



Original Article

Comparison of the accuracy of intraoperative lateral fluoroscopy versus postoperative computed tomography in spinal fusions

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ABSTRACT

Background: This study compared the accuracy of intraoperative lateral fluoroscopic images versus postoperative computed tomography (CT) 3D studies in the treatment of thoracolumbar spinal fusions.

Methods: In a tertiary care hospital (study duration 6 months), we compared the use of lateral fluoroscopic images with the postoperative CT scans in 64 patients with thoracic or lumbar fractures undergoing spinal fusions.

Results: Out of the 64 patients, 61% were lumbar followed by 39% thoracic fractures. In the lumbar spine, the accuracy of screw placement utilizing lateral fluoroscopy versus postoperative CT 3D was 97.4%, while in thoracic spine, accuracy was reduced to 84.4%. Of the 64 patients, just 4 (6.2%) patients demonstrated lateral pedicle cortex penetration, 1 (1.5%) patient had a medial pedicle cortex breach, while none exhibited anterior vertebral body cortex penetration.

Conclusion: This study documented the efficacy of lateral fluoroscopy in intraoperative thoracic and lumbar spinal fixation as confirmed by postoperative CT 3D studies. These findings support the continued use of fluoroscopy rather than CT intraoperatively to lower the risk of radiation exposure to both patients and surgeons.

Keywords: Computed tomography 3D, Lateral fluoroscopy, Spinal fixations, Transpedicular screws, Traumatic spinal injuries

INTRODUCTION

Traumatic spinal injuries are a common cause of morbidity and mortality in young adults, resulting in a major personal disability. Surgical approaches typically include spinal decompressions and transpedicular screw placement to address thoracic and/or lumbar fractures. Numerous navigation systems have been developed to improve the precision of pedicle screw placement and decrease the risk of neurovascular injury.^[7] The risk of screw misplacement is greatly reduced when intraoperative fluoroscopy is used, especially in the anteroposterior position.^[6] The risks of pedicle medial/lateral violation need to be ruled out for proper transpedicular screw fixation which is best confirmed on CT 3D reconstruction.^[1] Here, in 64 patients with thoracic or lumbar fractures undergoing instrumented fusions, we compared the accuracy of utilizing intraoperative lateral fluoroscopy with postoperative CT 3D navigation.^[8]

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MATERIALS AND METHODS

Study design

This prospective cross-sectional study performed over 6 months, looked at 64 patients with traumatic thoracic or lumbar fractures who underwent pedicle screw fixation utilizing intraoperative lateral fluoroscopy. Postoperatively, the accuracy of pedicle screw placement was evaluated with CT 3D studies.

Clinical data

There were 64 patients included in our study; 87.5% were male (*n* = 56) while 12.5% were female (*n* = 8), with ages predominantly <30 years (90.6%) [Table 1]. The most common injuries included; falls (67.2%), traffic accidents (28.2%), and other causes of trauma (4.6%). The majority were lumbar (61%) (*n* = 39) followed by thoracic (39%) (*n* = 25) fractures.

Radiological evaluation

Anteroposterior, lateral radiographs of the spine, computed tomography (CT) 3D scans, and magnetic resonance imaging were done in all patients preoperatively. Intraoperatively, only

lateral fluoroscopic guided screw fixation was performed with a C-arm [Figure 1]. To determine the accuracy of pedicle screw placement, all patients underwent postoperative CT 3D scans to confirm the accuracy of surgical screw placement. In addition, any breaches of the anterior, medial, or lateral pedicle walls were graded according to the Gertzbein and Robbins classification.^[4]

Statistical analysis

Statistical analysis was performed using SPSS version 23.

RESULTS

Accuracy of screw placement

Comparison of lateral fluoroscopic screw placement versus postoperative CT 3D showed that accuracy in lumbar region was 97.4%, while it was 84% in the thoracic region [Table 2].

