OpEyes-Augmented Reality Surgical Navigation and Advanced Minimally Invasive Pedicle Screw Navigation: A Pilot Study

Abstract 031897

Track:
Operative Technique

Sub Track:
Spine: Minimally Invasive

Introduction:

The spine surgery market is moving away from open dissection to minimally invasive spine surgery (MISS). Precise operative navigation is imperative for MISS to achieve its potential.[1,2] Guidance systems have been available for years, but adoption is limited by laborious set-up, costs and intraoperative imaging requirements. Herein is described the use of OpEyes-Augmented Reality (Novarad, American Fork, UT) for navigation and guidance of MISS for highly accurate insertion of pedicle screws (Figure 1).

Figure 1. OpEyes-Augmented Reality in use in the OR.

Objective:

Evaluate the utility and potential precision of OpEyes-Augmented Reality (AR) technology for the guidance/navigation of minimally invasive placement of pedicle screws in a cadaver.

Method:

A Microsoft HoloLens 2 (Microsoft, Redmond, WA) was used as the hardware platform for OpEyes-AR software. AprilTags, printed with CT visible ink, were either adhered to the skin, anchored to the iliac crests, or a vertebra. Following CT, the radiologist identified virtual pathways for ideal placement of pedicle screws for each vertebra (Figure 2).

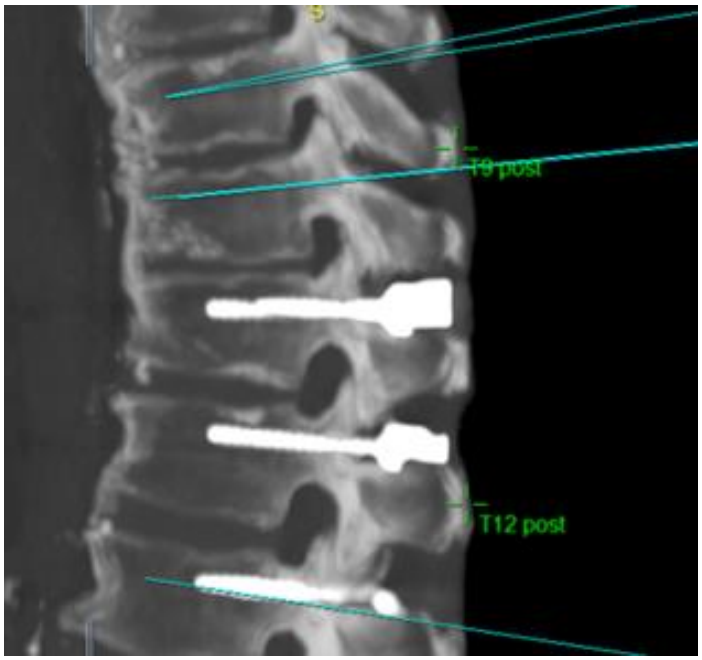

Figure 2. Annotated virtual pathways and pedicle screws inserted by alignment with the virtual pathways which provide depth and trajectory in both the axial and coronal planes.

The annotated studies were wirelessly uploaded to the software/visor combination by viewing an encrypted QR code assigned by the pre-op system. The studies were registered to the AprilTags captured during CT. The virtual pathways were called by voice command for each vertebra and were used to establish skin entry point, trajectory, and depth, while aligned with a target bullseye (Figure 3). Fluoroscopy was not required for navigation (Figure 4). Excella MIS hardware was used for placement of the screws into the pedicles of a donor torso (Innovasis, Salt Lake City, UT).

