

Clinical Study

Assessment of pedicle screw placement accuracy in thoracolumbosacral spine using freehand technique aided by lateral fluoroscopy: results of postoperative computed tomography in 114 patients

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Abstract

BACKGROUND CONTEXT: Pedicle screw fixation is currently widely used in spine surgery for various pathologies. Increasing screw placement accuracy would improve the outcomes.

PURPOSE: To determine the accuracy rate of screw placement in a group of patients who underwent pedicle screw fixation with conventional techniques.

STUDY DESIGN: A case series.

PATIENT SAMPLE: It includes patients undergoing posterior spinal fixation with pedicle screw insertion. Outcome measures include the accuracy of screw placement in pedicles defined by postoperative computed tomography (CT).

METHODS: After surgery, an axial thin-cut CT scan was performed in all patients. Screw position was classified as correct when the screw was completely surrounded by the pedicle cortex and incorrect when any part of the screw was outside the pedicle boundaries.

RESULTS: Seven hundred seventy screws were inserted at vertebral levels T7–S1 of 114 patients between March 2012 and December 2012. There were three wound infections and one death. Eighteen screws were diagnosed as having an incorrect position (2.3%). The highest accuracy was observed in levels L4 and L5 (0.8% inaccuracy rate for each), whereas the highest inaccuracy rate was observed in T9. The mean inaccuracy rate was 10.5% for levels T7–T9, 3.5% for levels T10–L2, and 0.9% for levels L3–S1. The differences were statistically significant. Only one screw (5%) needed revision.

CONCLUSIONS: The results of our study show that conventional methods for pedicle screw placement remain safe and accurate, with best results obtained in the lumbosacral spine, followed by the thoracolumbar junction. Nonetheless, results are less accurate in the midthoracic spine. © 2015 Elsevier Inc. All rights reserved.

Keywords: Pedicle screw; Spine; Accuracy; Computed tomography; Freehand; Fluoroscopy

Introduction

Transpedicular screw fixation, more simply referred to as pedicle screw fixation, is currently widely used in spine surgery and is accepted for the treatment of various pathologies in the thoracic, lumbar, and sacral spine. It is extensively

used in the lumbar spine as a means of stabilization to enhance arthrodesis, and its use has gained acceptance in the thoracic spine in the recent years [1]. The most common indications for pedicle screw placement include degenerative diseases, trauma, deformities, spondylolisthesis, spine tumors, infection, and congenital pathologies [2].

Historically, screws were inserted by freehand using anatomical landmarks and aided by fluoroscopy, either unidirectional or bidirectional; however, this conventional method can be technically challenging. Some authors have suggested that using navigation-aided techniques, either computed tomography (CT) navigation [3–6] or O-arm navigation [7], improves accuracy, especially in the thoracic spine [8]. However, these techniques are more

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expensive and complex. In contrast, some authors do not consider navigation-aided methods to have any overall superiority over conventional methods [9,10], especially if outcomes other than accuracy rate (eg, neurologic complications, fusion rate, pain relief, or health outcome scores) are considered [10]. Moreover, these techniques are associated with an increased radiation exposure to the patient and surgeon and increased operative time [2].

Besides the technique used for screw placement, it is evident that increasing screw placement accuracy would decrease adverse effects, improve device strength, and improve the long-term yield and outcome of the operation. However, there is a huge variation in the reported accuracy of pedicle screw placement, which mainly stems from the inadequacy of intra- or postoperative imaging assessments [3].

The purpose of this study was to determine the accuracy rate of screw placement in a group of patients who underwent pedicle screw fixation in the thoracolumbosacral spine using a conventional freehand open technique aided by intraoperative lateral fluoroscopy. The results are then compared with published data.

Materials and methods

The study was performed between March 2012 and December 2012 in the Department of Neurosurgery at Shohada Tajrish Hospital, Tehran, Iran. The patients were recruited consecutively from those who were scheduled to undergo a posterior spinal fixation (PSF) procedure using pedicle screw placement. Before surgery, the patients underwent a routine evaluation including a physical examination, obtaining lab data (including complete blood count, erythrocyte sedimentation rate, C-reactive protein, and coagulation analysis), and spine imaging (including X-rays and CT from the relevant levels) [11]. All data (including instrumented levels and postoperative complications) were recorded in a computerized database [12]. All surgeries were performed by the senior author of the study (RM-L), who was the chief resident of neurosurgery during that period. All procedures included a standard posterior open approach and pedicle screws were inserted using anatomical landmarks observed during surgery and aided by lateral C-arm fluoroscopy. During surgery, the proper location of the screws was certified by examination and fluoroscopy. Pedicle screws were then augmented by standard rods and transverse connectors. Laminectomies were or were not performed based on the primary pathology. After surgery, an axial CT scan with three-dimensional (3D) reconstruction was performed in all patients using a spiral multidetector 16-slice CT scan (GE Brivo CT315; General Electric, United Kingdom) [13,14]. The CT scans were obtained with 2-mm axial slices of the instrumented levels. These images were then inspected for evidence of pedicle violation by the main surgeon and another independent surgeon.

EVIDENCE & METHODS

Context

Pedicle screw malposition can result in inferior outcomes in instrumented fusion as well as neural and potentially vascular injury. The authors aimed to investigate the accuracy of pedicle screw placement using a conventional technique in 114 patients.

Contribution

In total, 2% of pedicle screws were malpositioned. The rate of misplacement was less than 1% in the low lumbosacral region. Highest placement accuracy (99.2%) was noted for L4 and L5 with the greatest extent of malposition documented at T7-T9 (10.5%).

Implications

The findings of this study reinforce the results of other research regarding the placement accuracy of pedicle screws in the thoracic and lumbosacral regions. Readers should note that the malposition rates reported for this study, as well as other investigations on this topic, are highly dependent on the criteria used for defining a malpositioned screw. In addition, the fact that all cases were derived from a single neurosurgical practice means that findings may be specific to the technical performance of pedicle screw placement at that center. This may impair the clinical translation of this study's findings.

—The Editors

Screw position was classified as correct when the screw was completely surrounded by the pedicle cortex and as incorrect when any part of the screw was outside the pedicle boundaries, which could happen as a slight cortical breach or a larger cortical violation. Incorrect positions were further subclassified as lateral, medial, superior, or inferior based on the pedicle wall that was traversed.

Chi-square was used for comparison between categorical variables. All analysis was performed using PASW Statistics 18 package (Predictive Analytics Software; SPSS, Inc., Chicago, IL, USA). For all analyses, p values less than .05 were considered statistically significant.

The study design was approved by the Ethical Committee of Shahid Beheshti University of Medical Sciences, and the study was performed with adherence to the statements of the Declaration of Helsinki and the regulations of the institutional review board [15]. All patients gave their written consent, both to undergo surgery and to participate in the study.

Results

One hundred fourteen patients were operated by PSF between March 2012 and December 2012. The most common

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