ADVANCED NEUROIMAGING TECHNIQUES IN EVALUATING PEDIATRIC EPILEPSY

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ABSTRACT:
Accurate localization of the seizure onset zone is important for better seizure outcomes and preventing deficits following epilepsy surgery. Recent advances in neuroimaging techniques have increased our understanding of the underlying etiology and improved our ability to noninvasively identify the seizure onset zone. Using epilepsy-specific magnetic resonance imaging (MRI) protocols, structural MRI allows better detection of the seizure onset zone, particularly when it is interpreted by experienced neuroradiologists. Ultra-high-field imaging and postprocessing analysis with automated machine learning algorithms can detect subtle structural abnormalities in MRI-negative patients. Tractography derived from diffusion tensor imaging can delineate white matter connections associated with epilepsy or eloquent function, thus, preventing deficits after epilepsy surgery. Arterial spin-labeling perfusion MRI, simultaneous electroencephalography (EEG)-functional MRI (fMRI), and magnetoencephalography (MEG) are noninvasive imaging modalities that can be used to localize the epileptogenic foci and assist in planning epilepsy surgery with positron emission tomography, ictal single-photon emission computed tomography, and intracranial EEG monitoring. These advanced structural and functional imaging modalities can be combined with postprocessing methods to better understand the epileptic network and obtain valuable clinical information for predicting long-term outcomes in pediatric epilepsy.

KEYWORDS: Children, CT, Epilepsy, monitoring, pediatrics, seizure.

INTRODUCTION:

Epilepsy is the most typical chronic medicine disorder within the medical specialty population. The incidence of encephalopathy in childhood is around 40–100 cases per a hundred people,with the very best incidence within the initial year of life (Hauser, 1994). Though the semipermanent outcome in all fairness favours nearly two thirds (Sillanpää and Schmidt, 2006) of patients in terminal remission, around third of kids have drug-resistant encephalopathy. The role of neuroimaging in encephalopathy is police investigation structural abnormalities that will be associated with encephalopathy and supply info for acute and semipermanent treatment coming up with and concerning prognosis (Semah *et al.*, 1998). Recent advances in neuroimaging techniques have allowed the likelihood of processing the refined structural abnormalities that may cause encephalopathy and predicting and reducing medicine impairment once surgical resection (Jeevanandan, 2017). The more, methodologies to outline purposeful property, which can be associated with the comorbidity of encephalopathy and seizure outcome, have conjointly speedily progressed.In this review, we have a tendency to explore the recent developments in neuroimaging techniques for evaluating medical specialty encephalopathy with a spotlight on the acquisition technique, post process analysis, and multidisciplinary approach victimisation varied neuroimaging modalities. We have a tendency to divide these tools into structural neuroimaging, that examines the structure of the

systema nervosum, and purposeful neuroimaging, that measures a side of human brain operation that supports localized changes in brain metabolism associated with neural activity.

Structural neuroimaging in epilepsy:

Although computerized axial tomography (CT) will speedily rule out Associate in Nursing intracranial hemorrhage or a mass requiring imperative neurosurgical attention, resonance imaging (MRI) has become a vital imaging modality to spot epileptogenic lesions attributable to its superior depiction of the brain anatomy and tissue composition (Bronen *et al.*, 1996). Patients with traditional standard CT scan ought to endure more evaluations since tomography will determine bound epileptogenic lesions in 8%–12% of patients with normal CT results (King *et al.*, 1998). Yet, refined abnormalities like a malformation of animal tissue development and hippocampal induration area unit are typically not known with this resolution and customary tomography protocol (Sharma *et al.*, 2019).Finally, a designation is usually confirmed in surgical histopathology that wasn't detected on MRI (Bien *et al.*, 2009). The sensitivity of tomography examinations may be improved victimisation epilepsy-specific tomography protocols understood by neuroradiologists with the attention of clinical focus hypotheses (Von Oertzen *et al.*, 2002).FCD shows varied characteristics looking at the biological process stage of myelination of the lesion and close brain. In patients below two years more mature, some FCD lesions might show a high T2 or aptitude signal and a lower T1 signal thanks to secondary degenerative disorder, dysmyelination, or gliosis (Yagishita *et al.*, 1997). In cases of negative tomography findings throughout infancy, repetition imaging is suggested at 6-month intervals or once twenty four months once additional mature myelination will reveal otherwise unknown animal tissue dysplasia (Gaillard *et al.*, 2009).

