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Role of Magnetic Resonance Imaging in Patients with Seizure Disorders

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ABSTRACT

Neuroimaging is primarily used in seizure patients to identify structural or metabolic issues and diagnose syndromic or etiological issues. MRI imaging is superior to X-ray and CT scanning for determining epilepsy etiology in both adults and children. It is used to identify structural causes of epilepsy, while computed tomography is preferred for developing seizures in the emergency room. To identify the structural abnormalities of brain associated with seizuredisorders. A cross-sectional study was conducted at Sree Mookambika Institute of Medical Sciences in Tamil Nadu, involving 62 patients aged and sex. Participants were selected through convenient sampling and a structured proforma. Socio-demographic variables, clinical diagnosis and MR imaging findings were used to identify structural abnormalities in patients with seizures. Informed consent was obtained from patients and data was collected and analyzed using SPSS software. A study of 62 patients aged 1-30 years found that the majority of patients presented with GTCS, with a male predominance. Over half of the patients presented within one to three months of onset of seizures. Magnetic resonance imaging (MR) abnormalities were found in 61.3% of the participants, with infarct being the second most common abnormality. Most males (41.9%) were diagnosed as abnormal, while only 12.4% of females were. MR positivity was highest in patients with motor, febrile and tonic seizures. MRI is helpful for pre-operative planning and post-operative monitoring, and is superior for evaluating epilepsy cases, acute cerebrovascular disease, developmental cortical abnormalities and vascular malformations without radiation exposure.

INTRODUCTION

A seizure is a paroxysmal change in neurologic function brought on by abnormally high levels of electrical activity in the neurons. Chronic epilepsy is characterized by recurring seizures that are not brought on by a sudden systemic or neurological injury. Seizures are a clinical symptom of aberrant, excessive neuronal activity that starts in the cerebral cortex's grey matter[1]. Seizures are caused by an imbalance in the central nervous system's typical ratio of excitation to inhibition. One of the most prevalent neurological conditions worldwide is epilepsy. The number of people who experience recurrent, unprovoked seizures worldwide is at least fifty million[2].

Neuroimaging is mostly used in seizure patients to find structural or metabolic problems that need special care and to help make a syndromic or etiological diagnosis[3]. There are numerous neuro-radiological examinations that can be used to diagnose and determine the cause of the lesion. These include a skull x-ray, a pneumocephalogram, a CSF analysis, a carotid angiography, an EEG, a CT scan and an MRI[4]. In this context, the groundbreaking development of MRI for epilepsy evaluation has been a huge boon for both the clinical management of patients with neurologic diseases and the detection of cerebral abnormalities[3].

In terms of sensitivity and specificity for determining the etiology of epilepsy in both adults and children, magnetic resonance imaging (MR imaging) is clearly superior to X-ray and computed tomography (CT) scanning. Finding the structural causes of epilepsy is one of the main clinical uses of MRI[5]. In the emergency room, computed tomography is typically preferred for patients with newly developing seizures[6]. However, it only plays a small part in the assessment of patients with uncontrollable epilepsy. When defining the structure of the brain, magnetic resonance imaging offers improved resolution and a higher diagnostic yield for epileptogenic lesions. The development of high-resolution magnetic resonance imaging with an epilepsy protocol has greatly increased the likelihood of identifying the etiology, having a favorable clinical influence on patient management [7,8].

This study focuses on the importance of magnetic resonance imaging as a method for evaluating structural problems, identifying the etiological factors causing seizures and classifying the different types of seizures. Patients who are experiencing seizures are managed and monitored in large part by magnetic resonance imaging[9]. Investigating the prevalence of structural abnormalities in seizures is helpful. It is quick, painless, non-invasive, and can be completed without hospitalization.

Aims and Objectives: To identify the structural abnormalities of brain associated with seizure disorders.

