

Comparison of Accuracy of Percutaneous Placement of Thoracolumbar Pedicle Screws with Open Method

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ABSTRACT

Background: A common complication in insertion of pedicle screws by percutaneous or standard open technique is misplacement of screws which can occur through any wall of the pedicle and damage adjacent structures. **Objective:** The purpose of our study is to compare the accuracy of screw placement through either technique, carried out in our setup in traumatic thoracolumbar spine fractures. **Study Design:** Descriptive correctional study. **Settings:** Department of Neurosurgery, SMBB Institute of Trauma, Dow University of Health Sciences, Dr. Ruth K. M. Pfau Civil Hospital Karachi, Pakistan. **Duration:** July 2018 and December 2021. **Methods:** Data of all patients with traumatic single level thoracolumbar fractures undergoing pedicle screw fixation either by percutaneous or open technique with or without decompression between July 2018 and December 2021 was retrieved from hospital records. The study reviewed patient demographics, neurological grading using the ASIA impairment scale, operative notes, and post-operative CT scans. The accuracy of screw placement was evaluated based on axial, coronal, and sagittal images using the Gertzbein-Robbins grading system. Information was collected on a pre-designed proforma and SPSS version 26 was used for the data analysis. **Results:** Total of 260 screws were placed in 65 patients, out of which 88 were placed by percutaneous and 172 by open technique. Although there was a higher incidence of pedicle breach in percutaneous technique (n=10) as compared to open technique (n=10), statistical analysis showed no significant difference (p-value>0.05) between the two techniques. **Conclusion:** Although there is a higher incidence of malposition in pedicle screw placement by percutaneous technique, but the statistical difference in accuracy of screw placement between the two groups is not significant. Also, no relation was found between the rates of misplacement for lumbar and thoracic screws or distribution of the direction of pedicle breach among the groups.

Keywords: Spinal fractures, Minimally invasive surgical procedures, Spinal Fusion / instrumentation, Pedicle Screws / adverse effects.

INTRODUCTION

In spine fractures, around 80% of fractures are thoracolumbar which may cause complete, incomplete or no neurological deficit.¹ Traumatic thoracolumbar fractures may be managed conservatively or may need

surgical intervention which may include decompression of the neural elements along with stabilization through various types of implants.^{2,3}

There has been an increased popularity of minimally invasive technique in spinal surgery than standard open

posterior approach in thoracolumbar region because of lesser blood loss, muscular dissection, risk of infection, post-operative pain and decreased hospital stay.⁴ On the other hand, surgeries with minimal invasive techniques have more exposure to ionizing radiations which can be reduced by electromagnetic and robotic navigation.^{5, 6} There has always been a challenge to master the accuracy of percutaneous screw placement since its introduction by Fedrich P. Magerl in 1977.⁷

Since its introduction in 1977, minimally invasive techniques for fixation of spine fractures have gained popularity due to their decreased per-operative dissection. A common complication in insertion of pedicle screws is misplacement which can occur through any wall of the pedicle and damage adjacent structures. It is widely recognized that the misplacement of screws using either the traditional open technique or the percutaneous method can reach up to 35%.⁸⁻¹⁰ The purpose of current study was to compare the accuracy of percutaneous screw placement with open method carried out in our setup in traumatic thoracolumbar spine fractures.

METHODS

This descriptive correctional study was done at Department of Neurosurgery, SMBB Institute of Trauma, Dow University of Health Sciences, Dr. Ruth K. M. Pfau Civil Hospital Karachi, Pakistan.

Data of all patients with traumatic single level thoracolumbar fractures undergoing pedicle screw fixation either by percutaneous or open technique with or without decompression between July 2018 and December 2021 was retrieved from hospital records.

Patients who did not have a post-operative CT scan were excluded. After taking informed consent the patients were divided in two groups. For the Surgical Procedure for percutaneous pedicle screw placement: the patient was kept in prone position, C-arm positioned to true AP and incision was given at lateral border of pedicle at desired level.

Jamshidi needle was kept at middle of lateral border of pedicle and parked. Placement was confirmed on lateral view (figure 2) and pedicle crossed under image guidance into the vertebral body. Guidewire inserted (figure 3) and Jamshidi needle removed. Entry point for tapping was made with awl, pedicle was tapped and appropriate size screw was placed. Rods were inserted and distraction done, if needed. Screw heads were tightened and skin was approximated. For Open Pedicle Screw Fixation: the patient was kept in prone position. Exposure of the bony elements was done via a vertical midline incision.

Awl was placed at the junction of superior articular process and transverse process of desired vertebral levels. Trajectory was confirmed with C-arm, awl inserted at entry point followed by pedicle finder and tap. Ball tipped probe was used to assess for any breach in pedicle. Appropriate size polyaxial head screws were carefully inserted. Rods were placed and distraction, if needed, was done. Screw heads were tightened and wound was closed. Patient demographics, neurological grading via ASIA impairment scale, operative notes and post operative CT scan were reviewed and data was recorded on pre-designed proforma.

