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Magnetic Resonance Imaging and Its Benefit in Epilepsy and Seizure Disorders Diagnosis

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Abstract

Background Brain magnetic resonance imaging (MRI) is one of the most important investigations in epilepsy, which can detect any structural abnormality such as infarctions, gliosis, tumors and other different abnormalities.

Objective To investigate types of structural brain lesions and its relation to their seizure semiology.

Methods This is a retrospective cross-sectional study involving 352 patients. Collected data were taken from patient's files in epilepsy clinic between 2016-2021. Sequences were used according to MRI epilepsy protocols.

Results Files of 352 patients were reviewed, males 222 (63.1 %) while the rest were females (36.9 %), mean age of patients was 30.69 years ± 11.011 and mainly from the age group 18-30 years old (57.1%). Regarding the clinical diagnosis of seizure 210 (59.65%) to have focal type seizures and 142 (40.35%) of the patients with generalized types. One-third of seizure subtypes was a generalized tonic-clonic seizure (32.1%), followed by focal aware seizure (19.3%), focal to bilateral tonic-clonic (15.6%). Regarding MRI findings, (62%) of the patients had a normal study, temporal lobe pathology 32 (9.1%) patients, gliosis 21 (6%) patients, generalized brain atrophy was 15 (4.3%) patients, nonspecific white matter lesion was 10 (2.8%) patients, cerebrovascular insult was (2.8%).

Conclusion The commonest MRI findings in epileptic patients was normal scan, followed by mesial temporal lobe lesions, gliosis, nonspecific white matter lesions, brain atrophy and cerebrovascular insults.

Keywords Epilepsy, MRI, seizure, tonic-clonic

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List of abbreviations: CSF = Cerebrospinal fluid, CT = Computed topography, EEG = Electroencephalogram, MRI = Magnetic resonance imaging, PET = Positron emission tomography

Introduction

Seizure is a paroxysmal disruption of brain activity brought on by abnormally high levels of neuronal electrical activity. A patient with epilepsy has repeated seizures that are not caused by an underlying acute neurological or systemic illness (1). Epilepsy is a chronic disorder. The prevalence of epilepsy is estimated to be 5 to 10 people per 1000, while the incidence is between 0.3 to 0.5%. Even with the finest medical care, up to 20% of patients still experience seizures (2). Seizures disorders are diagnosed using a variety of tests, including magnetic resonance imaging (MRI) scans, cerebrospinal fluid (CSF) analyses, brain computed topography (CT) scans, electroencephalogram (EEG), and simple x-rays. Additionally, positron emission tomography (PET) and magnetic resonance imaging (MRI) scans are quite helpful. The radiological localization of epileptogenic areas has gained importance due to advancements in neuroimaging technology and the widespread use of epilepsy surgery to remove the epileptogenic lesion [3]. It was believed that the existence of a radiological lesion strongly supported a zone of seizure origin, essentially independent of clinical presentation and EEG results. When it comes to pediatric patients, the existence of localized epileptogenic lesions discovered by MRI has been shown to be associated with successful resective epilepsy surgery for the chosen individuals, even in the face of generalized epileptiform discharges. This information was utilized to guide the surgical treatment option. A number of technological and scientific advancements were essential to the eventual creation of MRI scanners [4]. In 1992, functional MRI of the brain had been introduced, which was later developed by Rosen et al. The validity of criteria for computed tomography-based brain atrophy assessment in 2003. Currently, a wide range of field strengths, such as 1.5T, 3.T, and 7T, have been used in research, clinical applications, and MRI using whole-body superconducting magnets. At greater field strengths, the enhanced signal-to-noise ratios and enhanced resolution are accessible [5,6].

The objective of the study was to investigate types of structural brain lesions and its relation to their seizure semiology.

Methods

Study type and settings

This is a retrospective cross-sectional study involving 352 patients' files, those referred from different medical departments with history of seizure.

Study sample and sampling technique

Files of 352 patients from various regions of Iraq with variable semiology, durations and different treatment regimens of their seizure disorders or epilepsy by using the revised expanded version of the 2017 International League Against Epilepsy (ILAE) seizure classification. All the patients underwent their scans by Philips 3T MRI scanner in Saad Al-Witry Neuroscience Hospital from 2016 to 2021. All MRI scans were performed by a 3 Tesla device (Siemens Healthineers, Germany) on the same hospital. Sequences were used according to MRI epilepsy protocol (Sagittal spin-echo T1-weighted imaging, Fat-suppressed axial, sagittal, axial and coronal T2-weighted imaging, sagittal proton density–weighted imaging).

Inclusion criteria

All patients were older than 18 years of age that had an MRI of the brain as a part of their diagnostic work up from September 2016 up to march 2021.

