ORIGINAL RESEARCH

Functional outcome of posterior short segment pedicle screw fixation including index vertebra for thoracolumbar fracture

Dr. Ashish Patidar[1], Dr. Akshay Jain[2], Dr. Naman Gupta[3], Dr. Ashok Kumar Jat[4]

[1]Associate Professor, [2]Assistant Professor, [3]Senior Resident, [4]PGMO, Department of Orthopaedics, R.D. Gardi Medical College, Ujjain, DH Harda, Madhya Pradesh, India

Correspondent Author
Dr. Ashish Patidar
Associate Professor, Department of Orthopaedics, R.D. Gardi Medical College, Ujjain, DH Harda, Madhya Pradesh, India

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ABSTRACT

Background– The thoracolumbar spine is vulnerable to fracture during fall from height or road traffic accidents. The fracture of thoracolumbar spine can be associated with neurological deficits, long-term discomfort and disability. The optimal management of these injuries remains a substantial research subject. **Aim-** To evaluate the efficacy in terms of radiological surgical and neurological recovery after posterior short segment pedicle screw fixation including index vertebra. **Methodology–** It was prospective observational study of 20 patients conducted from September 2019 to September 2021 on thoracolumbar fractures who underwent pedicle screw fixation at R.D. Gardi Medical College and Hospital of district Madhya Pradesh. **Results–** All surgical procedure were conducted uneventfully within 100min (60%) with operative blood loss of <150ml (76.7%) and with <5 (60%) days of post-operative hospital stay. The overall associations between pre hip flexion & 1 year hip flexion, pre knee extension & 1 year knee extension, pre ankle dorsi-flexion & 1 year ankle dorsi-flexion, pre ankle planter & 1 year ankle planter, pre EHL& 1 year EHL were showing Chi-square value of 2.719 (p=0.606), 5.969 (p=0.201), 43.308 (p=0.000), 10.337 (p=0.242), 37.447 (p=0.002) respectively. **Conclusion –** The goals of treatment in thoracolumbar fractures are restoring vertebral column stability and obtaining spinal canal decompression, leading to early mobilization of the patient. Absolute indications of surgery are progressive neurological deficit in order to prevent future deterioration and restore neuro-logical functions as a result of reversible injuries.

Keywords – Short segment fixation, Index vertebral fractures, Posterior approach, Pedicle screw fixation.

INTRODUCTION

The human spinal column, characterized by individual vertebrae, serves as the central support structure, resembling a column when viewed from the front, hence the name vertebral column[1]. Comprehensive knowledge of osseo-ligamentous and neurological components is imperative for effective evaluation and management of spine trauma. The spinal column comprises anterior elements (spinal bodies and intervertebral discs), posterior elements (transverse processes, spinous processes, laminae, pedicles, superior and inferior articular facets), and ligaments that connect these components[2]. Pedicles, crucial for stability in screw placement, represent the strongest part of a vertebra, facilitating the transfer of weight from the neural arch to the vertebral body[3]. Advancements in understanding the anatomic, morphometric, and biomechanical features of thoracolumbar (TL) vertebrae have influenced the management of unstable TL fractures, an area marked by ongoing debate[4]. Conservative measures are preferred for cases with minimal kyphotic deformity, no neurological deficit, or a stable fracture pattern. Surgical strategies aim to correct kyphosis and decompress the canal in cases with neurological deficits, with the choice of approach—be it anterior, posterior, or a combination—remaining a point of discussion[5]. Considering biomechanical principles like the load-sharing concept, anterior column reconstruction with dorsal compression osteosynthesis instrumentation is considered the treatment of choice. A single-stage combined approach is favored over a staged procedure for its biomechanical advantages, safety, and reduced blood loss[6]. Efforts to minimize vertebral levels involved in fusion led to short-segment posterior fixation, but traditional methods faced challenges with a high incidence of instrument failure. The proposed solution involves short-segment posterior fixation with pedicle fixation at the fracture level to enhance kyphosis correction and reduce failure rates. This approach, utilizing a trans-pedicular short same-segment construct, seeks to rebuild the anterior column without extensive arthrodesis, minimizing surgery-related injury[7]. The aim of the study is to evaluate the efficacy, in terms of radiological, surgical, and neurological recovery, after posterior short-segment pedicle screw fixation, including the index vertebra. This investigation aims to contribute valuable insights into the outcomes and benefits of this specific surgical approach for thoracolumbar fractures.

