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Navigation-guided Pedicle Screw Placement: Can This Procedure Substitute the Conventional Use of Fluoroscopy in the Thoracic and Lumbar Spines?

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Objective: The accuracy, safety and radiation exposure are always major concerns in pedicle screw placement under guidance of C-arm fluoroscopy in the thoracic and lumbar spines. The authors have performed a prospective study to assess the accuracy and clinical benefits of a navigation (Stealth Station®, Medtronic, CO, USA) coupled with O-arm® (Medtronic, CO, USA) guided method (NAVOG) in the placement of pedicle screw in the thoracic and lumbar spines by comparing with conventional fluoroscopy guided method (CFG) since 2008.

Methods: The present study included 54 patients: Using NAVOG, 106 pedicle screws inserted from T7 to S1 in 24 patients; using CFG, 204 pedicle screws from T5 to S1 in 45 patients. The position of pedicle screws after placement was analyzed by using postoperative high resolution CT scans. According to postoperative position of screws, the patients were classified into four groups: Group A: perfectly within the pedicle; Group B: violation the cortex less than 2mm; Group C: violation the cortex 2 -4 mm; Group D: violation the cortex more than 4 mm. If the cortex violation by screw was noticed, the location of violated pedicle cortex was evaluated. Intraoperative parameters including preparation time for screwing procedure, screwing time, and number of X-ray shot in each group were also assessed.

Results: In CFG patients, 186 (91.2%) were observed among in group A; whereas in NAVOG, 99 (93.4%). In CFG, 18 screws violated the pedicle cortex (group B: 6; group C: 8; group D: 4) ($P < 0.05$, χ^2 test). The distribution of the cortex violated was as follows: Medial cortex in 6 cases, lateral in 9, and lower in 3. In NAVOG, 7 pedicle screws were incorrectly placed to compromise pedicle (group B; 4, group C; 2, group D; 1) (lateral cortex in 4 cases, medial cortex in 1, and upper cortex in 2). Each screwing time was 1 to 12.83 minutes (average 3.79 minutes) in CFG and 1.25 to 7.9 minutes (average 4.45 minutes) in NAVOG ($P < 0.05$, T-test). Mean number of X-ray shot for each screw placement in CFG was 8.9, while there was no radiation exposure during the screw placement procedure in NAVOG. Mean preparation time for screw placement was about 4 minutes in CFG, and 19 minutes in NAVOG ($P < 0.05$, T-test). Postoperatively, 5 patients operated using CFG presented transient leg paresthesia related to screw position. Among them, one patients required reoperation for the reposition of screw. In the meantime, one patient using NAVOG presented transient leg paresthesia related with intraoperative screw malposition postoperatively, which had been identified and corrected during operation.

Conclusions: The present study demonstrates that navigation-guided procedure could substitute for the C-arm fluoroscopy-guided one for the pedicle screw placement in the thoracic and lumbar spines, because screw placement using NAVOG appears to be more accurate and safe than the one using CFG, although the preparation and screwing time for NAVOG is still longer than the one for CFG. Reduction of radiation exposure must be the most important advantage of NAVOG.