Outcome of Short Same-segment Fixation in Thoracolumbar Junction Fractures

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ABSTRACT

Background: Short same-segment posterior fixation (SSPF) minimizes the number of vertebral levels involved in fixation of a spine fracture. Short same-segment posterior fixation with pedicle fixation at the level of the fracture suggests biomechanical advantages toward maintenance of kyphosis correction, reducing failure rates with the aim of improving spinal motion and early rehabilitation.1,4

Materials and methods: All patients with thoracolumbar junction fractures included in our study were evaluated between 2014 and 2016 with biomechanical criteria and clinical outcome. The immediate postoperative radiographs were compared with radiographs of each follow-up, evaluating any loss of correction by measuring kyphotic angle using Cobb’s method, also at each follow-up, clinical outcome was measured using Oswestry disability index. The intraobserver and interobserver reliability were analyzed.

Results: There were 35 patients with unstable thoracolumbar fractures in our study who were operated using posterior spinal fixation system during 2014 to 2016 with pedicle screw insertion at the level of the fractured vertebrae. The average follow-up was 18 months. The average preoperative kyphotic angle as measured by Cobb’s method in all the cases was 17.2°, which improved to 5.9°, achieving a mean of 65% correction immediately postoperatively. At final follow-up, average postoperative Cobb’s angle was 7.7°, maintaining 55% correction at final follow-up. Disability improved from 78% mean preoperatively to 47.27% mean postoperatively at final follow-up.

Conclusion: Short same-segment posterior fixation decreases implantation failure rate and has better biomechanical stability compared with traditional SSPF; however, long-term kyphosis correction to a greater extent was not maintained, which was also statistically insignificant. Despite this loss of kyphosis correction, clinical pain and disability improved at long-term follow-up.

Keywords: Kyphosis correction, Short-segment posterior fixation, Thoracolumbar burst fracture.

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INTRODUCTION

Thoracolumbar region is a common area for burst fractures and also for fracture dislocation because of it being a transition zone between fixed kyphotic spine and mobile lordotic lumbar spine.5 The short same-segment construct represents an attempt to rebuild the anterior column without the need for anterior graft or plate fixation and also avoiding extensive arthrodesis of the motion segments. This concept is based on the study done by Mahar et al (Korovessis6) in cadaveric models where they found that segmental screw fixation, i.e., pedicle screws, at the level of burst fracture could improve axial torsion force at short same-segment posterior fixation (SSPF; one level up and down). Adding to this concept we have additionally chosen screw insertion at the level of the fractured vertebrae as well as making the construct a short same-level posterior fixation, which gives additional biomechanical advantages to the construct and helps in improvement of axial torsion stability.7

MATERIALS AND METHODS

Our study is a retrospective review of 35 thoracolumbar burst fracture patients including patients having fracture dislocation type of injury who were treated with SSPF between August 2014 and March 2016. The primary outcome measure was biomechanical stability provided by the construct and the incidence of loss of kyphosis correction and the associated clinical improvement within the follow-up period. All patients were surgically treated with posterior pedicle screw instrumentation with insertion of pedicle screws above the fractured vertebrae, one level below it and also at the level of the fractured vertebral level, making it a short-same segment construct; additionally, posterior fusion was also done in patients having posterior ligamentous complex (PLC) injury using autograft from posterior superior iliac spine.8

OBSERVATION AND RESULTS

Thirty-five patients with unstable thoracolumbar fractures were operated by using posterior pedicle short same-segment fixation system during 2014 to 2016. Twenty of the operated patients were males and remaining 15 were females; 19 patients in the study were below 35 years of age. The most common mode of
Thoracolumbar fracture was fall from height (19 cases), road traffic accidents (9 cases), or weight falling on the back (7 cases). Eight patients had other associated injuries, with bilateral fracture of the calcaneum being the commonest (3 cases). Out of 35, 4 patients had a simple wedge compression fracture, type I (AO classification), 21 patients had burst fracture (Type II) (Figs 1 and 2), and 10 patients had fracture dislocation (Type III) type of fracture having PLC injury (Figs 3 and 4). All fracture dislocation fractures were flexion rotation type. Majority of patients (17 cases) sustained a fracture at L1, D12 – 12 patients, D11 – 4 patients, L2 – 3 patients. The average preoperative kyphotic angle as measured by Cobb’s method in all the cases was 17.2°, which improved to 5.9° (Fig. 5) following instrumentation immediately postoperatively (Table 1). At final follow-up, there was a slight gain of kyphotic angle and loss of vertebral height, suggestive of insignificant increase of deformity compared with immediate postoperative period (Fig. 6), with average postoperative Cobb’s angle at the end of 1 year to be 7.7° (Table 1). Preoperatively, out of the 25 patients, 15 patients had useful paraplegia (Frankel grades IV and V), and 20 patients had useless paraplegia (Frankel grades III, II, and I). At the end of 1 year follow-up, 18 patients had...
useful paraplegia, while 17 had useless paraplegia. On final follow-up, we observed that six patients who were in Frankel’s grade I did not show any improvement while eight patients in grade V maintained their neurological status. Incomplete neurological deficit improved by at least one Frankel grade in 21 patients. None of the patients in our study had deterioration in neurological status.