METHODOLOGY

It was prospective observational study of 20 patients of thoracolumbar fractures who underwent pedicle screw fixation at R.D. Gardi Medical College and Hospital of district Madhya Pradesh. It was conducted from September 2019 to September 2021 on the patients of thoracolumbar fracture visiting to the hospital. As patient came with history of trauma at R.D. Gardi Medical College & Hospital will be evaluated at department of Orthopaedics R.D. Gardi Medical College & Hospital in the form of clinical history (sign symptoms) and if there is any previous imaging finding of fracture spine , patient showing positive findings for diffuse or focal spinal injury will be evaluated by MRI scanning and their findings will be correlated by clinical follow up or post-operative data and all the data observed on individual case shall be entered in case record Performa that shall be entered in master chart of observation for calculations and analysis.

The **inclusion Criteria** were

1. Patient age <65 yrs.
2. Patient with or without neurological deficit.
3. Patient with single level fracture vertebra.
4. Patient with mild kyphosis and scoliosis with cobb angle <25º. 5) Patient having TLICS≥4.

Exclusion Criteria

1.Patient having pathological fracture, osteoporotic fracture, multiple fracture &/or dislocation.
2.Patient having previous surgery at the site of fracture vertebra.
3.Patient unfit for surgery.

Routine X-ray and clinical examination of the patients will be done at postoperative at 03months 06 months and 09 months. All the data were analyzed by SPSS (statistical package for social science) version 25 and applying appropriate statistical tests. Permission has been obtained from the ethics review board of the institution.

SURGICAL APPROACH

Position: Prone (most common), abdomen free with bolsters, Reduces venous plexus filling, Avoid pressure points at hip, chest.

Incision: Midline incision, Tip of superior spinous process to spinous process of affected level, Tip of iliac crest: L4/5 interspace, Posterior superior iliac spine: S2

Screw insertion: Once the pedicle track has been created, it is important to confirm a complete intraosseous trajectory by pedicle and body palpation using a pedicle sounding device. At any point in the process, radiographic confirmation can be obtained. Screw of appropriate diameter and length is carefully inserted into the same created trajectory.

Outcome– Posterior short same-segment trans-pedicular screws offer a viable treatment for single-level traumatic thoracolumbar fractures, ensuring satisfactory surgical and functional outcomes with minimal postoperative deviations in Cobb angle and vertebral height. A comprehensive study with a substantial sample size and extended follow-up is crucial for validating the long-term efficacy of this approach. Few images of post-operative cases as an example –

Case 01


Case 02

Case 03

RESULTS

Table 1: General details wise distribution of study cases

General details of cases	Frequency	Percentage (n=30)
Age groups		
<=25	10	33.3
26-35	13	43.3
>35	7	23.3
Gender		
Male	17	56.7
Female	13	43.3
Fracture level		
D10	2	6.7
D11	3	10.0
D12	12	40.0
L1	8	26.7
L2	2	6.7
L3	2	6.7
L4	1	3.3
Mode of injury		
Fall from height	17	56.7
Road traffic accident	13	43.3
Cases distributed by American spine injury association grading		
A	3	10.0
B	2	6.7
C	7	23.3
D	18	60.0
Thoracolumbar injury classification and severity score (Pre-op)		
50.	16	53.3
6.0	8	26.7
7.0	6	20.0
Duration of surgery		
<=100 min	18	60.0
>100 min	12	40.0
Blood loss during surgery		
<150ml	23	76.7
>=150	7	23.3
Hospital stay (duration)		
< 5 days	18	60.0
>= 5 days	12	40.0

Table 2: Association between pre hip flexion & 1 year hip flexion

Pre hip flexion	1 year hip flexion		Total
	IV/V	V/V	
0/V	1	3	4
	25.0%	75.0%	100.0%

I/V	0	1	1
	0.0%	100.0%	100.0%
II/V	1	6	7
	14.3%	85.7%	100.0%
III/V	3	8	11
	27.3%	72.7%	100.0%
IV/V	0	7	7
	0.0%	100.0%	100.0%
Total	5	25	30
	16.7%	83.3%	100.0%
Chi-square = 2.719, p=0.606			

Table 3: Association between pre knee extension & 1 year knee extension

Pre knee extension	**1 year hip flexion**		**Total**
	IV/V	**V/V**	
0/V	2	2	4
	50.0%	50.0%	100.0%
I/V	0	1	1
	0.0%	100.0%	100.0%
II/V	2	5	7
	28.6%	71.4%	100.0%
III/V	1	10	11
	9.1%	90.9%	100.0%
IV/V	0	7	7
	0.0%	100%	100.0%
Total	5	25	30
	16.7%	83.3%	100.0%
Chi-square = 5.969, p=0.201			

