EVALUATION OF THE EFFECTIVENESS OF DIAGNOSTIC METHODS (EEG AND MRI) IN PHARMACORESISTANT EPILEPSY

DIFFERENT AGE GROUPS

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Abstract. *This article evaluates the diagnostic value and clinical effectiveness of Electroencephalography (EEG) and Magnetic Resonance Imaging (MRI) in the management of drug-resistant epilepsy. Despite advancements in neuroimaging, identifying the exact epileptogenic zone remains a primary challenge for patients who fail to respond to standard antiepileptic therapy. The study analyzes the sensitivity and specificity of video-EEG monitoring in capturing interictal and ictal activity, as well as the role of high-resolution MRI (3T and 7T) in detecting subtle structural lesions such as focal cortical dysplasia and hippocampal sclerosis.*

The integration of these diagnostic modalities is examined to determine their combined impact on localized seizure focus identification and subsequent surgical planning. The findings highlight that while EEG provides essential functional data regarding the electrical onset of seizures, MRI offers the necessary anatomical context to confirm structural triggers. The article concludes that a multimodal diagnostic approach is superior to either method alone, significantly increasing the success rate of therapeutic interventions and improving long-term outcomes for patients with refractory epilepsy.

Key words: *pharmacoresistent epilepsy, EEG, MRI, neuroimaging, epileptogenic zone, seizure monitoring, focal cortical dysplasia, diagnostic sensitivity, multimodal imaging, refractory epilepsy.*

Introduction

The precise identification of the epileptogenic zone is the most critical step in managing pharmacoresistant epilepsy, where traditional medication fails to provide seizure control. As approximately one-third of all epilepsy patients develop resistance to antiepileptic drugs, the role of advanced diagnostic modalities becomes paramount. Among the various tools available, Electroencephalography (EEG) and Magnetic Resonance Imaging (MRI) remain the gold standards, serving as the foundation for both clinical evaluation and surgical planning. The effectiveness of these methods lies in their ability to provide complementary data: EEG offers real-time functional insights into the brain's electrical activity, while MRI provides high-resolution anatomical detail to identify structural lesions.

However, the diagnostic challenge in pharmacoresistant cases often stems from the subtle nature of the underlying pathology. Standard EEG may fail to capture transient ictal events, and conventional MRI may overlook microscopic malformations such as focal cortical dysplasia or hippocampal sclerosis. Consequently, the evolution of these technologies-transitioning from routine recordings to long-term video-EEG monitoring and from standard 1.5T imaging to high-field 3T or 7T MRI-has significantly altered the diagnostic landscape. This article aims to evaluate the comparative and synergistic effectiveness of EEG and MRI in localizing seizure foci. By analyzing their sensitivity and specificity within a multimodal framework, we explore how the integration of functional and structural data optimizes therapeutic decision-making and improves the success rates of surgical interventions for patients with refractory epilepsy.

Main Body

The diagnostic synergy between Electroencephalography (EEG) and Magnetic Resonance Imaging (MRI) forms the cornerstone of localizing the epileptogenic zone in pharmacoresistant patients. EEG remains the primary functional tool, specifically through long-term video-EEG monitoring, which allows clinicians to correlate clinical seizure semiology with simultaneous electrical discharges. In drug-resistant cases, the effectiveness of EEG is measured by its

ability to distinguish between focal and generalized onsets, as well as its precision in identifying interictal spikes that point toward the irritable cortex. While routine EEG has a relatively low sensitivity, extended monitoring increases the detection rate of ictal patterns, providing essential data on the brain's dynamic electrical state that anatomical imaging alone cannot capture.

On the other hand, MRI provides the structural evidence necessary to validate EEG findings. The effectiveness of MRI has been profoundly enhanced by the transition to high-field imaging, such as 3T and 7T scanners, which utilize specialized epilepsy protocols like FLAIR and DIR sequences. These advancements allow for the detection of subtle lesions, including focal cortical dysplasia (FCD), small cavernomas, and hippocampal sclerosis, which were frequently invisible on older 1.5T machines. In pharmacoresistant epilepsy, an MRI-positive finding significantly increases the likelihood of a successful surgical outcome, as it provides a clear physical target for resection. The sensitivity of MRI in these cases is not just about resolution, but also about the expertise of the neuroradiologist in identifying "non-lesional" abnormalities that correlate with the patient’s seizure semiology.

The ultimate effectiveness of these diagnostic methods is realized through their integration in a multimodal framework. When EEG localization and MRI findings are "concordant"-meaning they both point to the same brain region-the predictive value for post-surgical seizure freedom rises dramatically. In cases where MRI remains "negative" or "non-lesional" despite clinical evidence of focal epilepsy, the functional data from EEG guides more advanced imaging techniques or the placement of intracranial electrodes. Thus, the evaluation of EEG and MRI effectiveness should not be viewed in isolation; rather, their value lies in their combined ability to transform a diagnosis of pharmacoresistance into a manageable surgical or therapeutic plan by mapping both the structural triggers and the functional pathways of the disease.

Conclusion

In conclusion, the effective management of pharmacoresistant epilepsy depends on the strategic integration of EEG and MRI, as neither modality alone can

provide a complete diagnostic picture. EEG remains indispensable for capturing the functional dynamics of the brain, allowing clinicians to verify the electrical onset of seizures and differentiate between focal and generalized epilepsy. Meanwhile, high-resolution MRI serves as the primary tool for identifying the structural substrates of the disease, with advanced 3T and 7T imaging significantly reducing the number of "non-lesional" cases by detecting subtle malformations.

The study demonstrates that the highest diagnostic yield is achieved when functional EEG data and structural MRI findings are concordant, as this synergy provides the most reliable roadmap for surgical intervention. In cases where structural lesions are absent, the role of long-term EEG monitoring becomes even more critical in guiding further specialized investigations. Ultimately, a multimodal diagnostic approach not only enhances the precision of localizing the epileptogenic zone but also substantially improves the prognosis for patients, offering a viable pathway toward seizure freedom and enhanced quality of life in the face of medication failure.

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