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Epilepsy in Images: MRI and EEG Correlations

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Brief Report

Epilepsy is a chronic neurological disorder characterized by recurrent seizures resulting from abnormal electrical activity in the brain. Accurate diagnosis and management rely heavily on neuroimaging and electrophysiological techniques, particularly magnetic resonance imaging (MRI) and electroencephalography (EEG). The integration of these modalities has transformed the understanding of epileptogenic networks, aiding in the localization of seizure foci and guiding surgical planning in refractory cases. MRI provides detailed structural information, revealing cortical malformations, hippocampal sclerosis, or post-traumatic lesions that may underlie seizure activity. Advanced imaging techniques such as Functional MRI (fMRI), Diffusion Tensor Imaging (DTI) and MR spectroscopy further enhance diagnostic precision by identifying subtle structural or metabolic abnormalities invisible on conventional scans.

EEG, on the other hand, captures the brain's electrical activity in real-time, detecting interictal spikes or epileptiform discharges that signify hyperexcitable cortical regions. When MRI findings are combined with EEG data, clinicians can establish a powerful correlation between anatomical and functional disturbances. This combined interpretation is especially valuable in cases of MRI-negative epilepsy, where EEG helps pinpoint regions of interest for surgical exploration or neurostimulation therapy. The synergy between MRI and EEG not only improves diagnostic accuracy but also deepens our understanding of the pathophysiology of epilepsy, enabling personalized treatment strategies and better outcomes for patients [1].

Recent advances in imaging technology and computational analysis have further strengthened the correlation between MRI and EEG in epilepsy research. High-resolution 3D MRI combined with quantitative EEG source imaging allows clinicians to visualize epileptic networks with exceptional accuracy. Techniques like simultaneous EEG-fMRI provide dynamic insights into how electrical discharges correspond to hemodynamic changes across different brain regions.

Artificial intelligence and machine learning algorithms are now being employed to analyze these multimodal datasets, improving the detection of subtle lesions and predicting seizure onset patterns. Such integrative approaches are paving the way toward precision neurology, where diagnosis and treatment are tailored to the individual's specific brain structure and functional activity, ultimately enhancing seizure control and quality of life for patients with epilepsy [2].

Keywords: MRI-EEG correlation; Epileptic focus localization; Neuroimaging in epilepsy

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Conflict of Interest

None.

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