Section: Orthopaedics

Original Research Article

A STUDY OF POSTOPERATIVE CT EVALUATION OF PEDICLE SCREW PLACEMENT DONE BY FREE HAND TECHNIQUE

Manikandan M[1], Vikram M[2], Anjan Ramachandranath V[3], Suganthan[4]

[1]Assistant Professor, Department of Orthopaedics, Government Villupuram Medical College, India.
[2]Assistant Professor, Department of Orthopaedics, Government Villupuram Medical College, India.
[3]Associate Professor, Department of Orthopaedics, Government Villupuram Medical College, India.
[4]Junior Resident, Department of Orthopaedics, Government Villupuram Medical College, India.

Received : 30/10/2025
Received in revised form : 08/12/2025
Accepted : 27/12/2025

Keywords:
Pedicle screw, Free hand technique, CT evaluation, Spine.

Corresponding Author:
Dr. Manikandan M,
Email: drmani89903ortho@gmail.com

DOI: 10.47009/jamp.2026.8.1.154

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2026; 8 (1); 806-809

ABSTRACT

Background: Pedicle screw misplacement in spine surgeries leads to many complications include nerve root injury, CSF leak, pedicle fracture, screw fatigue, screw breakage (Adnan A. Faraj et al., 1997).[1] So, we are involved in reducing pedicle screw breaches with use of Computed Tomography images taken preoperatively to know the vertebral anatomy and to minimize the breaches based on it. **Aim:** The aim of this study is to know the effectiveness of free hand technique in pedicle screw fixation done with CT evaluation and to assess the placement of screws relating to spinal canal and neural foramen. **Materials and Methods:** In this study, 28 patients who had been planned for pedicle screw instrumentation, the pedicle dimensions were measured preoperatively and the screw breaches were evaluated on postoperative day one, with 1 mm CT images. Sample group had both traumatic and non-traumatic patients. Intra-operatively, C-arm was used in all the cases. Postoperative pedicle screw breaches had been graded using Gertzbein-Robbins classification. The breaches graded, grade C or more, considered as misplaced screws, which could cause morbidity to patients. **Result:** Among 141 pedicle screws (in 74 spinal levels) inserted in 28 patients (12 traumatic and 16 non-traumatic), zero breaches noted in six patients, totally 60 breaches, among them 15 screws are misplaced, with accuracy rate of 89.3% and breach rate of 10.6%. Misplaced screws were significantly more common in non-trauma cases, with 14 out of 15 screws (93.3%), in contrast, only 1 misplaced screw (8.3%) was observed in trauma cases. **Conclusion**: Pedicle screw insertion with pre operative CT evaluation has reduced significant breach in surgery, which analyzed through post operative CT evaluation, yet, further evaluation regarding intraoperative factors need to done to reduce pedicle breaches with emerging modalities in spine surgery.

INTRODUCTION

Many modalities are available to reduce the pedicle screw breaches from free hand technique, computer-assisted Orthopedic Surgery Planning System (Othmar Schwarzenbach et al., 1997),[2] computed tomography assisted navigation technique to advanced robot assisted techniques, yet the screw breaches are happening which leads to complications (Alexander Perdomo-Pantoja et al., 2019).[3] Computed tomography assisted techniques are feasible and more accessible than any other techniques. Our aim of this study is to know the effectiveness of free hand technique in pedicle screw fixation done with CT evaluation.

MATERIALS AND METHODS

According to the study (Mesare et al., 2021),[4] ,analysis of these pedicle screws using postoperative CT scans accuracy of pedicle screw fixation of lumbar spine was (95.25%),so p is taken as 95.25%, absolute precision 8%, confidence limit 95% as limit (using open epi software sample) size is calculated to be 28.We enrolled the study subjects from 28 patients with traumatic origin and non-traumatic – Degenerative, Isthmic spondylolisthesis which is unstable nature. The mean age of the 17 men and 11 women was 44.6 years (Range: 19 to 70 years). The indications for these patients include traumatic 12 patients includes burst, chance fracture with or without neurological deficit based on Thoracolumbar Injury Classification and Severity Score (TLICS)

ISSN (O): 2687-5365; ISSN (P): 2753-6556

(Lee et al., 2005),[9] if ≥5(more than or equal to 5), patients underwent surgery. Non traumatic patients all are unstable spondylolisthesis individuals with clinical neurological deficit. All patients took CT, MRI scan preoperatively and CT scan on Post operative day one.

