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Original Article

The Outcome of Minimally Invasive Percutaneous Transpedicular Screw Fixation (TPSF) in Thoracolumbar Spine Fractures

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ABSTRACT

Background & Objective: This study aimed to determine the outcome of percutaneous transpedicular screw fixation (TPSF) in patients with thoracolumbar fractures.

Material & Methods: A total of 157 patients with thoracolumbar fractures were included from the Department of Neurosurgery, LGH, PINS, Lahore. Patients were evaluated with plain X-rays, CT, and MRI scans. Neurological status was documented preoperatively and postoperatively. All patients were treated with Minimally Invasive Percutaneous Transpedicular screw fixation. Data for operative time and per-operative blood loss was obtained through the operative notes. The severity of postoperative pain and length of hospital stay were also documented.

Results: Out of 157 patients, 69.4% were male and 30.6% were female. The 141 (89.8%) were traumatic from road traffic accidents/falls, and 16 (10.2%) were pathologic. The 128 (81%) patients were discharged on the first day, 23(15%) were discharged on the second day, and 6(3.8%) on the third day. 79% of patients had a single level of spine fracture whereas, 20% had 2 spinal fracture levels. The average operative time for MIS percutaneous TPSF was 55 minutes. Postoperative pain was markedly reduced as compared to traditional open surgery and no patient had any new neurological deficit. The mean blood loss was 25 ml and none of the patients needed a postoperative blood transfusion.

Conclusion: Percutaneous transpedicular instrumentation is an ideal surgical approach for thoracolumbar spinal stabilization.

Keywords: Thoracolumbar Fractures, Percutaneous Transpedicular Screw Fixation, Minimally Invasive Spine Surgery, Road Traffic Accidents (RTA).

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INTRODUCTION

The thoracolumbar region is the most common region involved in spinal trauma and accounts for 90% of all spinal fractures.[1] This junction is a transition zone from the thoracic spine that is kyphotic and fixed with a rib cage to more mobile and lordotic lumbar spine that makes it vulnerable to trauma.[2] The commonest cause of thoracolumbar fractures are Motor vehicle accidents and falls.[1-2] These can be associated with other systemic injuries like chest and abdominal trauma.[3,4] Denis classified thoracolumbar fractures according to spinal stability that involves anterior, middle, and posterior columns.[5,6]

According to the mechanism of injury and involved column, these thoracolumbar fractures are divided into four main types, i.e., Compression Fractures, Burst Fractures, Flexion-Distraction fractures, and Fracture Dislocation. Patients with trauma are assessed clinically and radiologically with X-rays, CT, and MRI of the thoracolumbar region. If the injury is obvious on CT and correlates with neurological status, MRI is not needed as it causes unnecessary delay in surgical intervention, where urgent spinal cord decompression is required, especially, if decompression needs to be done within six hours of injury.[7,8,9]

Surgical treatment is recommended for thoracolumbar fractures. It includes decompression of neurological structures and stabilization of the spine with or without fusion. Decompression can be achieved either by posterior decompression by laminectomy or reduction of vertebrae.[10,11] These fractures are stabilized in routine with open transpedicular fixations which include large incisions, massive blood loss, drain placement, longer hospital stay, long post-operative recovery, and marked pain.[12,13,14]

Minimally invasive spine (MIS) surgery and percutaneous transpedicular screw fixation (TPSF) are gradually gaining popularity worldwide, but it is still less commonly performed in our country. We started minimally invasive percutaneous transpedicular fixation in 2018. It has the advantage of smaller incisions, minimal blood loss, less operative time, decreased hospital stay, less post-operative pain, and early rehabilitation as it prevents significant muscle atrophy, scarring, and denervation of muscles and joints that are associated with open transpedicular fixation.[15,16]

MATERIAL & METHODS

Study Setting

A total of 157 patients with Thoracolumbar Fractures were operated on with percutaneous transpedicular screw fixation (TPSF) at Neurosurgery Unit-III, Lahore General Hospital (LGH)/Punjab Institute of Neurosciences (PINS) from March 2018 to February 2020.

