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Original Research Article

Prospective Observational Assessment of the Outcome and Efficacy of Short-Segment Pedicle Screw Fixation in Patients with Unstable Thoracolumbar Spine Fractures

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Abstract

Aim: To evaluate the outcome and efficacy of short-segment pedicle screw fixation in patients with unstable thoracolumbar spine fractures.

Methodology: A prospective observational study of 40 patients of 15-65 years of age, was carried out in the Department of Orthopedics, Vardhman Institute of Medical Science, Pawapuri, Nalanda, Bihar, India. Detailed history, clinical examination, an x-ray of the thoracolumbar spine, CT scan, or MRI (if required) of the thoracolumbar spine was done pre-operatively and post-operatively in all cases. The neurological status and improvement of pain were documented at the time of admission, discharge, and every subsequent follow-up visit. Neurological status was assessed using the Frankel grading scale for spinal cord injury. Pain assessment was measured by Denis pain scale.

Results: Out of 40 patients, 21 (52.5%) were females and 19 (47.5%) were males with a mean age of 36.65 ± 16.74 years (range 20-63). Most of the cases had fall injury (82.3%), while 17.5% had road traffic accidents. The majority of cases (42.5%) had L1 vertebral fracture followed by T12 and L2 fractures (22.5% and 20% respectively). Preoperatively the mean preoperative kyphotic angle was 17.42 ± 9.23 (range 7-30) degrees which also improved to 2.05 ± 1.34 (range 1-3) degrees after 6 months of postoperative period. Preoperatively 60% of cases had Frankel type E injury which improved to 82.5% at 6 months. Preoperatively the mean Denis pain scale was 4.72 ± 1.42 (range 2-5) that also improved to 1.24 ± 0.83 (range 1-3) at 6 months.

Conclusion: This study suggest a favorable outcome for short-segment fixation with transpedicular screws in traumatic thoracolumbar spine fractures with excellent functional outcomes and less complications.

Keywords: Transpedicular screws, Thoracolumbar, Kyphotic angle.

Introduction

The thoracolumbar spine can be divided into the thoracic spine, the thoracolumbar junction (T10-L2) and the lumbar spine. The thoracic spine is the more rigid of these structures and therefore requires significant force to cause injury. Whereas the lumbar spine, with its thick intervertebral discs and sagittal-oriented facet joints, and the lack of the thoracic cage, is comparatively more mobile. The thoracolumbar junction is the most common region of thoracolumbar fractures due to that transition point of increased mobility [1]. The majority of thoracolumbar junction fractures result from high impact trauma, including motor vehicle accidents and falls.

Thoracolumbar vertebral body fractures are common spinal injuries, and fractures of burst type account for 21-58% of all thoracolumbar spinal fractures [2]. According to the United States National Spinal Cord Injury Statistical Center, in approximately 54 cases per million people, 17,000 new spinal cord injury cases occur each year [3]. Over 250,000 patients are currently living with permanent deficits. Blunt trauma is associated with an incidence of 1.9% thoracic fractures [3].

Injuries at the thoracolumbar junction, although very common, comprise a heterogeneous group of injuries that has led to an increased discrepancy over the ideal surgical or nonsurgical management. The primary objectives of the treatment of traumatic unstable thoracolumbar fractures are early pain relief, early stability, preventing and/or improving neurological involvement, and good nursing care [4, 5]. Non-operative treatment can only be employed in patients with less vertebral body compression (<50%) [6, 7]. Conservative management techniques include thoracolumbar orthosis, plaster cast, Jewett brace, and a plastic body cast for approximately 12 weeks. The majority of the compression fractures are stable and are treated with simple observation or an orthosis [8].

For surgical intervention, approach alternatives include anterior, posterior, lateral, or combined approaches. The operative planning and stabilization of these fractures usually include a multifactorial decision-making process. In unstable fracture with more than 50% vertebral compression transpedicular screw fixation is the gold standard surgical treatment procedure. The advantages of transpedicular screw fixation are early pain relief, early stability, shorter hospital stay, complete rehabilitation, reduced bedridden complication, reduced morbidity, and mortality [9]. Pedicle screw fixation provides short, rigid segmental stabilization that allows preservation of motion segments and stabilization of the spine in the absence of intact posterior elements, which is not possible with non-pedicular instrumentation however it can be associated with complications such as cord damage, Dural leak which can occur due to malpositioned screw.