Accuracy of placement was noted for all screws on axial, coronal and sagittal images according to Gertzbein-Robbins grading. Frequency and percentages were calculated for all categorical variables and mean was calculated for numerical values. Comparison was done using chi-square test and p-value of <0.05 was considered to be clinically significant.

RESULTS

In this study a total number of 65 patient out of which 44 were male with mean age being 39.5 years. Majority of patients had ASIA grade of A and B. First lumbar vertebra was the most common fracture site followed by 12th thoracic vertebra.

Screws were placed by percutaneous and open technique in 22 and 43 patients respectively. Total of 260 screws were placed out of which 88 by percutaneous and 172 by open technique with most of screws (80) being placed in 2nd lumbar vertebra.

In open technique, 161 (93.6%) screws while 78 (88.6%) screws from the percutaneous technique were completely inside the pedicle (Grade 0). 1 screw from the percutaneous technique was completely out of the pedicle (Grade 3).

Although there was a higher incidence of pedicle breach in percutaneous technique (n=10) as compared to open technique (n=10), statistical analysis showed no significant difference (p-value>0.05) between the two techniques.

A relatively higher incidence of medial (6.8% vs 3.5%), lateral (3.4% vs 1.7%) and superior (1.2% vs 1.1%) penetration was observed in the percutaneous pedicle screw fixation group as compared to open technique but this was not found to be statistically significant (p-value=0.521). (Table 1)

Among 91 screws inserted in dorsal vertebrae, only 3 (3.3%) were found to be misplaced compared to 18 screws out of 169 (10.6%) inserted in the lumbar vertebrae, however this relation was also found to be statistically

insignificant (p-value=0.569). This relation was found to be insignificant even when the two surgical techniques were considered individually.

Figure 1: Frequency of level of vertebral fracture

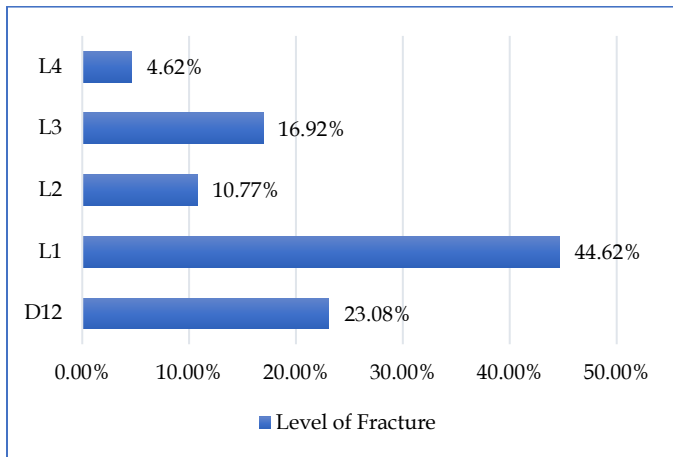


Figure 2: Number of screws placed by open and percutaneous technique according to vertebral level

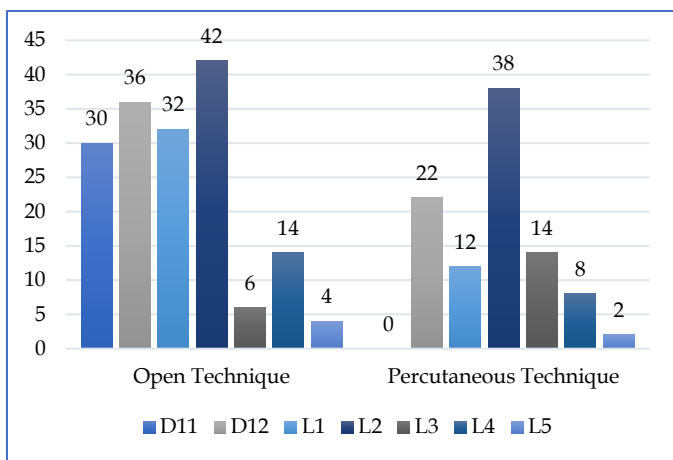


Figure 3: Frequency of grades of pedicle breach in open and percutaneous technique

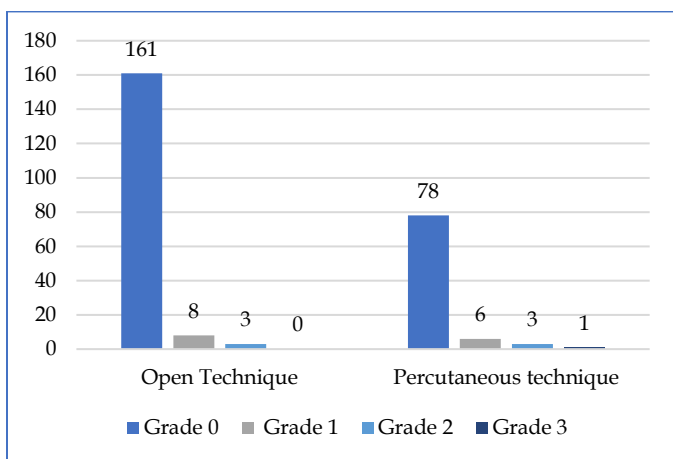
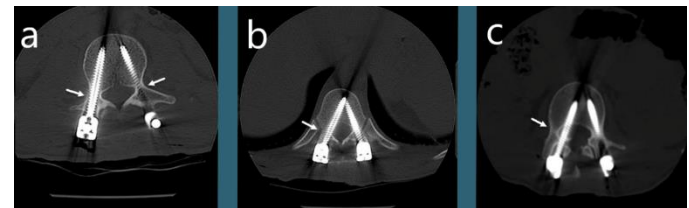


