

Short term radiological outcome of inserting screw at fracture level in posterior short segment fixation in thoracolumbar burst fractures

Pradhan RL¹, Pandey BK², Khanal KR³

¹Rabindra Lal Pradhan, Associate Professor; ²Bimal Kumar Pandey, Assistant Professor; ³Krishna Raj Khanal, Resident; Department of Orthopaedics, Kathmandu Medical College Teaching Hospital, Kathmandu, Nepal

Abstract

Background: Unstable thoracolumbar burst fractures are treated surgically by short segment fixation but may be associated with high implant failure. Supplementation of anterior column by insertion of screw at fracture site makes it more biomechanically stable.

Objectives: The purpose of this prospective study was to evaluate radiological parameters in thoracolumbar fractures treated with intermediate screw fixation with a minimum follow up of two years.

Methods: This prospective study was conducted from 2011 till 2012 where unstable thoracolumbar fractures treated with short segment posterior instrumentation with screw at fracture site were evaluated. All patients (average age 34.64 were followed up for at least 24 months and were classified according to Thoracolumbar Injury Classification and Severity Score and load sharing classification. Out of total 32 patients, four lost to follow up. Radiological parameters like vertebral body height and segmental kyphosis were evaluated and pain was evaluated by Visual Analogue Scale score.

Results: Preoperative pain showed mean Visual Analogue Scale score of 8.29 that improved to 0.97 at final follow up. Average preoperative loss of vertebral body height was 48.19%, which improved to 11.4% after surgery ($p < 0.001$). Final vertebral body collapse was 12.98% with mean percentage loss of vertebral height at 1.57%. Average segmental kyphotic angle was 22.54 before surgery, which corrected to 5.89 immediately after surgery ($p < 0.001$). Final segmental kyphosis was 8.46. Loss of kyphosis correction was 2.57. Two patients had implant failure, but was solidly united during implant removal in both cases.

Conclusion: Excellent maintenance of reduction in thoracolumbar burst fractures with short segment fixation with intermediate screws at fracture site with limited decompression resulted in improved neurologic function and satisfactory clinical outcomes, with a low incidence of implant failure and progressive deformity.

Key words: Intermediate screw, Radiological outcome, Thoracolumbar burst fracture

INTRODUCTION

Thoracolumbar burst fracture is one of the most common injuries of the spine and there is always some controversy regarding the indications and type of operative treatment even in the posterior approach^{1,2}. The anterior approach and instrumentation have had success in the past, but there are report of it being time consuming and demanding as well as having potential risks of major vascular damage^{3,4}. With pedicle screw instrumentation, the posterior approach alone can avert the need for reconstruction from anterior as it includes all three columns. Most authors believe that

short segment posterior instrumentation and fusion is the best available option as it has reduced complication, reduce the blood loss, preserving segmental motion with an acceptable anatomic and functional outcome⁵. Furthermore, studies have shown that posterior instrumentation is as effective as anterior surgery alone or combination of anterior and posterior surgery with posterior alone surgery alone being less time consuming and with less blood loss⁶. However, there are also reports of high percentages of instrumentation failure^{7,8}. To avoid the failure some authors' advice to treat these patients with long segment fixations i.e. two segment above and two segments below the fracture site but one has to compromise on motion segments.

Recently the restoration of anterior column has gained importance in fixation of thoracolumbar fractures and

Address for correspondence

Dr. Rabindra Lal Pradhan
Associate Professor, Department of Orthopaedics
Kathmandu Medical College
E-mail: rabi.ortho@gmail.com

have reported good outcome with balloon-assisted vertebroplasty, however this system is rather expensive⁹. Among the various methods of treatment available is insertion of screw at the fracture site which is supposed to dissipate the load uniformly hence leading to less implant failure. Biomechanical studies have shown that the addition of intermediate screws at the level of a burst fracture significantly increases the stiffness of a short segment pedicular fixation¹⁰. It has been reported that inclusion of the fracture level into the construct offered a better kyphosis correction, in addition to fewer instrument failures, without additional complications, and with a comparable if not better clinical and functional outcome¹¹. Some have even gone further in treating fractures with load sharing score (LSC) of >7 with posterior instrumentation with screw augmentation at the fracture site and have claimed good to excellent results¹².