CT 3D Documentation of operative pedicle breaches

While evaluating pedicle screw placement according to the classification system described by Gertzbein and Robbins using postoperative CT 3D, 95.5% of patients had adequate screw placement under lateral fluoroscopic guidance, while 4.6% had inadequate screw placement. In the thoracic spine, two of 25 (8%) had minor breaches, one of 25 (4%) had moderate displacement, and one out of 25 (4%) had severe displacement. In lumbar region, 39 (2.5%) had a minor perforation, while there were no moderate or severe screw displacements.

Locations of breaches

The total number of cases with any breach was 5 (7.8%); 1 (1.5%) had a medial wall breach while 4 (6.25%) had lateral wall breaches [Table 3]. A minor perforating medial wall breach occurred in one of 25 (4%) patients undergoing thoracic screw placement, but none were found following

Table 1: Demographic characteristics of patients included in our study.

Characteristic	Subcategory	Number	Percentage
Age	<30 years	58	90.6
	>30 years	6	9.3
Gender	Male	56	87.5
	Female	8	12.5
Mechanism of injury	Fall from height	43	67.2
	RTA	18	28.2
	Miscellaneous	3	4.6
Site of fracture	Thoracic	25	39
	Lumbar	39	61

RTA: Road traffic accident

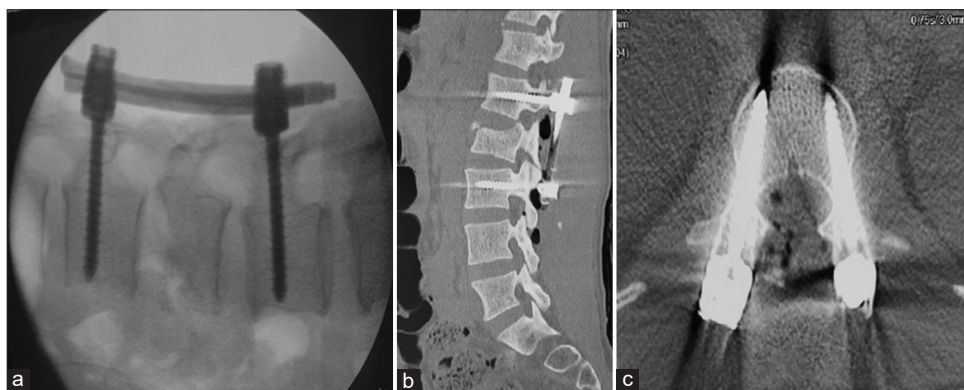


Figure 1: Intraoperative lateral fluoroscopic view of screw placement (a), postoperative sagittal (b), and axial (c) views of CT scan showing placement of transpedicular screws.

Table 2: Placement of screws according to size of screws used and accuracy.

Characteristic	Subcategory	Number	Percentage
Size of screws used	Adequate	61	95.4
	Inadequate	3	4.6
Placement of screws	Correct placement	59	92.1
	Incorrect placement	5	7.9
Accuracy of screws	Thoracic	21	84
	Lumbar	38	97.4
Breach	Medial	01	1.5
	Lateral	04	6.25

Table 3: Description of breach by screws according to the vertebral level.

Screw placement	Thoracic n=25 (39%)	Lumbar n=39 (61%)
Correctly placed	84%	97.4%
Minor breach		
Medial	1	0
Lateral	1	1
Moderate breach		
Medial	0	0
Lateral	1	0
Severe displacement		
Medial	0	0
Lateral	1	0

n: Number

the placement of lumbar screws. Of lateral wall breaches, only one was found in the lumbar region and three were in the thoracic region [Figure 2]. Notably, no patient required secondary surgery for pedicle screw misplacement, because there was no new neurological deficit.

