Intraoperative CT-Based Pedicle Screw Navigation in Pediatric Spine Deformity Increases Operative Time and Radiation Exposure with Minimal Effect on Screw Accuracy for Experienced Surgeon

Vishal Sarwahi[1], Sayyida Hasan, Keshin Visahan, Matan Grunfeld, Yungtai Lo[2], Terry David Amaral[1]
[1]Cohen Children's Medical Center, [2]Albert Einstein College of Medicine

INTRODUCTION:
In pediatric spine deformity surgery, the accuracy of pedicle screws is a crucial safety objective. Intraoperative CT-guided navigation has the dual benefit of enabling screw insertion under navigation guidance and assessing screw accuracy after insertion. This, however, modifies surgical workflow, which may lengthen surgical time and affect blood loss. In addition, it increases exposure to radiation. This raises the question of how much intraoperative CT navigation improves surgical precision and how it slows down surgeons thereby affecting surgical outcomes.
METHODS:
Pediatric patients undergoing spine deformity surgery using intraoperative CT navigation were compared with patients undergoing deformity surgery with freehand technique. In the navigated group, the reference frame was applied to the caudad spinous process after exposure, and a CT spine was performed at 50-70% of the recommended pediatric dose according to the manufacturer. At the completion of screw insertion, a scan was conducted to confirm screw accuracy at a lower dose. If reference frame displacement or navigational precision was a concern, a scan was repeated. In the freehand technique, fluoroscopy was utilized for affirmation of levels, shoulder balance post correction, and on occasion, for assistance with screw insertion. Radiographic, radiation exposure, and perioperative data was collected. Kruskal-Wallis and Fisher's exact tests were conducted.
RESULTS:
A total of 91 AIS patients (2,116 screws) undergoing posterior spinal fusion with intraoperative CT navigation were compared to adolescent idiopathic scoliosis (AIS) patients with pedicle screws placed freehand and confirmed on fluoroscopy. Patients were similar in age, BMI, preoperative Cobb, and preoperative kyphosis ($p > 0.05$). Postoperative Cobb, kyphosis, and overall Cobb correction were similar. Blood loss was similar between the groups, however, navigation patients had significantly longer surgical time and anesthesia time for patients with a similar number of fixation points and levels fused. Radiation exposure was higher in the navigation group. Length of stay was similar between the patients ($p > 0.05$). No significant difference in postop complications, infection rate, or 30-day return to ED. In 5 patients more than two scans had to be performed as the accuracy was lost during surgery. In 10 navigation patients, most screws were first inserted free hand and then checked for placement with an intraoperative CT spin. Only 3 screws in these 10 patients were backed off slightly as the tip was protruding anteriorly. These anterior protrusions were <4mm and were therefore acceptable. In the free hand group, screw accuracy was confirmed on postop radiographs. None of the screws in both groups needed revision. The cost of equipment, prolonged OR time, need for CT tech contributed to increased cost in navigation group.
DISCUSSION AND CONCLUSION:
The use of navigation for pedicle screw placement does not improve patient safety or screw precision. The drawback may involve considerably extended anesthesia and surgical time. Additionally, radiation exposure is increased. Navigation, however, could potentially offer prevention of screw misplacement. Therefore, the value of navigation is determined by the individual surgeon.