Accuracy in Pediatric Epilepsy

Abstract

One of the most prevalent and devastating neurological conditions that affects children and infants is epilepsy. We used to treat pediatric epilepsy according to the type of seizure because we didn't know much about the causes of the condition in children. We are now entering the age of precision medicine in pediatric epilepsy thanks to new tools and tests. The new etiological classification system proposed by the International League against Epilepsy is used in this review to describe new tools for identifying seizure foci for epilepsy surgery, define treatable epilepsy syndromes, and discuss advancements in pediatric epilepsy diagnosis.

Keywords: Neurological condition • Epilepsy • Precision medicine • Seizure • Pediatric epilepsy diagnosis

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Introduction

One of the most prevalent health issues affecting young children is epilepsy. A seizure will occur in about 5% of children1. A new Meta investigation discovered that the dynamic period pervasiveness of epilepsy (the quantity of yearly new what's more, existing instances of epilepsy) was 4.8/1000 overall and in the USA was 0.94/1000 for youngsters under 18 years of age. The lifetime prevalence of epilepsy the number of active and existing cases of epilepsy between birth and the time of assessment for children under the age of 18 was 7.2/10002, according to the same study. Children and their families are impacted in numerous ways by epilepsy and the conditions that cause it, including cognition, behavior, and socioeconomic status. Epilepsy that cannot be controlled and the conditions that cause seizures have lasting effects on a child that can last a lifetime and even raise the risk of sudden death. The pathophysiology of epilepsy is poorly understood, and we lack tools for diagnosing the condition and its root cause. However, diagnosis of the cause of epilepsy in infants and children has significantly improved in recent years [1,2]. Epilepsy's classification has changed; Seizures and epilepsy are no longer described in the same way. There are now new ways to find out what causes seizures and epilepsy; consequently, new treatments for epilepsy and seizures have emerged. We have new instruments to recognize kinds of epilepsy and to confine the seizure center in central epilepsy. The International League Against Epilepsy (ILAE) has developed a new classification system based on a deeper comprehension of the pathophysiology of epilepsy as well as new methods for diagnosing and treating epilepsy. The field of pediatric epilepsy has entered the age of precision medicine. The objective of determining and treating the cause of epilepsy rather than its symptoms is getting closer and closer. How has our ability to determine the cause of epilepsy changed? What new diagnostic tools are currently available for each of the ILAE's etiological categories? What do you do with these tools? Some of these questions will be answered in this review [3,4].

Subsequent changes in epilepsy classification

Seizures and epilepsies were recently reclassified by the ILAE. Although some of the terminology has been slightly modified3, the classification is still largely based on clinical and Electroencephalography (EEG) characteristics. The term "partial onset" has been replaced by "focal onset," and focal onset seizures fall into two categories: aware and unable to remember things. Central seizures that become summed up seizures are presently alluded to as central to reciprocal tonic-clonic rather than incomplete with auxiliary speculation. A considerable lot of the portrayals of the engine and non-engine movement that happens during the seizure continue as before. The move toward classifying epilepsies according to their etiology and improving the definition of epilepsy syndromes has been the most significant change. This modification takes into

53

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account some of the significant advancements that have been made in defining the causes of epilepsy, particularly in infants and children who experience seizures [5,6].

Diagnosis of epilepsy

Using imaging techniques: Advanced sequences like Diffusion Tensor Imaging (DTI), Diffusion Kurtosis Imaging (DKI), and neurite orientation dispersion and density imaging (NODDI) produce more sensitive images than T1 and T28. They also increase the diagnostic advantages of VBM and tractography, whether used in place of or in addition to conventional MRI sequences5, 8, and 12. This has been observed in FCD and Temporal Lobe Epilepsy (TLE), where accurate FCD subtype classification was made possible by DTI-based VBM analysis. DTI-based VBM and tractography analysis revealed subtle microstructure and connectivity patterns that correlate with cognitive impairments (such as verbal and memory) in relation to age of first seizure in children with active idiopathic epilepsy and without cognitive impairment. Even though DKI and NODDI are more sensitive than DTI8, their application in pediatric epilepsy is currently limited. There is a need for research into how they can be used [7,8].

Magnetic Resonance Imaging (MRI) processing and analysis can significantly overcome this obstacle and enhance microstructural changes by incorporating Voxel Based Morphometry (VBM). Focal Cortical Dysplasia (FCD), a complicated and highly epileptogenic condition, is a prime example. Cortical thickness and gray-white contrast are consistently measured more precisely when VBM is incorporated into conventional MRI images and its other measurements—such as sulcal depth/gyrification and Jacobian distortion provide a more precise illustration of FCD. Traditional MRI analysis fails to detect FCD in more than half of patients with histological confirmation, despite the fact that complete surgical resection can successfully alleviate epilepsy burden [9,10].

