

# Functional Analysis of Effectiveness of Short Segment with Index Vertebra Fixation as Compared with Long-segment Fixation in the Management of Thoracolumbar Spinal Injuries

N Thanappan<sup>1</sup>, T Saravanamuthu<sup>2</sup>, K Singaravel<sup>2</sup>, P Sivakaran<sup>3</sup>

<sup>1</sup>Professor, Department of Orthopaedics and Traumatology, Madurai Medical College, Madurai, Tamil Nadu, India, <sup>2</sup>Assistant Professor, Department of Orthopaedics and Traumatology, Madurai Medical College, Madurai, Tamil Nadu, India, <sup>3</sup>Postgraduate Student, Department of Orthopaedics and Traumatology, Madurai Medical College, Madurai, Tamil Nadu, India

## Abstract

**Background:** Dorsolumbar fractures are unstable mostly which requires surgical spinal stabilization to maintain anatomical reduction and stability and also to promote early bony fusion and mobilization. Posterior short-segment pedicle screw fixation is usually done for burst fractures. Even though early clinical results of this surgery are usually satisfactory, a high failure rate and progressive kyphosis remain a concern. To overcome this, in addition to short-segment fixation, the pedicle screw is inserted at the fracture site. Long-segment fixation is usually done for fracture dislocations.

**Materials and Methods:** A total of 25 patients with dorsolumbar spinal injuries admitted in Government Rajaji Hospital and Madurai Medical College were selected for the study and followed for a period of 24 months. Of these, four patients were lost follow-up, and hence, 21 cases were included in the study and followed for a period of 2 years.

**Results:** A total of 25 patients were selected for the study. Our results showed good to excellent in long segment, 72.7% of the patients were good (eight cases), and in short segment, 70% of the cases were good (seven cases). In long segment, 27.7% of the patients were fair (three cases), and in short segment, 30% of the cases were fair (three cases). In our study, the mean of Oswestry Disability Index in long segment is 32.31 and mean in short segment is 31.99. In our study, only one patient had rod breakage, but the patient had no pain and no neurological deficit, and functional outcome is good.

**Conclusion:** We conclude that short-segment fixation with index vertebra fixation provides as good results as long-segment fixation with reduction in cost and time of surgery in the treatment of thoracolumbar spinal injuries.

**Key words:** Index vertebra, Short segment, Long segment, Spine injuries

## INTRODUCTION

Fractures in the thoracic and lumbar spine account for 90% of all spinal fractures. The dorsolumbar junction is unique due to its anatomy and biomechanical environment. Dorsolumbar spine fractures are the most common cause

of traumatic paraplegia.<sup>[1]</sup> They are most commonly seen in younger patients. It involves most commonly in the region between T11 and L1. Injuries are mostly due to fall from height, motor vehicle accidents, and injuries related to occupation and recreational activities. The treatment usually is either conservative or surgery. Surgery involves either posterior reduction and instrumentation or anterior decompression and instrumentation or combined.<sup>[2,3]</sup> Most commonly done procedure is posterior instrumentation. Most important aim of the management is to mobilize the patient early and rehabilitation. Conservative treatment was used until 1970. Hippocrates was the first to treat the spinal fractures in the form of bed rest, postural reduction, mobilization, ambulatory bracing, and combination of

Access this article online	
 www.ijss-sn.com	Month of Submission : 01-2019
	Month of Peer Review : 02-2019
	Month of Acceptance : 02-2019
	Month of Publishing : 03-2019

**Corresponding Author:** Dr. T Saravanamuthu, Department of Orthopaedics and Traumatology, Madurai Medical College, Madurai, Tamil Nadu, India, E-mail: majorscaphoid@gmail.com

these.<sup>[4]</sup> The main goal was to mobilize the patient with or without brace early. Dorsolumbar burst fractures are unstable mostly which requires surgical spinal stabilization to maintain anatomical reduction and stability and also to promote early bony fusion and mobilization. Now, most of the dorsolumbar fractures are treated surgically to allow early mobilization and to avoid the complications of prolonged bed rest. For the past 20 years, spine surgery has seen a dramatic increase in the operative management. Posterior short-segment pedicle screw fixation is usually done for burst fractures. Even though early clinical results of this surgery are usually satisfactory, a high failure rate and progressive kyphosis remain a concern. To overcome this, in addition to short-segment fixation, pedicle screw is inserted at the fracture site. Long-segment fixation is usually reserved for fracture dislocation.<sup>[5,6]</sup>

