

Original Article

Frequency of Misplacement of Percutaneously Placed Pedicle Screws in Thoracolumbar Fractures

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ABSTRACT

Objective: To determine the frequency of misplacement of percutaneously placed screws in the management of thoracolumbar fractures.

Material and Methods: A descriptive case series was conducted at the Department of Neurosurgery, Punjab Institute of Neurosciences, Lahore. The study comprised all individuals who had minimally invasive percutaneously implanted thoracic or lumbar pedicle screws placed. CT scans were conducted on the patient 24 hours after surgery as part of their usual post-operative care to capture axial pictures to find Pedicular cortical breaches in any direction.

Results: Mean age of the patients was 32 years. 82.7% were male whereas 17.3% were females. We found that the frequency of misplacement was 10.9% in the management of thoracolumbar fractures. 110 patients received 600 pedicle screws placed percutaneously. Of these, 534 screws (89.1%) were ideally placed inside the pedicle. 7% showed minor pedicle penetration, 3.6% showed moderate pedicle penetration and only 0.3% showed severe penetration. Out of misplaced screws (10.9%), 7.3% of patients were between 15 – 40 years, and 3.6% were between 41 – 50 years. Out of misplaced screws (10.9%), 9.7% were male patients and 1.3% were female patients. For thoracic injury, 4.5% of patients suffered from misplaced screws, and for lumbar injury, 6.5% of patients were observed for misplaced screws (p-value: 0.008).

Conclusion: The frequency of misplacement was 10.9% in the management of thoracolumbar fractures. The misplacement rate of the percutaneously placed screw is low. Therefore, we concluded that the percutaneously placed screw is safe to use.

Keywords: Thoracolumbar Fracture, Misplacement, Percutaneous Placed Pedicle Screw.

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Date of Print: 30-06-2023

DOI: 10.36552/pjns.v27i2.871

Date of Submission: 02-05-2023
Date of Revision: 12-06-2023
Date of Acceptance: 25-06-2023
Date of Online Publishing: 30-06-2023

INTRODUCTION

The purpose of this study was to see how frequently percutaneously implanted screws were

misplaced in the treatment of thoracolumbar fractures. One of the most prevalent types of spine injuries is a thoracolumbar fracture. Traditional treatment methods frequently entail open internal fixation (OIF), which can result in significant surgical trauma and blood loss, extending the healing period. Percutaneous pedicle screw fixation (PPSF) has lately become a common method for treating thoracolumbar fractures, with promising results. However, since PPSF has been more widely accepted, pertinent issues such as insufficient reduction and postoperative reduction loss have steadily emerged. Thoracolumbar fractures are the most common axial skeleton fractures, accounting for about 50 – 74% of all fractures. Two-thirds of these fractures occur between the T11 and L2 vertebrae. These injuries are quite painful and nearly one-third of these patients have concomitant spinal cord injury with variable neurological deficits. Such Injuries have a huge impact on patient's quality of life as it leads to prolonged absence from the workplace and cause chronic ongoing pain. Thus thoracolumbar fractures have also a significant socioeconomic impact.¹⁻³

Spinal instability with neurologic impairments can result from traumatic spinal fractures. The bulk of such fractures occurs at the thoracolumbar junction (T11 – L2), owing to regional biomechanics that pits the stiff, kyphotic thoracic spine against the more dynamic, lordotic lumbar spine. Burst fractures are responsible for 30 to 64% of thoracolumbar spinal fractures.⁴ Chapman et al,⁵ found 153 individuals with flexion-distraction-type injuries between 1989 and 2003. Motor vehicle collisions falls, and motorbike crashes were the most common injury mechanisms. Nonoperative care, posterior surgery alone, anterior surgery alone, or combined treatment are among the therapeutic options. Neurologic state, unplanned subsequent procedures, complications, and kyphosis angle were the primary outcomes. Management of

these fractures depends on the individual characteristics of the fractures. Stable fractures can be managed conservatively but unstable fractures need operative intervention. Open pedicular fixation is the conventional treatment done for these unstable fractures.⁶⁻⁷ The significance of proper screw placement in terms of best patient outcomes in terms of a biomechanical construct and decreased morbidity remains crucial. Misplaced pedicular screws provide a risk of harm to neurological, vascular, and visceral tissues, as well as the possibility of durotomies and Pedicular fractures. Misplacement rates for pedicle screws using typical open procedures vary between 5% and 40%. The difference in precision has led to the development of technology adjuncts, most notably intra-operative fluoroscopy and, more recently, computer-assisted 3D navigation, to maintain correct screw placement during surgery.⁸⁻⁹ However, even after using these adjuncts, there is still great variation in the reported misplacement rates of percutaneously placed screws. Previously, it is reported the thoracolumbar misplacement rate in percutaneously placed screws was 2%. However, Hansen et al, in 2015¹⁰ reported a misplacement rate of 9.4% in their study.