Correction of sagittal deformity is important for the maintenance of fracture reduction and may have an effect on satisfactory functional outcome and studies have shown that maintaining the anterior body height leads to a better functional outcome¹³. The purpose of this prospective study was to evaluate the radiological parameters (changes in kyphotic deformity and vertebral body height) in thoracolumbar fractures treated with intermediate screw fixation, regardless of the (LSC)¹⁴ with a minimum follow up of two years.

METHODS

This was a prospective study conducted at Kathmandu Medical Teaching Hospital from August 2011 till December 2012 where all thoracolumbar fractures treated surgically with short segment posterior instrumentation with screw at fracture site were evaluated. The inclusion criteria were a single fresh unstable burst fracture with or without posterior ligamentous complex injuries and unstable burst fractures with neurologic deficits, vertebral body collapse exceeding 50 % and/or segmental kyphosis exceeding 20°. The following were the exclusion criteria: burst fractures treated non-operatively, burst fractures surgically treated with short segment fixation without screw at the fracture site and long segment fixation and patients with poly trauma but fixed with intermediate screws. Osteoporotic fractures and multilevel spinal fractures were also excluded.

All patients were evaluated with plain X-rays, computed tomography (CT) and/or magnetic resonance imaging (MRI) and complete neurologic examination was done

by one of the two authors at the time of admission. All patients were treated with short segment posterior instrumentation with screw at the fracture site and were followed up for at least 24 months. All patients were classified according to the thoracolumbar injury classification and severity score (TLICS)¹⁵ and load sharing classification.

SURGICAL TECHNIQUE

Patients were positioned prone on a lumbar frame with pillows to reduce the intra-abdominal pressure and to create a positional reduction on the fracture site. A midline posterior longitudinal incision was used to expose one level above and below the fractured vertebra. Proper dissection was done so as to minimally damage the soft tissue around the facet joints while inserting the pedicle screw. Rods were then pre-contoured before insertion according to the normal sagittal alignment of the injured level. A cantilever correction was performed by bringing the rod to the screw and slight distraction was done so as to gain the anterior body. In patients with a partial neurologic deficit a limited decompression was performed via a laminectomy as determined by preoperative CT/MRI with removal of the spinous process to visualize the dural sac. Direct decompression was then performed by tapping the retropulsed bone fragments into the vertebral body through a posterior approach. Cross-links were used in those patients requiring a laminectomy and fusion. We did not routinely perform posterior fusion for patients with intact posterior column, however, if the posterior element injuries including facet joint or posterior ligamentous complex injuries were found to be injured a posterior fusion was added.

POSTOPERATIVE PROTOCOL AND FOLLOW-UP

Postoperative protocol for all patients includes mobilization once the pain subsided, usually on the third post operative day. An external orthosis (Taylor brace) was used for approximately three months postoperatively in all patients. Radiographs were obtained immediately after operation and at follow-up intervals of three, six and twelve and final follow up at 24 months. Back pain was determined on the basis of Visual Analog Scale (VAS)¹⁶. Implants were not routinely removed as some of the patient refused second operation as they had no problem doing their activities of daily living. Eight patients who had no posterior ligamentous injury opted for implant removal and were removed after 12-16 months of surgery.

RADIOLOGICAL PARAMETERS

Loss of vertebral body height was defined as the percentage of fractured vertebral body compression with respect to the next adjacent intact vertebrae, above and below the fractured vertebrae¹⁷. Segmental kyphosis was determined by measuring the Cobb angle. These parameters were taken at the time of admission, immediate post operation and final follow up. We evaluated the loss of fixation at the fracture site based on the criteria of poor outcome widely accepted for radiological outcome evaluations which include a correction loss of more than 10° of the local kyphotic angle value at the final observation compared with immediate post operative findings, pedicle screws or rods breakage or pulled-out screw.