Exclusion criteria

Patients with (shell, bullet injuries, metallic prosthetic body parts, claustrophobia), pediatric patients, patients with previous craniotomy.

Data collection tool

Details of patients' age, sex, seizure types, subtypes and the brain image findings evaluating the significance of brain MRI in the diagnosis of epilepsy and seizure disorders were obtained from patient's files.

Statistical analysis

The collected data was organized, tabulated, and statistically analyzed using SPSS version 24 and Microsoft Excel worksheet 2016. The results mostly expressed as frequency and percentage except for age which presented as mean ± standard deviation. Chi square test had been used for comparison, and level of significance was considered as P value >0.05.

Results

The current study was performed on 352 patients, about ⅔ of them were males 222 (63.1 %) while the rest were females (36.9 %). The mean of age was 30.69 years ±11.01 years and the distribution of age was mainly 18-30 years old (57.1%). The original diagnosis of patients with normal MRI was (62.2%), the rest group was diagnosed as abnormal at 37.8% (Table 1).

Table 1. Distribution of the patients according to the demographic features of the patients, and MRI finding

Parameters		Number	%
Age (year)	18-30	201	57.1
	31-45	112	31.8
	46-60	33	9.4
	>61	6	1.7
Sex	Male	222	63.1
	Female	130	36.9
MRI finding	Normal	219	62.2
	Abnormal	133	37.8

N = 352

Table 2 shows that 219 (62.2%) patients have normal MRI study while the most abnormal finding was medial temporal pathology seen in (9.1%), gliosis seen in (6.0%), (4.3%) for generalized atrophy and finally non-specific white matter lesion and stroke was seen in 10 (2.8%) patient each.

The distribution of gender according to the MRI finding shows that both normal and abnormal MRI was more in male (129, 93) respectively, and the age group of 18-30 was the major affected age in abnormal MRI (Table 3).

MRI findings in the generalized types of seizure revealed that the abnormal finding was (94.2%) for generalized tonic-clonic followed by about (3%) for both myoclonic seizures and generalized atonic. The result was significant as the overall P value was (0.029) as shown in table 4.

The MRI finding in the focal types of seizure showed that the abnormal finding was mostly for focal aware seizure (32.4%) followed by (focal to bilateral tonic-clonic, focal with awareness loss, temporal lobe seizure, Frontal lobe seizure, and Epilepsia partialis continua) as patient's number was (26.2%, 21.9%, 12.4%, 5.2%, 4.0% and 2.0%) respectively. However, the result was not significant as the overall P value was (0.128) (Table 5).

Table 2. Distribution of the patients according to the finding of MRI

MRI findings		Frequency	Percent
Normal MRI		219	62.2
Abnormal MRI	Medial temporal pathology	32	9.1
	Gliosis	21	6.0
	Generalized atrophy	15	4.3
	Non-specific white matter lesion	10	2.8
	Stroke	10	2.8
	Cavernoma	5	1.4
	Cystic lesion	5	1.4
	Leukodystrophy	5	1.4
	Brain contusion	5	1.4
	Brain calcification	4	1.1
	Hemiatrophy	4	1.1
	AVM	3	0.9
	Focal atrophy	3	0.9
	Low-grade glioma	3	0.9
	Tuberus sclerosis	2	0.6
	Focal cortical dysplasia	1	0.3
	Meningioma	1	0.3
	Multiple sclerosis	1	0.3
	Parietoocipital heterotopia	1	0.3
	Porencephaly	1	0.3
	Sturgeon weber	1	0.3
Total		352	100.0

Table 3. Distribution of the patient's gender and age according to the finding of MRI

Parameter		Normal MRI	Abnormal MRI
Sex	Male	129	93
	Female	90	40
Age (year)	18-30	125	76
	31-45	75	37
	46-60	15	18
	>61	4	2

Table 4. Distribution of the generalized types of seizure according to the finding of MRI

Generalized seizure type	Normal MRI N (%)	Abnormal MRI N (%)	Total N (%)
Generalized tonic-clonic	81 (75.0%)	32 (94.2%)	113 (79.6%)
Myoclonic seizure	24 (22.2%)	1 (2.9%)	25 (17.6%)
Absence	3 (2.8%)	0 (0.0%)	3 (2.1%)
Generalized atonic	0 (0.0%)	1 (2.9%)	1 (0.7%)
Total	108 (100%)	34 (100%)	142 (100%)

N = 141, P value by Chi square test is 0.029

Table 5. Distribution of the focal types of seizure according to the finding of MRI