Posterior approach instrumentation can be divided into long segment fixation (involving more than two upper and lower neighboring levels), short-segment fixation (involving one level above and one below the fractured level) and mono-segment fixation. Nowadays short-segment pedicle screw instrumentation is a well described and popular technique to reduce and stabilize thoracic and lumbar spine fractures. Many authors also observed that short segment fixation is rather more superior to long segment fixation because of its advantages like lesser duration of surgery time, minimal blood loss, lesser duration of back pain, low incidence of stiffness, etc.

Materials and Methodology

A prospective observational study of 40 patients was carried out in the Department of Orthopedics, Vardhman Institute of Medical Science, Pawapuri, Nalanda, Bihar, India for 12 months. Detailed history, clinical examination, an x-ray of the thoracolumbar spine, CT scan, or MRI (if required) of the thoracolumbar spine was done pre-operatively and post-operatively in all cases.

The neurological status and improvement of pain were documented at the time of admission, discharge, and every subsequent follow-up visit. Neurological status was assessed using the Frankel grading [10] for spinal cord injury. Pain assessment was measured by Denis pain scale [11]

Inclusion Criteria

Patients of age 15-65 years with single level traumatic thoracolumbar fracture (T10-L4) with or without neurological involvement

Exclusion Criteria

Polytrauma patients/ head injury patients/ patients with open fractures/ pathological fractures.

Frankel Grading [10]:

A: Complete (no sensory or motor function is preserved)

B: Incomplete (Sensory, but no motor function is preserved below the neurological level)

C: Incomplete (Motor function is preserved below the neurological level, and the majority of key muscles below the neurological level have a muscle power grade of <3)

D: Incomplete (Motor function is preserved below the neurological level, and the majority of key muscles below the neurological level have a muscle power grade of > 3)

E: Normal (sensory & motor function is normal)

Denis Pain Scale [11]:

P1: No pain

P2: Occasional minimal pain; no need for medication

P3: Moderate pain, occasionally medications; no interruption of work or activities of daily living

P4: Moderate to severe pain, occasionally absent from work; significant changes in activities of daily living

P5: Constant, severe pain; chronic pain medications

Results

Out of 40 patients, 21 (52.5%) were females and 19 (47.5%) were males with a mean age of 36.65 ± 16.74 years (range 20-63). Most of the cases had fall injury (82.3%), while 17.5% had road traffic accidents. The majority of cases (42.5%) had L1 vertebral fracture followed by T12 and L2 fractures (22.5% and 20% respectively). 22.5% patients had burst type and 72.5% cases had wedge compression fracture. 12 cases (30%) had neurological involvement, out of which 22.5% had nerve root involvement and 7.5% patients had incomplete neurological involvement.

Screw failure was seen in only 3 cases (7.5%). 17.5% patients reported numbness post-operatively and 12.5% patients reported back pain as post-operative complication.

Table 1: Patients' demographic, clinical and functional details

Variables		Number (n)	%
Gender	Males	19	47.5
	Females	21	52.5
Age (in years)		36.65 ± 16.74 years	
Mode of injury	RTA	7	17.5
	Fall Injury	33	82.5
Fracture level	T11	3	7.5
	T12	9	22.5
	L1	17	42.5
	L2	8	20.0
	L3	2	5.0
	L4	1	2.5
Fracture type	Burst	11	27.5
	Wedge compression	29	72.5
Neurological involvement	Intact	28	70.0
	Nerve root	9	22.5
	Incomplete	3	7.5
Complication	Dural tear	1	2.5
	Back pain	5	12.5
	Screw fracture	3	7.5
	Numbness	7	17.5

Table 2: Frankel Grading Scale, Denis Pain Scale and Kyphotic angle measurements of patients immediately before/ after surgery and after 6 months recall

