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ORIGINAL ARTICLE

Open vs Percutaneous Pedicle Screw Fixation in Thoraco-Lumbar Traumatic Fracture

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ABSTRACT
Introduction: Thoracolumbar fractures are commonly managed using open transpedicular fixation; however, minimally invasive techniques such as percutaneous pedicle screw fixation have been increasingly adopted due to their potential advantages. Emerging evidence suggests improved perioperative outcomes with the percutaneous approach compared to the conventional open method.
Objective: To compare the outcomes of open versus percutaneous pedicle screw fixation in patients with thoracolumbar traumatic fractures.
Materials and Methods: This randomized controlled trial was conducted at the Department of Neurosurgery, Mayo Hospital, Lahore, from March 2021 to September 2021. A total of 60 patients meeting the inclusion and exclusion criteria were enrolled and randomly allocated into two equal groups using the lottery method. Group A underwent percutaneous pedicle screw fixation, while Group B underwent open pedicle screw fixation. All procedures were performed under general anesthesia by a single surgical team. Intraoperative parameters including operative time, incision length, and blood loss were recorded, while postoperative hospital stay was also documented for comparison.
Results: The mean age of patients in Group A and Group B was 35.80±8.74 years and 40.76±14.30 years, respectively, with male predominance in both groups. Group A demonstrated significantly better outcomes compared to Group B in terms of operative time (44 vs. 74.03 minutes, p<0.001), incision size (26.70 vs. 67.86 mm, p<0.001), intraoperative blood loss (51.33 vs. 215.33 mL, p<0.001), and hospital stay (1.00 vs. 2.60 days, p<0.001).
Conclusion: Percutaneous pedicle screw fixation is superior to open pedicle screw fixation for the management of thoracolumbar traumatic fractures, offering significant advantages in operative time, surgical invasiveness, blood loss, and duration of hospitalization.
Keywords: Outcome, Open, Percutaneous, Pedicle, Screw Fixation, Thoracolumbar, Traumatic, Fracture.

INTRODUCTION
These fractures are most often produced by failures of both the anterior and middle columns of vertebral bodies, with or without bending force.[1] Numerous trauma survivors are more likely to have vertebral fractures in their neck and back, with approximately a third of these patients also suffering from spinal cord damage and other neurologic deficits.[2] A thoracolumbar fracture is caused by a variety of factors, including the patient's age. A high-energy trauma, such as a car accident, motorbike accident, or a fall, is more likely to cause a fracture in younger individuals. Falls from a standing posture to the ground in the elderly might cause fractures because of osteoporosis and diminished cognitive abilities.[3].

Patients with serious medical conditions and those who have had several traumas are less likely to withstand open PSF. PPSF, a less invasive method, has been developed as a result of this constraint. Open surgical techniques are thought to provide the benefit of restoring sagittal alignment and stabilising fractures without the morbidity and extended operational periods associated with open exposures[1,4]. The importance of preoperative fracture type evaluation cannot be overstated in patients with inadequate reduction. Patients with type C fractures should not have percutaneous short segment fixation.[2, 3]

Transpedicle screw fixation is a more recent and common method for internal fixing. According to the Cochrane study on pedicle screw fixation for traumatic thoracolumbar fractures, "pedicle screw fixation may be classified into many groups depending on the lengths of the fractured segments and pedicle screws in the fractured vertebra.[4]

Three-column open transpedicle screw fixation is widely used in clinical practise because it provides the following advantages: increased rigidity and stability of the spine by maintaining anatomical alignment of the spinal column; created a multidimensional spinal fixation and more flexible system to accommodate a patient's unique anatomy; and, in some cases, even fewer neurological risks and early painless mobilisation. The open operation, on the other hand, has been linked to blood loss, infection, and long-term discomfort thereafter.[5, 6]

One trial found that the outcome of percutaneous method was significantly better than open surgical technique i.e. intraoperative time 98.4±35.9 vs. 140.3±76.8 min, incision size 7.3±0.3 vs. 11.6±2.3 mm, Intraoperative bleeding 49.3±34.0 vs. 311.5±246.4 mL and Postoperative hospital stay 2.7±3.7 vs. 5.6±10.6 days.[7] Another trial found that the outcome of percutaneous method was significantly better than open surgical technique i.e. intraoperative time (60±9 vs. 53±10min, p=0.011), Blood loss (331±141 vs. 56±17ml, p-value<0.0001).[6] Rationale of this study is to compare the outcome of open vs Percutaneous Pedicle Screw Fixation in thoracolumbar Traumatic Fracture.