MATERIALS AND METHODS

We aimed to determine the frequency of misplacement of percutaneously placed screws in the management of thoracolumbar fractures. Misplaced screws are defined as screw trajectories being located outside the pedicle boundaries. subdivided as minor (< 3 mm), Moderate (3 mm-6 mm), and Severe (> 6 mm) assessed after 24 hours on CT-spine. A Traumatic thoracolumbar fracture means that a vertebra is broken in the thoracic (middle) or lumbar (lower back) region of the spine as a result of trauma to the back, assessed on an X-ray & CT scan.

Study Design & Setting

A descriptive case series was conducted for six months (02.03.2021 to 02.09.2021) after approval of synopsis, at the Department of Neurosurgery, Punjab Institute of Neurosciences (PINS), Lahore.

Sampling Technique & Sample Size

It was determined to use non-probability sequential sampling. A sample size of 110 instances was computed using a 95% confidence level, a margin of error of 5.5%, and a screw misplacement rate of 9.4%.

Inclusion Criteria

All patients male and female between 15 – 50 years of age undergoing percutaneous pedicle screw placement for thoracolumbar fracture will be included in the study.

Exclusion Criteria

All patients undergoing open transpedicular screw fixations were excluded. The cases of pathological thoracolumbar fractures were excluded.

Data Collection & Analysis

Data collection was started after approval of the synopsis by CPSP and the Ethical Review Committee (ERC) of the hospital, on a proforma, by the principal investigator. Informed consent was taken from 110 patients before including them in the study. A detailed demographic (name, age, gender) and contact details were taken. All patients were treated by a single surgeon. All patients undergoing minimally invasive percutaneously inserted thoracic or lumbar pedicle screws were included in the analysis. CT scans were performed 24 hours post-operatively on the patient as part of their routine post-operative care to collect axial images to identify Pedicular cortical breaches in any

direction. Age was presented as mean $\pm$ SD. Gender and misplacement were presented as frequency and percentages. Data was stratified for age, gender, and level of fracture. Post-stratification chi-square test was applied.

RESULTS

110 patients included who fulfilled the inclusion and exclusion criteria to determine the frequency of misplacement of percutaneously placed screws in the management of thoracolumbar fractures.

Age & Gender Distribution

Out of 110 patients, 74.5% (n = 82) were in the age group of 15 – 40 years and 25.5% (n = 28) were in the age group of 41 – 50 years. The mean age was 32.63 ± 8.88 years (**Table 1**). 82.7% (n = 29) were male whereas, 17.3% (n = 16) were females.

Table 1: Distribution of Age (n = 110).

Age Range	Frequency	Percentage
15 – 40 years	82	74.5
41 – 50 years	28	25.5
Total	110	100.0
Mean age $\pm$ SD = 32.63 ± 8.88 years		

Screw Placements

110 patients received 600 pedicle screws placed percutaneously. Of these, 534 screws (89.1%) were ideally placed inside the pedicle. Alternatively, 42 screws (7%) showed minor pedicle penetration, 22 screws (3.6%) showed moderate pedicle penetration and only 2 screws (0.3%) showed severe penetration. We found that the frequency of misplacement was 10.9% (**Table 2**).

Stratification of Misplaced Screws

W.R.T Age, Gender & Level of Injury

The data were stratified for age, gender, and level

of injury (**Tables 3 – 5**), respectively. Out of misplaced screws (10.9%), 7.3% of patients were between 15 – 40 years, and 3.6% were between 41 – 50 years. Out of misplaced screws (10.9%), 9.7% were male patients and 1.3% were female patients. As per the chi-square test, insignificant differences exist for age groups and gender between corrected placed and misplaced screws. For thoracic injury, 4.5% of patients suffered from misplaced screws, and for lumbar injury, 6.5% of patients were observed for misplaced screws. This result was significant (p-value: 0.008).