Variable		Immediate	After 6 months
Frankel Grading	C	7 (17.5%)	2 (5.0%)
	D	9 (22.5%)	5 (12.5%)
	E	24 (60.0%)	33 (82.5%)
Denis Pain Scale		4.72 ± 1.42	1.24 ± 0.83
Kyphotic Angle (degree)		17.42 ± 7.23	2.05 ± 1.34

Preoperatively the mean preoperative kyphotic angle was 17.42 ± 9.23 (range 7-30) degrees which also improved to 2.05 ± 1.34 (range 1-3) degrees after 6 months of postoperative period. Preoperatively 60% of cases had Frankel type E injury which improved to 82.5% at 6 months. Preoperatively the mean Denis pain scale was 4.72 ± 1.42 (range 2-5) that also improved to 1.24 ± 0.83 (range 1-3) at 6 months.

Discussion:

Thoracolumbar joint is highly susceptible to injury because it is a transition area from the rigid and less mobile thoracic spine due to the attached ribs bilaterally to a more flexible caudal lumbar spine [12]. These type of fractures can cause neurological deficit, which is a direct consequence of the spinal cord and/or root(s) damage. Fractures are treated with surgical or nonsurgical methods. The management of traumatic fractures of the thoracic and lumbar spine remains controversial. A large number of

publications, describing various surgical techniques for the reduction and fixation of spinal fractures, followed by discussions among the authors has not led to a general consensus on the optimal treatment [13, 14]. Various methods of posterior fixation e.g. hook and Harrington rods have evolved over the past few decades. However, pedicle screw instrumentation has revolutionized spine surgery [15].

In our study, Most of the cases had fall injury (82.3%), while 17.5% had road traffic accidents. The majority of cases (42.5%) had L1 vertebral fracture which is similar to Azam F et al study [16] in which 50% of cases had L1 fracture [15]. Most of the cases (72.5%) had wedge compression fracture, while 22.5% patients had burst type. Similarly in a study by Arif M et al [17], 73.68% cases had wedge compression and 15.78% had burst type fracture.

Preoperatively, the mean preoperative kyphotic angle was 17.42 ± 9.23 (range 7-30) degrees which also improved to 2.05 ± 1.34 (range 1-3) degrees after 6 months of postoperative period in this study. Robert et al [18] in their study of thoracolumbar fractures treated with pedicle screw instrumentation involving 52 patients reported a measurable loss of reduction of more than 5 degree of kyphotic angle in 10 patients out of which 8 had more than 10 degree. There was significant improvement in kyphosis from 34 degree preoperatively to 4 degree post-operatively during last follow up in a study by Hansen et al [19]. There was significant improvement in kyphosis from 34 degree preoperatively to 4 degree post-operatively during last follow-up in study by Yaser et al [20].

In our study, 17.5% patients had numbness, 12.5% had back pain, 7.5% had screw fracture and 2.5% patients had dural tear. Robert et al [18] concluded that primary cause for progressive deformity was failure of fixation construct due to bending or breakage of screws, loosening or pull out of screws or translation of vertebra that had been included in the instrumentation. Hansen et al in their historical cohort study of pedicle screw instrumentation included 3863 patients of which 586 patients were in trauma group. They calculated total rate of screw fracture as 0.7% and compared with contemporary literature available at that time which was 0.4% among trauma group [19]. Stephen et al included 617 patients treated with pedicle screw instrumentation in the survey in 1993 and among those 236 were for trauma. They concluded that over all complication rate was 27.4% among those intra-operative complications were 9.6% and post-operative complications were 17.8% which included screw misplacement (5.2%), pedicle fracture during surgery (2.3%), dural tear (1.9%), permanent nerve root injury (2.3%), postoperative deep vein thrombosis (4.2%), deep infection (4.2%), screw loosening (1.1%), screw breakage (0.6%) [21,22].

Conclusion:

This study suggest a favorable outcome for short-segment fixation with transpedicular screws in traumatic thoracolumbar spine fractures with excellent functional outcomes and less complications.

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