The use of Intraoperative High-density Electrocorticography to characterize Somatosensory Evoked Potentials in Awake Tumor Resections

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Disclosures

• I have no actual or potential conflict of interest in relation to this presentation
Introduction

• Intraoperative brain mapping techniques are utilized in neuro-oncology to maximize the extent of tumor resection and seizure control, and minimize the operative morbidity

• Somatosensory-evoked potentials (SSEPs) with standard strip electrodes is widely used in clinical practice for mapping of the sensorimotor cortex

• However, “traditional” arrays of electrodes have a quite limited and inconsistent spatial resolution

• The use of high-density electrocorticography (ECoG) with better spatial resolution can be an alternative to “traditional” electrodes arrays
Objective

• The aim of this study is to understand the topography of SSEPs assessed with high-density electrocorticography (ECoG) electrodes and correlate them with anatomical landmarks along with high-frequency oscillatory activities of the brain.
Methods

- ECoG activity was recorded in the awake and sedated state, from high-density subdural hybrid grids (53 channels, 1-2.7mm contact diameter, 10mm spacing) placed over the sensorimotor area in four patients with brain tumors during awake craniotomies.
- Electrical stimulation was applied to the median nerve at a low frequency ranging from 0.5 to 0.6Hz.
- Broad-band filtering (30-1000Hz) was used to confirm the cortical potentials (N20/P25), 40ms after stimulation onset.
- Spectral components of the neural data were examined with time-frequency analysis.
- Anatomical landmarks such as hand knob and blood vessels were used to determine the location of the grid on the brain and coregister it on a 3D cortical mesh generated with preoperative MRI scans.
Results

• Visual inspection revealed widespread SSEPs spanning the entire grid with phase reversals which precisely delineated the central sulcus for each patient.

• The spectral analysis revealed a superimposed ultra-high frequency oscillation (>500Hz) predominant on contacts in close proximity to the central sulcus.

• The amplitude of the HFOs correlated with the maximum amplitude of the SSEPs better in the awake (r = 0.74, p<0.001) compared to the sedated state (r = 0.84, p<0.001)
Central sulcus (CS) localization via median somatosensory evoked potentials phase reversal technique (MSSEP-PRT) reveals characteristic phase reversed evoked oscillations occurring 20ms after stimulation onset. Through visualization, neural activates correlating to the electrical stimulation to the median nerve, vividly defines the sensory area of the brain while the patient is sedated and after the patient is awake. (Blue patches).
Central sulcus (CS) localization via median somatosensory evoked potentials phase reversal technique (MSSEP-PRT) reveals characteristic high frequency oscillations (>500Hz), gamma activates (60-200Hz) and phase reversed evoked oscillations occurring 20ms after stimulation onset. Through visualization, neural activates correlating to the electrical stimulation to the median nerve, vividly defines the sensory area of the brain during awake craniotomy (A and B: Red patches, C: Blue patches).
Due to the complexity of the exposed brain during surgery, several recordings in different locations with strip electrodes may be needed to find the appropriate position to the target somatosensory cortex which increases the risks of hemorrhage, trauma, or infection.

Previous MSSEP studies revealed that the high frequency oscillation potentials have similar somatotopic organization to the SSEPs.

As such, single placement with a high density grid and viewing the SSEPs and HFOs in real time significantly reduces the time in localizing the central sulcus.
Summary Points

• The spatial distribution of the SSEPs using high-density grids were able to reliably identify the central sulcus in real-time in perirolandic tumors

• Combined with HFOs, the gradient of the phase reversals visualized intraoperatively can assist in surgical planning