DISCUSSION

Thoracolumbar spine fractures continue to be a major source of potential morbidity. Treatment advances have reduced the invasiveness of our procedure and, in certain stable cases, removed it entirely.¹¹ Many factors influence how a thoracolumbar rupture fracture is treated surgically. The choice of anterior, posterior, or mixed methods is heavily influenced by fracture shape, neurologic condition, and surgeon preference. With developments in instruments and procedures, short-segment structures using a single-stage approach (anterior versus posterior) have become realistic choices.¹²⁻¹³ The current study aimed to ascertain the prevalence of screw misplacement in the therapy of thoracolumbar fractures. In this study, we found that the frequency of misplacement of percutaneously placed screws was 10.9%. 110 patients received 600 pedicle screws placed percutaneously. Of these, 534 screws (89.1%) were ideally placed inside the pedicle. Alternatively, 42 screws (7%) showed minor pedicle penetration, 22 screws (3.6%) showed moderate pedicle penetration and only 2 screws (0.3%) showed severe penetration.

Raley et al,¹⁴ studied the rate of misplacement

Table 2: Distribution of Misplaced Screws (600 screws).

Correctly Placed Screws	Mal-positioned Screws (n = 66, 10.9%)		
	Minor < 3 mm	Moderate 3 – 6 mm	Severe > 6 mm
n = 534 (89.1%)	42 (7%)	22 (3.6%)	2 (0.3%)

Table 3: Stratification of misplaced screws with respect to patient age.

Age Groups	Misplaced Screw		Total	Chi-Square Test
	Yes n = 66	No (n = 534)		
15 – 40 Years	44 7.3%	403 67.2%	447 74.5%	$\chi^2 = 2.392$ p-value = 0.121 (insignificant result)
41 – 50 Years	22 3.6%	131 21.8%	153 25.5%	

Table 4: Stratification of misplaced screws with respect to patient gender.

Gender	Misplaced Screw		Total	Chi-Square Test
	Yes (n = 66)	No (n = 534)		
Male	58 9.7%	438 73%	496 82.7%	$\chi^2 = 1.406$ P value = 0.235 (insignificant result)
Female	8	96	104	

Table 5: Stratification of misplaced screws with respect to the injury level.

Injury Level	Misplaced Screw		Total	P-value
	Yes (n = 66)	No (n = 534)		
Thoracic	27 4.5%	137 22.8%	164 27.3%	$\chi^2 = 6.88$ P value = 0.0087 (significant result)
Lumber	39 6.5%	397 66.2%	436 72.7%	

and clinical problems associated with percutaneous pedicle screw insertion in the thoracic and lumbar spine. The total perforation rate was found lower than that reported in the literature for the open approach. The rate of

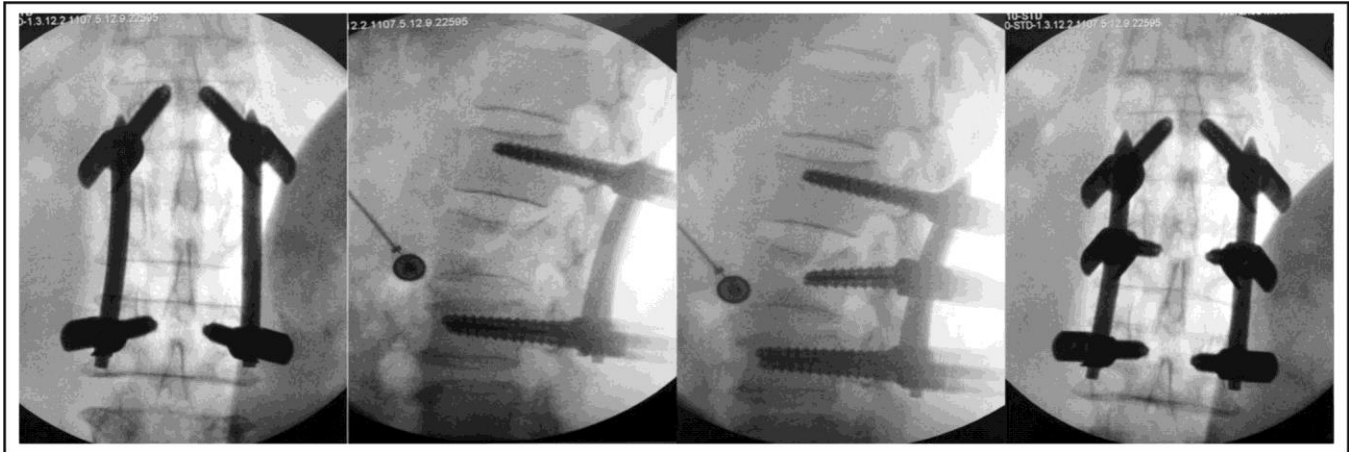


Figure 1: Anteroposterior and lateral X-ray views of pedicle screws.



