

## ORIGINAL ARTICLE

# Incidence of Misplaced Pedicle Screw in Free Hand Technique in Spine Fixation Patients

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## ABSTRACT

**Objective:** To evaluate the frequency of pedicle screw displacement during free-hand technique in spinal fixing

**Material & Methods:** This retrospective prospective study was carried out at Department of Neurosurgery Lady Reading Hospital Peshawar from June 2021 to December 2021. Total 90 patients were included. The screws were implanted utilising a free-hand placement technique. Facet joints and transverse processes were among the anatomical landmarks that were revealed. According to the level approached, the pedicle screw's entry location was selected. The insertion was done medially to the intersection of the origin of the transverse process and the lamina in the proximal thoracic spine and laterally to the pars interarticularis (T1 to T3).

**Results:** 90 people in all were included in the trial. With a mean age of 37.5 years, the age varied from 15 to 60 years. Male to female ratio was 2:1, with 60 (66.7%) males and 30 (33.3%) females. Pedicle screws totaling 540 were inserted. 310 (57.4%) of the screws were placed at the lumbar spine, followed by 198 (36.7%) at the thoracic spine and 32 (5.9%) at the sacral spine.

**Conclusion:** Pedicle screw cortical violation was found to be very high. Small pedicle breaches, however, have the potential to cause neurological lesions that can be reversed if the misaligned screws are fixed.

**Keywords:** Freehand technique, Pedicle screw fixation, Spinal fracture

## INTRODUCTION

For thoracic and lumbar spine arthrodesis, free hand pedicle screw fixation is a well-known surgical technique.<sup>1</sup> The vertebral pedicle is surrounded by significant anatomical features, so this technique demands extreme precision when approaching and positioning the pedicle screw.<sup>2,3</sup> It offers great stability to the spinal fusion carried out utilising the posterior technique and is employed in the treatment of various diseases. Mistakes made during the procedure could result in pedicle fractures, neurological, vascular, or visceral damage, among other consequences.<sup>4,5</sup>

There are many other approaches that have been detailed in contemporary literature, but free hand techniques stand out since they may be used anywhere, especially in underdeveloped countries where there is a lack of technology.<sup>6,7</sup>

Many spine surgeons frequently do freehand pedicle screw placement in spine surgery, which is thought to be both safe and effective.<sup>8</sup> However, there is no one unique or uniform technique, and there are significant discrepancies among studies that may not give easily reproducible characteristics. Additionally, other procedures have detailed a variety of entry locations and trajectories based on the spinal level or region.<sup>9</sup>

This study's objectives were to analyse the prevalence of improperly positioned pedicle screws using free hand technique and the relationship between neurological damage and the margin of error in screw placement.

## METHODS

This retrospective prospective study was carried out at Department of Neurosurgery Lady Reading Hospital Peshawar from June 2021 to December 2021. Total 90 patients were included. The screws were implanted utilising a free-hand placement technique. Facet joints and transverse processes were among the anatomical landmarks that were revealed. According to the level approached, the pedicle screw's entry location was selected. The insertion was done medially to the intersection of the origin of the transverse process and the lamina in the proximal thoracic spine and laterally to the pars interarticularis (T1 to T3). The entrance site is located medially, lateral to the pars interarticularis, and at the point where the middle thoracic spine's lamina and upper facet meet the proximal part of the transverse process (T4 to T9). The entrance

point for the screw in the lumbar spine is where the vertical line connecting the middle and lateral thirds of the superior articular process and the line traversing the middle half of the transverse process meet. This is where the screw's route in the lower thoracic spine (T10 to T12) begins.

Monoaxial and polyaxial titanium pedicle screws with diameters ranging from 4.5 to 6.5 mm and lengths determined by intraoperative measurements were used. The size of the implants was established by the patients' preoperative tests. During surgery, an image intensifier tool was used to see the screws.

