year with interval of 06 weeks for 03 months, at 06 months and after one year. At each follow up, we measured the kyphotic angle, any loss of vertebral height and VAS Score. All data was analyzed by using SPSS version 23. For quantitative variables i.e; age, height and kyphotic angle, were measured in terms of Mean+ S.D and we used the Shapiro Wilk test to measure the normality of quantitative variables. The qualitative data like gender

and fracture type, was measured in terms of frequency and percentages. Mann Whitney U test was used was used to assess statistical significance. A p value of < 0.05 was considered as significant.

## RESULTS

Total number of patients in our study were 64 with all patients having burst fractures at thoracolumbar region with intact neurology. In Group A, 32 patients were treated short segment posterior instrumentation with trans pedicular bone graft substitute while in group B remaining 32 patients were treated with short segment posterior instrumentation only. In terms of age, both groups showed a similar distribution, with Group A having a mean age of  $31.3 \pm 10.3$  years and Group B having a mean age of  $31.7 \pm 5.9$  years, with no significant difference between the two groups ( $p = 0.861$ ). The gender distribution was also comparable across both groups. In Group A, there were 17 males (53.12%) and 15 females (46.87%), while Group B had 16 males (50%) and 16 females (50%). The chi-square test revealed no significant difference in gender distribution between the two groups ( $p=0.911$ ), indicating a balanced representation of males and females in both groups. (Table 1)

**Table 1:** Patients Age and Gender Distribution

Variable	Group A (n=32)	Group B (n=32)	P-value
<b>Age (years)</b> Mean $\pm$ SD	31.3 $\pm$ 10.3	31.7 $\pm$ 5.9	0.861
<b>Gender</b>			
Male	17 (53.12%)	16 (50%)	0.911
Female	15 (46.87%)	16 (50%)	

For the kyphotic angle, both groups showed similar values across the preoperative and postoperative time points. There was no significant difference between the groups in the preoperative, immediate post-operative, or 3-month postoperative periods (p-values of 0.867, 0.806, and 0.27, respectively). However, at 6 months and 1 year, Group A exhibited a more significant improvement compared to Group A, with p-values of 0.00 at both the 6-month and 1-year follow-ups.

In terms of vertebral height, Group A showed significant improvements i-e at 3 months, Group A

had a significantly higher vertebral height compared to Group B ( $p$ -value = 0.003) as well as at 6 months and 1 year, Group A continued to show superior results in vertebral height, with  $p$ -values of 0.007 and 0.02, respectively.

Regarding VAS scores, both groups started with high pain levels before surgery, with no significant difference between them ( $p$ -value=0.78). Postoperative pain levels decreased significantly for both groups, with Group A showing slightly better results in pain relief, especially at the 6-month and 1-year follow-ups ( $p$ -values of 0.01 and 0.01, respectively). However, no significant difference in pain scores was observed at the immediate postoperative or 3-month postoperative time points ( $p$ -values of 0.65 and 0.73, respectively).

Overall, the results suggested that both groups showed improvements in kyphotic angle, vertebral height, and VAS scores following surgery, with some significant differences emerging at specific postoperative intervals, particularly in kyphotic angle and vertebral height between the groups as given in Table 2.

**Table 2:** Outcome comparison among group A & Group B

Variables	Group A (Mean $\pm$ SD)	Group B (Mean $\pm$ SD)	P-value*
<b>Kyphotic Angle (°):</b>			
Pre-op	25.8 $\pm$ 5.2	26.1 $\pm$ 5.0	0.867
Post-op Immediate	8.2 $\pm$ 2.5	8.5 $\pm$ 2.7	0.806
Post-op 3 months	12.5 $\pm$ 3.0	13.0 $\pm$ 3.2	0.27
Post-op 6 months	15.0 $\pm$ 3.5	16.0 $\pm$ 3.8	0.04
After 1 year	18.5 $\pm$ 4.0	19.5 $\pm$ 4.2	0.03
<b>Vertebral Height (mm):</b>			
Pre-op	21.5 $\pm$ 3.0	21.2 $\pm$ 2.8	0.871
Post-op 3 months	25.8 $\pm$ 2.5	24.9 $\pm$ 2.7	0.003
Post-op 6 months	24.8 $\pm$ 2.6	23.2 $\pm$ 3.0	0.007
After 1 year	23.1 $\pm$ 2.8	21.3 $\pm$ 3.3	0.02
<b>VAS Score (0–10):</b>			
Pre-op	8.5 $\pm$ 1.2	8.4 $\pm$ 1.1	0.78
Post-op Immediate	3.5 $\pm$ 1.0	3.7 $\pm$ 1.2	0.65
Post-op 3 months	2.8 $\pm$ 0.9	2.9 $\pm$ 0.8	0.73
Post-op 6 months	2.3 $\pm$ 0.8	2.4 $\pm$ 0.9	0.01
After 1 year	2.0 $\pm$ 0.8	2.05 $\pm$ 0.7	0.01

\*As data was not normally distributed Mann Whitney U test was used to assess statistical significance.



