Pilot Study Evaluating Feasibility of Augmented Reality Assistance in Spinal Surgical Training for Pedicle Screw Placement

Olexa J., Shear B., Chiu A., Trang, A., Sharma A., Han N., Crandall K., Chryssikos T., Ludwig S., Scwhartzbauer G., Sansur C.

Background: Augmented reality (AR) has demonstrated utility as a navigation tool during spine surgery. This technology may also have potential impact in surgical education. The present study aims to evaluate feasibility of a novel AR overlay tool to assist trainees while learning to place thoracic pedicle screws.

Methods: Participants were four surgical trainees with no spinal surgery experience. First, thoracic spinal anatomy and pedicle screw placement technique was reviewed with a Neurosurgery spine fellow. Then, each participant placed 10 total thoracic pedicle screws into spine sawbone models (Thoracic Levels T1-T10). Each group placed 5 screws on one side, received feedback, and then placed 5 more screws at the same levels on the contralateral side. Group 1 placed all screws freehand. Group 2 used an AR overlay with pre-planned trajectories demonstrating optimal pedicle screw trajectory for the first 5 screws. Group 2 then placed 5 freehand screws on the contralateral side. Pre- and Post-insertion CTs of the models were obtained. Screw insertion point (IPE) , target point (TPE), and trajectory angle (TAE) errors, and screw position (via Gertzbein-Robbins classification) were assessed.

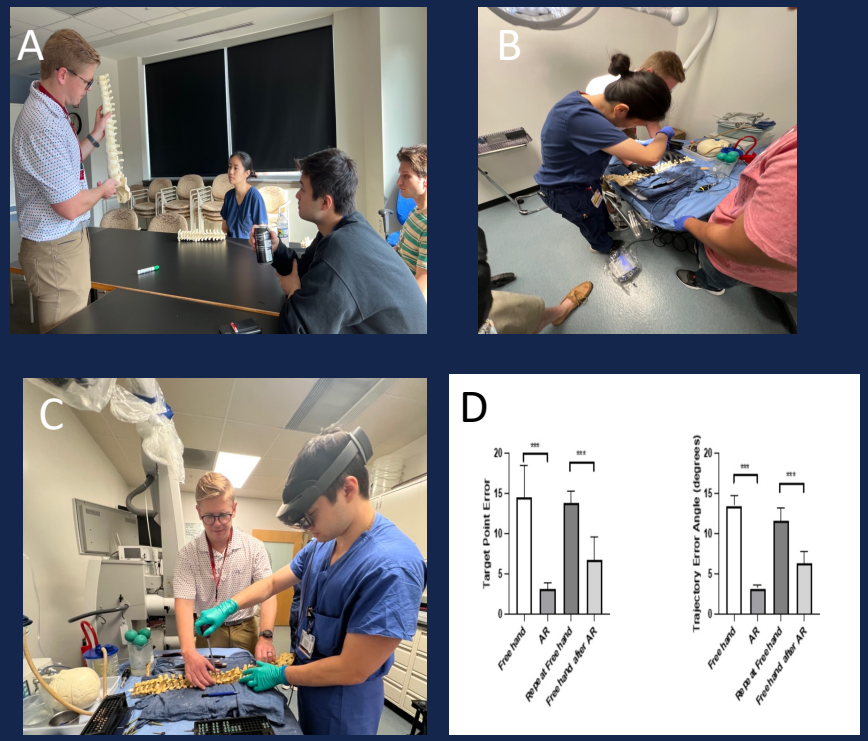

Figure 1: A) Didactic session reviewing relevant spinal anatomy B) Group 1 placing pedicle screws without AR-assistance C) Group 2 placing pedicle screws with AR-assistance D) Graph demonstrating comparative accuracy thresholds between groups

Results: Forty total screws were placed. Group 1 did not demonstrate improvement in screw trajectory accuracy between rounds. Group 2's freehand trial (TPE: 6.98 +/- 2.88mm, TAE: 6.22 +/- 3.71 degrees) was significantly more accurate in TPE and TAE than Group 1's second freehand trial (TPE 12.94 +/- 2.71mm, TAE: 11.65 degrees +/- 4.13 degrees) ($p < 0.00045$, $p < 0.00067$, respectively) . In addition, Group 2's freehand trial resulted in significantly less unacceptable screw trajectories compared to Group 1's second freehand trial (2/10 vs. 6/10, $p< 0.017$). Group 1 AR trial trajectories were significantly more accurate than all combined freehand trial trajectories (IPE: 5.38 +/- 2.55mm, TPE: 11.34 +/- 2.32mm, TAE: 10.46 +/- 3.61 degrees) ($p< 0.032$, $p< 0.00013$, $p <0.000089$, respectively).

Conclusion: This pilot study supports the feasibility of AR assistance in surgical trainee spinal education. The AR group demonstrated significantly more accurate and acceptable screw placements than repeated free-hand trials despite equivalent experience level. Further studies with increased participants and other practice media are warranted for further validation of this tool.

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