Objective: To compare the outcome of open vs PPSF (Percutaneous Pedicle Screw Fixation) in thoracolumbar Traumatic Fracture.

MATERIAL & METHODS
This randomized controlled trial (RCT) was conducted in the Department of Neurosurgery at King Edward Medical University (KEMU)/Mayo Hospital, Lahore, during March 2021 to September 2021. A total of 60 patients were enrolled using a probability-based simple random sampling technique, with 30 patients allocated to each study group. The sample size was calculated using a 5% level of significance and 95% power of the test, based on expected mean values of 17.6 ± 13.6 for open transpedicular screw fixation and 9.7 ± 3.7 for percutaneous transpedicular screw fixation, applying the standard formula for comparison of two means. Patients aged 16 to 70 years of either gender presenting with thoracolumbar traumatic fractures confirmed on X-ray, computed tomography (CT), and magnetic resonance imaging (MRI) were included in the study. Patients with congenital spinal deformities on clinical examination, multilevel disc herniation confirmed on MRI, or those requiring decompression procedures were excluded.

Data Collection Procedure: Cases fulfilling inclusion criteria were enrolled in study from wards of Department of Neurosurgery, Mayo

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Hospital, and Lahore. Informed consent was taken. Demographic data including name, age and gender was also recorded. Patients were randomly divided in two equal groups by using lottery method. In group A patients underwent Percutaneous Pedicle Screw Fixation, patient kept in prone position after paint and drap localization of fractured vertebrae by C arm, pedicle localized with AP radiograph with marker in place, 3-4cm skin incion made , K-wire inserted into pedicle under Carm guidance, proper position of Kwire localized in pedicle, hand drilling with cannulated drill bit over the k wire to make path for screw insertion position of the screw is confirmed with C arm , straight distraction to restore the height of vertebrae ,wound is closed. aseptic dressing done. In group B patients underwent Open Pedicle Screw Fixation the patient kept in prone position under GA , level was identified by C Arm X-ray, incision given and open layer by layer ,laminas exposed, facet joint exposed, pedicle finder is used to cannulate, length of screw is measured by feeler. Pedicle screw inserted and rods placed hemostasis secured wound close layer by layer. All surgeries were done under general anesthesia by a single surgical team with assistance of researchers. During surgery, the duration of the procedure, the length of the incision, and the amount of blood lost were recorded (As per operational definition). Patients were transferred to the Neurosurgical unit after surgery and released when they were able to walk, had no complications, and were vitally stable. It was reported that the patient required a post-operative hospital stay (As per operational definition) All data were obtained using a custom constructed proforma (attached).

Data Analysis: SPSS version 26 was used to input and evaluate the data obtained. Quantitative data such as the age and duration of the fracture, the length of the incision, the length of the operation, the amount of blood lost during the operation, and the length of the postoperative hospital stay were provided as mean±SD. Qualitative data such as gender and the number of vertebrae involved were provided as frequencies and percentages, and a chi-square test was used to compare the two groups of open trans pedicle screw fixation versus percutaneous trans pedicle screw fixation. A p-value of 0.05 was considered significant.

RESULTS

Data were collected from 60 patients, mean age in Group A was 35.80±8.74 years, while in Group B it was slightly higher at 40.76±14.30 years, with age ranges of 20–51 years and 18–70 years, respectively. Male patients were predominant in both groups, accounting for 76.7% in Group A and 83.3% in Group B, whereas females comprised 23.3% and 16.7%, respectively. The mean duration of fracture prior to surgery was longer in Group A (4.76±6.48 days) compared to Group B (2.73±2.08 days), with ranges of 1–30 days and 1–7 days, respectively.