STATISTICAL ANALYSIS

Data were analyzed using the program SPSS version 20. Paired samples t-test used to compare the correction in kyphotic angle and the loss of vertebral body height in immediate post operative period and at the final follow up and a p-value of less than 0.05 was considered statistically significant.

RESULTS

There were a total of 28 thoracolumbar burst fracture (T11 to L2) patients (21 males and 7 females) with an average age of 34.64 years (range 17–57 years). There were 16 patients with L1 fracture, eight with D12 and four with fracture at L2 vertebra.

Table 1 shows the detailed clinical characteristics of all patients. The most affected vertebral body is L1. The average point of TLICS and LSC were 3.5 and 6.5 points, respectively. Ten patients had normal neurology (American Spinal Injury Association (ASIA) E), 10 had incomplete deficits (ASIA B, C, D), and seven had complete deficit (ASIA A). Fall from height was the most common injury mechanism (n=25) and rest of the injuries occurred in a road traffic accident. In this series, the average injury–surgery interval was three days (range 1–5 days), and the mean operation time was 96.6 min (range 80–140 min).

ASSESSMENT OF RADIOGRAPHIC PARAMETERS

The average preoperative loss of vertebral body height was 48.19 %, which improved to 11.4% after surgery (p<.001). The final vertebral body collapse was 12.98 % with mean percentage loss of vertebral height at 1.57. The average segmental kyphotic angle was 22.54 before surgery, which was corrected to 5.89 immediately after surgery (p<0.001). The final segmental kyphosis was 8.46. Loss of kyphosis correction was 2.57.

All patients exhibited excellent improvement of pain and function after surgery. The preoperative pain level showed a mean VAS score of 8.29 improved to 2.86 postoperatively, and to 0.79 at the final follow-up (p<0.001). No patient had persistent postoperative back pain. All eleven patients with incomplete neurologic deficits had improvement by at least one ASIA grade

Table 1: Demographics and pre and post operative measurements

Parameters	Mean	Standard deviation	Minimum	Maximum
Age	34.64	0.475	17	57
Injury to surgery days	3.00	1.217	1	5
Duration of surgery (minutes)	116.96	13.218	90	140
Follow up (months)	33.11	5.452	24	44
LOB pre operative (percent)	48.19	12.839	14.2	75
LOB post operative (percent)	11.403	6.20	2	22.8
LOB at last follow up (percent)	12.98	6.54	2.04	26.31
Pre-operative segmental kyphosis	22.54	4.772	15	31
Post-operative segmental kyphosis	5.89	3.37	0	12
Segmental kyphosis at final follow up	8.46	3.574	2	15
VAS score pre-operative	8.29	0.854	7	10
VAS score post-operative	2.86	0.756	2	4
VAS score at final follow up	0.79	0.686	0	2
TLICS	5.54	1.478	3	8
LSC	5.82	1.124	4	8

*TLICS – Thoraco-lumbar injury classification system

LSC – Load sharing classification

neurologic improvement on final follow-up observation, with seven (70 %) patients demonstrating complete neurologic recovery. All neurologically intact patients remained unchanged. No neurological deterioration was observed in this study. All patients exhibited excellent improvement of pain and function after surgery.

COMPLICATIONS

There were two cases of postoperative infection which was controlled with intravenous antibiotics and surgical toileting. There were two cases of implant failure, including breakage of rods and loosening of cap of pedicle screw but both patients had solid union observed during implant removal.