CT scan done in CT TOSHIBA AQUILLON LIGHTNING MODEL (16 Slice) – TS – 035A/4C (Equipment ID: G-XL-83855, Equipment Serial number: 4AC1762277), 1 mm CT cuts for all cases pre and post operatively. To make the measurement calibrations more accurate, the patients were laid in the gantry isocentre of CT machine with the sagittal axis along C7 and S1 spinous process.

CT scan evaluation done in bone window using Vitrea viewer (v 6.9.87.1) with 1 mm cut CT images. In all approaches incision made one level above and one level below the surgical level. Inter-nervous plane created between two paraspinal muscles. Axial cuts for placement of pedicle screws and its relation to the spinal canal by measuring pedicle width at isthmus, pedicle axis length including the vertebral body upto anterior cortex, transverse angle along the axis of pedicle in relation to sagittal plane preoperatively and for medial, anterior, lateral breaches of pedicle screws postoperatively. Sagittal cuts for pedicle height at level of isthmus, sagittal angle in caudocranial axis of pedicle aiming anterosuperior part of vertebral body in relation to transverse plane preoperatively and neural foramen involvement, inferior and superior breaches of pedicle screws postoperatively.

Diapason polyaxial pedicle screws are commonly used today for fixations and also used in this study for its high pull out strength (Amy W. L. Kwok et al., 1996) (Ching-Chi Hsu et al., 2005).[11,12] In our study we used, convergence trajectory with caudocranial insertion as it shows more superior than both cortical bone trajectory and traditional trajectory (Wray et al., 2015) (Cho et al., 2010).[7,8]

PREOPERATIVE CT EVALUATION

EVALUATION OF TRAJECTORY

To assess the orientation of pedicle axis preoperatively and axis of pedicle screw postoperatively which the orientation is caudocranial(-)/craniocaudal (+) and mediolateral (-) / lateral-medial (+), the signs are used in the study with reference to previous studies (Cool et al., 2021) (Farshad et al., 2022).[10,11]

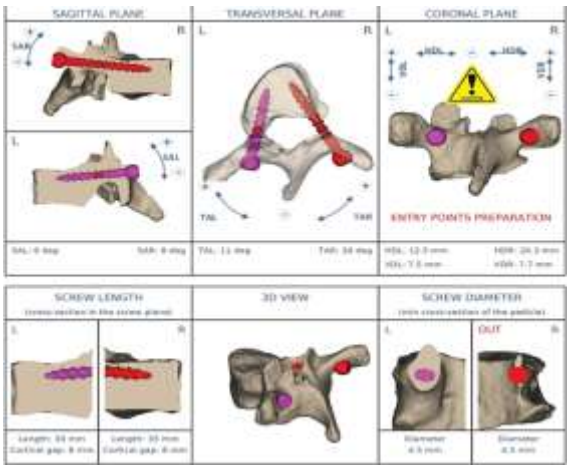
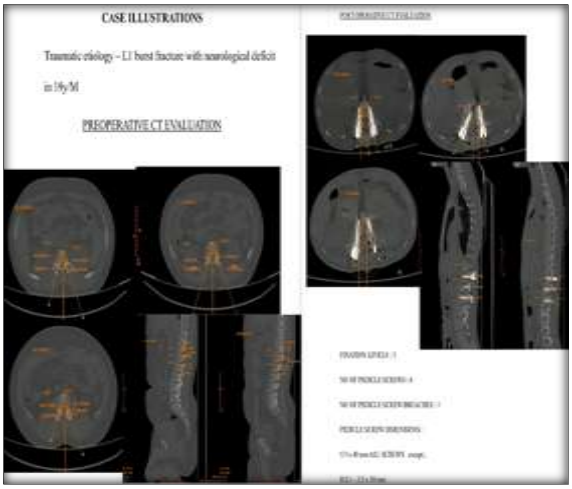


Figure 1: Signs assigned to trajectories based on its orientation to transverse and sagittal plane (Cool et al., 2021),[10]

Axial CT cuts: Pedicle width – External cortical diameter measured at the level of isthmus. Pedicle axis length –From outer lamina to inner side of vertebral body cortex along the center of pedicle. In S1, the length measurement included the outer aspect of anterior cortex for bicortical purchase in cephalomedial trajectory (Shaikh et al., 2012).[12] S1 axial cut measurements. Here, it is measured in anterolisthesis individual whose sacral pedicle alignment and sacral body are not overlapping because of listhesis. Hence in mid-sagittal, sacral promontory (as we used medial trajectory) to spinous process measurement done and used that in measuring sacral axial measurements. Transverse angle (axial angle) of pedicle in relation to sagittal plane along the pedicle Axis. Sagittal CT cuts: Pedicle height – External cortical diameter measurement at level of isthmus in sagittal plane. Sagittal angle in relation to transverse plane along the center of pedicle axis in sagittal cuts.

