Mayo School of Continuous Professional Development

EMG, EEG, and Neurophysiology in Clinical Practice

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Intracranial recordings and HFO’s

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Disclosure

Relevant financial relationships
• None

Off-label/investigational uses
• None
Overview

• Treatment of Intractable Focal Epilepsy
  • Epilepsy Surgery

• Review principles of Intracranial Recordings
  • Electrocorticography
  • High Frequency Oscillations

• Neuromodulation for Epilepsy
  • VNS, DBS, RNS
Refractory Epilepsy: What if medications do not work?

- 2.5 million with epilepsy in the U.S.
- >50% with partial epilepsy
- 30% refractory to medical therapy
- 2000 epilepsy surgeries/year
- 60-70% of those evaluated for epilepsy surgery get a resection

Options for epilepsy surgery

• Selective Amagydalohippocampectomy
• Anterior temporal lobectomy
• Lesionectomy
• Focal cortical resection
• Multiple subpial transection
• Hemispherectomy
• Corpus Callosotomy
• NeuroModulation Devices
Evaluation for Epilepsy Surgery

- H&P
- Ictal/interical video EEG
- Structural imaging: MRI
- Functional imaging: PET, SPECT, fMRI
- Neuropsychological testing
- Wada test

- Multidisciplinary conference
  - Epileptologists
  - Epilepsy surgeon
  - Neuropsychologist
  - Radiologist
  - EEG Technologists
  - Nursing Staff (inpatient/outpatient)
  - Administrative support
  - Research support
Epilepsy Surgery: Goals

• Removal of the “epileptogenic zone”
• Seizure freedom
• Working & Driving
• Limit morbidity and mortality
Indications for Intracranial EEG Monitoring

• Localization of seizure onset when non-invasive testing is inadequate
• Tailoring of cortical resection
• Mapping cortical function
Temporal Depth Electrodes
The Operating Room

• You NEED to know where your electrodes are being placed
  • Without knowledge of placement you cannot plug in electrodes appropriately
• All the tails have different colors
  • Each package is different
• Double-sided grids

• Verify that electrodes are working properly
Subdural Electrodes
Safety for the Grid/Depth Patient

• Increased level of risk

• Risk related to surgery
  • Bleeding
  • Infection
  • Swelling

• Pain related to surgery
  • Incision pain
  • Jaw pain
Post-op day 1

4 days later
Intracranial Monitoring

• Advantages
  • More localization value
  • Get the address not just the state
  • Less artifact

• Disadvantages
  • Invasive
  • Narrow coverage
  • If seizure does not occur adjacent to electrode then there is no localization value
Intracranial Monitoring

• Typically a bipolar montage is used
  • Montaging by row
  • May need to make additional montages based on recording

• Usually a secondary referential montage is used
  • Subdural ground/reference

• Much lower sensitivities
High Frequency Oscillations (HFOs)

- Some interictal EEG spikes correspond to the epileptogenic zone, some do NOT
- High sampling (>800 Hz) of scalp and depth electrodes can show interictal local field potentials (HFOs).
- HFOs occur spontaneously during slow wave sleep and can be evoked during sensory information processing.
- In the epileptic brain, interictal pathological HFOs are associated with brain areas capable of generating spontaneous seizures.
- HFOs can occur either independently or coincident with some EEG spikes.
High Frequency Oscillations (HFOs)

• Pathological HFOs may identify interictal EEG spikes that reliably reflect the epileptogenic zone

• Pathological HFOs can occur before or during the onset of some epileptic seizures

• Pathological HFOs could be an electrophysiologic biomarker of brain areas that are capable of generating spontaneous seizures

• Capturing pathological HFOs, therefore, could provide important information to identify the epileptogenic zone and help plan surgical resection that may ultimately improve the prognosis of seizure freedom.
High Frequency Oscillations (HFOs)
Brain Mapping

- fMRI
  - Non-invasive
  - Looks at subtle blood flow changes while patients are doing a specific task
  - Labor intensive
  - Biggest limitation is verbal/visuospatial memory
Brain Mapping

• Wada
  • Intracranial sodium amytal
  • Most helpful for memory and language lateralization
  • Cannot localize as entire internal carotid vascular territory effected
• Invasive
  • Very small risk of stroke
Brain Mapping

- Cortical stimulation
  - Stimulation through intracranial grid
  - Typically done during Phase II monitoring
    - Early vs. Late in admission
  - Risk of causing a seizure
    - Seizures should not be considered helpful for localization of ictal onset
  - Typically rescue medication is immediately available
- Patient must be awake and cooperative
Brain Mapping

• Cortical stimulation
  • G1 and G2 are chosen
  • Typically will have patient read passage
    • Repetitive
  • Gradually increase stimulation
    • Monitor EEG for after discharges
    • Monitor patient for clinical changes
Brain Mapping

• Intraoperative
  • Intracranial SEP
    • Localize primary somatosensory cortex
• Awake Mapping
  • Stimulation or Serial Testing
  • Motor
  • Speech
  • Sensory
  • Visual
Surgical Outcomes

• Can be up to 80% curative in the most ideal circumstances
• Minimally invasive approaches are being attempted
  • Laser Ablation
  • Ultrasound
• Must know neuroanatomy and neurophysiology to be successful