### Aim

This study aims to compare the analysis of functional outcome in thoracolumbar fractures and dislocations fixed with long-segment spanning fixation and short segment with index vertebra fixation, this study was undertaken.

## MATERIALS AND METHODS

A total of 25 patients with dorsolumbar spinal injuries admitted in Government Rajaji Hospital and Madurai Medical College were selected for the study and followed for a period of 24 months. Of these, four patients were lost follow-up, and hence, 21 cases were included in the study and followed for a period of 2 years. The prospective study was done in patients with post-traumatic dorsolumbar fractures and dislocations in the Department of Orthopaedics, Madurai Medical College and Government Rajaji Hospital, Tamil Nadu. 25 patients were treated surgically between August 2015 and September 2017 and followed for a period of 12 months. Of these, four patients were lost follow-up, and hence, 21 cases were included in the study and followed for a period of 1 year.

The first assessment of a patient included the history of injury, the mode of injury, a thorough clinical and neurological examination, and status of the stability. Then, priorities included resuscitation of patient and treatment of life-threatening injuries before stabilization of the spinal injuries.

The skeletal system was examined to rule out associated injuries. The patient's spine was examined for any swelling, contusion, tenderness, hematoma, gibbus, or step off. Protection of the spinal column was given immediately. Anteroposterior and lateral plain X-rays, computed tomography computerised tomography (CT) scans, and magnetic resonance imaging (MRI) were taken to identify all injuries and to assess the severity and nature of the injury. Neural canal and pedicle were identified in CT scan. Soft

tissue injuries and cord changes were identified in MRI. The level and type of fractures were classified according to AO Magerl classification and thoracolumbar injury classification score (TLICS) was calculated. The indications for surgical intervention were TLICS score > 4. The patient and his/her relatives were explained in detail about the nature of injury, severity of injury, the possible outcomes of non-surgical/surgical management, and the importance of rehabilitation.

The patients under the effect of general anesthesia were positioned on the prone position and anteroposterior and lateral c-arm views were taken to determine the direction of the pedicles, end plates, and disc spaces. All patients underwent either short-segment posterior stabilization with index vertebra fixation or long-segment spanning fixation using Moss-Miami rods and pedicle screws.

### Surgical Technique

All patients were placed in prone position over radiolucent table. A standard posterior midline approach was used for exposure. For short segment with index vertebra fixation, pedicle screws were inserted into the vertebra one level above and below the fractured vertebra and pedicle screw inserted at the fracture site under fluoroscopic control at the intersection point of transverse process and facet joint. For long-segment spanning fixation, pedicle screws were inserted into the vertebra two levels above and two levels below the fractured vertebra under fluoroscopic control at the intersection point of transverse process and facet joint. End-on view is obtained under image intensifier to verify that the screw is within the pedicle. After connecting the rods and screws, distraction force was applied using distractor forceps to restore lordosis and anterior body height. Decompression was done in all cases with neurological deficit; wound closure was done in layers.

For functional assessment, modified Macnab's criteria and Oswestry Disability Index used in all patients preoperatively, immediate post-operative, 3<sup>rd</sup> month, 6<sup>th</sup> month, and 12 months follow-up.

