Evaluating the Accuracy of Preoperative CT in Predicting Maximal Pedicle Screw Size for Lumbar Fusion

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INTRODUCTION:

Computed tomography (CT) is the gold standard for preoperative planning in lumbar spinal fusion, offering insights for optimizing pedicle screw dimensions. Although previous studies have examined the accuracy of screw placement, the ability of CT to predict the maximal pedicle screw size is still not well studied. Additionally, there is a paucity of literature investigating the concept of pedicle expansion with screw placement. The aim of this study is to evaluate whether lumbar pedicles can safely accommodate larger pedicle screws than those suggested by preoperative CT to and assess the accuracy of different CT imaging planes for optimal screw selection.

METHODS:

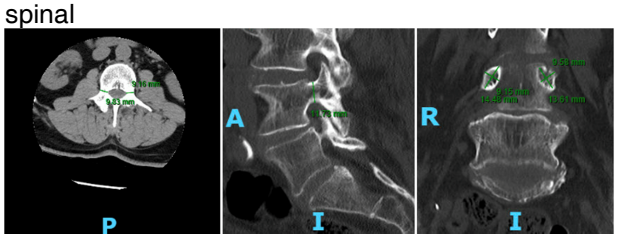
A retrospective cohort study analyzed patients undergoing primary one-level minimally invasive transforaminal lumbar interbody fusion (MI-TLIF) by a single surgeon between 2020 and 2023. Pedicle width, height, and width + height were measured on axial, sagittal, and coronal CT views preoperatively and postoperatively. Nonparametric statistical analyses were employed: Wilcoxon signed-rank tests compared pre- and postoperative changes at vertebral levels L3–L5, while Mann-Whitney U tests assessed differences in width and height measurements between imaging planes (axial vs. coronal for width; sagittal vs. coronal for height).

RESULTS:

Twenty patients and eighty screws/pedicles were evaluated. Significant differences between preoperative and postoperative pedicle widths were seen at L3 ($p=0.036$), L4 ($p<0.001$), and L5 (<0.001) on CT axial view and at levels L3 ($p<0.012$), L4 ($p<0.001$), and L5 ($p<0.001$) on CT coronal view. Differences in preoperative and postoperative pedicle heights were seen at levels L4 ($p=0.002$) and L5 ($p<0.001$) on CT sagittal view and at L4 on CT coronal view. Width and height measurements were significantly different between axial vs coronal views ($p<0.001$) and sagittal vs coronal views ($p<0.001$) preoperatively and postoperatively.

DISCUSSION AND CONCLUSION:

The observed discrepancies across CT imaging planes suggest that traditional axial and sagittal views may underestimate pedicle dimensions, potentially leading to suboptimal screw selection. Coronal views, which better capture the pedicle's elliptical cross-section, may provide a more accurate "working window" for screw trajectory and may be beneficial in preoperative planning. Undersized screws, associated with reduced pullout strength and revision risks, could be mitigated by integrating multiplanar CT data or applying correction factors during preoperative planning. Further research is warranted to validate correction factors and explore 3D modeling techniques for precision screw diameter selection in spinal fusion procedures.



View	Level	Preop	Postop	p-value
Axial				
	L3	9.76 ± 2.20	10.40 ± 1.69	**0.036**
	L4	10.99 ± 1.42	12.97 ± 1.15	**<.001**
	L5	14.05 ± 1.58	15.51 ± 1.43	**<.001**
	Overall	12.23 ± 2.28	13.87 ± 2.12	**<.001**
Sagittal				
	L3	11.90 ± 1.22	12.54 ± 1.41	0.161
	L4	12.53 ± 1.77	13.27 ± 1.67	**0.002**
	L5	12.40 ± 1.40	13.83 ± 1.44	**<.001**
	Overall	12.41 ± 1.56	13.44 ± 1.59	**<.001**
Coronal (W)				
	L3	10.70 ± 2.42	12.25 ± 2.04	**0.012**
	L4	10.65 ± 1.84	12.66 ± 1.47	**<.001**
	L5	11.57 ± 1.64	13.28 ± 1.72	**<.001**
	Overall	11.06 ± 1.85	12.88 ± 1.66	**<.001**
Coronal (H)				
	L3	14.60 ± 2.22	15.45 ± 2.06	0.069
	L4	16.06 ± 1.95	17.05 ± 1.71	**0.015**
	L5	19.04 ± 3.18	18.64 ± 2.90	**0.66**
	Overall	17.23 ± 3.05	17.56 ± 2.54	**0.079**