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Clinical Study

Accuracy of fluoroscopically-assisted pedicle screw placement: analysis of 1,218 screws in 198 patients

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Abstract

BACKGROUND CONTEXT: We retrospectively analyzed a total of 1,218 pedicle screws for accuracy, with postoperative computed tomography (CT), in 198 patients who were operated on between March 2004 and September 2012.

PURPOSE: To determine the incidence of screw misplacement in patients who received a transpedicular screw fixation, with intraoperative fluoroscopy in the lateral and lateral with anteroposterior (AP) positions. The results are compared between the two groups.

STUDY DESIGN: Retrospective comparative study of accuracy of pedicle screw placement in thoracic and lumbar spine.

PATIENT SAMPLE: The sample consists of 198 consecutive patients who underwent transpedicular screw fixation.

OUTCOME MEASURES: Accuracy of screw placement was evaluated by postoperative CT scan. Misplacement was defined in cases where more than 25% of the screw size was residing outside the pedicle.

METHODS: The indications for hardware placement, radiologic studies, patient demographics, and reoperation rates were recorded. Five hundred twenty-eight screws (Group A, n=81) were inserted into the vertebral body with the assistance of lateral fluoroscopy only, whereas 690 screws (Group B, n=117) were inserted with the assistance of lateral fluoroscopy, and the final positions of the screws were checked with AP fluoroscopy.

RESULTS: A total of 1,218 screws were analyzed, with 962 screws placed at the lumbosacral region and 256 screws at the thoracic region. According to the postoperative CT scan, 27 screws (2.2%) were identified as breaching the pedicle. Nineteen of them (3.6%) were in Group A, whereas 8 (1.16%) were in Group B. The rate of pedicle breaches was significantly different between Group A and B (p=.0052). In Group A, the lateral violation of the pedicle was seen in 10 screws (1.9%), whereas medial violation was seen in 9 screws (1.7%). In Group B, the lateral violation of the pedicle was seen in six screws (0.87%), whereas medial violation was seen in two screws (0.29%). The medial and lateral penetration of screws were significantly different between Groups A and B (p<.05). A pedicle breach occurred in 21 patients, and 15 of them underwent a revision surgery to correct the misplaced screw. Of these patients, 11 (13.6%) were in Group A, and 4 (3.4%) were in Group B (p=.0335).

CONCLUSIONS: In this study, we evaluated and clarified the diagnostic value of intraoperative fluoroscopy in both the lateral and AP imaging that have not yet been evaluated in any comparative study. We concluded that the intraoperative use of fluoroscopy, especially in the AP position,

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significantly decreases the risk of screw misplacement and the results are comparable with other advanced techniques.

Keywords: Accuracy; Misplacement; Pedicle screw; Fluoroscopy; Spinal stabilization; Intraoperative imaging

Introduction

The use of pedicle screws for spinal stabilization was first described by Boucher in 1959 [1]. Since then, their superior stabilizing effects in all three parts of the spinal column have been strongly proven by both clinical and biomechanical studies [2–4]. Today, transpedicular screw fixation is widely used in all levels of the spine. However, despite advanced intraoperative imaging technologies, the placement of pedicle screws remains a technically demanding procedure. Depending on various factors, accurate screw placement rates vary and range between 28% and 100%. [5–8].

The accurate placement of the pedicle screw is essential to prevent intraoperative neural and vascular injuries [6,9–11]. Misplaced screws also carry the risk of the loss of construction, which may be related to later instability [12]. There are many different techniques currently used for the placement pedicle screws. The free-hand technique is one of the most common procedures and has been used widely for pedicle screw placement. Unfortunately, the accuracy rates are not satisfactory and this technique carries a high risk of screw misplacement, especially in inexperienced hands. For these reasons, many techniques have been developed to achieve proper screw placement, including intraoperative fluoroscopy, fluoro-based navigation, and computed tomography (CT) navigation [6,13–17]. Although the accuracy rates have significantly increased with the use of intraoperative navigation systems, the availability of these devices is not always possible because of their high costs.

In this study, we retrospectively analyzed 1,218 thoracolumbar pedicle screw accuracies in 198 patients. The aim was to evaluate the fluoroscopically-assisted accuracy and to clarify the diagnostic value of intraoperative fluoroscopy in both lateral and anteroposterior (AP) imaging that have not yet been evaluated in any comparative study.

Materials and methods

Data extraction

The data of 198 patients who received pedicle screw placements between March 2004 and September 2012 were retrospectively reviewed. The indications for hardware placement, radiologic studies, patients' demographics, and reoperation rates were recorded. Any misdirection of screw positions was noted. The accuracy of the pedicle screws was evaluated by the postoperative CT scan and lateral and AP X-ray images. A breach was defined in cases where more than 25% of the screw size was residing outside the pedicle.

Radiologic assessment

Preoperative X-ray images of the AP and lateral views, a thin cut CT, and magnetic resonance imaging through the level of the pathology were performed in all patients. The screw size and length were determined on the basis of these studies in each patient and at each level. To evaluate the screw misdirection in the lateral, medial, superior, and inferior positions, every consecutive patient who had pedicle fixation underwent postoperative lateral and AP X-ray and thin cut CT imaging within postoperative 24 hours.

Surgical technique

All the screw placements were performed by one surgeon (EK). All screws were placed using intraoperative fluoroscopy, and 528 of the 1,218 screws were placed with the aid of lateral fluoroscopic images only (Group A, N=81). However, 690 screws were placed with the aid of lateral fluoroscopic images, and the final positions of screws were checked with AP fluoroscopic images at the end of the operation (Group B, N=117). The use of fluoroscopy technique was dependent on the operating table. The AP fluoroscopy was used when the appropriate operating table was available.

Preoperative radiologic data and anatomical landmarks were used to determine the pedicle entry point. For the lumbar spine, the entry point was the intersection of the transverse process and superior articular facet of the corresponding level. In the thoracic spine, the entry point was the triangular bony confluence between the superior articular facet, transverse process, and pars interarticularis. The entry points, which were determined by the anatomic landmarks, were checked with lateral fluoroscopic images, and laminectomies were performed, if needed, before beginning screw placement. After the screw starting point determination, a rongeur was used to expose the cancellous bone of the pedicle. An awl was used to penetrate the pedicle and the sagittal direction was checked with lateral fluoroscopic images. Then a straight pedicle probe was inserted through to the pedicle, about 30 to 35 mm in all cases. Before the removal of the probe, it was rotated 360° around itself to create a large hole. Finally, a ball-tipped pedicle feeler was used to control a breach in all four quadrants and the anterior body cortex. The pedicle screw was then inserted through the previously created hole with fingertip pressure only. Some of the screws' final positions were checked with AP fluoroscopic images (Group B). The screw size was defined according to preoperative CT images, and the average screw sizes ranged between 5.0 and 6.5 mm in diameter and 40 and 50 mm in length for the