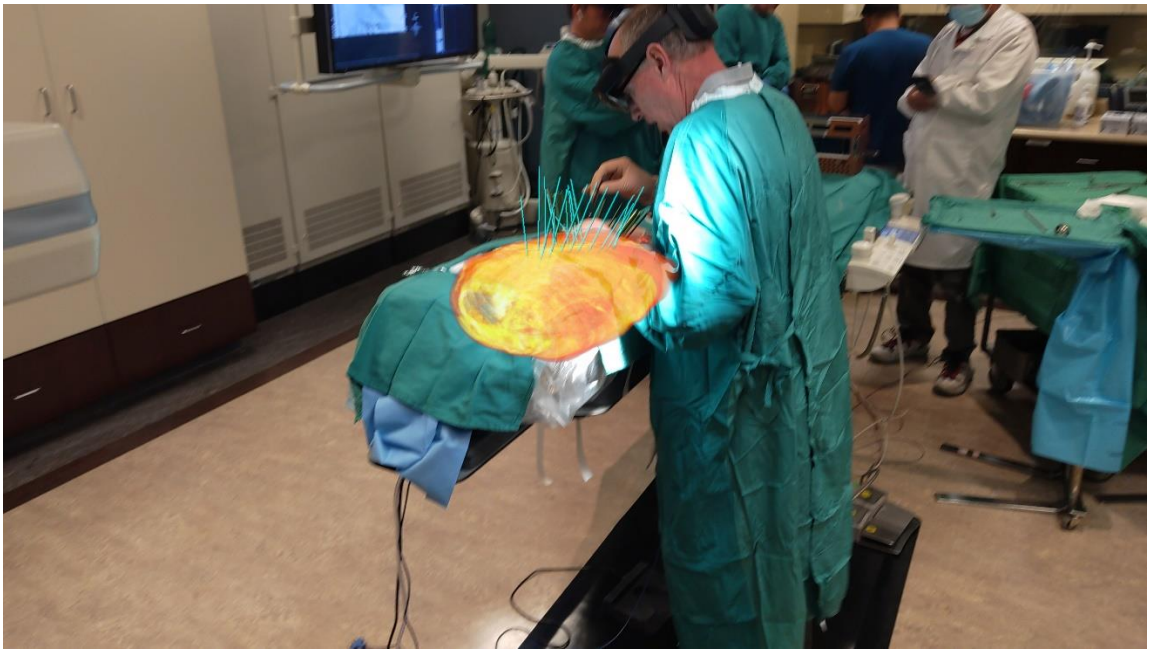

Figure 3. Real time use of OpEyes-AR for MISS. Note the holographic view, alignment and trajectory of the virtual insertion pathways for each annotate pedicle.

Figure 4. OpEyes-AR guidance of pedicle screw insertion. Note the Jamshedji needle aligned with the virtual pathway. The green line segments intersecting the fiducials indicate the operative continuous registration algorithm.

Result:

Pedicle screws were instrumented through levels L5-T9 for a total of 15 screws. There were no breaches. Many of the thoracic pedicles were narrow with little or no tolerance (Figure 5). Guidance and navigation were performed solely with OpEyes-AR.

Figure 5. OpEyes-AR precision percutaneous guidance of screws through narrow pedicles.

Conclusion:

OpEyes-AR is a tether-less, holographic visor and software combination offering the potential for precise navigation of MISS percutaneous insertion of pedicle screws with a nominal OR footprint, and elimination of OR imaging.

References:

1. Tsung-Jen Huang, Ki-Tack Kim, Hiroaki Nakamura, Anthony T. Yeung, Jiancheng Zeng, "The State of the Art in Minimally Invasive Spine Surgery," *BioMed Research International*, vol. 2017.
2. Adrian Elmi-Terander, Gustav Burström, Rami Nachabé, Michael Fagerlund, Fredrik Ståhl , Anastasios Charalampidis, Erik Edström & PaulGerdhem, "Augmented Reality Navigation with Intraoperative 3D Imaging vs Fluoroscopy-assisted free-hand surgery for spine fixation surgery: A Matched-Control Study Comapring Accuracy," *Scientific Reports, Nature Research*, 10:707, 2020.

Conclusion Statement From Your Research Findings:

Percutaneous pedicle screw insertion, using augmented reality for guidance is precise, and removes the burden of fluoroscopy exposure.

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