Post- operative evaluation of breaches: Breaches were evaluated using the Gertzbein & Robbins classification (Elswick et al., 2020) (Gertzbein & Robbins, 1990).[17,18] Grade A and B can be a considered as breached yet satisfactory result. In grade C to E, the penetration depth was more than 2 millimeters along the pedicle inferiorly, superiorly, laterally, medially, or anywhere from the corpus, the screw was considered misplaced as reference literatures (Mesare et al., 2021) (Silbermann et al,2011).[4,13]

ISSN (O): 2687-5365; ISSN (P): 2753-6556



DISCUSSION

In this study, we used totally 141 pedicle screws fixation done in 28 patients (27 open, one percutaneous fixation in trauma patient), in which 69 screws in trauma patients and 72 in non- trauma patients. Total breaches occurred is 60, with 15 screws are misplaced. Misplaced screws most commonly occurred in non-traumatic individuals, which is 14 among 15 misplaced screws and is statistically significant. Non traumatic cases operated for central canal stenosis and unstable spondylolisthesis with pars defect and neural involvement particularly in all cases below and at the level of L3.The deformed morphology and sclerotic bone and unstable nature of spine during entry point and trajectories, and the intervertebral anatomic relationships while the patient is prone during surgery may not match the preoperative CT data taken in prone – which can be rectified with intraoperative 3D O-arm based navigation technique (Yoshimoto Ishikawa et al., 2011),[19] may be the major cause for high level of misplaced screws among them. The breaches yet occurred in traumatic patients but they comes under low grade breaches except one in thoracic spine which is grade C. This can be explained by sone intact soft tissue structure with non-deformed anatomy landmarks, which done from D10 to L4. No patients developed any deficit postoperatively. The advanced methods like robot assisted, CT navigation technique and Orthopaedic planning systems are developed, the CT based preoperatively evaluated pedicle screw fixation seems more practical as the robotic assisted surgery are reduced intraoperative radiation exposure yet it increases intraoperative time, 3D fluoroscopy increases the accuracy tin pedicle screw fixation but heavily increases radiation exposure among surgical team and patients intraoperatively, Orthopaedic planning system and computer guided navigation techniques need deep pre operative planning and anatomic matching which not yet normalized everywhere. Using navigation techniques itself has higher breach rate in thoracic spine compared to lumbar vertebrae (Victor Kosmopoulos et al., 2007).[14] Among 141 pedicle screws (in 74 spinal levels) inserted in 28 patients (12 traumatic and 16 non-traumatic), zero breaches noted in six patients, totally 60 breaches, among them 15 screws are misplaced, with accuracy rate of 89.3% and misplaced breach rate of 10.6%. The breach rate is higher when compared to Aigner et al. (2021),[15] Mesare et al. (2021),[4] and lower compared to Salem et al. (2021).[16]

CONCLUSION

From the above inference and from reference literature with free hand techniques, pedicle screw insertion with pre operative CT evaluation has reduced significant breach in surgery, post operative complications in most prevalent practically accessible technique, which analyzed through post operative CT evaluation, yet, further evaluation regarding intraoperative factors need to done to reduce pedicle breaches with emerging modalities in spine surgery.