Focal seizure type	Normal MRI N (%)	Abnormal MRI N (%)	Total N (%)
Focal aware	39 (35.1%)	29 (29.3%)	68 (32.4%)
Focal to bilateral tonic-clonic	28 (25.2%)	27 (27.3%)	55 (26.2%)
Focal with awareness loss	28 (25.2%)	18 (18.2%)	46 (21.9%)
Temporal lobe seizure	8 (7.2%)	18 (18.2%)	26 (12.4%)
Frontal lobe seizure	6 (5.4%)	5 (5.0%)	11 (5.2%)
Epilepsy a partial is continua	0 (0.0%)	2 (2.0%)	2 (0.9%)
Sensory seizure	1 (0.9%)	0 (0.0%)	1 (0.5%)
Occipital lobe seizure	1 (0.9%)	0 (0.0%)	1 (0.5%)
Total	111 (100%)	99 (100%)	210 (100%)

N = 211, P value by Chi square test is 0.121

Discussion

Patients that are given the provisional diagnosis of seizures may have a variety of brain MRI findings based widely on the causality. Due to the great soft tissue penetration, good resolution, lack of radiation exposure and its problems and the availability of the MRI it can serve a fantastic aid in identifying intracranial pathologies which may aid the diagnostic work up and the whole course of management of each individual case [(7)]. This study had reviewed the files of 352 patients from various regions of Iraq with variable semiology, durations and different treatment regimens of their seizure disorders or epilepsy from 2016 to 2021.

The current study found that majority of the sample were males and of age group 18-30 years, which is comparable to Sharma et al. and Ponnatapura et al. studies [(8,9)]. Chabarwal and Kardam noticed that the most common age groups were those in their 2nd and 3rd decade of life, which approaches current result although they included children in their study [(10)].

In this study, most of the patients had a normal exam followed by temporal lobe pathology included (mesial sclerosis, mesial atrophy, hippocampal atrophy and focal temporal atrophy). While Patel et al. in 2017 found in his study on 150 patient study that (38%) were normal and the most common abnormality was stroke followed by gliosis and infections, tumors, demyelinating lesions and mesial temporal sclerosis respectively [(11)]. On the other hand, abnormal findings were mainly for generalized tonic-clonic followed by myoclonic seizures and generalized atonic this can be explained as focal epileptogenic lesions and their clinical presentations are very different among different age groups in terms of range and manifestation. In surgical series, mesial temporal sclerosis (MTS) is the most prevalent lesion in adults; in children, however, MTS is rare and when it does occur, it usually manifests as dual pathology. Developmental tumors, encephalomalacia due to infarction, hypoxia, trauma, or infection, and abnormalities of cortical development are the most prevalent lesions in younger age epilepsy surgery candidates. In most circumstances, a thorough examination of the features of the lesion on brain MRI is adequate to predict disease.

MRI findings can influence treatment planning for individuals with epilepsy, for example, if an MRI shows a focal lesion that is causing seizures, it may be a target for surgical intervention. On the other hand, if there are generalized abnormalities detected on an MRI (e.g., diffuse cortical atrophy), it may suggest that medical management is more appropriate [(12)].

Regarding the clinical diagnosis of seizure in this study, the overall seizure types were 210 (59.65%) for focal type and 142(40.35%) of them with generalized types. Slimen et al. agreed with our study as he found that GTCS were the most common although it was very higher percent on comparison with our results, which may be because of different sample size and age groups used in both studies [(13)]. Also, Sharma et al. 2019 stated that GTCS as the most prevalent 56.2% then focal aware seizure 16.5% and then focal awareness loss and myoclonic both 5% [(8)]. It is crucial to mention that structural imaging is crucial to rule out an underlying etiology (such as a subdural hematoma) in individuals without established epilepsy who presented with abrupt seizures and may need a particular treatment intervention.

MRI is useful in diagnosing the type of epilepsy and in finding a causal focal lesion in people with newly diagnosed or previously undiagnosed epilepsy [(14)]. A considerable portion of epileptic patients have normal MRI results or findings that are unclear. Functional neuroimaging techniques, such as ictal single-photon emission computed tomography (SPECT), fludeoxyglucose-positron emission tomography (FDG-PET), or functional magnetic resonance imaging (fMRI), may help with surgical planning for patients with drug-resistant focal epilepsy [(15)]. This is particularly true for patients with MRI-negative epilepsy, whose prognosis for a seizure-free outcome after surgery is worse than for patients with an epileptogenic lesion on structural MRI [(16)].

In conclusion, most of the patients with seizure were males, of young age of less than 30 years of age. Generalized tonic-clonic seizures are commonest type. The commonest MRI findings in epileptic patients was normal scan, followed by various types as mesial temporal lobe lesions, gliosis, brain atrophy and cerebrovascular insults.

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Author contribution

Dr. Obaid: study design, editing. Dr. Jabbar: literature review. Dr. Salman: data collection and statistical analysis.

Conflict of interest

None.

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