Table 4: Association between pre ankle dorsi-flexion & 1 year ankle dorsi-flexion

Pre ankle dorsi-flexion	**1 year hip flexion**					**Total**
	I/V	**II/V**	**III/V**	**IV/V**	**V/V**	
0/V	1	2	1	0	0	4
	25.0	50.0	25.0	0.0%	0.0%	100.0%
I/V	0	0	0	1	0	1
	0.0%	0.0%	0.0%	100.0	0.0%	100.0%
II/V	0	0	5	2	1	7
	0.0%	0.0%	62.5	25.0	12.5	100.0%
III/V	0	0	0	7	4	11
	0.0%	0.0%	0.0%	63.6	36.4	100.0%
IV/V	0	0	0	1	5	7
	0.0%	0.0%	0.0%	16.7	83.3	100.0%
Total	1	2	6	11	10	30
	3.3%	6.7%	20.0%	36.7%	33.3%	100.0%
Chi-square = 43.308, p=0.000						

Table 5: Association between pre ankle planter & 1 year ankle planter

Pre ankle planter	**1 year hip flexion**			**Total**
	I/V	**IV/V**	**V/V**	
0/V	1	1	2	4
	25.0	25.0	50.0	100.0%
I/V	0	0	1	1
	0.0%	0.0%	100.0	100.0%
II/V	0	2	5	7
	0.0%	28.6	71.4	100.0%
III/V	0	1	10	11
	0.0%	9.1	90.9	100.0%
IV/V	0	0	7	7

	0.0%	0.0%	100.0	100.0%
Total	1	4	25	30
	3.3%	13.3%	83.3	100.0%
Chi-square = 10.337, p=0.242				

Table 6: Association between pre EHL& 1 year EHL

Pre EHL	**1 year hip flexion**					**Total**
	I/V	**II/V**	**III/V**	**IV/V**	**V/V**	
0/V	1	2	1	0	0	4
	25.0	50.0	25.0	0.0%	0.0%	100.0%
I/V	0	0	0	1	0	1
	0.0%	0.0%	0.0%	100.0	0.0%	100.0%
II/V	0	0	5	4	0	9
	0.0%	0.0%	55.6	44.4	0.0%	100.0%
III/V	0	0	1	6	3	10
	0.0%	0.0%	10.0%	60.0	30.0	100.0%
IV/V	0	0	0	2	4	6
	0.0%	0.0%	0.0%	33.3	66.7	100.0%
Total	1	2	7	13	7	30
	3.3%	6.7%	23.3%	43.3%	23.3%	100.0%
Chi-square = 37.447, p=0.002						

DISCUSSION

Thoracolumbar fracture are spinal injuries typically occurring because of high-velocity trauma. According to the AO/ASIF spine fracture classification system, this kind of fracture can be categorized as type A, B and C. These injuries are highly unstable, as fracture can occur in any of 3- column usually leading to neurological deficit. The mechanism of injury involves multiple forces, which includes flexion, extension, shear, torsion, and compression**[8]**.

Management of thoracolumbar fractures is a reduction of the dislocated segment and restore vertebral body height with decompression of the canal, and obtain the most stable fixation**[9]**. Conservative treatment of thoracolumbar fractures is mostly done in stable injury patterns. Operative management of this kind of fractures is recommended in conditions in which spinal instability is present, and this instability further deteriorates the neurological condition of the patient, and slower mobilization and rehabilitation**[10]**. Surgical intervention is recommended for unstable fracture of the spine because there are not only fractures but also various degrees of ligament and disc injuries. The appropriate approach for treatment of spinal fracture is mainly of three types such as anterior, combined anterior and posterior, or posterior-alone approach with a short-segment or long-segment construct. The anterior reconstruct is better if fracture involves the anterior column, and it provides better neural decompression, and fusion with fixation, but interlocked facet joints in the posterior column cannot be relieved[11].

The combined anterior and posterior approach gives following advantages, like an improved sagittal alignment, better neural decompression, and easy reduction of fracture site, but it also has difficulties, including more operative time, more bleeding of tissue, and the need to change position during the surgery**[12]**. Improved resistance in spine disorder can be obtained through Anterior approach as compared with posterior stabilization. However, short-segment fixation and the use of pedicle screws at the index vertebrae have shown ability to correct the deformity. The differences between the anterior or posterior approaches regarding canal decompression and neurologic outcomes are none**[13]**. The posterior approach alone has better outcomes with respect to surgical time and blood loss during operation. Short segment pedicle screw fixation including index vertebrae provides 3-column fixation to control axial, translational, and rotational displacements. Simultaneous corrective forces can be applied in axial compression or distraction, flexion or extension, and in rotational, coronal, and sagittal translation**[1]**.