Inclusion & Exclusion Criteria

All patients with Thoracolumbar Fractures included those who needed thoracolumbar fixation and underwent percutaneous TPSF. Patients with multisystem trauma, multiple bony injuries, multiple spinal injuries, and injuries more than 4 weeks old were excluded.

Clinical Assessment & Data Collection

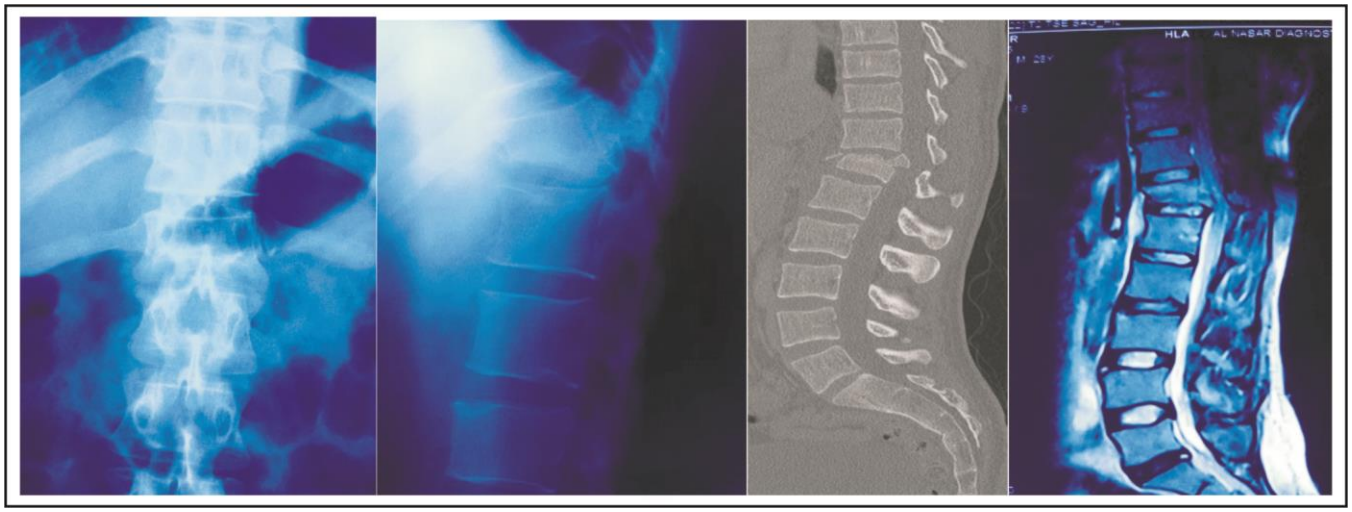
Patients were evaluated for neurological status and this data was documented. All patients were evaluated preoperatively with X-rays, CT, and MRI scans of the involved area. All patients who were operated on with minimally invasive percutaneous transpedicular fixation were included in the consecutive sampling. Postoperatively, all patients were assessed and documented for operative time (in minutes), and blood loss (in ml) as reported in the anesthesia and operative notes. They were also documented for the severity of postoperative pain according to the Visual Analogue Scale (VAS), neurological

status, and length of postoperative hospital stay (in days).