Figure 1: Preoperative CT axial image of the burst fracture

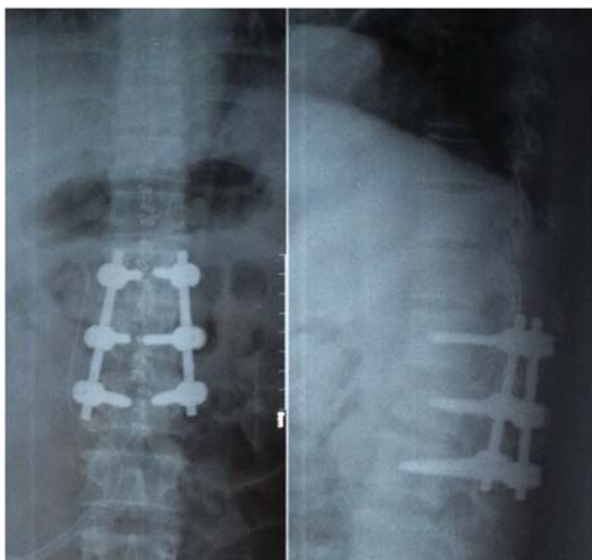


Figure 2: Post operative X-ray showing fixation implants in situ



Figure 3: Two years follow up after fixation of burst fracture showing maintenance of reduction

DISCUSSION

Our results show that short segment posterior fixation with intermediate screw at the fracture vertebra have good to excellent results in majority of the patients with few complications. Initial fixation methods involved long fusion constructs bridging two to three levels above and two levels below the fractured vertebra. Long segment fixations are more stable but increased number of spinal levels has to be fused leading to long term back pain. Hence, to preserve motion segments, shorter fusion constructs that consisted of transpedicular screws one level above and one level below the fractured vertebra have been advocated¹⁸. However, it has been reported that short segment posterior alone fixation leads to poor outcome both radiologically and functionally with many instrument failures¹⁹. It was reported earlier that short segment fixation led to implant failure in 45% of patients within six months of operation^{8, 20}. Load sharing classification was developed when the authors noted that 36% of short segment fixation had implant failure when the score was more than six. Therefore, to augment short-segment fixation, anterior column reconstruction with adequate fixation points can be an alternate treatment method.

The concept of an intermediate screw to increase the stiffness of a short-segment construct was first introduced by Dick et al²¹. It has been shown in biomechanical studies that addition of intermediate screws at the level of a burst fracture significantly increases the stiffness of a short segment pedicular fixation¹⁰. The use of intermediate screws provides the advantage of a stiffer construct and therefore a lower probability for

loss of reduction. Other possible advantages for its use are the effect of three point fixation of the fractured segment and a better pulled-out strength as two more fixation points are provided. In addition, we used the intermediate screws combination of the precontoured rod that provides a three point bending force to restore vertebral body height, support the collapsed vertebrae and correct segmental kyphosis.

Farrokhi et al conclude that, inclusion of the fracture level into the construct has offered a better kyphosis correction, in addition to fewer instrument failures, without additional complications, and with a comparable if not better clinical and functional outcome and recommended insertion of screws into pedicles of the fractured thoracolumbar vertebra when considering a short segment posterior fixation, especially in Magerl type C fractures¹¹.

We agree with Guven et al²² that fracture level screw fixation technique could achieve and maintain correction, which was more prevalent in short-segment fixation. This technique provides the correction of deformity through vertebral endplate augmentation with its buttress effect (bending force). Previous studies have shown that the mean loss of kyphosis correction ranging from 3° to 12° was reported in the clinical results of short segment pedicle screw fixation. The mean correction loss in our series was 2.57^{7,8}.

In our series, we did not perform spinal fusion (posterior or posteriolateral) with no posterior ligamentous injury and thus can preserve spinal motion segments. Our indication for posterior fusion is posterior element injuries, such as facet joint or posterior ligamentous complex injuries.

It had been shown in various long term studies that fusion is not necessary to maintain the correction in kyphotic deformity in these fractures even in short segment fixation²³. Improvement in clinical outcomes was observed in all patients, and two cases of implant failure were found. This technique eliminates the need of the anterior approach in thoracolumbar burst fractures which is associated with increased morbidity and additional risk of injury to visceral and vascular structures related to anterior approach.