MATERIALS AND METHODS

This descriptive cross-sectional study was conducted among 62 patients irrespective of age and sex, from October 2022 to June 2023 at the Department of Radiodiagnosis, Sree Mookambika Institute of Medical Sciences, Kulasekharam, Tamil Nadu. Convenient sampling was used to select the participants.

Inclusion Criteria: Patients referred for MRI of the brain who presented with history of seizures irrespective of age and sex.

Exclusion Criteria:

- Patients with specific implanted devices such as pacemakers, metallic implants and certain cerebral aneurysm clips which contradict MRI
- Uncooperative, severe claustrophobia exacerbated by Magnetic Resonance Imaging
- Those who were unwilling or unable to give consent

A structured proforma was used including the following Socio-demographic variables such as (name, age and sex), clinical diagnosis and MR imaging findings such as cortical malformations, infections, cerebro vascular accidents and space occupying lesions. MRI features of structural abnormality, used to identify the cause of seizure was performed by 1.5T Siemens Magnetom Sempra 16 channel system using a phased-array surface coil with 6 channels. Both MR positivity and MR diagnosis were assessed. Informed consent was obtained from the patients.

Data Analysis: Data was Collected and entered in Microsoft excel and analysed using SPSS software. Continuous variables like age were expressed as mean and standard deviation. Description of categorical variables like age category, sex, MR abnormality, duration of illness and MR diagnosis were expressed as frequency and proportion. Fisher's exact test was used for binary variables. Chi square test was used for association between categorical variables. All tests were two tailed and results were considered statistically significant if the $p<0.05$ at 95% confidence interval.

RESULTS

Maximum number of patients was in the age group of 1-30 years (50%)Sex ratio = M: F 1.38:1 this Table depicts the frequency and age and sex distribution among the participants. Male 36(58.1%) and female 26 (39%).Male predominance was noted (Table 1 and 2).

DISCUSSIONS

Based on the cause, patients who clinically presented with seizures had a wide range of abnormalities on MR imaging. Due to its effectiveness

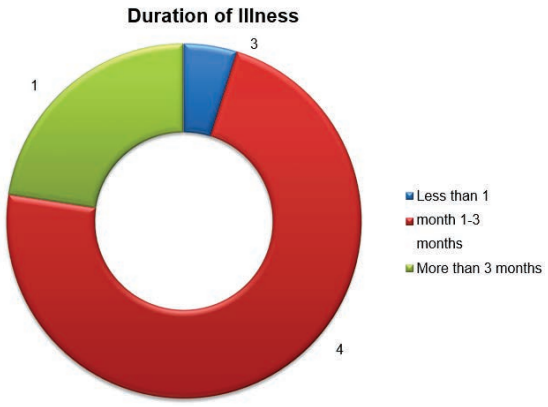

Fig. 1: Donut chart showing distribution based on duration of illness

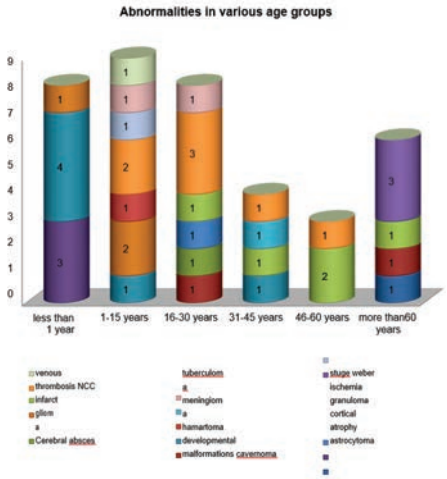

Fig. 2: Compound bar graph showing distribution of abnormalities according to age groups