## RESULTS

A total of 25 patients were selected for the study. In our study, almost 88% of the cases (22 patients) were male and only 3 patients (12%) were female. We evaluated all patients with modified Macnab's criteria. Our results showed good to excellent in long segment, 72.7% of the patients were good (eight cases), and in short segment, 70% of the cases were good (seven cases). In long segment, 27.7% of the patients were fair (three cases), and in short segment, 30% of the cases were fair (three cases). In our study, the mean

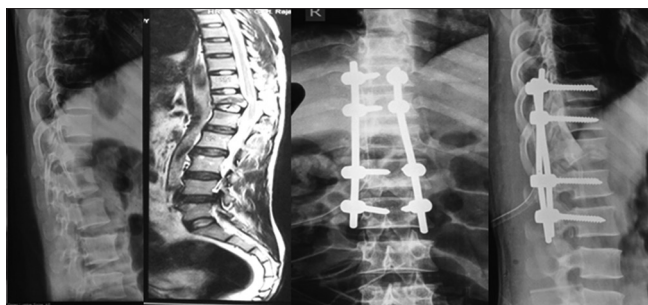


Figure 1: Postoperative xray



Figure 2: Clinical photo on follow up



Figure 3: Preoperative xray

of Oswestry Disability Index in long segment is 32.31 and mean in short segment is 31.99. In our study, calcaneal fractures were most commonly seen. In our series, patients underwent either posterior short-segment fixation with inclusion of fractured vertebra or long-segment spanning fixation with two levels above and below the fracture. Ligamentotaxis was done in all fractures and dislocations utilizing the partially intact posterior ligamentous complex. In our study, we have not encountered loss of kyphotic correction in any of the cases. Radiologically, mean



Figure 4: 6 months follow up xray



Figure 5: Clinical photo on follow up



Figure 6: Post operative xray

kyphotic angle in long-segment group preoperatively was 26.8° which was reduced to 5.84° postoperatively, and mean kyphotic angle in short-segment group preoperatively was 21.4° which was reduced to 4.75°. However, there was loss of kyphotic correction in long-segment group during follow-up. In our study, operative time and amount of blood loss are increased in long-segment fixation well comparable to the above study.





Figure 7: Clinical photo on follow up

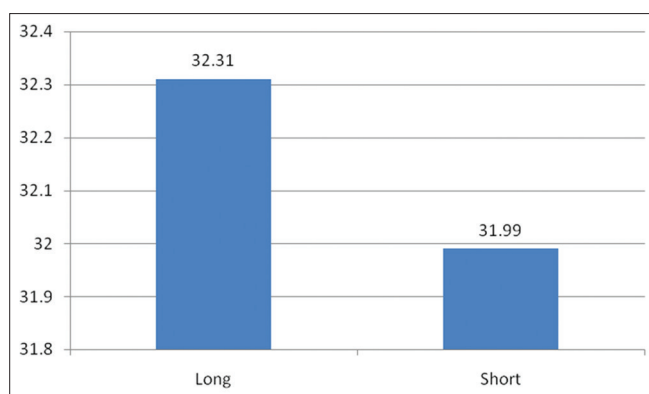


Figure 8: Oswestry disability index

## DISCUSSION

The dorsolumbar injuries of the spine are the most common in whole of spinal trauma. The anatomy of the dorsolumbar spine makes it highly vulnerable to high-energy trauma associated with motor vehicle accidents and falls. Main objectives of initial evaluation and diagnosis include injury characterization. The goal of treatment is to obtain pain-free stable spine and maximum restoration of function. Thoracolumbar junction is the most common site of the spinal injuries with 52% occurring between T11 and L1 (Burgos *et al.*, 1988; Kraus *et al.*, 1975).<sup>[7,8]</sup>

Spinal injuries are more common in younger individuals. They are most commonly caused by fall from height and motor vehicle accidents (Carpenter, 1991).<sup>[9]</sup> Spinal injuries was also common in sports activities in adolescents (Hubbard 1974).<sup>[10]</sup> Four-fold increased risk is seen in males than females in many of the studies. Depending on the type of spinal injury, associated spinal and non-spinal injuries occur in up to 50% of patients (Cotler *et al.*, 1986).<sup>[11]</sup> Transpedicular screws and rod system are currently the standard in fixation of thoracolumbar spine. Long-segment

spanning fixation with two levels above and below the fracture is a method which provides good stability, but motion between adjacent segments cannot be preserved. Posterior surgery with a short-segment stabilization allows early mobilization. Posterior surgery corrects deformity but post-operative vertebral collapse common, which leads to post-surgical kyphosis. To prevent this, inclusion of fractured vertebra in short-segment fixation is done.