The mean operative time was significantly shorter in Group A (44.00±6.87 minutes) compared to Group B (74.03±9.85 minutes) (p<0.001), with respective ranges of 30–60 and 55–90 minutes. Similarly, the incision size was markedly smaller in Group A (26.70±3.01 mm) than in Group B (67.86±7.26 mm) (p<0.001). Intraoperative blood loss was also significantly lower in Group A (51.33±12.52 mL) compared to Group B (215.33±61.51 mL) (p<0.001). Furthermore, the mean postoperative hospital stay was shorter in Group A (1.00±0.00 days) compared to Group B (2.60±0.67 days), which was also statistically significant (p<0.001).

Table 1: Baseline Characteristics of Patients

Variable	Group A (n=30)	Group B (n=30)
Age (years) (Mean ± SD)	35.80 ± 8.74	40.76 ± 14.30
Age Range (Min–Max)	20–51	18–70
Male	23 (76.7%)	25 (83.3%)
Female	7 (23.3%)	5 (16.7%)
Duration of Fracture (days) (Mean ± SD)	4.76 ± 6.48	2.73 ± 2.08
Duration Range (Min–Max)	1–30	1–7
Single Vertebra Involved	30 (100%)	30 (100%)

The duration of fracture analysis revealed that Group A had a higher mean duration (4.76±6.48 days) compared to Group B (2.73±2.08 days), although both groups had a minimum duration of 1 day.

All patients in both groups had involvement of a single vertebra (100%), with no cases of multi-level involvement observed, ensuring homogeneity of the study population in terms of fracture extent.

Table 2: Operative Outcomes in Study Groups

Variable	Group A (n=30)	Group B (n=30)	p-value
Operative Time (minutes) (Mean ± SD)	44.00 ± 6.87	74.03 ± 9.85	<0.001
Range (Min–Max)	30–60	55–90	
Incision Size (mm) (Mean ± SD)	26.70 ± 3.01	67.86 ± 7.26	<0.001
Range (Min–Max)	20–30	55–80	
Blood Loss (mL) (Mean ± SD)	51.33 ± 12.52	215.33 ± 61.51	<0.001
Range (Min–Max)	30–80	150–400	
Hospital Stay (days) (Mean ± SD)	1.00 ± 0.00	2.60 ± 0.67	<0.001
Range (Min–Max)	1–1	2–4	

Table 3: Gender Distribution and Duration of Fracture in Study Groups

Variable	Category / Parameter	Group A (n=30)	Group B (n=30)
Gender	Male	23 (76.7%)	25 (83.3%)
	Female	7 (23.3%)	5 (16.7%)
Duration of Fracture (days)	Mean ± SD	4.76 ± 6.48	2.73 ± 2.08
	Minimum	1	1
	Maximum	30	7

Table 4: Number of Vertebrae Involved

Vertebrae Involved	Group A (n=30)	Group B (n=30)	Total (n=60)
Single Vertebra	30 (100%)	30 (100%)	60 (100%)

DISCUSSION

Open and percutaneous minimally invasive surgery for thoracolumbar fractures is still a contentious issue. As with open surgery, percutaneous pedicle screws have a similar effect. When it comes to pain and healing after surgery, however, it is stated that PPSF is more gentle on the patient's body and less expensive.[8,9] While PPSF has been linked to both lower and higher financial charges, the results on the economic costs of minimally invasive surgery for thoracolumbar fractures remain in dispute.[8, 10] In this study, we compared open technique with Percutaneous Pedicle Screw Fixation in thoracolumbar Traumatic Fracture. Results showed that mean operative time (Percutaneous: 44.00 vs. Open: 74.03, p-value<0.001), Incision size (Percutaneous: 26.70 vs. Open: 67.86, p-value<0.001), intraoperative bleeding (Percutaneous: 51.33 vs. Open: 215.33, p-value<0.001) and hospital stay was significant shorter for percutaneous technique.

One trial found that the outcome of percutaneous method was significantly better than open surgical technique i.e. intraoperative time 98.4±35.9 vs. 140.3±76.8 min, incision size 7.3±0.3 vs. 11.6±2.3 mm, Intraoperative bleeding 49.3±34.0 vs. 311.5±246.4 mL and Postoperative hospital stay 2.7±3.7 vs. 5.6±10.6 days.[7]

Another trial found that the outcome of percutaneous method was significantly better than open surgical technique i.e. intraoperative time (60±9 vs. 53±10min, p=0.011), Blood loss (331±141 vs. 56±17ml, p-value<0.0001).[6] Both these studies support the results of this study by showing better outcome in terms of operative time, blood loss and postoperative hospital stay with percutaneous pedicle screw fixation.

