O-arm and Stealth System Navigation for Pedicle Screw Placement in Thoracolumbar Spine Surgery
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Introduction: Pedicle screws are commonly used for posterior stabilization in the thoracolumbar spine. Various navigation systems have been introduced to improve the accuracy of screw placement and prevent vascular and neurological injury. The O-Arm generates a 3-D image of the spine, similar to CT scanning, that is downloaded to the Stealth Station. This gives real time transverse, coronal, and sagittal images of the spine and replaces the need for fluoroscopy and thus reduces radiation exposure. While various studies have reported on the use of CT-based and Isocentric 3D fluoroscopy-based navigation, there is a paucity of data on the use of O-Arm and Stealth. The objectives of this study were to (1) evaluate the accuracy of pedicle screw placement using O-Arm and Stealth, (2) assess the time required for draping, positioning of the O-Arm, and screw placement, (3) evaluate whether tapping improves the accuracy of pedicle screw trajectory, and (4) compare the results of intraoperative neuromonitoring with the actual number of screws that breached the medial cortex on CT.

Methods: In this prospective study, we evaluated pedicle screw placement in patients that underwent surgery using O-Arm and Stealth at our institution. The times required for draping, positioning the O-Arm, and screw placement were recorded. The number of tapped screws and neuromonitoring results were noted. “Snap-shot” navigation images with the awl in the pedicles and O-Arm-CT scan confirmation images were analyzed to assess accuracy.

Results: Between February and August 2010, 188 screws were placed in 25 patients (16-75 years old) using O-Arm and Stealth; 116 screws were evaluated, the remaining screws were excluded from analysis due to either poor image quality or missing images. The average time required for O-Arm draping was 3.5 minutes, initial O-Arm positioning was 6.1 minutes, and final positioning was 4.9 minutes. The overall mean time required between attachment of the array and screw placement was 8.1 minutes/screw. The mean time required for screw placement alone was 5.9 minutes/screw. Measurements on O-Arm snap-shot images of the distance from the awl tip to the anterior and lateral cortex were on average 3.14 mm shorter than that of screws on final CT images; thus the screws were actually deeper than the position shown on snap-shot images of awls. Three screws (2.5%) breached the medial cortex (by less than 2 mm) and three screws were misaligned by an average of 13.76°. All misaligned screws had been tapped. Intraoperative stimulations of all screws were normal despite the fact that three screws breached the medial cortex, resulting in a false negative rate of 1.59% for neuromonitoring.

Conclusions: The use of O-Arm and Stealth led to a low rate of pedicle screw misalignment in the present study. The mean time to place the screws was less than previously reported times for CT navigation, but longer than those for screw placement using conventional technique. It is important to be aware of the potential discrepancy between the position of the awl on snap-shot images and actual screw placement on CT-O-Arm. Our findings suggest that the final screw position may be deeper than awl positions appear on the navigation image.