Percutaneous TPSF

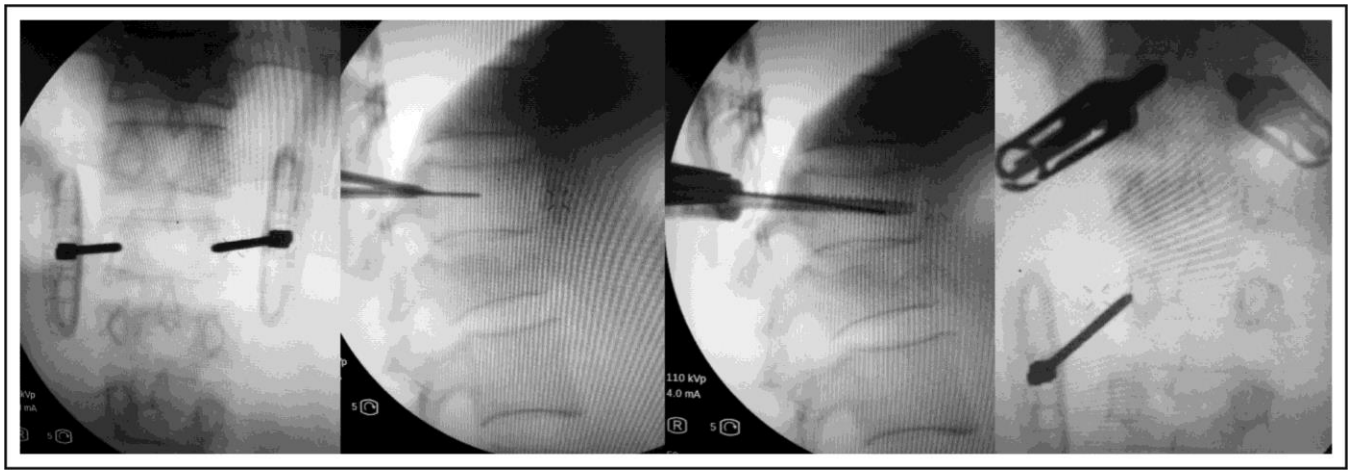
Percutaneous TPSF was done under general anesthesia in a prone position with the abdomen freely hanging and padding under pressure points. After aseptic measures, the fracture levels were identified under the C-arm image intensifier. Pedicles were marked under fluoroscope/C-arm in the AP (anteroposterior) dimension. Inch-long skin incisions were made over marked pedicles. Pedicles were reached using monopolar cautery. Jamshed needles were inserted in pedicles at 9° clock position on the left side and 3° clock position on the right side. Jamshedi needles were passed through the pedicles and inserted into the bodies of the vertebrae under C-arm's lateral dimension. A guide wire was passed through and Jamshidi needles were removed over the guide wire. Dilators were passed over the guide wire followed by the tapping of screw sites. Finally, the screws were inserted over a guide wire and the wire was removed. Rod was inserted and passed through all screws on that side and fixed. Due to tightened curved rod, ligamentotaxis was achieved and reduction was done. Whenever required, the distraction was done separately as well. Wounds were closed in three layers, i.e., fascia, subcutaneous layer, and skin. Skin closed with absorbable Monocryl 4/0 that doesn't require removal.

Figure 1 shows X-rays (AP and Lateral views), CT scans, and MRI of a D12 burst fracture. MRI highlights the cord compression. **Figure 2a** shows tapping of D12 pedicles with Jamshedi needles under fluoroscopic AP views, **Figure 2b** is showing the guide wire passed through pedicles into the D12 vertebral body, **Figure 2c** shows tapping of the pedicle and vertebral body as seen in lateral views of fluoroscopy and **Figure 2d** is transpedicular screws in AP view. **In Figure 3,** lateral and AP fluoroscopic views show stabilization of fractured vertebra with transpedicular screws and rods. The last image (3c) shows the minimal skin incisions used in the surgery.