REFERENCES

1. Faraj AA, Webb JK. Early complications of spinal pedicle screw. Eur Spine J. 1997;6(5):324-326.
2. Schwarzenbach O, Berlemann U, Jost B, Hodler J, Ferdinand T, Langlotz F, Nolte LP, Ozdoba C. Accuracy of computer-assisted pedicle screw placement: an in-vivo computed tomography analysis. Spine (Phila Pa 1976). 1997 Apr 15;22(8):452-8. Doi: 10.1097/00007632-199704150-00012. PMID: 9121602.
3. Perdomo-Pantoja A, Ishida W, Zygourakis C, Holmes C, Iyer RR, Cottrill E, et al. Accuracy of Current Techniques for Placement of Pedicle Screws in the Spine: A Comprehensive Systematic Review and Meta-Analysis of 51,161 Screws. World Neurosurg. 2019.
4. Mesare VU, Kulkarni RV, Gursale A, Tiwari A, Kaware R. Accuracy of pedicle screw fixation in lumbar spine by freehand technique studied postoperatively by computed tomography.JOrthop Spine 2021;9:73-78
5. Kwok AWL, Finkelstein JA, Woodside T, Hearn C, Hu RW. Insertional torque and pull-out strengths of conical and cylindrical pedicle screws in cadaveric bone. Spine (Phila Pa 1976). 1996 Nov 1;21(21):2429-34.
6. Hsu CC, Chao CK, Wang JL, Hou SM, Tsai YT, Lin J. Increase of pullout strength of spinal pedicle screws with conical core: biomechanical tests and finite element analyses. J Orthop Res. 2005;23(4):788–794. Doi: 10.1016/j.orthres.2004.11.002.
7. Wray S, Mimran R, Vadapalli S, Shetye SS, McGilvray KC, Puttlitz CM. Pedicle screw placement in the lumbar spine: effect of trajectory and screw design on acute biomechanical purchase. J Neurosurg Spine. 2015 Feb;22(2):186-93. Doi: 10.3171/2014.10.SPINE14205. Epub 2015 Feb 13.
8. Cho W, Cho SK, Wu C. The biomechanics of pedicle screw-based instrumentation. J Bone Joint Surg Br. 2010 Aug;92(8):1061-5. Doi: 10.1302/0301-620X.92B8.24237.
9. Lee JY, Vaccaro AR, Lim MR, Oner FC, Hulbert RJ, Hedlund R, Fehlings MG, Arnold P, Harrop J, Bono CM, Anderson PA, Anderson DG, Harris MB, Brown AK, Stock GH, Baron EM. Thoracolumbar injury classification and severity score: a new paradigm for the treatment of thoracolumbar spine trauma. J Orthop Sci. 2005 Nov;10(6):671-5. Doi: 10.1007/ s00776-005-0956-y. PMID: 16307197; PMCID: PMC2779435.
10. Cool, J., van Schuppen, J., de Boer, M.A. et al. Accuracy assessment of pedicle screw insertion with patient specific 3D printed guides through superimpose CT-analysis in

ISSN (O): 2687-5365; ISSN (P): 2753-6556

thoracolumbar spinal deformity surgery. Eur Spine J 30, 3216–3224 (2021). https://doi.org/10.1007/s00586-021-06951-9
11. Farshad, M., Spirig, J. M., Winkler, E., Suter, D., Farshad-Amacker, N., Jarvers, J.-S., Tschöke, S. K., Heyde, C.-E., & Calek, A.-K. (2022). Template guided cervical pedicle screw instrumentation. North American Spine Society Journal (NASSJ), 10, 100120. https://doi.org/10.1016/j.xnsj.2022.100120
12. Shaikh KA, Bennett GM, White IK, Bullis CL, Fulkerson DH. Computed-tomographybased anatomical study to assess feasibility of pedicle screw placement in the lumbar and lower thoracic pediatric spine. Childs Nerv Syst. 2012;28(10):1743-1754.
13. Silbermann J, Riese F, Allam Y, Reichert T, Koeppert H, Gutberlet M. Computer tomography assessment of pedicle screw placement in lumbar and sacral spine: comparison between free-hand and O-arm based navigation techniques. Eur Spine J. 2011 Jun;20(6):875-81.
14. Kosmopoulos V, Schizas C. Pedicle screw placement accuracy a meta-analysis. Spine. 2007 Feb 1;32(3):E111-E120. Doi: 10.1097/01.brs.0000254048.52381.3e. PMID: 17264778.
15. Aigner R, Bichlmaier C, Oberkircher L, Knauf T, König A, Lechler P, et al. Pedicle screw accuracy in thoracolumbar fractures- is routine postoperative Ct scan necessary? Bmc Musculoskelet Disord 2021;22:986.
16. Salem SHM, Abdelwanees AK, Makia MA, Abdelkhalek MH. Clinical correlation with postoperative computed tomography assessment of the accuracy of lumbar pedicular screws insertion. Egypt J Hosp Med 2021;83:1096-100.
17. Elswick CM, Strong MJ, Joseph JR, Saadeh Y, Oppenlander M, Park P. Robotic-Assisted Spinal Surgery Current Generation Instrumentation and New Applications. Neurosurg Clin N Am. 2019.
18. Gertzbein SD, Robbins SE. Accuracy of pedicular screw placement in vivo. Spine (Phila Pa 1976). 1990 Jan;15(1):11-4. Doi: 10.1097/00007632-199001000-00004. PMID: 2305285.
19. Ishikawa Y, Kanemura T, Yoshida G, Matsumoto A, Ito Z, Tauchi R, Muramoto A, Ohno S, Nishimura Y. Intraoperative, full-rotation, three-dimensional image (O-arm)–based navigation system for cervical pedicle screw insertion. J Neurosurg Spine. 2011 Nov;15(5):472-8. Doi: 10.3171/2011.6.SPINE10809.

ISSN (O): 2687-5365; ISSN (P): 2753-6556