Table 1: Side of pedicle penetration and grade with open and percutaneous technique

Penetration side	Open Technique			Percutaneous Technique		
	Grade I	Grade II	Grade III	Grade I	Grade II	Grade III
Medial	4	2	0	4	1	1
Lateral	2	1	0	2	1	0
Superior	2	0	0	0	1	0

Figure 4: Axial CT scan showing (a) ideal screw placement (Grade 0), (b) Cortical encroachment more than 2mm (Grade 2), (c) screw entirely outside the pedicle (Grade 3)



DISCUSSION

The rate of misplacement of pedicle screws is a major factor when assessing a surgical technique of spine fixation. Spinal instrumentation surgeries have many variations, which is also evident in the numerous studies published with regards to the misplacement rates. It is important to highlight that screw misplacement refers to the deviation from the optimal location of the screw rather than being a complication that occurs after the surgery. Such deviation does not necessarily lead to harm for the patient. In fact, many screws that are laterally misplaced are considered safe and their position does not raise significant concerns. What could be potentially alarming are the medially misplaced screws that may cause neurological injury. The literature includes a strong consensus that misplacement of screws be assessed in increments of 2mm.¹¹

By utilizing multidimensional CT scan in the post-operative phase of the study, it became possible to assess screw misplacement in various directions. The extent of deviation in screw misplacement is an important consideration when evaluating its clinical significance. Out of the screws assessed in this series (21 in total), slightly more than half (14 screws) had a misplacement of 2 mm or less. It should be noted that screws placed in a medial direction have a higher likelihood of affecting the nerves and dura within the spinal canal, making them potentially riskier. The study revealed that screws misplaced in the medial direction were more common than those misplaced laterally. In previous studies on percutaneous screws in the lumbar region, it was also noted that medial misplacement occurred more

frequently, while other studies found no significant preference for medial or lateral misplacement.^{12, 13}

None of the screws required to be repositioned and there were no post-op complications related to the misplacement suggesting that this higher misplacement rate may not necessarily cause any harm, adding to the evidence that misplaced screws seldom cause morbidity.¹⁴ Literature review shows dorsal spine to have an increased rate of misplacement, likely due to shorter, thin pedicles compared with lumbar vertebra. However, our study did not find such relationship.

Novel techniques to reduce the incidence of malposition like use of O-arm and robotic arms with navigation to guide placement of screws are being increasingly applied. They have higher rates of accuracy as compared to conventional c-arm.^{15,16} However due to increased cost of these systems their use is not widespread.

There have been conflicting results in the literature regarding accuracy of percutaneous screws. But most of the studies support that accuracy is similar to that of open technique. Therefore, based on our results as well we do not consider percutaneous pedicle screw placement to have more risk of malposition than open procedure. The accuracy of percutaneous placement of thoracolumbar pedicle screws with an open method may be limited by several factors. The size and shape of the pedicle can vary from patient to patient, making it difficult to accurately place the screws.

The accuracy of pedicle screw placement is highly dependent on the surgeon's skill and experience. Inexperienced surgeons may struggle to accurately place screws, leading to potential complications such as nerve injury, spinal cord damage, or implant failure. Overall, while the accuracy of percutaneous placement of thoracolumbar pedicle screws with an open method may be limited by various factors, careful consideration of patient and surgical factors and the use of appropriate techniques and instrumentation can help improve the accuracy of screw placement and reduce the risk of complications. Larger studies with a sufficient number of patients are needed to further evaluate the accuracy and effectiveness of this technique.

CONCLUSION

There has been observed to be a higher incidence of malposition in pedicle screw placement by percutaneous technique, but the statistical difference in accuracy of screw placement between the two groups is not significant. Also, no relation was found between the rates of misplacement for lumbar and thoracic screws or distribution of the direction of pedicle breach among the groups.

LIMITATIONS

In addition to the factors mentioned previously, another limitation of studying the accuracy of percutaneous placement of thoracolumbar pedicle screws with an open method is the often-limited sample size of studies. This can make it challenging to draw definitive conclusions regarding the accuracy of this technique.

SUGGESTIONS / RECOMMENDATIONS

To address this limitation, larger studies with a sufficient number of patients should be conducted to assess the accuracy of percutaneous placement of thoracolumbar pedicle screws with an open method. Additionally, studies should be designed to compare this technique to other surgical methods for spinal stabilization, such as open or minimally invasive techniques, to determine the optimal approach for each individual patient.

CONFLICT OF INTEREST / DISCLOSURE

None.

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