Stereoelectroencephalography (SEEG) to Help Treat Refractory Epilepsy

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Refractory Epilepsy

- Epilepsy that cannot be controlled or treated by medication, also known as intractable or drug resistant epilepsy.
- Affects about a third of epilepsy patients (20-40%)
- Some disagreement on the precise definition of refractory epilepsy, difficult to diagnose
Treatment of Refractory Epilepsy

- Inactivation or complete disconnection of Epileptogenic Zone (EZ)
  - Epileptogenic Zone is defined as the “area of cortex x that is necessary and sufficient for initiating seizures and whose removal (or disconnection) is necessary for complete abolition of seizures” (Lüders et al. 1993)
  - Can be inactivated by precise lesions in the brain or removed surgically
Detecting the Epileptogenic Zone

- **Brain Imaging**
  - Functional Magnetic resonance imaging (fMRI)
  - Different forms of electroencephalography, both noninvasive and invasive (EEG)
    - Focus on stereoelectroencephalography

- **EEG**
  - Measures electrical activity of the brain
  - Ionic currents in neurons produce voltage fluctuations
Stereoelectroencephalography (SEEG)

- EEG through electrodes implanted in/on brain tissue (invasive)
  - Subdural Grid Electrodes
    - Square or rectangular grid used to cover large surface area of brain
SEEG continued

- Stereotactic Depth Electrodes
  - Thin wires with electrodes, implanted deep into cerebral tissue
Implantation of Depth Electrodes

- Multiple Brain Images produced to create mapping of brain
- Stereotactic Planning software used to evaluate placement of depth electrodes
Implantation of Depth Electrodes Continued

- Surgeons use robots to assist with lining up guiding screws for electrodes
SEEG Monitoring

- Patients monitored for 3-15 days to allow for seizures to occur, doctors pinpoint epileptogenic zone
Advantages of SEEG depth electrodes

- Minimally invasive compared to subdural electrodes
- Low complication rates (1-5%)
- Allows for monitoring of deep brain structures to determine EZ
- Seizure-free rate after SEEG-guided resections was 62% after 12 months
Disadvantages

- High cost for procedure
- Complications are serious
  - Can result in loss of motor function or death
- Somewhat new method
Discussion

- Can become more accurate and have less complications in future
- Depth electrodes can pave way for brain-machine interfaces
  - Electric signals in brain can be interpreted and used to operate computers
  - Only 2 dimensional movement as of now, could become more advanced in the future
Sources

- Turning to SEEG for Pediatric Patients with Refractory Epilepsy https://consultqd.clevelandclinic.org/2015/03/turning-to-seeg-for-pediatric-patients-with-refractory-epilepsy/