Standard CT scans were performed while the patient was supine, using 2-mm slices in the sagittal, axial, and coronal planes that were parallel to the pedicles. We want to examine the pedicle screws' placement in relation to the possibility of pedicular cortical injury from the screw in free hand technique. If discovered, the cortical implant's penetration was measured in millimetres. The measurement of pedicle breaches in any cortical bone took into account three factors: none, up to 2 mm, and larger than 2 mm.

A second observer conducted a neurological assessment on the patients they had chosen in the first ten days after surgery, judging neurological injuries different from those at the time of the patient's admission to be new. These data were then displayed to determine whether there could be a connection between the damage and the screw location. Using SPSS 23.0, statistical analysis was carried out.

## RESULTS

90 people in all were included in the trial. With a mean age of 37.5 years, the age varied from 15 to 60 years. Male to female ratio was 2:1, with 60 (66.7%) males and 30 (33.3%) females. Figure-i

Pedicle screws totaling 540 were inserted. 310 (57.4%) of the screws were placed at the lumbar spine, followed by 198 (36.7%) at the thoracic spine and 32 (5.9%) at the sacral spine. Figure-ii

160 (29.6%) of the screws were found to be breaching some pedicle cortex during tomography examination. These breaches happened in the pedicle's lateral cortex in 50 (31.2%), medial cortex in 87 (54.4%), inferior cortex in 10 (6.2%), superior cortex in 4 (2.5%), and anterior cortex in 9 (6.6%) of the implants. Figure-iii

Minor breaches were only detected by postoperative imaging and didn't require relocation. Due to their strong individual holding

capacities, 4 (2.5%) screws with a partially misdirected course towards the disc space were not disturbed. After surgery, there was no repositioning done. There were no vascular complications, CSF leaks, spinal canal breaches, or iatrogenic nerve root injury.

