



Comparative study of pedicle screw trajectory in scoliosis surgery: freehand technique versus navigated angular guidance using the PYTHEAS Your Guided Trajectory

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Abstract

Introduction Pedicle screw fixation is the reference technique in scoliosis surgery, enabling optimal three-dimensional correction and solid spinal stabilization. However, the risk of screw malposition remains significant, particularly in severe deformities, due to vertebral rotation and pedicle dysplasia. Technological advances such as intraoperative navigation and robotic assistance have consistently been shown to improve pedicle screw placement accuracy but are limited by cost, complex workflow, and intraoperative radiation exposure.

Purpose The aim of this study was to evaluate the effectiveness of the PYTHEAS Your Guided Trajectory (PYGT) navigated angular guidance system for pedicle screw placement, compared with the conventional freehand (FH) technique.

Materials and methods This retrospective single-center study compared two consecutive cohorts of patients undergoing posterior spinal fusion for progressive scoliosis. Screw positioning was assessed using intraoperative 3D imaging according to the Gertzbein and Robbins classification (grades A–E). Cortical breaches were qualitatively analyzed to distinguish screw–pedicle size mismatch from true directional errors. A secondary analysis assessed the influence of surgeon experience (Junior < 5 years vs. Senior > 10 years).

Results 31 patients (mean age 16.3 years) were included, allowing analysis of 635 pedicle screws (317 FH; 318 PYGT). A significantly higher proportion of Grade A screws was observed in the PYGT group compared with the FH group (90.5% vs. 60.6%, $p < 0.001$). Direction-related malposition rates were markedly reduced with PYGT (2.8% vs. 22.6%, $p < 0.001$). No Grade D or E screws were observed in the PYGT group. Surgeon experience significantly influenced accuracy in the FH group but had no impact in the PYGT group.

Conclusion The PYGT system significantly improved radiographic pedicle screw placement accuracy in posterior spinal surgery and reduced directional errors compared with the freehand technique, particularly in deformity surgery. These findings support the technical effectiveness of the system. Further studies are required to determine whether these improvements translate into clinically meaningful benefits. Direct comparative studies with contemporary navigation and robotic systems are also needed to better define the role of PYGT with regard to radiation exposure, operative time, workflow, cost-effectiveness, and clinical outcomes.

Level of Evidence IV Retrospective comparative study.

Keywords Pytheas Your Guided Trajectory · Pedicle screw placement · Navigation · Scoliosis · Spinal fusion

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