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Automated Unsupervised Identification of Seizure Onset Zone in Functional MRI

Epilepsy is a debilitating disorder that affects 50 million people worldwide, including one in 150 children. About 20-30% of children with epilepsy have drug-resistant epilepsy (DRE), resulting in significant morbidity and mortality. Early diagnosis and treatment of DRE, particularly in children, is crucial in minimizing neurological damage. Surgery is the most effective treatment for DRE, with early surgery correlating with better outcomes. Minimally invasive surgery and management of the seizure onset zone (SOZ) should be considered earlier rather than later. However, surgical intervention in DRE requires the accurate localization of the SOZ. Common brain imaging techniques have been investigated to identify the SOZ and propagation zone, but their accuracy depends on the timing of the scan.

Researchers at Arizona State University, in collaboration with a researcher at Phoenix Children's Hospital, have developed a novel tool for unsupervised, accurate localization of SOZ from independent components (ICs) of resting state functional magnetic resonance imaging (rs-fMRI). Using a phased approach, fMRI noise-related biomarkers are used through image processing techniques to eliminate noise ICs. Then, SOZ markers are used through a maximum likelihood-based classifier to determine SOZ localizing ICs. This tool outperformed state-of-the-art techniques for SOZ localizing IC identification with mean accuracy of 84.7% (4% higher), prevision of 74.1% (22% higher), specificity of 81.9% (3.2% higher) and sensitivity of 88.6% (16.5% higher).

This tool helps identify SOZ localizing ICs in children with drug resistant epilepsy and could result in improved long-term postoperative outcomes.

Potential Applications

- Identification of SOZ localizing rs-fMRI-independent components
- Reduction in the number of potential ICs to be analyzed by a neurosurgeon

Benefits and Advantages

- This tool does not require prior training data
- Eliminates the need for expert sorting
- May reduce false positives and increase true positives of SOZ localizing ICs
- Outperformed state-of-the-art techniques for SOZ localizing IC identification with mean accuracy of 84.7% (4% higher), prevision of 74.1% (22% higher), specificity of 81.9% (3.2% higher) and sensitivity of 88.6% (16.5% higher)
- Reduces the time commitment for pre-surgical evaluation
  - Reduces the number of potential ICs to be analyzed
- Consistent performance across age and gender and has been validated with surgical outcomes
- Appears to perform best for those under 5 years of age
  - May enable successful surgeries early in life, potentially improving long-term postoperative outcomes

For more information about this opportunity, please see

Banerjee et al – Front. Neuroimaging - 2023

For more information about the inventor(s) and their research, please see

Dr. Gupta's departmental webpage