

Augmented Reality Display For Pedicle Screw Insertion Using A Novel Machine Vision Image Guided System: Pre-Clinical Study And Initial Clinical Finding

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Purpose

Augmented reality (AR) can display virtual tool overlay onto real-world imaging. We tested the feasibility of a novel AR display on Machine Vision Image Guided System as an adjunct during cervical and thoracolumbar instrumented fusion with preclinical and initial clinical results.

Materials and Methods

Preclinical testing was performed on spinal phantoms with fine cut CT scan. C2 pars and C3-S1 pedicle screw insertions were simulated bilaterally (n=48). Optimal starting point was determined by the operating surgeon to allow the greatest angular tolerance. For each screw, an optimal trajectory, followed by 4 near-breach trajectories were identified in both radiological and AR displays (240 trajectories). Comparisons of mean breach angles between radiological and same-side AR camera, for each of the left and right sides of the spine were analyzed by non-parametric Mann-Whitney-U test. Initial clinical experience included 5 patients with 28 screws' trajectories shown as adjunct AR display for untracked instruments.

Results

Directional angular breach tolerances were analyzed for right-handed surgeons:

Direction Left pedicle Right pedicle

(mean \pm SD) Medial Lateral Superior Inferior Medial Lateral Superior Inferior

Radiological 11.3 \pm 6.4 $^\circ$ 16.5 \pm 7.6 $^\circ$ 24.3 \pm 11.3 $^\circ$ 21.1 \pm 9.4 $^\circ$ 10.8 \pm 4.3 $^\circ$ 16.1 \pm 8.9 $^\circ$ 27.5 \pm 8.1 $^\circ$ 20.7 \pm 7.3 $^\circ$

AR 8.7 \pm 7.8 $^\circ$ 32.1 \pm 30.8 $^\circ$ 35.4 \pm 21.5 $^\circ$ 38.7 \pm 26.7 $^\circ$ 8.4 \pm 5.2 $^\circ$ 20.0 \pm 21.3 $^\circ$ 57.3 \pm 25.4 $^\circ$ 27.1 \pm 15 $^\circ$

p-value - - 0.023 0.013 - 0.035

Initial clinical experience was consistent with the preclinical analysis.

Conclusions

AR display for angular tolerance in pedicle screw insertion showed either equivalent or larger angles than radiological display. AR display may be a useful adjunct for spinal instrumented fusion, especially for untracked surgical instruments.