Accuracy and Safety in Pedicle Screw Placement in the Thoracic and Lumbar Spines: Prospective Randomized Comparison Study between Conventional C-arm Fluoroscopy and Navigation Coupled with O-arm Guided Methods

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Purpose: The authors have performed a prospective and randomized study for pedicle screw placement in the thoracic and lumbar spines to compare between C-arm fluoroscopy-guided (CFG) and navigation (Stealth Station®, Medtronic, CO, USA) coupled with O-arm® (Medtronic, CO, USA) image-guided (NCOG) methods. The study was expected to demonstrate the efficiency of the NCOG in screw placement.

Methods: A study was carried out in the consecutive 30 patients during a period of 4 months in early 2010. All surgical procedures were performed by a 10-year-experienced single spine surgeon (K.S.R.). All patients were randomly assigned to one of the two guiding methods for pedicle placement. According to the postoperative CT scan images, the position of screw was classified into four grades according to the degree of screw misplacement in the pedicle. The grade 0 defined cases in which a screw was perfectly well located in the pedicle; the grade 1 defined cases in which there was a cortex violation of < 2 mm in length; the grade 2 defined cases in which there was a cortex violation of 2-4 mm in length; and the grade 3 defined cases in which there was a cortex violation of > 4 mm in length. Besides, the location of cortex violation was also observed.

Result: In CFG group, 78 pedicle screws were inserted from T9 to S1 in 15 patients; in NCOG group, 74 pedicle screws from T9 to S1 in 15 patients. In CFG, 22 screws (28.2%) violated the pedicle cortex (grade 1: 14; grade 2: 7; grade 3: 1) (medial cortex in 6 cases, lateral in 14, and inferior in 2). In NCOG, 12 pedicle screws (16.2%) compromised the pedicle cortex (grade 1: 10, grade 2: 2) (medial cortex in 7, and lateral in 5 cases). Statistically NCOG group showed lower incidence of misplacement of screw (P< 0.05, χ² test) and a lesser degree of cortex violation (P< 0.05, Spearman correlation) than CFG group. The time required for inserting a screw was 1.2 to 10.4 minutes (average 3.6 minutes) in CFG and 2.3 to 6.7 minutes (average 4.2 minutes) in NCOG (P< 0.05, T-test). Mean time required for preparation of screw placement was about 4 minutes in CFG, and 15 minutes in NCOG (P< 0.05, T-test). Mean times of X-ray shot for each screw placement in CFG was 6.5, while none in the NCOG. Postoperatively, 2 patients with misplacement of a screw under CFG presented ipsilateral leg paresthesia possibly related to the screw position. Among them, one patient required reoperation for reposition of the screw. The other patient improved the leg symptom spontaneously.

Conclusion: The present study demonstrates that pedicle placement in the thoracic and lumbar spines under the NCOG is significantly more efficient compared with that under the CFG in terms of accuracy and safety, although the time required for the preparation and the screw placement procedure is rather long in surgery under the NCOG. In addition, the NCOG surgery can be considered as a preventive measure against radiation hazards for medical personnel and as an intraoperative CT scan for in situ verification of the screw position.