Posterior transpedicular screw fixation initially was reported by Boucher, in 1959.<sup>[12]</sup> Since then, modern instrumentation systems have been developed. These systems control segmental motions in three dimensions, preserve motion segments, avoid long fusions, and provide a more stable construct. Short-segment posterior fixation is the most common and simple treatment, offering the advantage of incorporating fewer motion segments in the fusion. A review of literature showed that short-segment posterior fixation alone led up to 54% incidence of implant failure and rekyphosis in the long-term follow-up, and 50% of the patients with implant failure had moderate-to-severe pain. To prevent this, several techniques have been developed such as short segment with inclusion of fracture vertebra, long-segment spanning posterior fixation, and bone grafting. Altay *et al.*<sup>[13]</sup> reported that the use of four pairs of screws (two above and two below) to lengthen the lever arm of the construct would probably not only enhance the stability but also allow effective reduction of kyphotic deformity. Tezeren and Kuru,<sup>[14]</sup> in their study comparing short-segment versus long-segment fixation in thoracolumbar burst fractures, demonstrated that long-segment instrumentation is an effective way to manage thoracolumbar burst fractures. However, long-segment instrumentation prolonged the operative time and increased the amount of blood loss significantly. Carl *et al.*<sup>[15]</sup> also reported that segmental transpedicular fixation two levels above the kyphosis should be used at the thoracolumbar junction where compressive forces act more anteriorly. Therefore, they preferred to put the pedicle screw two levels above the fracture site to prevent progressive kyphosis as well as hardware failure. On the other hand, preferring one level fixation distal to fracture site was to preserve the motion segment as much as possible in the lumbar level.

Butt *et al.* reported success of short-segment pedicle screw fixation in thoracolumbar burst fractures; however, 40% hardware failure rate that they reported is worrisome. Gurr and McAfee (1988)<sup>[16]</sup> found that two levels above and below the injured level in an unstable calf spine model provided more stiffness than the intact spine. In the present study, long posterior fixation significantly improved stability compared to intact and injured conditions in all loading modes. Katonis *et al.* (1999)<sup>[17]</sup> found that one level above

and one level below the fracture in the lumbar area formed a rigid construct with no correction loss. In this study, we compared patients treated with posterior approach using short-segment pedicle screw with index vertebra fixation with those treated with long-segment spanning fixation to study the effectiveness of fixation in preventing post-operative development of kyphosis and hardware failure and also for evaluation of functional outcome. To the best of our knowledge, this is one of the study comparing short segment with index vertebra fixation and long-segment spanning fixation for the treatment of thoracolumbar fractures and dislocations. The most important purpose of the surgical management of thoracolumbar fractures is to minimize the change in the patients' lives. Pain relief and radiological correction are major outcome criteria for surgical treatment of thoracolumbar burst fractures from the patients' perspective. Modified Macnab's scale and Oswestry Disability Index were used to assess the improvement of back pain in posterior short-segment fixation and long-segment fixation treated patients during the follow-up periods which ranged from 6 months to 1 year. Long-term pain relief significantly improved in both treatment groups in all studies. Among the included studies, the results showed that there was no significant difference in pain reduction between the two groups. Our study suggests that there was no significant difference in kyphosis between short-segment fixation and long-segment fixation groups at last follow-up, no progression of kyphosis occurs in both groups. Implant breakage was found in one case with long-segment fixation, but patient is able to do his activities and his functional outcome was good. Superficial infection was observed in one case in long segment, but it settled well with i.v antibiotics and regular dressing. In long-segment fixation, the duration of surgery is prolonged and the amount of blood loss is also more when compared to short-segment fixation. No significant difference in functional outcome in short-segment group with index vertebra fixation when compared to long-segment spanning fixation.

