Multi-Modal, Non-Invasive Epilepsy Network Mapping

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Disclosures

None
Introduction

• Epilepsy is a disorder of brain networks
• Network disruptions found in patients with temporal lobe epilepsy (TLE):
  – Reduced connection of epileptogenic zone to the default mode network
  
  – Increased small-worldness
  
  – Lower functional connectivity
• Objective: Create a software algorithm that maps networks in epileptic patients non-invasively with commonly available equipment for pre-surgical evaluation.

Methods

• Non-Invasive Techniques:
  – Resting state fMRI (rsfMRI)
  – Diffusion Tensor MRI (DTI)
  – Scalp EEG long term monitoring

• Pre-process data to remove non-physiologic noise and co-register images

• Correlation analysis to model functional networks

Results: Case 1 - Right TLE

Pre-surgical Evaluation
- 27 y.o. female with seizures for many years
- MRI: No MTS
- PET: Left temporal hypometabolism
- Wada: Language left with bilateral memory

Model Observations
- Inferior right temporal lobe ictal discharge (blue volume)
- Significant (p<0.0001) paucity of connections ipsilateral to epileptogenic tissue.
- Widespread epilepsy network (blue dots)
Results: Case 2 - Bi-Temporal

Pre-surgical Evaluation
- 25 y.o. male with 5 year history of seizures
- 7 of 8 seizures left temporal onset.
- MRI: No MTS
- Wada: Language and memory supported bilaterally

Model Observations
- Bilateral temporal lobe ictal discharge (blue volume)
- Symmetric (99% C.I.) global network connectivity
- Localized epilepsy network (blue dots)
Results: Post-Operative Changes

- Three months post-op MRI, repeated rsfMRI for Case 1
- Case 1 showed significant disconnection of the modeled epilepsy network (p < 0.001)
Discussion

Limitations
• Scalp EEG is less precise than invasive monitoring
• fMRI does not measure frequencies > 1 Hertz

Future Directions
• Outcomes 1 year post-op (Engel Class)
• Longitudinal network development
• Network connectivity in response to different temporal lobe resection techniques, when do we see the most disconnection?
Summary Points

1. Created a novel algorithm incorporating non-invasive, non-concurrent data to pre-operatively map epilepsy networks
2. Modeled networks in 2 example cases: unilateral TLE and bilateral TLE
3. Showed post-operative disruption to modeled epilepsy network after surgery