At postoperative 1-month follow-up, average Oswestry disability score was severe at 51.53% (16–84%). At most recent follow-up, average Oswestry disability score was minimal at 4.5% (0–16%). Five patients were lost to long-term follow-up. Mean difference from 1-month postoperative follow-up to most recent follow-up (excluding failures) was 46.27%.

Complications noted in the series were implant failure (one case), bed sores (three patients), urinary tract infection (four cases), and superficial wound infection (one patient).

**DISCUSSION**

Short-same segment posterior instrumentation as stand-alone treatment offers a safe and effective modality in the management of thoracolumbar junction injuries.\(^5,6,8,9,10\) It provides the benefit of decreased involvement of motion segments than fixation with longer instrumentation. The inclusion of the fracture level has led to a stronger 3-point posterior support or fixation. Instrumentation at the fractured pedicle in turn converts the distractive forces of flexion into compression and thus stabilizes the construct.\(^3,9,12-14\) Also by including the fractured vertebrae, we thereby increase the working length of the construct, which gives more biomechanical stability.

Theoretically, ligamentotaxis allows posterior instrumentation to provide distractive forces, leading to fracture reduction and canal decompression. The annulus fibrosus attaching to the endplate is thought to play a critical role during the reduction of fragments near the endplate.\(^2,4,7,3\) Based on fracture reduction theory or ligamentotaxis, in this study, short same-segment pedicle screw instrumentation was designed and applied in clinical practice. In the beginning of the study, there were concerns that the insertion of pedicle screws into the fractured body might negatively affect canal restoration, because the increased pressure in the vertebra during screw insertion could push the fracture fragments backward.\(^6,8\) However, after posterior reduction of the fracture, the intervertebral pressure has already been reduced to some degree, which, to a large extent, could allow the increased pressure caused by screw insertion. Insertion of pedicle screws at the level of the fracture resulted in a segmental construct that can improve the biomechanical stability by protection of the fractured vertebral body and supporting the anterior column indirectly.\(^5,6,8\)

In addition, in a cadaveric biomechanical study, Mahar et al (Korovessis\(^6\)) showed that insertion of the screws at the fracture level improved biomechanical stability by providing additional fixation points, which may aid in fracture reduction and kyphosis correction. They also concluded that segmental fixation with additional screws at the level of the fracture increases construct stiffness and shields the fractured vertebral body from anterior loads. Comparing our study with a study done on long segment fixation by Tezeren and Kuru,\(^15\) the loss of kyphosis at the end of 3-year follow-up is similar to our study.

In this study, immediate kyphosis correction was successfully attained through short same-segment fixation, with a mean postoperative angulation of 0.64° of lordosis compared with 16.49° of kyphosis preoperatively as measured by the traditional Cobb’s method. At mean 21.64-month follow-up, however, patients had suffered loss of kyphosis correction (8.78°), with one patient requiring reoperation due to hardware failure or pseudarthrosis. Excluding failure cases, 7.21° of kyphosis correction remained at most recent follow-up compared with preoperative kyphosis.
Despite statistically insignificant loss of kyphotic correction, the patients in this study showed clinical improvement in pain and disability with early rehabilitation. After an initial Oswestry disability index score of 51.53% at 1-month follow-up, patients experienced a mean absolute decrease of 47.27% in disability (p < 0.0001), with a most recent follow-up average score of 4.50%. Importantly, the absolute loss of kyphosis correction was relatively small (statistically nonsignificant), which may account for the improved clinical and functional status of patients despite slight loss of kyphosis correction. Furthermore, implant failure rate (8%) was lower than with short same-segment fixation compared with previous studies of traditional SSPF. In addition, insertion of the screws at the fracture level improved biomechanical stability by providing additional fixation points that may aid in fracture reduction and kyphosis correction, segmental fixation with additional screws at the level of the fracture increases construct stiffness and shields the fractured vertebral body from anterior loads.

CONCLUSION

In conclusion, this study indicated that SSPF decreases implantation failure rate and reoperation rate and offers greater biomechanical advantages. The purpose of treating vertebral fractures is to achieve early neurological restoration, overcome damage to spinal segments anatomically, and accomplish firm and stable fixation. Our study demonstrates that stabilization of spine using posterior short same-segment transpedicular fixation is safe, technically easy, and effective. The anatomical restoration is good. It allows early mobilization and better nursing care and shortens the hospital stay. The compression of spinal cord provides optimal environment for neurological recovery. However, long-term kyphosis correction was not maintained, which was also statistically not significant and biomechanically better maintained than long segment fixation when compared with a study conducted by Tezeren and Kuru in December 2005 and hence, proves to be a more biomechanically stable fixation. Despite this insignificant loss of kyphosis correction, clinical pain and disability improved at long-term follow-up.

REFERENCES