Figure 2: Correctly placed screws.

complications, including pedicle fracture, were modest. Screw malpositioning is the most often reported complication, with an overall frequency of 0 – 42%. Vascular injuries caused by screw misplacement are potentially life- and limb-threatening consequences that need early detection and quick treatment of vascular lesions

as well as screw relocation. Visceral injuries from pedicle screw insertions are quite uncommon. Inadvertent pneumothorax, effusion, or esophageal damage can develop from the closeness of vertebral bodies to tissues such as the lung and pleura. Screws can break because of a weak anterior column, increasing kyphosis, or pseudoarthrosis. Vascular damage can potentially occur during the corpectomy, graft placement, and screw insertion. In most cases, manual compression or primary healing of the tear is sufficient to address this problem. Visceral injuries and postoperative lymphocystes, also known as chylo retroperitoneum, are infrequent.¹³

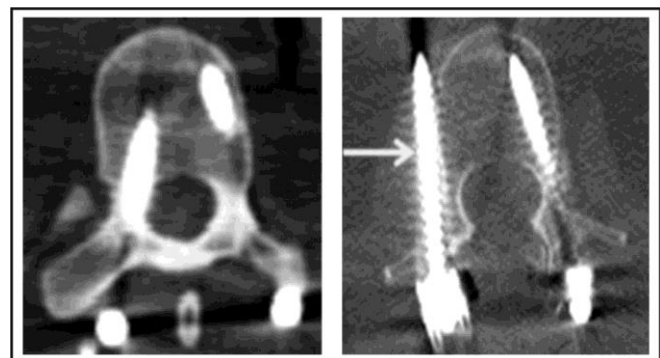


Figure 3: Misspositioned screws.

McCormack et al,¹⁵ reported that, preoperatively, this point system can be used to

predict screw breakage when using short-segment, posteriorly placed pedicle screw implants. According to the findings of Gotzen et al,¹⁶ in thoracolumbar compression fractures Grade II, posterior one-level stabilization and fusion is a recommended surgical treatment. Kaneda et al,¹⁷ concluded that anterior decompression, strut-grafting, and Kaneda device fixation gave satisfactory radiographic and functional outcomes in patients with a thoracolumbar spine burst fracture and accompanying neurological impairments. For the treatment of unstable burst fractures, Sasso et al,¹² reported that both techniques produced initial improvements in sagittal alignment; however, the posterior short-segment group lost this significance at follow-up, whereas the anterior-only group maintained improvement in sagittal alignment at follow-up compared to preoperative measurements. Hitchon et al,¹⁸ thoracolumbar burst fractures patients, and the instrumentation was inserted posteriorly, while in some of the individuals, it was positioned anterolaterally. When the anterior technique is employed, the angular deformity is more successfully repaired and maintained, according to the authors' and others' findings.

Kossmann et al,¹⁹ described the innovative minimal access method to the anterior thoracic and lumbar spine. This open, but minimally invasive, access approach has advantages over "pure" endoscopic spinal surgical treatments. Bühren et al's,²⁰ experience with this minimally invasive stabilizing approach for thoracic spine and thoracolumbar junction injuries established the method's viability. When compared to open surgery, the advantages of minimally invasive surgery were less postoperative discomfort, shorter hospitalization, earlier function recovery, and lower morbidity of the operating technique. Hansen et al,¹⁰ evaluated the accuracy and safety of percutaneous pedicle screws inserted in the thoracic and lumbosacral spine using fluoroscopic guidance. Percutaneous pedicle screw insertion

with fluoroscopic guidance is safe and accurate, equivalent to open pedicle screw insertion procedures. Siebenga et al,²¹ hypothesized that thoracolumbar AO Type A spine fractures without neurologic deficit treated with short-segment posterior stabilization would have a better radiographic outcome and at least the same functional outcome as nonsurgically treated thoracolumbar fractures. When compared to surgical care, individuals with a high level of evidence had equivalent functional results, fewer complication rates, and cheaper costs with conservative management. Furthermore, the posterior techniques have fewer problems than the anterior or combination approaches.⁴

CONCLUSION

The prevalence of misplacement in the care of thoracolumbar fractures was found to be 10.9%. The percutaneously implanted screw has a low misplacement rate. Percutaneous pedicle screw fixation is a safe spinal fixation approach in the treatment of traumatic thoracolumbar fractures.

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Additional Information

Disclosures: Authors report no conflict of interest.

Ethical Review Board Approval: The research was a retrospective study.

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.	Ajlan Ali	Data Calculation and Data Analysis.
3.	Tariq Imran	Interpretation of Results.
4.	Zubair Mustafa	Statistical Analysis.
5.	Muhammad Aqeel Natt	Literature Review.
6.	Asif Bashir	Literature Review and Quality Insurer.