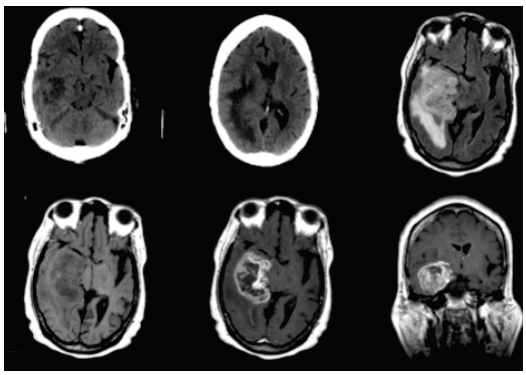

Fig. 3: Grade IV astrocytoma. Nonehanced CT Image and fluid-attenuated inversion recovery (FLAIR) MAI

in pinpointing the abnormalities, MRI was useful in planning the subsequent treatment in patients with seizure disorder. Early in the course of epilepsy,

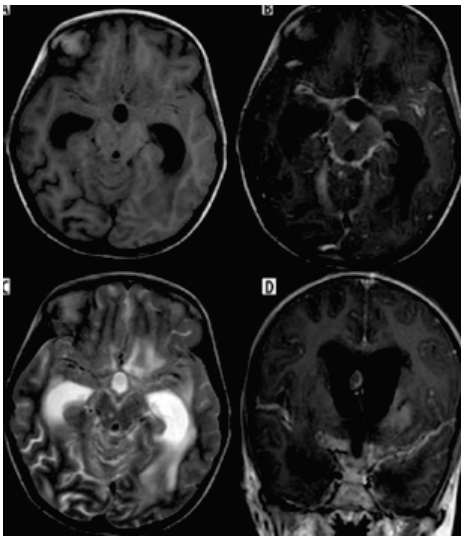

Fig. 4: Tubercular leptomeningitis. A (T1W axial) and C (T2w axial) show altered signal intensity in the basal cisterns. B (T1WCE axial) and D (T1WCE control) show diffuse leptomeningeal enchancement along the basal cistern and syvian fissures with dilated ventricles

neuroimaging was crucial because it could reveal the underlying cause and enable direct therapy strategies. With the aid of MRI imaging, nonspecific abnormalities such as periventricular leukomalacia and atrophy, static remote lesions such as porencephaly, focal lesions that cause seizures such as focal cortical dysplasia and mesial temporal sclerosis that may be candidates for epilepsy surgery could be identified. Additionally, it aided in the detection of subacute and chronic processes such as metabolic diseases and was crucial for spotting acute processes such as tumors, strokes, encephalitis and hydrocephalus that necessitated urgent intervention (Fig 1 and 2).

According to the inclusion, exclusion and modified ILAE 2017 criteria, 62 individuals having a clinical history of seizures were included in this study. Each patient's clinical history was noted and all of them underwent standard biochemical tests in accordance with the proforma and also an MRI with a SIEMENS 1.5 T MRI scanner (Fig 3 and 4).

The individuals in this study had seizures that lasted anywhere between a few days to a few months. The most frequent clinical diagnosis, which accounted for 48 cases (80%), was GTCS. The age of the patients in our study ranged from infants to 70 years with male predominance (58% males and 39% females). The MR imaging revealed abnormalities in 38 out of 62 patients (53%) which included infarct (8.1%), glioma (4.8%), NCC (11.3%), tuberculoma (3.2%), cortical atrophy (4.8%), venous thrombosis (1.6%), developmental malformations (9.7%), ischemia (4.8%), Sturge-Weber

Table 1: Age and sex wise distribution among the study participants

Age in years	Male	Female	Total (n = 62)	Frequency (%)
Less than 1	4	8	12	19.4
1-15	10	6	16	25.8
16-30	10	5	15	24.2
31-45	4	6	10	16.1
46-60	2	1	3	4.8
More than 60	6	0	6	9.7
Total	36 (58.1%)	26 (41.9%)	62	100

Table 2: Distribution of patients on the basis of clinical diagnosis of seizures

Clinical Diagnosis	No. of patients (n = 62)	Frequency (%)
GTCS	49	79
Myoclonic seizures	4	6.5
Motor seizures	2	3.2
Focal seizures	2	3.2
Febrile seizures	1	1.6
Neonatal seizures	1	1.6
Partial seizures	2	3.2
Tonic seizures	1	1.6
Total	62	100.0

syndrome (1.6%), cavernoma (3.2%), hamartoma (1.6%), granuloma (1.6%), meningioma (1.6%) and cerebral abscess (1.6%).