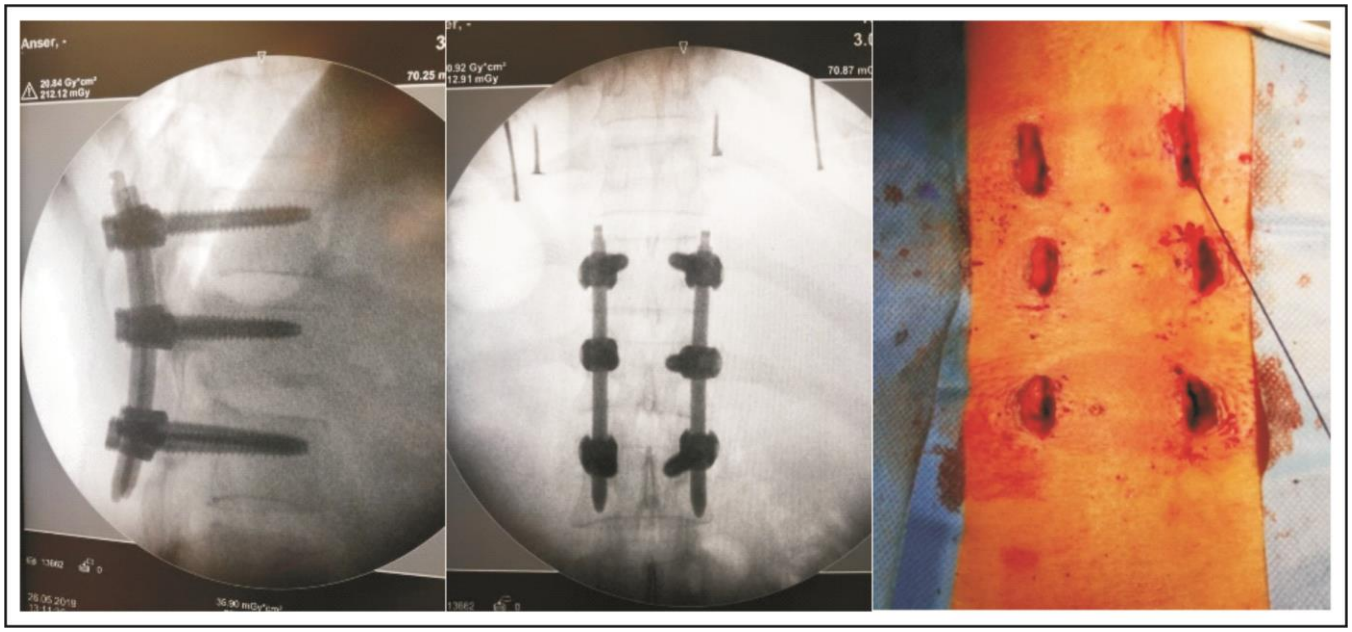
(a) (b) (c) (d)

Figure 1 (a): X-ray AP view of the fractured vertebra at D12(b): X-ray lateral views of the compressed vertebra; 1(b): Sagittal CT of D12 burst fracture; 1(c): MRI sagittal view with cord compression. (images used with patient permission)



(a) (b) (c) (d)

Figure 2(a): AP view fluoroscopy showing placement of Jamshedi Needles in pedicles; **2(b):** Lateral view: guide wire in vertebral bodies; **2(c):** Tapping of the pedicle and vertebral bodies; **2(d):** TP screws in AP view. (images used with patient permission)



(a) (b) (c)

Figure 3(a): Transpedicular instrumentation: Fluoroscopic lateral views; **3(b):** AP views; **3(c):** Skin incisions. (images used with patient permission)

RESULTS

Demographic Results

Out of 157, 109 patients (69.4%) were males and 48 patients (30.6%) were females. The mean age of the patients was 26.1 years, with a range of 16 – 52 years. 141 (89.8%) patients sustained these thoracolumbar fractures due to trauma from either high-speed motor vehicle road traffic accidents (RTA) or falls from height, whereas, 16 (10.2%) patients had pathological fractures. Out of 157, 124 patients (79%) had a single level of spine fracture whereas, 31 patients (20%) had 2

spinal fracture levels and two patients (1%) had 3 spinal fracture levels **(Table 1)**.

Table 1: Number of fractured spinal levels.

Level	Incidence Percentage
1-Level	79%
2-Level	20%
3-Level	1%

MIS Percutaneous TPSF Operative Time & Blood Loss

The average operative time for MIS percutaneous TPSF was 55 min (range = 30 to 190 minutes). This wide range of operative time was further divided into 4 groups. In 97 (62%) patients, the operative time was between 30 – 60 minutes, 48 (30%) patients had 60 – 90 minutes, 9 (6%) patients had 90 – 120 minutes, while 3 (2%) patients, the surgery was completed between 120 – 190 minutes **(Table 2)**. The mean blood loss was 25 ml (range = 20 – 50 ml) and none of the patients needed a postoperative blood transfusion.

Postoperative Pain

The mean Postoperative Visual Analogue Scale (VAS) score for pain was 3.9 (range = 2 to 7) and, only 11 patients needed any opioid analgesic for pain relief. Therefore, patients could be easily mobilized within the bed and out of bed depending upon their preoperative neurological status.

Neurological Status & Hospital Stay

None of the patients developed any deterioration of neurological postoperatively. The average postoperative hospital stay was 1.2 days (range = 1 – 3 days). The 128 (81%) patients were discharged on the first postoperative day, while 23 (15%) were sent home on the second day, and 6 (4%) were discharged on the third postoperative day (Table 3).