ADVANCES IN STRUCTURAL NEUROIMAGING:

Ultra high field MRI:

The detection rate of refined epileptic lesions is additionally suffering from the field strength (Packiri, Gurunathan and Selvarasu, 2017).3 Tesla (3 T) tomography is believed to be additional sensitive to refined epileptic lesions in some patients WHO area unit MRI-negative at one.5 T , particularly (Nguyen *et al.*, 2010) when phased array surface coils area unit used (Knake *et al.*, 2005). The more utilization of ultra-highfield (7 T) tomography has magnified for in vivo brain imaging, giving the next magnitude relation signal-to-noise , signal/ noise ratio and contrast-to-noise ratio, which might end in higher spatial resolution. Compared with standard field-strength tomography (1.5–3 T), the diagnostic price of seven T tomography has been incontestable for polymicrogyria , moyamoya malady hippocampal induration , brain tumors , stroke and induration (Tallantyre *et al.*, 2011). During a prospective study, seven T tomography was performed for twenty one consecutive patients (17 adults, four children) with one seizure onset zone WHO were antecedently thought-about MRI-negative. GRE and aptitude pictures discovered a definite lesion in twenty ninth of patients (1 child), with the histopathological designation of FCD all told patients WHO underwent surgical operation . Yet, there are a few reports of the clinical application of seven T tomography in medical specialty encephalopathy . High cost, magnified susceptibleness artifacts, image irregularity, and patient comfort and safety issues as well as magnified radiofrequency power deposition, dizziness, nausea, and bimetal style should be thought-about once victimisation ultra-high-field tomography in clinical follow for medical specialty encephalopathy (Balchandani and Naidich, 2015).

Diffusion tensor imaging:

Diffusion tensor imaging (DTI) has been reportable to higher visualize the nervous tissue fiber tracts by estimating the direction, orientation, and property of the nervous tissue fiber tract supporting the differential quality of water molecules on versus perpendicular to the fiber bundles. DTI tractography will

delineate 3D-specific nervous tissue tracts from the advantageous choice of aeolotropic water diffusion by connecting fibers that tolerate anatomically placed regions of interest (Chaitanya *et al.*, 2017). This method may be helpful for evaluating nervous tissue tract alterations related to encephalopathy (Concha *et al.*, 2009). It may also be used as a presurgical analysis tool to avoid smooth-spoken pathways like the pyramidal tract for motor operate, optic radiation for transference visual info, or arced fibre bundle for language, notably in youngsters for whom invasive presurgical analysis is difficult (Winston *et al.*, 2011). DTI has conjointly been accustomed to visualize the purposeful property of seizure tracts by developing a geography map of seizure network nodes (Subha and Arvind, 2019). However, tractography has its limitations, i.e., it tends to possess high variability and low dependability looking at technical factors like knowledge acquisition, fiber modeling, fiber reconstruction, and professional interpretation as well as decisions of seed regions and stopping thresholds (Essayed *et al.*, 2017).

POSTPROCESSING OF STRUCTURAL NEUROIMAGING IN NON LESIONAL EPILEPSY:

Although a visible scrutiny of high-resolution tomography will improve the detection of refined epileptogenic lesions like hippocampal induration and FCD, a traditional visual analysis has restricted ability to acknowledge the presence and extension of refined lesions. (Rajeshkumar, Venkat Kumar, *et al.*, 2018). Advanced tomography post process techniques are developed to spot refined structural abnormalities by quantifying the anatomic options of the brain while not the requirement for long manual measurements or subjective visual assessments (Kumar *et al.*, 2015). Voxel-based morphometry (VBM), the foremost common morphometric technique thus far, may be used for T1-weighted pictures to extract grey substance and nervous tissue maps for comparison with a standard management info. the utilization of VBM has indicated that lesions with magnified grey substance concentration area unit in agreement with FCD lesions visible on tomography in 63%–87% of cases (Colliot *et al.*, 2006). VBM conjointly permits the improved visual image of FCD with a junction map to spotlight blurring of the gray-white matter boundary Associate in Nursing an extension map to delineate abnormally deep sulci (Karthiga, Rajeshkumar and Annadurai, 2018). Surface-based morphometry techniques reconstruct the animal tissue surface and permit the measuring of morphologic options like animal tissue thickness, curvature, and depth and texture options (blurring of the gray-white matter boundary) to sight the abnormal anatomical structure and sulcal patterns of FCD that might not be detected on VBM (Rajeshkumar, Agarwal, *et al.*, 2018)**.**

LOCALIZATION OF EPILEPTIC ACTIVITY:

In patients while not definite abnormalities on standard tomography, purposeful neuroimaging might aid our understanding of the mechanisms underlying the epileptic method, resulting in a additional correct localization of abnormal vegetative cell activities (Ezhilarasan, Evraerts, *et al.*, 2017) by measure in vivo insertion, metabolic changes, or neurotransmission abnormalities related to the seizure (Avinash, Malaippan and Doraiswamy, 2017). In fact, 18F-fluorodeoxyglucose (FDG)-positron emission (PET) is that the most generally used modality for police investigation focal areas of relative hypometabolism, which can mirror purposeful disturbances in cerebral activity related to the epileptogenic zone (Gheena and Ezhilarasan, 2019). The regional cerebral hypometabolism known by FDG-PET typically includes a wider distribution than that of the seizure focus, which might represent the main focus and therefore the projection areas of seizure activity (Burneo *et al.*, 2015). This might verify the extent of the operation problem. FDG PET is additionally a great tool for predicting seizure management once encephalopathy surgery; the extent of operation of the hypometabolism on FDG-PET could also be related to higher surgical seizure outcome (Menon *et al.*, 2018)**.**

