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The Epileptic Focus and the Epileptic System

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Annotation: The modern classification of epilepsy is an important aspect in understanding and treating this condition, as it helps improve diagnostic accuracy and therapy effectiveness. This literature review is dedicated to analyzing current approaches to epilepsy classification, including changes proposed in recent years. The article examines the main categories of epileptic syndromes, such as focal, generalized, and unspecified epilepsies, as well as their subtypes and characteristics. The significance of genetic, structural, and metabolic factors, which influence the pathogenesis of epilepsy and play an important role in choosing therapeutic tactics, is discussed. The review emphasizes the importance of integrating new technologies, such as genetic testing and functional neuroimaging, into the diagnostic process. Special attention is given to the revision of classification criteria proposed by the International League Against Epilepsy (ILAE) and its role in clinical practice.

Keywords: Epilepsy, epilepsy classification, epileptic syndromes, focal epilepsy, generalized epilepsy, diagnosis, genetic factors, neuroimaging, International League Against Epilepsy (ILAE).

Introduction

Epilepsy is one of the most common neurological diseases, affecting approximately 1% of the world's population. The main characteristic of epilepsy is spontaneous seizure attacks caused by abnormal electrical activity of neurons. This pathological condition arises due to the formation of epileptic foci in the brain, which trigger paroxysmal activity. The spread of this activity is carried out through complex neural networks, called the epileptic system.

The epileptic focus is a structured area of the brain where hyperactivity of neurons arises, provoking epileptic seizures. Understanding the mechanisms of the formation and functioning of the epileptic focus, as well as the spread of abnormal activity through the epileptic system, is key to more effective treatment of epilepsy. This paper presents the main pathophysiological aspects of the epileptic focus and epileptic system, as well as modern methods of diagnosis and treatment.

Research objectives:

1. Examine the pathogenesis of the formation of the epileptic focus and epileptic system.

2. Analyze existing methods of diagnosing and treating epilepsy.

3. Discuss new approaches to therapy and their potential impact on the treatment of refractory forms of epilepsy.

Methods

This review used scientific articles published in international peer-reviewed journals on neurology and epileptology over the last 20 years. The main databases for the literature search included PubMed, Scopus, and Web of Science. More than 50 sources were analyzed, including the results of clinical studies, meta-analyses, and systematic reviews.

Diagnostic methods discussed in the article:

Electroencephalography (EEG): the main tool for assessing brain electrical activity, detecting, and localizing epileptic foci. Magnetic resonance imaging (MRI): used to identify structural changes in the brain associated with epilepsy, such as hippocampal sclerosis and cortical dysplasias. Positron emission tomography (PET): helps visualize the brain's metabolic activity and assess functional disturbances in areas associated with epileptic foci. Surgical interventions and neurostimulation methods, such as vagus nerve stimulation, were considered therapeutic options for patients with drug-resistant epilepsy.

Results

1. Epileptic foci: Epileptic foci can form in various parts of the brain. The temporal lobe is most frequently the location of epileptic foci, especially in patients with temporal epilepsy. Hippocampal sclerosis, a structural change in the temporal lobe, is the most common cause of epileptic activity. MRI allows these structural changes to be detected in most patients with temporal epilepsy.

2. Epileptic system: The epileptic system includes neural networks that provide the generation and spread of epileptic discharges. Studies have shown that genetic mutations and brain damage caused by trauma or infections play a key role in the development of the epileptic system. Genetic studies have revealed that mutations in genes associated with channelopathies (e.g., mutations in SCN1A and KCNQ2 genes) can lead to increased neuronal excitability and therefore contribute to the development of epileptic foci.

3. Diagnosis: Modern methods of epilepsy diagnosis, such as EEG and MRI, allow for the precise identification of epileptic foci and the extent of the involvement of the epileptic system. Electroencephalography detects epilepsy-specific abnormal discharges, such as sharp waves and spike-wave complexes. MRI helps identify structural changes, such as hippocampal atrophy, dysplasias, and tumors, which may be the source of epileptic activity.

4. Treatment: The main approach to treating epilepsy involves the use of antiepileptic drugs, such as carbamazepine, valproate, and lamotrigine. However, 30-40% of epilepsy patients have drug-resistant forms of the disease, which require surgical intervention. Surgical removal of the epileptic focus can significantly improve the prognosis for such patients. Neurostimulation, including vagus nerve stimulation and deep brain stimulation, is also an effective method for treating refractory epilepsy.

Discussion

The results of this review confirm that the epileptic focus plays a central role in seizure generation, and its correct diagnosis can significantly improve the choice of treatment strategy. The localization of the focus is crucial for predicting clinical manifestations and for selecting treatment methods. Temporal epilepsy, for example, often presents with complex partial seizures and may require surgical intervention if it is resistant to drug therapy.

The epileptic system, which represents the neural networks responsible for the spread of epileptic activity, remains an important area of research. Future work should focus on in-depth studies of the pathogenesis of the formation of the epileptic system, including genetic and molecular mechanisms. This will lead to a better understanding of how epileptic discharges spread and create new opportunities for therapy.

The introduction of new technologies in diagnosis, such as fMRI and PET, improves the accuracy of determining epileptic foci and allows for more precise surgical planning. Modern neurostimulation methods, in turn, provide alternative treatment paths for patients for whom surgery is not feasible.

Conclusion

The study of epileptic foci and the epileptic system is a crucial aspect of understanding the pathogenesis of epilepsy and the development of new diagnostic and treatment methods. The use of modern imaging methods, as well as new approaches to surgical treatment and neurostimulation, significantly improves the prognosis for patients with refractory epilepsy. Future research in genetics and molecular biology may provide even more opportunities for personalized therapy, which will improve the quality of life for patients.

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