OpEyes-Augmented Reality Surgical Navigation and Guidance for Improved Positioning of Pedicle Screws During Open Back Surgery

Abstract 032737

Track:
Operative Technique

Sub Track:
Spine: Open Surgery

Introduction:

Open dissection allows visualization of the complex spatial anatomy of the spine. Positioning of pedicle screws depends on the expertise of the surgeon, often with operative x-ray imaging as guidance. OpEyes-AR software operates in tandem with the HoloLens 2. This system registers and superimposes CT virtual images, onto the spine (Figures 1 and 2). We report the first series of pedicle screw data with true augmented reality navigation for open spine surgery.

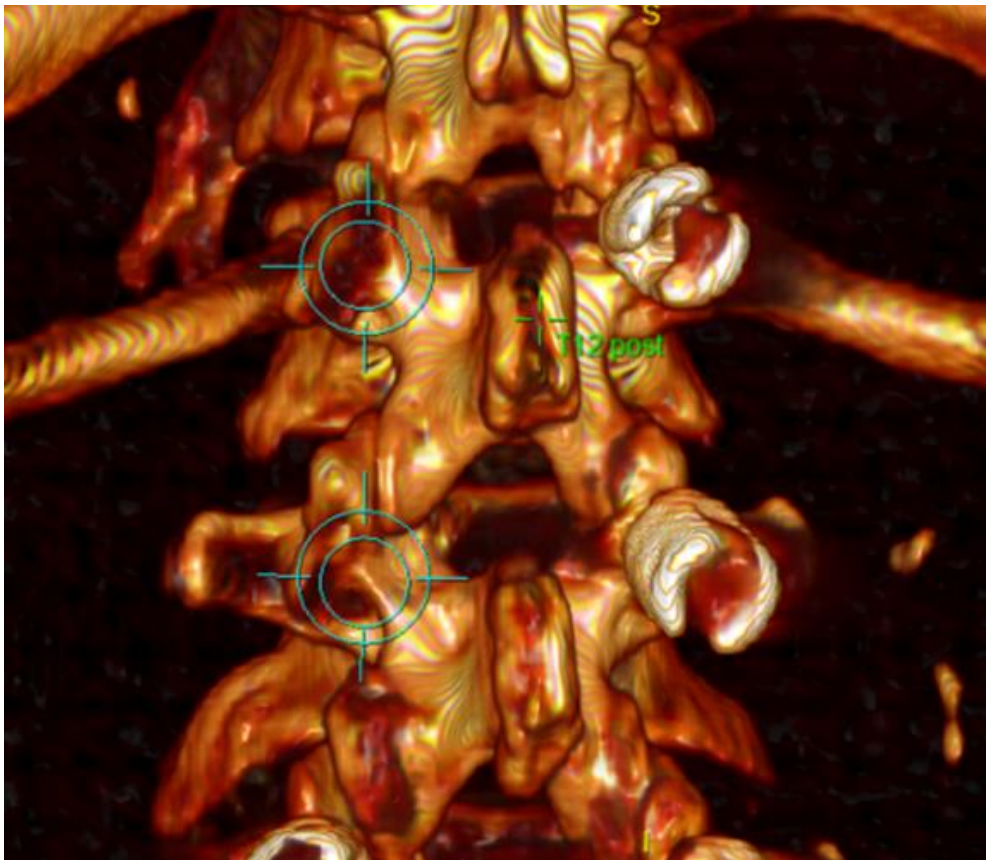

Figure 1. Targeting view of the pedicle sites on the left, and inserted screws on the right.

Figure 2. Virtual pedicle screw insertion pathways registered on a donor. Note the optical codes for registration.

Objective:

The objective of this study is to quantify the accuracy of OpenSight-Augmented Reality (AR) for guiding pedicle screw insertion during open back surgery, without fluoroscopy, as an improvement in accuracy over freehand placement.

Method:

Four cadavers were instrumented by 5 neuro-spine surgeons using OpEyes-AR software (Novarad, American Fork, UT) with the HoloLens 2 (Microsoft, Redmond, WA) as the hardware platform. Sixy-six pedicle screws were positioned. Prior to imaging, April Tags printed with image visible ink, were adhered to the back of each donor on the skin, the vertebra or the iliac crests. CT images were reviewed and annotated with virtual insertion pathways. Studies were wirelessly uploaded to OpEyes-AR by viewing an encrypted QR code assigned by the pre-op workstation. The surgeon verbally activated the automatic holographic alignment, and virtual screw insertion information was called up. A targeting system with a virtual trocar and target bullseye established skin entry point, trajectory, and depth. A post-surgical CT scan was graded according to the Gertzbein-Robbins scale (Figure 3, Table 1).[1]

Figure 3. Lateral view of pedicle screws seated with OpEyes-AR without the aid of fluoroscopy.

Table 1. Gertzbein and Robbins scale.[1]

Gertzbein and Robbins Grading Scale	
A	No breach
B	0-2 mm
C	2.1-4.0 mm
D	4.1-6.0 mm
E	> 6 mm

Result:

Of the total 66 AR guided screws, 64, or 96.97% were inserted accurately (Gertzbein-Robbins grades A and B (Table 2).

Table 2. Pedicle screw positional grading according to Gertzbein-Robbins.[1]

	Cadaver 1		Cadaver 2		Cadaver 3		Cadaver 4	
Vertebrae	**Right**	**Left**	**Right**	**Left**	**Right**	**Left**	**Right**	**Left**
T8			A				A	A
T9	B		A	C			A	A
T10	A	A	C	B			A	A
T11	A	A	A	A	A	A	A	A
T12	A	A	B	A	A		B	A
L1	A	A	A	A	A		A	A
L2	A	A	A	A	A	A	A	A
L3	A	A	A	A	A	A	A	B
L4	A	A	A	A	A		A	A
L5	A	A	A	A	A		A	A
Total Screws	9	8	10	9	7	3	10	10

Conclusion:

In this study OpEyes-AR appreciably outperformed the freehand technique, reported at 83.6%. [2] The visor-headset is non-tethered, has a nominal OR footprint and does not use fluoroscopy as a navigational aid.

References:

1. D. Gertzbein and Stephen E. Robbins. Accuracy of pedicular screw placement *in vivo*. Spine,15:1:11-14, 1990.

2. Solomiichuk V, Fleischhammer J, Molliqaj, et al. Robotic versus fluoroscopy-guided pedicle screw insertion for metastatic spinal disease: a matched cohort comparison. Journal of Neurosurgery, 42(5):E13, 2017.

Conclusion Statement From Your Research Findings:

OpEyes-AR demonstrated a considerable improvement in pedicle screw placement accuracy (+13.4%) when compared to freehand technique.

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