Another non-invasive technique, Magneto Encephalography (MEG), stands out from the two previously mentioned due to its high spatial and temporal resolution. Epileptic foci associated with cortical dysplasia and surgical outcomes are enhanced by MEG. A recent study16 found that MEG localization had a capture rate of 91 percent for histopathically confirmed FCD (82 percent in type I and 100 percent in types II and III), while MRI had a capture rate of 64

percent (59 percent in type I, 62 percent in type II, and 100 percent in type III). When it comes to mapping epileptogenic zones, MEG has been more accurate than non-invasive video EEG monitoring because it can detect electrical activity in deep brain structures; More specifically, the high sensitivity of MEG for localizing seizure foci persists even in the infant population17 when it comes to localizing seizure foci. New surgical treatment options have emerged as a result of advancements in quantitative algorithms for modeling the epileptogenic zone and the growing popularity of Stereo Electro Encephalography (SEEG), which enables the exploration of deep epileptogenic foci, feasible bilateral intracranial recordings, and three-dimensional mapping of epileptogenic zones. In a recent study, the use of SEEG in the detection and algorithmic analysis of high-frequency oscillations revealed an average specificity of 96.03% and a sensitivity of 81.94% for the identification of seizure onset. According to the data that are currently available, SEEG use increases the likelihood of underlying epilepsy surgery, with seizure-free outcomes ranging from 50% to 88%18.

Testing for immune diseases has advanced

The number of autoimmune neurological conditions has skyrocketed over the past ten years. A lot of them result in seizures. A list of autoimmune encephalitis and the antigen targets of the autoantibodies that cause seizures is provided in.When pediatric patients who were previously normal present with acute or sub acute onset of seizures and signs of infection, additional behavioral symptoms, or movement disorders, it is important to think about autoimmunity as a cause of seizures and epilepsy. A diagnosis of presumed autoimmune encephalitis can also be supported by abnormal brain imaging and an abnormal EEG. Immunomodulatory treatment (corticosteroid and intravenous immunoglobulin, plasma exchange, and rituximab) and testing for Para neoplastic tumors should be started as soon as possible in patients with autoimmune encephalitis. Treatment right away can be very effective.

Genetic tests

More than 70% of epileptic conditions that is, conditions in which epilepsy presents as a core or associated symptom are said to be caused or influenced by enetic abnormalities. Because distinct gene mutations can result in the same phenotype and single-gene mutations can result in variable phenotypes, determining

whether an epilepsy-causing gene mutation is difficult. Genetic testing has become an essential component of pediatric epilepsy evaluations due to the fact that genetic epilepsy syndromes typically manifest in infancy or childhood. Multigene panels, clinical exome sequencing, clinical genome sequencing, and chromosomal microarrays for testing infants and children with epilepsy have rapidly evolved from narrowly applicable tools such as Fluorescence in Situ Hybridization (FISH) and single-gene testing) to massively parallel sequencing. The advantages and disadvantages of the various types of genetic testing for genetic causes of epilepsy are listed in. Cutting edge sequencing (NGS) is growing the rundown of epilepsy-related qualities as well as revealing variation designs that possibly could foresee pathogenicity, sickness pathophysiology what's more, development, and helpful focusing on. The findings of studies involving epileptic children are presented in. The majority of studies employ WES or epilepsy gene panels, occasionally in conjunction with an epilepsy gene panel. Only one of the studies utilized WGS because of the cost. An epilepsy panel that includes mitochondrial gene testing and covers a total of 553 genes is now available from MNG Laboratories (Atlanta, GA, USA). The number of genes in the epilepsy panels is rapidly increasing. The cost of whole exome and whole genome testing is falling at such a rapid rate that these genetic tests may replace imaging as the next test. Genetic testing yields the highest results in pediatric patients, particularly infants with epilepsy syndromes or infant epileptic encephalopathies, as shown in.In genetic and non-genetic pediatric epilepsies, epigenetic biomarkers, in addition to NGS, are beginning to contribute to the improvement of diagnostic precision. There are many epigenetic factors, but some of the most important ones in pediatric epilepsy are DNA methylation, histone modification, and non-coding RNA. Due to the fact that evidence of their presence can clarify disease manifestations and evolution, these factors provide a more in-depth diagnostic value. Since recent studies have demonstrated that DNA methylation is prevalent in TLE, the possibility of using DNA methylation as a diagnostic epigenetic biomarker for this non-genetic condition is a prime example. DNA methylation, as an epigenetic biomarker, can also help predict disease progression and prognosis for many genetic epilepsies (like Dravet, benign familial neonatal seizures, and epileptic

neurodevelopmental disorders, or NDDs), as it controls the disease and changes how genes are expressed and functioned (like KCNQ3, SCN3A, and GABRB2, respectively).

Conclusion

We now have new tools for treating epilepsy thanks to improved methods for identifying structural, metabolic, genetic, autoimmune, and structural diseases of the nervous system. The disorders in are just the beginning of the precise treatment options for epilepsy. New drugs, protein replacement, gene therapy, and many other promising treatments for the most devastating epilepsies that affect infants and children are made possible by the precise definition of the cause of epilepsies. Also on the horizon are advancements in the localization of developmental and structural changes that cause focal epilepsy. One of the most exciting periods in epilepsy is now, and it is truly a period of precision medicine.

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