MRI and CT Derived 3D-Printed Patient Specific Brain Model for Localizing Stereoelectroencephalography (SEEG) Electrodes

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Learning Objectives

To understand how 3D printing can aide clinicians in comprehending the complex anatomy of patients undergoing SEEG electrode implantation.

Introduction

Intracranial EEG recording is often required with intractable epilepsy cases to determine the resection site. A drawback to stereoelectroencephalography (SEEG) electrodes versus subdural electrodes is the difficulty in interpreting where precisely each electrode contact is relative to pertinent brain anatomy and other implanted electrode contacts. Graspable 3D models have been argued to be more helpful in surgical outcomes, patient interactions, learning and teaching, and medical research(1). We have developed a technique for visualizing depth electrodes in high-resolution 3D printed models for the purpose of aiding neurosurgeons in preparing for resective epilepsy surgeries.

Methods

Axial 3D T1 MRI was acquired prior to SEEG placement. Post-operatively a CT scan was obtained. Cortical segmentation was performed using freesurfer on the anatomical MRI(2). A surface model was then wrapped around the binarized CT using slicer (www.slicer.org). Both the cortical surfaces and the electrode models were then loaded into Blender (www.blender.org) for additional 3D modeling. Electrode models were hollowed out from the MRI model of the brain tissue using a boolean modifier. The refined brain model was separated by hemisphere exported to Preform (www.formlabs.com) software for 3D printing. The Formlabs printer (Form 2) is a stereo lithography printer, using high-resolution ultraviolet laser on clear photopolymer resin.?The electrodes were printed out separately and color coded to the surgeon’s reference list (Figure 1). The printed model was then processed to remove supports and add a clear finish to enhance model clarity (Figure 2).

Results

The 3D model accurately showed the depth electrode placement. With each hemisphere printed separately, the electrodes were more visible deeper in the brain.

Conclusions

3D printed models aide in a clinician's ability to visualize electrode location for SEEG data interpretation and surgical planning. This technique can be easily replicated with the appropriate scans to create an accurate model for clinicians to work and plan from.

References

1.Rengier F, Mehndiratta A, von Tengg-Kobligk H, et al. 3D printing based on imaging data: review of medical applications. Int J Comput Assist Radiol Surg. 2010;5(4):335-341. ?

2. Fischl B, Sereno MI, Dale AM. Cortical surface-based analysis. II: Inflation, flattening, and a surface-based coordinate system. Neuroimage. 1999;9(2):195-207.

Figure 1

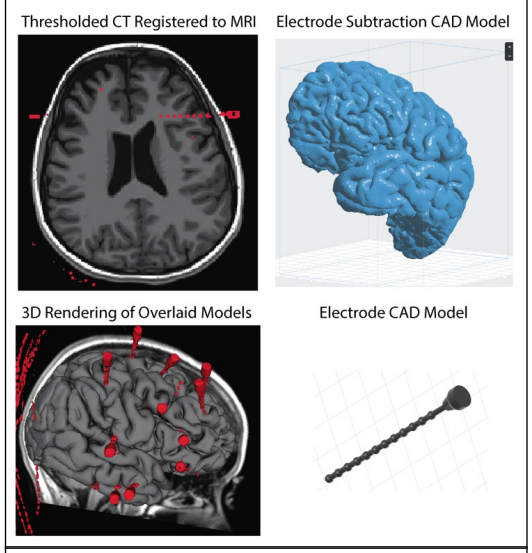

Figure 2