## CONCLUSION

Advantages of surgical stabilization of the unstable dorsolumbar fractures in terms of restoration or preservation of neurological function, achievement of pain-free fracture site, early mobilization, and, thereby, fewer complications associated with prolonged bed

rest. Radiological loss of kyphosis was very less in short segment with index vertebra fixation when compared to long-segment spanning fixation; however, the study period is short to draw conclusion. In long-segment spanning fixation, even though the amount of blood loss is more, operating time is prolonged, and complications rate was high; there is no significant difference in functional outcome between short-segment pedicle screws with index vertebra fixation when compared to long-segment spanning fixation. However, considering the operating time, blood loss, and neurological recovery, short segment with index vertebra fixation is a better alternative to long-segment spanning fixation in treating thoracolumbar fractures and dislocations.

## REFERENCES

1. Bucholz RW, Heckman JD. Rockwood and Green's Fractures in Adults. 5<sup>th</sup> ed., Vol 2. Philadelphia, PA: Lippincott Williams and Wilkins; 2001. p. 1293-466.
2. Henderson RL, Reid DC, Saboe LA. Multiple noncontiguous spine fractures. *Spine* 1991;16:128-31.
3. Saboe LA, Reid DC, Davis LA, Warren SA, Grace MG. Spine trauma and associated injuries. *J Trauma* 1991;31:43-8.
4. Holdsworth F. Fractures, dislocations, and fracture-dislocations of the spine. *J Bone Joint Surg Am* 1970;52:1534-51.
5. Denis F. Spinal instability as defined by the three-column spine concept in acute spinal trauma. *Clin Orthop* 1984;189:65-76.
6. Denis F. The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. *Spine* 1983;8:817-31.
7. Burgos J, Rapariz JM, Gonzalez-Herranz P. Anterior endoscopic approach to the thoracolumbar spine. *Spine* 1988;23:2427-31.
8. Kraus JF, Franti CE, Riggins RS, Richards D, Borhani NO. Incidence of traumatic spinal cord lesions. *J Chronic Dis* 1975;28:471-92.
9. Carpenter MB. Core Text of Neuroanatomy. 4<sup>th</sup> ed. Baltimore, MD: Wilkins and Wilkins; 1991.
10. Hubbard D. Injuries of the spine in children and adolescents. *Clin Orthop* 1974;100:56-65.
11. Cotler JM, Vernace JV, Michalski JA. The use of Harrington rods in thoracolumbar fractures. *Orthop Clin North Am* 1986;17:87-103.
12. Boucher HH. A method of spinal fusion. *J Bone Joint Surg Br* 1959;41:248-59.
13. Altay M, Ozkurt B, Aktekin CN, Ozturk AM, Dogan O, Tabak AY. Treatment of unstable thoracolumbar junction burst fractures with short- or long-segment posterior fixation in magerl type a fractures. *Eur Spine J* 2007;16:1145-55.
14. Tezeren G, Kuru I. Posterior fixation of thoracolumbar burst fracture: Short-segment pedicle fixation versus long-segment instrumentation. *J Spinal Disord Tech* 2005;18:485-8.
15. Carl AL, Tromanhauser SG, Roger DJ. Pedicle screw instrumentation for thoracolumbar burst fractures and fracture-dislocations. A calf spine model. *Spine* 1992;17:317-24.
16. Gurr KR, McAfee PC. Cotrel-dubousset instrumentation in adults. A preliminary report. *Spine* 1988;13:510-20.
17. Katonis PG, Kontakis GM, Loupasis GA, Aligizakis AC, Christoforakis JJ, Velivassakis EG, *et al.* Treatment of unstable thoracolumbar and lumbar spine injuries using cotrel-dubousset instrumentation. *Spine* 1999;24:2352-7.

**How to cite this article:** Thanappan N, Saravanamuthu T, Singaravel, Sivakaran. Functional Analysis of Effectiveness of Short Segment with Index Vertebra Fixation as Compared with Long-segment Fixation in the Management of Thoracolumbar Spinal Injuries. *Int J Sci Stud* 2019;6(12):146-150.

**Source of Support:** Nil, **Conflict of Interest:** None declared.