The load sharing classification has been proposed to predict the failure of posterior short-segment fixation.

Previous studies have concluded that an LSC six or less is likely to be good candidates, while an LSC seven or more requires the anterior approach to reconstruct the anterior column¹⁴. However, the significance of LSC has been questioned in thoracolumbar fractures as many studies have shown to have excellent results with posterior only fixation with intermediate screws at fracture site in patients with LSC score more than seven²³.

Gelb et al¹² reported that patients with a Load Sharing Classification point total of \geq seven had an 8.8 degree loss of correction compared with a 6.8 degree loss of correction in patients with a point total of \leq six. In their study none of their patients experienced instrumentation failure, and none required revisions because of significant progressive kyphotic deformity.

We also did not have any difficulty in inserting screws in the fractured vertebra and agree with Kose et al that the hold and pullout strength was good in all cases. We could insert screws at the fractured vertebra bilaterally except in two cases where there was gross fracture of the pedicles.

The loss of correction averaged 2.57 in our series and is similar to the reviewed literature, however it was not correlated clinically. Many reports have stated that there is no significant correlation was found between the final kyphosis and pain scale²⁴.

CONCLUSION

The present study has demonstrated that unstable thoracolumbar burst fractures, regardless of LSC point, in patients with or without neurologic deficits can be decompressed and stabilized with intermediate screws following posterior short-segment instrumentation through a single posterior approach. Improvement in clinical outcomes was observed in all patients, and only two cases of implant failure and no progressive deformity was found. With this procedure the anterior approach with its morbidity and risk of injury to visceral and vascular structures can be eliminated in treating unstable thoracolumbar spine fractures.

ACKNOWLEDGEMENT

We thank Dr. Umesh Aryal, PhD, for his help in the statistical analysis of this study.