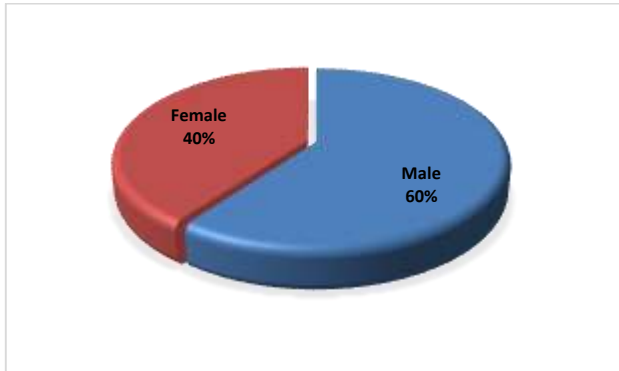


Figure-1: Gender wise distribution

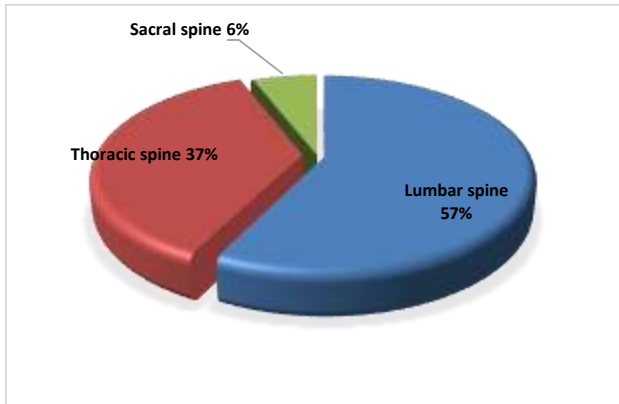


Figure-2: Site of Placement

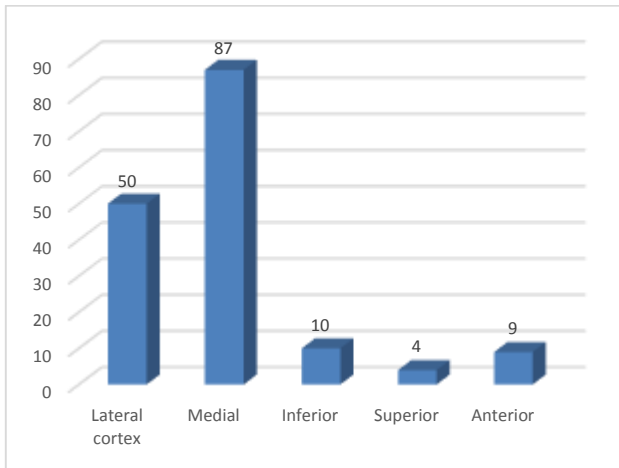


Figure-3: Misplaced screw location

**DISCUSSION**

The understanding of the potential morbid power of the anterior surgical route for thoracolumbar fusions was one of the factors that drove the spread of the thoracolumbosacral spinal fusion technique employing a completely posterior approach and pedicle screws. Direct pedicle palpation during screw positioning, which is frequently used by surgeons, makes it possible to feel cortical extravasation throughout its course, especially in ruptures greater

than 2 mm.<sup>10,11</sup> However, a procedure has a learning curve, thus even when dealing with skilled surgeons, this study was hampered when a trainee participated in the location of the implants. With maturity during surgery, there is a greater chance that these pedicle defects will be identified before the implant is implanted and that it may be modified at the same time.<sup>12</sup>

Inadequate placement of the pedicle implants has been linked both directly and indirectly to serious issues like infection, pneumothorax, chylothorax, pleural effusion, pleural damage, dura-mater damage, pedicle fracture, implant loosening, and paraparesis.<sup>13</sup> Xu R et al concluded that there is a zone of up to 4 mm in the medial pedicle that is considered safe, which equates to 2 mm of the subarachnoid space.<sup>14</sup> In the most recent research, extravasation of the medial cortex up to 2 mm is usually recognised as safe. The lateral cortex might breach by up to 6 mm if the in-out-in technique is used, without any clinical consequences. Due to their intrinsic flexibility, pedicles of paediatric patients may sustain screws up to 115% without causing cortical damage.<sup>15</sup>

In our study poor placement was found in 29.6% of pedicular implants, which is lower than 79% rate concluded by Polly DW et al,<sup>16</sup> however comparable with the results by Magerl et al of 23%.<sup>17</sup> The literature found inconsistent results for the breach's position, which was medial in 14–30% of instances and lateral in 60–68%.

In this study, lateral ruptures affected 31.2% of the screws, and medial ruptures affected 54.4% of the screws. The outcomes differ significantly from one another. The studies mentioned above, however, link the thoracic and lumbar vertebrae separately, a subject that these authors did not cover.

This research showed no correlation between neurological symptoms and the physically improper position of the implant, but did show a statistical correlation between the breach and the existence of postoperative neurological alterations. It might be argued that the vertebrae most prone to pedicle screw misalignment were L1, T12, and T10, in that order. However, when comparing the breaches across identical vertebrae, this judgement does not hold true, which might be explained by the fact that many vertebrae only got a few screws during these surgeries and that their placement mistake was overstated. From vertebrae T5 to T8, this index did not rise, according to prior studies.<sup>18</sup> However, when comparing the breaches across identical vertebrae, this judgement does not hold true, which could be explained by the fact that many vertebrae only got a few screws during these surgeries and that their positioning mistake was overstated.

There were no difficulties in our series, which is consistent with the great majority of studies in the literature that reported no neurological or vascular concerns following freehand insertion of thoracic screws. In their case series, which included both thoracic and lumbar procedures, the incidence of durotomies was 4.3%, indicating that the overall complication rate following freehand pedicle screw placement was low.<sup>19</sup> Kim YB et al evaluated the outcomes of almost 3,000 screws inserted by eight different surgeons and found a generally low complication rate, further demonstrating the safety of the method.

Although free hand screw placement techniques are often used, adopting one approach might be challenging for a spinal surgeon or trainee because there aren't many published publications that describe the specific technical details. The fact that each level of the spine has a unique beginning point and/or trajectory further complicates matters.<sup>20</sup>

**CONCLUSION**

Pedicle screws that were ruptured utilising a freehand approach were very common, especially with regard to medial injuries. However, with improved pedicle implant placing, such misalignment might be recoverable. To support the theories put forth at this time, a larger sample of this test's results must be evaluated.

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