Long-segment pedicle screw fixation was reserved for the unstable fracture with involves more than two segments. The main objective behind long-segment fixation (2 levels above and 2 levels below) was to obtain more than one fixation points so as to distribute stress while achieving and maintaining reduction and alignment of the spine. Though, this procedure causes loss of motion segments**[14]**.

Hence, to save motion segments, short-segment pedicle screw fixation through index vertebrae was practiced. However, comparing the short and long segment is also controversial. In our study, we have considered posterior fixation with pedicle screws 1 levels above and 1 level below the fracture level as short-segment fixation with 1 screw in index vertebra**[15]**.

Alanay A (2001)[16]- in a retrospective study on 20 patients of thoracolumbar (n ¼ 14) or lumbar fracture-dislocations (n ¼ 6) treated with short segment posterior instrumentation, reported a complication rate of 60% with short-segment posterior fixation. Poor initial postoperative alignment due to short-segment fixation mainly in the lumbar spine was considered as the most important factor for failure.

Sodhi et al (2017)[17]- analyzed 91 patients with thoracolumbar fractures treated with short-segment posterior fixation retrospectively and concluded statistically significant factors contributing to failure included the presence of a burst fracture, a preoperative load-sharing classification score, and translation/dislocation.

Chen et al (2017)[18]- compared the outcomes of long-segment (2 levels above and 2 levels below) or short-segment posterior fixation (1 level above and 1 below, and included the fractured vertebra itself) and anterior fusion in both groups in 16 patients of lumbar split fracture-dislocation and reported better outcomes in terms of intraoperative blood loss and operative time for the short-segment group than the long-segment group with no difference in radiological and neurological outcomes between the 2 groups.

Authors of various studies 3–5 on burst fractures have supported the use of index screws in fractured vertebrae, which provide an additional anchor during the reduction maneuver and help in the correction of deformity through vertebral endplate augmentation. Few studies have reported the use of index screws along with short-segment constructs in cases of fracture-dislocations.

Chokshi et al (2019)[19]- treated 50 patients with thoracolumbar fracture dislocation with short-segment construct and index screws. They concluded that inclusion of the fracture level in short-segment fixation for thoracolumbar fracture-dislocation with McCormack load sharing score 6 gives good kyphosis correction and maintenance. Blood loss and operative time in our study were less than the long-segment fixation. In our study, we found that there were no statistically significant differences in radiological outcomes with regard to local kyphosis, translation percentage, and displacement angle by either of the methods of fixation at the final follow up.

Most of the participants for fixation is in the age group in 26-35years 10(50%) this is very much comparable to other study. In **Khurjekar et al (2015)[20]** in his study the most common age group was 22-49 years. In **Farrokhi et al[21]** also find similar results the mean age of the participants in his study was 34.5 years.

In our study we found that in short segment fixation the amount of blood loss <100 ml (40%) and duration of surgery < 100 min (60%) which is very much similar to the study conducted by Mittal et al in his studythe mean duration of surgery was 3 hour and mean blood loss was 112ml.

CONCLUSION

Posterior short segment instrumentation is sufficient for almost all type A fracture and type B fracture in a non-ankylosed spine.

In our experience, short-segment pedicle screw fixation including index vertebra can be used for treating thoracolumbar fracture, as it is associated with less blood loss, decreased intraoperative time, and it further saves fusion segments with similar radiological and clinical outcomes as long-segment fixation. Long segment fixation can be reserved in cases where inserting pedicle screws in fractured vertebrae (index screws) becomes difficult due to loss of integrity of posterior elements and pedicles at the fracture level.

There is no superiority of long segment over short segment stabilization with index level screw in the correction of kyphotic angle and maintaining sagittal plane.

Moreover, short segment stabilization has faster relief of pain, lesser tissue destruction than long segment with same biomechanical stability

Limitation- A small number of patients in each group and short duration of follow up.

We did not compare short and long segment fixation in our research. So, we cannot comment on which is the better option.

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Conflicts of interest-No conflicts of interest.

Ethical approval- The study was approved by the Research Ethics Committee of the R. D. Gardi Medical College, district Ujjain.

Consent for publication -Not applicable

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