REFERENCES

1. Wood K, Buttermann G, Mehbod A, Garvey T, Jhanjee R, Sechrist V. Operative compared with nonoperative treatment of a thoracolumbar burst fracture without neurological deficit: a prospective, randomized study. *J Bone Joint Surg. Am* 2003; 85:773-81.
2. Stadhoudier A, Oner FC, Wilson KW, et al. Surgeon equipoise as an inclusion criterion for the evaluation of nonoperative versus operative treatment of thoracolumbar spinal injuries. *Spine J* 2008; 8:975-81.
3. Hamdan AD, Malek JY, Schermerhorn ML, Aulivola B, Blattman SB, Pomposelli FB Jr. Vascular injury during anterior exposure of the spine. *J Vasc Surg.* 2008; 48:650-4.
4. Fantini GA, Pawar AY. Access related complications during anterior exposure of the lumbar spine. *World J Orthop* 2013;4:19-23
5. Mahar A, Kim C, Wedemeyer M, et al. Short-segment fixation of lumbar burst fractures using pedicle fixation at the level of the fracture. *Spine* 2007;32:1503-7
6. Danisa OA, Shaffrey CI, Jane JA, Whitehill R, Wang GJ, Szabo TA, et al. Surgical approaches for the correction of unstable thoracolumbar burst fractures: a retrospective analysis of treatment outcomes. *J Neurosurg* 1995; 83:977-83.
7. Kramer DL, Rodgers WB, Mansfield FL. Transpedicular instrumentation and short-segment fusion of thoracolumbar fractures: a prospective study using a single instrumentation system. *J Orthop Trauma* 1995; 9:499-506.
8. McLain RF, Sparling E, Benson DR. Early failure of short-segment pedicle instrumentation for thoracolumbar fractures: a preliminary report. *J Bone Joint Surg. Am* 1993; 75:162-7.
9. Marco RA, Kushwaha VP (2009) Thoracolumbar burst fractures treated with posterior decompression and pedicle screw instrumentation supplemented with balloon-assisted vertebroplasty and calcium phosphate reconstruction. *J Bone Joint Surg. Am* 91:20-28
10. Anekstein Y, Brosh T, Mirovsky Y. Intermediate screws in short segment pedicular fixation for thoracic and lumbar fractures: a biomechanical study. *J Spinal Disord Tech* 2007 Feb; 20(1):72-7.
11. Farrokhi MR, Razmkon A, Maghami Z, Nikoo Z. Inclusion of the fracture level in short segment fixation of thoracolumbar fractures. *Eur Spine J* 2010; 19:1651-6.
12. Gelb D, Ludwig S, Karp JE, Chung EH, Werner C, Kim T, Poelstra K Successful treatment of thoracolumbar fractures with short-segment pedicle instrumentation. *J Spinal Disord Tech.* 2010 ; 23(5):293-301.
13. Dai LY, Jiang LS, Jiang SD. Conservative treatment of thoracolumbar burst fractures: a long term follow-up results with special reference to the load sharing classification. *Spine* 2008; 33:2536-44.
14. McCormack T, Karaikovic E, Gaines RW. The load sharing classification of spine fractures. *Spine* 1994;19:1741-1744
15. Vaccaro AR, Lehman RA Jr, Hurlbert RJ, Anderson PA, Harris M, Hedlund R, Harrop J, Dvorak M, Wood K, Fehlings MG, Fisher C, Zeiller SC, Anderson DG, Bono CM, Stock GH, Brown AK, Kuklo T, Oner FC. A new classification of thoracolumbar injuries: the importance of injury morphology, the integrity of the posterior ligamentous complex, and neurologic status. *Spine* 2005; 30(20):2325-33.
16. Walsh TL, Hanscom B, Lurie JD et al. Is a conditionspecific instrument for patients with low back pain/leg symptoms really necessary? The responsiveness of the Oswestry Disability Index, MODEMS, and the SF-36. *Spine* 2003 28:607-615
17. Keynan O, Fisher CG, Vaccaro A et al. Radiographic measurement parameters in thoracolumbar fractures: a systematic review and consensus statement of the spine trauma study group. *Spine* 2006 31:E156-E165
18. Dick W, Kluger P, Magerl F, Woersdorfer O, Zach G. A new device for internal fixation of thoracolumbar and lumbar spine fractures: the 'fixateur interne'. *Paraplegia* 1985;23:225-32
19. Roy-Camille R, Roy-Camille M, Demeulenaere C. Osteosynthesis of dorsal, lumbar, and lumbosacral spine with metallic plates screwed into vertebral pedicles and articular apophyses. *Presse Med* 1970; 78:1447-8.
20. Butt MF, Farooq M, Mir B et al. Management of unstable thoracolumbar spinal injuries by posterior short segment spinal fixation. *Int Orthop* 2007 31:259-264
21. Dick JC, Jones MP, Zdeblick TA, Kunz DN, Horton WC. A biomechanical comparison evaluating the use of intermediate screws and cross linkage in lumbar pedicle fixation. *J Spinal Disord* 1994;7:402-7
22. Guven O, Kocaoglu B, Bezer M, Aydin N, Nalbantoglu U. The use of screw at the fracture level in the treatment of thoracolumbar burst fractures. *J Spinal Disord Tech* 2009; 22:417-21.
23. Kose KC, Inanmaz ME, Isik C, Basar H, Caliskan I, Bal E. Short segment pedicle screw instrumentation with an index level screw and cantilevered hyperlordotic reduction in the treatment of type-A fractures of the thoracolumbar spine. *Bone Joint J.* 2014; 96-B (4):541-7.
24. Wang XY, Dai LY, Xu HZ, Chi YL. Kyphosis recurrence after posterior short-segment fixation in thoracolumbar burst fractures. *J Neurosurg Spine* 2008 8:246-254.