MAPPING OF ELOQUENT BRAIN FUNCTION:

Functional tomography (fMRI) relies on the principle that metabolically active regions of the brain have magnified blood flow, called activation-flow coupling. It's accustomed to determine blood activity level-dependent (BOLD) signals, that area unit determined by the native concentration of deoxygenated and ventilated hemoprotein in response to neural activities (Ashwini, Ezhilarasan and Anitha, 2017). Recently, functional magnetic resonance imaging has become a promising noninvasive different technique to the Wada check (intracarotid truth drug test) within the adult population to guide the operation arranged by characteristic essential areas of the brain close to the seizure focus and minimize the chance of recent deficits (Sepeta *et al.*, 2016). The patient is asked to perform a series of tasks throughout a task-based functional magnetic resonance imaging study. though robust preliminary proof shows that functional magnetic resonance imaging may be accustomed displace and localize language and motor operate in medical specialty encephalopathy surgery candidates, purposeful mapping via task-based functional magnetic resonance imaging is difficult in youngsters thanks to an absence of cooperation, biological process state, and age-dependent cerebral physical property (Collinge *et al.*, 2017). Furthermore unclear that language and memory tasks turn out optimum activation and the way it's statistically quantified. more studies specifically targeting medical specialty encephalopathy populations area unit required. Resting-state functional magnetic resonance imaging has been accustomed to localize the smooth-spoken cortex by characteristic specific brain resting-state networks for presurgical coming up with patients WHO might not be able to work during a task based mostly on paradigm .

ADVANCES IN FUNCTIONAL NEUROIMAGING:

Functional tomography may be a hemodynamic imaging technique that lacks the temporal resolution of encephalograms (Anitha and Ashwini, 2017). The mix of encephalograms with functional magnetic resonance imaging (EEG-fMRI) permits the detection of daring signal changes associated with attack or interictal epileptic discharges (IEDs) (Lakshmi *et al.*, 2015). EEG-fMRI has been accustomed to follow propagation of the seizure and seizure foci in periods across the brain and eventually delineate the epileptogenic network of focal and epilepsy (Ezhilarasan, Lakshmi, Vijayaragavan, *et al.*, 2017). What is more purposeful property analysis is victimisation EEG-fMRI will determine the period impact of IEDs on noesis (Nordli, Xiao and Zhou, 2016). and predict the surgical outcome of encephalopathy (Perumalsamy *et al.*, 2018). However, aggregation EEG-fMRI recordings in some youngsters is difficult thanks to an absence of cooperation, and varied factors as well as sedation, age, sleep, and therefore the impact of anticonvulsant drug medication on hemodynamic parameters ought to be more investigated (Mehta *et al.*, 2019). Magnetoencephalography (MEG) records the magnetic fields generated by synchronic neural activities of the brain with wonderful spatial and temporal resolution. The strength of one thousand thousand is that the field flux isn't distorted by muscle artifacts or materials that lie between the brain and recording devices (Ezhilarasan, Lakshmi, Nagaich, *et al.*, 2017). one thousand thousand has been accustomed to sight the precise location of sources and superposition them on brain tomography, called magnetic supply imaging (Ezhilarasan, 2018). Its accuracy for localizing the stimulative zone is to admire electrocorticography, attack SPECT, or PET.Its combined use with encephalogram might improve the accuracy of supply localization and identification of propagated activity . Additionally, one thousand thousand purposeful mapping is promising for medical specialty patients WHO cannot endure intraoperative animal tissue mapping (Bercovici *et al.*, 2008).

CONCLUSION:

In recent years, the sector of neuroimaging has undergone tidy development. Although several of the imaging techniques delineate here area unit still thought-about preliminary, the magnified convenience of ultra-high-field imaging, advanced imaging technology, and postprocessing analysis can improve the detection of refined lesions that underlie refractory epilepsy. A combined approach victimisation of many structural and purposeful neuroimaging datasets during a machine learning model might play a vital role in

noninvasively localizing the epileptogenic foci for doable surgical operation. what is more, purposeful neuroimaging modalities like functional magnetic resonance imaging and one thousand thousand may be used as alternatives to the Wada check to elucidate smooth-spoken structures for preventing surgical medicine deficits. Continuing advances in neuroimaging can enhance our understanding of the epileptic network and guide therapeutic ways to realize higher outcomes.

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CONFLICT OF INTEREST:
The authors declare no conflict of interest

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