Table 2: Variations of operative times.

Operative Time	Incidence Percentage
30 – 60 minutes	62%
60 – 90 minutes	30%
90 – 120 minutes	6%
120 – 190 minutes	2%

Table 3: Postoperative hospital stays variations.

Hospital Stay (Days)	Percentage
1 day	81%
2 days	15%
3 days	4%

DISCUSSION

This study determined the outcome of percutaneous transpedicular screw fixation (TPSF) in patients with thoracolumbar fractures. 141 (89.8%) were traumatic from car accidents/falls, whereas 16 (10.2%) were pathologic. The first day saw 128 patients (81%) discharged, the second day saw 23 (15%), and the third day saw 6 (3.8%). 79% of patients had a single level of spine fracture, whereas 20% had two levels of a spinal fracture. The average time for MIS percutaneous TPSF surgery was 55 minutes. When compared to standard open surgery, postoperative discomfort was significantly reduced, and no patient developed a new neurological defect. The average blood loss was 25 mL, and no patients required a postoperative blood transfusion. Only 11 individuals need an opioid analgesic to relieve discomfort. As a result, depending on their preoperative neurological state, patients might be readily transported within and out of bed. There was no postoperative neurological impairment in any of the patients.

Increased use of mechanized and fast-moving locomotives and multi-story buildings have raised spinal trauma many folds. These injuries are posing a huge social, financial, and psychological burden, not only to the patient, and their family but also to society and the state,[17,18] and therefore, the management of thoracolumbar

fractures, which is the commonest area involved in spine trauma, has been an area of interest throughout the second half of 20th as well as the 21st century. Modalities of the treatment for these fractures have evolved. These included all conservative treatments with postural reduction, casts in hyperextension, and different braces.[11,19,20] The period from the 1980s to early 2000 showed a huge advancement in the surgical open fixation of unstable vertebral fractures, with and without neural decompression or fusion. There has been an evolution of different types of instrumentation systems. This open method of transpedicular screw fixation (TPSF) is still the most widely used worldwide and most spine surgeons are accustomed to performing it. But, the open method of transpedicular screw fixation has its drawbacks including longer incisions, more tissue and muscle dissection, more blood loss necessitating blood transfusions, more facet joint violations, longer operative time, more postoperative pain, delayed mobilization of the patient, difficult rehabilitation and more truncal muscle atrophy.[21-23] Minimally invasive percutaneous transpedicular screw fixation is a newer treatment modality for thoracolumbar fractures and we experienced its advantages for the patients. It is gaining popularity worldwide and in Pakistan. The literature also suggests that it has a lot of advantages over traditional open TPSF, which include smaller incisions, less blood loss, less muscle, and tissue dissection, less operative time, less postoperative pain, early patient mobilization, easier rehabilitation, and less truncal muscle atrophy.[21,22,23]

CONCLUSION & RECOMMENDATION

Minimally invasive percutaneous transpedicular screw fixation is a newer treatment modality for thoracolumbar fractures in our country and has a lot of advantages over conventional open TPSF including reduced operative time, smaller incisions, less blood loss, and postoperative pain. Long-term follow-ups are still required in this regard.

LIMITATIONS

This was a single-centered study with limited sample size. More cases from multi-center studies could be added for the affirmation of the reported outcome.

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Additional Information

Disclosures: Authors report no conflict of interest.
Ethical Review Board Approval: The study was conformed to the ethical review board requirements.
Human Subjects: Consent was obtained by all patients/participants in this study.
Conflicts of Interest:
In compliance with the ICMJE uniform disclosure form, all authors declare the following:
Financial Relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.
Other Relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

AUTHOR CONTRIBUTIONS

Sr. No.	Author's Full Name	Intellectual Contribution to Paper in Terms of
1.	**Syed Ahmad Faizan**	Study Design, Methodology, and Paper Writing.
2.	**Muhammad Farooq**	Data Calculation and Data Analysis.
3.	**Zubair Mustafa Khan**	Interpretation of Results.
4.	**Tariq Imran**	Statistical Analysis.
6.	**Asif Bashir**	Literature Review and Editing.