Xin Wang in his study compared open surgery with Percutaneous minimally invasive surgery for treating thoracic spine fractures. AS per his findings PMIS is more beneficial in decreasing inflammation and blood loss for the treatment of patients with fractures in the thoracic spine.[11] Percutaneous and open pedicle screw fixation without fusion for the treatment of thoracolumbar fractures will be evaluated by Jan Kocis in 2020. He found that both open and percutaneous short-segment pedicle fixation were safe and effective procedures for treating thoracolumbar burst fractures. Type A3 and A4 fractures may benefit from percutaneous treatment without fusion.[12]

A recently published systematic review by Charles Andre Carazzo compared the outcomes of conventional open surgery versus minimally invasive spine surgery (MISS) for the treatment of AO Spine types B and C thoracolumbar injuries. As per his findings, certain advantages were observed with less-invasive procedures, like reduced blood loss and postoperative drainage, as well as decreased postoperative pain. However, for major outcomes, like functional status (mostly assessed with the Oswestry disability index, neurological improvement, and the rate of severe complications, there were no differences between the 2 treatment approaches.[13] In his systematic review and meta-analysis, Feng Tian compared the safety and efficacy of percutaneous short-segment pedicle instrumentation to open short-segment pedicle instrumentation. While percutaneous procedures were superior in terms of postoperative pain, blood loss, operating time and hospital stay compared to open procedures, they had no detectable impact on radiologic outcomes or the frequency of method-related complications. We concluded that percutaneous procedures may be employed in many circumstances to replace prolonged open surgery without increasing related complications, based on our results.[14] Percutaneous pedicle screw spinal fusion was also shown to be associated with a short operation time and little blood loss in patients requiring damage control surgery and elderly patients at high perioperative risk, according to Schmidt et al.[15] However, a number of studies advocated for percutaneous transpedicular screw insertion, despite the fact that this treatment needed more expertise than the standard open method.[16] According to reports, despite an increase in surgical time and blood loss, a wonderful learning curve happened.

The benefits of the percutaneous approach include preservation of the posterior musculature, less blood loss, a shorter surgical time, and a decreased risk of infection. Percutaneous fixation has limitations, including the incapacity to do direct spinal canal fusion and decompression. According to Lehmann et al., the surgeon's expertise in minimally invasive surgery should not be overlooked. Typically, the surgeon who could perform a percutaneous or paraspinal technique was more experienced. As a consequence, these findings may be explained by the peculiarities of these techniques and the surgeons' expertise.[17] Growing evidence is demonstrating that minimally invasive spine surgery (MISS) has become as effective as open surgery at treating thoracolumbar spine trauma, with advantages like less soft tissue disruption, lower infection rates, less blood loss, shorter operative time, less postoperative pain, and reduced length of hospitalisation. [14, 19, 20]

Limitations: This study has several limitations that should be considered while interpreting the results. First, the sample size was relatively small (n=60), which may limit the generalizability of the findings to a broader population. Second, the study was conducted at a single center, which may introduce institutional bias and reduce external validity. Third, although randomisation was performed, potential confounding factors such as fracture severity, bone density, and comorbid conditions were not stratified or adjusted for, which could influence outcomes. Fourth, the follow-up period was limited to immediate perioperative outcomes, and long-term outcomes such as functional recovery, implant stability, and complication rates were not assessed. Additionally, all procedures were performed by a single surgical team, which, while ensuring consistency, may limit the applicability of the results to other settings with varying levels of surgical expertise. Lastly, blinding was not feasible due to the nature of surgical interventions, which may introduce measurement or observer bias.

CONCLUSION

It is concluded that percutaneous pedicle screw fixation is a superior surgical technique compared to open pedicle screw fixation for the management of thoracolumbar traumatic fractures. The percutaneous approach is associated with significantly reduced operative time, smaller incision size, decreased intraoperative blood loss, and shorter postoperative hospital stay.

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