Augmented Reality Surgical Navigation for Procurement of Deep Brain Sites

Abstract 032799

Track:
Operative Technique

Sub Track:
Stereotactic and Functional Neurosurgery

Introduction:

Transformation of DICOM imaging data to 3D holographic images, precisely co-registered to the cranium with optical fiducials, provides precise guidance for surgical procedures. This enables the surgeon to operate looking at the patient without the distraction of referencing a flatscreen. Moreover, AR guidance precludes intraoperative imaging, eliminating ionizing radiation.

Objective:

To determine the accuracy of OpEyes-Augmented Reality (AR) for target intercept of 0.50mm deep brain sites.

Method:

A Microsoft HoloLens 2 (Microsoft, Redmond, WA) was used as the hardware platform for OpEyes-AR software (Novarad, American Fork, UT). AprilTags, printed with CT visible ink, were adhered to the exterior of the skull. Three 0.5mm targets were placed at 3 separate locations within a research grade skull filled with ballistic gel. Each target was approached from 5 exterior burr holes (Figures 1, 2) for a total of 15 “procedures.”

Figure 1. Lateral view of the skull showing burr holes 2, 3, 5 and two of the optical fiducials.

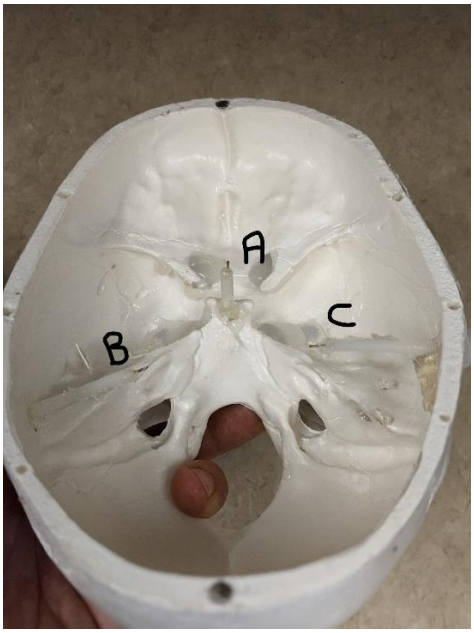

Figure 2. The interior location of the three 0.5 mm targets. With the ballistic gel removed.

The phantom was CT scanned and the 15 virtual needle pathways were annotated. Mean target distance/depth was 85.01 ± 12.84 mm (Table 1). Five individuals with training on the OpEyes AR system participated in the study for a total of 70 data points. Each participant followed the protocol of registering the virtual needle studies and calling individual pathways with verbal commands. Following every navigation attempt, the skull, containing the 18 gauge trocar, was scanned (Figure 3).

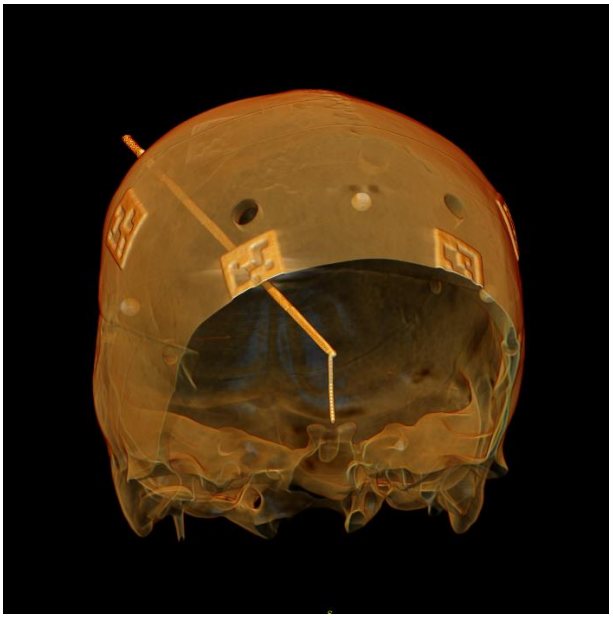

Figure 3. CT scan of post procedure skull and the needle approaches to the targets. Note the AprilTags on the exterior of the skull.

Distances were determined with the coordinate measure function of the NovaPacs 3D+ system (Novarad, American Fork, UT). Angle of error and radial error were calculated from vector coordinates. In addition, the radial error was also determined without the Z coordinate. Summary statistics were derived for results.

Result:

The angle of error was a mean of 2.30 degrees (99.9% CI ± 0.40). The radial error determined without the Z vector coordinate was an average of 2.98 mm (99.9% CI ± 0.637). The radial error calculated by Pythagorean vectors was a mean of 3.62 mm (99.9% CI ± 0.673) (Table 1).

Table 1. Accuracy metrics.

Angle of Error °	Radial Error[1] (mm)	3D Pythagorean Radial Error (mm)	Ave Target Depth (mm)
2.30 +/- 1.28	**2.98** +/- 1.62	**3.62** +/- 1.71	**85.01** +/- 12.84

Conclusion:

The accuracy of OpEyes-AR for target acquisition of a 0.5 mm target, over varying intra-cranial distances, demonstrates potential as values continue to approach those of other stereotactic systems.

Conclusion Statement From Your Research Findings:

OpEyes-AR, and augmented reality is an accurate device for some applications in neurosurgery.

Authors:
Ryan Parr, PhD, Novarad

Wendell Gibby, MD, Novarad

Edward Andrews, MD, University of Pittsburgh Medical Center

Joseph Maroon, MD, University of Pittsburgh Medical Center

Steve Cvetko, PhD, Novarad