**Figure-1** Radiographic presentation of Burst Fractures



**Figure-2:** Radiographic presentation of Burst Fractures

## DISCUSSION

Treatment of Burst fractures of lumbar & sacral spine involve conservative as well as surgical intervention. It accounts for 17% of all spine fractures<sup>1</sup>. Males are more common sufferer than females. Most common mode of injury is Road traffic accident followed by fall from height and sports injuries.<sup>2</sup> High energy trauma accounts for 7% of mortality as a result of paraplegia<sup>3</sup>. Cases account for neurological deficit are linked with this type of burst fractures in 50-60% of the sufferers<sup>4</sup>. Most thoracolumbar spine fractures affect one or more thoracic vertebra with one or more lumbar vertebral involvement as depicted by different literature reviews.<sup>5</sup>



The junction between thoracic & lumbar spine form a transition zone at this region that causes the stress forces to concentrate at this level & thus predisposes to injury.<sup>6</sup> In the present study 64 patients, divided into 2 equal group. In both groups short segment posterior pedicle screw fixation was performed with addition of trans- pedicular bone graft substitute in group A. In our study the preoperative & postoperative kyphotic angle, vertebral height & VAS were assessed. The vertebral height and kyphotic angle were better maintained in patients where short segment fixation with transpedicular bone graft was performed. A lot of studies are consistent with the present study.

In his study Fischer et al in 2016, the preoperative radiograph parameters including local kyphosis and anterior body height were similar for both groups ( $74.9\% \pm 12$  vs  $82.2\% \pm 9.5\%$  p 0.058). According to data, the height loss in group A was highest ( $10.8\% \pm 7.0$  vs  $4.6\% \pm 4.8\%$  vs  $7.2 \pm 8.5$  p 0.0002). With transpedicular bone graft, group B has greatest ability to resist angle loss ( $4.7 \pm 2.7$  vs  $2.7 \pm 2.1$  p 0.090).<sup>12</sup>

In a study conducted by Alanay et al. , they came to the conclusions that there was no difference in both the groups regarding the kyphotic deformity and loss of vertebral height.<sup>13</sup>

In 2023 Luo Z carried out his study regarding the short segment fixation and transpedicular bone grafting on 161 patients with single level thoracolumbar spine fracture. They came to the conclusion that loss of anterior vertebral height ratio and anterior vertebral height compression ratio of fracture vertebra was less where the transpedicular bone graft was added.<sup>14</sup>

According to S. Harpreet et al., the anterior and middle column of Thoraco lumbar injured vertebra can be supported with bone graft through pedicle of the fractured vertebra without fusion of the vertebra. They deduced that Pedicle screw fixation with transpedicular bone grafting increases the stability, restore the vertebral height, maintain the vertebral angle and improve the quality of life.<sup>15</sup>

Li et al., in 2016 performed transpedicular bone grafting with short segment fixation in 50 patients having single level thoracolumbar fracture. They came to the conclusion that Transpedicular bone grafting in

patients with thoracolumbar fracture restore the vertebral height and prevent the loss of kyphotic angle.<sup>16</sup>

## CONCLUSIONS

Posterior short segment fixation with bone graft is a satisfactory procedure for fixation of Thoracolumbar spine fractures. With only short segment fixation, satisfactory reduction cannot be achieved in the presence of ligaments and annulus fibrosus. Stresses are concentrated at the fractured vertebra increasing the chances of implant failure and loss of kyphotic angle. To prevent this complication, the fractured vertebra was included in the fixation to maintain the motion segment. Filling bone graft in the anterior and middle column results in better support and maintain the inter-vertebral pressure. Moreover, it also prevent the loss of Kyphotic angle.

Number of patients in our study were small, it requires a study with large number of patients with longer duration to establish the exact role of Transpedicular bone graft with short segment fixation in Thoracolumbar fractures of Spine to of vertebral height and kyphotic angle.

**Ethical Approval:** Ethical approval for this study was obtained from Ethical Review Board of General Hospital, Lahore. No. 35/112

**Conflict of Interest:** None

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## Author's Contribution

Conceptualization study design	MAM, OFT
Data Acquisition	MAM, OFT, WA, AA, MT, NAS
Data Analysis/ interpretation	MAM, OFT, WA, AA
Manuscript drafting	MAM, OFT, WA, AA, MT, NAS
Manuscript review	MAM, OFT, AA

All authors read and approved the final draft.

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