Surgical complications

There were few surgical complications encountered in our studied patients [Figure 3]. Following thoracic pedicle screw placement, two of 25 (8%) patients had intraoperative dural tears, with one additional patient (4%) experienced a postoperative cerebrospinal fluid (CSF) leak. Complications following lumbar screw placement included 1 instance (i.e., one of 39 patients or 2.5%) had intraoperative dural tears (i.e., without postoperative CSF leaks), 1 (2.5%) postoperative hematoma, and 1 (2.5%) postoperative infection.

DISCUSSION

Our study showed a trend of better accuracy for pedicle screw placement in the lumbar (97.4%) versus thoracic spine (84%). Jing *et al.*, using the Gertzbein-Robbins scale grade, found that 90% of screws in the freehand group and 95.8% of the screws in the navigation group were accurately

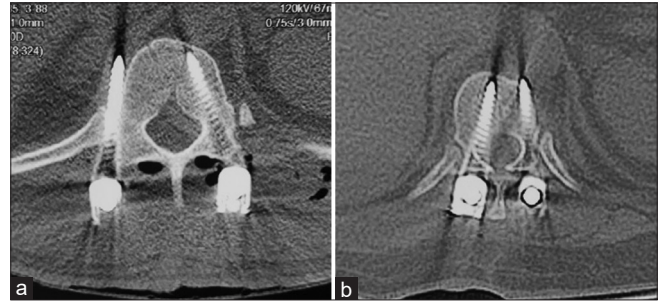


Figure 2: Postoperative CT 3D axial views to document a lateral breach of the right-sided screw (a) and a medial breach of the right-sided screw (b).

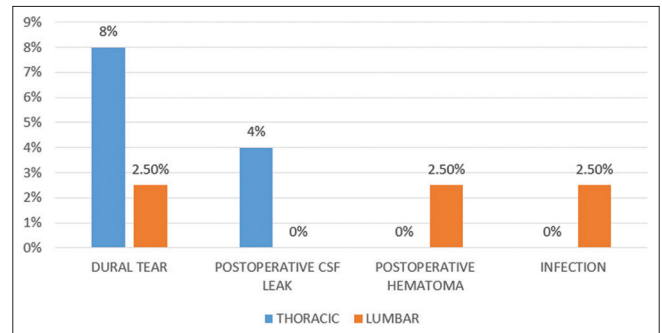


Figure 3: Postoperative complications observed in our studied patients.

placed.^[5] García-Fantini and De Casas noted that using traditional fluoroscopy, there was a 96.6% (226 PSs) accuracy for pedicle screw placement versus 99.3% (572 PSs) in the 3D fluoroscopy (grades 0 and 1).^[3]

Nevertheless, Jing *et al.* evaluated the placement of thoracolumbar screws using O-arm-based navigation versus conventional freehand technique and found that in the thoracic spine only 2 (2.3%) of 86 screws in the navigation group versus ten of 87 (11.4%) screws in the freehand group were inaccurately placed.^[5]

Pedicle breaches

We found 6.25% patients had lateral breach, all of them in the thoracic region (12%). Rampersaud *et al.* reported pedicle breaches in 31.6% (25 out of 79 screws) of all 2D-guided thoracic screw placement with 72% of pedicle breaches being lateral.^[9] Fichtner *et al.* noted that repeated surgery was warranted for 1.35% (15/1112 patients) of screws placed by IsoC-3D navigated fluoroscopy versus 4.38% (49/1120 patients) placed with conventional fluoroscopy (i.e., for malpositioned screws without neurological complications being 50% of both groups).^[2] In our series, no patient required secondary surgery attributed to malpositioning of screws and/or their contribution to new neurological deficits.

CONCLUSION

For 64 patients with thoracic or lumbar fractures undergoing intraoperative placement of pedicle screws, fluoroscopic guidance proved highly accurate (i.e., lumbar [97.4%] and thoracic [84%]) as corroborated on postoperative CT 3D studies.

Declaration of patient consent

The Institutional Review Board (IRB) permission obtained for the study.

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Conflicts of interest

There are no conflicts of interest.

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