

Abstract: Angulation-Errors in iCT navigated dorsal instrumentation of the spine. An interim analysis of intraoperatively planned trajectories vs. definitive screw placement.

Authors: U. Bertram; L. Weis; TP. Schmidt; H. Clusmann; C. Blume; CA. Mueller

Objective

Navigated screw placement is of increasing importance in spinal instrumentation surgery, due to its superior accuracy in contrast to conventional techniques. Especially cervical pedicle screw placement is considered safe only with the use of a navigated approach. However, even intraoperative CT (iCT) navigated pedicle screw placement is prone to error. Recently we have been confronted with the question of whether intraoperatively planned screw trajectories can be considered true with respect to actual screw placement and how angulation errors correlate with screw-misplacement.

Methods

Between March and December 2021 we prospectively recorded intraoperatively planned trajectories of 279 screws in 54 patients placed throughout the spine (104 cervical; 93 thoracic; 76 lumbar; 6 sacral) using BrainLab Curve Planning Station. 3D coordinate systems of planning and control CT scans were merged and vectors of individual screws compared to planned trajectories.

Results

Prior to intraoperative correction of misplaced screws 81% of all screws were placed accurately ($<2\text{mm}$), 14% showed minor ($<4\text{mm}$) and 5% major perforations of the pedicle wall. The mean axial angulation error was $3.4^\circ \pm 2.9$ and sagittal $3.6^\circ \pm 3.7$. Rotational (axial) angulation error was higher in the cervical (median 3.4 95%CI $3.6\text{--}4.8$) than in the thoracic (2.3 95%CI $2.3\text{--}3.4$) spine ($p=0.016$).

Overall axial and sagittal angulation error correlates positively with increase in Gertzbein&Robbins grade (Spearman's r : 0.19 and 0.23).

Major pedicle wall breaches ($>4\text{mm}$) were found in cases of median sagittal angulation error of 8.3° (95%CI $4.1^\circ\text{--}16^\circ$) while accurately placed screws featured a median sagittal error of 2.4° (95%CI $2.7^\circ\text{--}3.4^\circ$). Median axial angulation errors in major misplacements were 4.4° vs. 2.5° regarding acceptably placed screws in our cohort.

Conclusion

iCT remains a solid tool to facilitate accurate dorsal instrumentation throughout the spine. Rotational error of actually achieved compared to intraoperatively planned trajectories is confined to a minimum. However, angulation error correlates with pedicle violation and cannot be eliminated completely. The specific regional mobility of the spine must be kept in mind when applying pressure on the navigated drill-guide during pediculation to minimize angulation error.