MR imaging revealed 5 patients with cerebral infarction, with three acute infarcts, four chronic infarcts, and one small ischemia lesions. In a study by McGahan *et al*.[10], 31 out of 638 individuals who had their first stroke experienced early seizures. An additional finding was that hemorrhagic change following a stroke was a predictor of early seizure. Seven patients (11.3%) developed MR images resembling neurocysticercosis (NCC) lesions, with ring-enhancing lesions in cerebral hemispheres. NCC lesions had perilesional edema, mural nodule and choline peaks. Three cases had frontoparietal lobe perilesional.

Edema and one patient had multiple intraparenchymal ring-enhancing lesions. In 512 patients with persistent epilepsy studied by TRV elasco *et al*.[11],isolated NCC was discovered in eight patients(1.56%).In their investigation of 40 patients with a likely diagnosis of NCC,Tushar Patil *et al*.[13] stated that 72% of patients had one lesion, 27% had multiple lesions and parietal lobe was the prevalent site (4%). These findings were in line with the present study.

Two out of 62 individuals had tuberculosis after MR imaging, with thick walls, ring-enhancement and peri-lesional edema. MR Spectroscopy showed increased lactate. Supportive criteria included history of ATT usage, contact and pulmonary tuberculosis. Following therapy, all patients showed marked improvement. Naser Uama *et al*. [13]. study found that 1.4% of seizure cases had tuberculosis, and 66.6% responded well to medicalcare.

Cerebral atrophy was found in three individuals with a history of diabetes. Two patients had diffuse cortical and subcortical atrophic changes, while one had temporal lobe epilepsy Khan *et al*.[14] study found that cerebral atrophy is a late consequence of diabetes, with 47% of men and 43% of women experiencing it. This study supports the findings of Khan *et al*.[14].

In this study, only one individual had MRI findings indicative of cerebral venoussinus thrombosis. Patient had an infarct in the right frontoparietal lobe as well as thrombosis in the right transverse sinus and superior sagittal sinus. The patient had previously used an oral contraceptive and after receiving proper medical care clinical condition significantly improved. In a case report of a patient with a history of constant headaches, Gupta *et al*. [15] stated that an MR venogram study was used to diagnose the existence of superior sagittal sinus thrombosis with a minor venous infarct.

In this current study, 6 patients had signs of structural cortical developmental abnormalities. One patient had bilateral parietal lobe polymicrogyria. Another patient had right frontal lobe localized cortical dysplasia and various other developmental abnormalities. In a related study, Sanghvi *et al*.[16] found that on MR imaging, 9 of the 76 patients with seizures revealed focal cortical dysplasia and 3 of the patients had signs ofpolymicrogyria.

There were signs of hypoxia ischemic damage in three cases. One patient had bilateral periventricular T2W and FLAIR hyperintense foci in the white matter. Similar lesions were observed in the brain stem, periventricular white matter and bilateral basal ganglia of two other patients. These patients had significant perinatal history Liau *et al*.[17] study on 57 infants delivered at or after 35 weeks of gestation showed that 23 of them had stage 2/3 perinatal hypoxia ischemic encephalopathy. Their study concluded that a better predictor of hypoxic ischemia events thanthe normal myelination-related changes detected in the posterolateral putamen, posterior limb of theinternal capsule, and corona radiate vs peri-Rolandic cortex on T1W imaging.

Two patients had well-defined, non-enhancing lesions with hemorrhagic signal intensities. In one patient left temporal lobe was involved and in another patient right parietal lobe was involved. The lesions had a hypointense ring on gradient echo images. One male and one female patient with cavernoma were among the two patients who received the diagnosis. In both cases the lesions were supratentorial in nature. Hakan *et al*.[18] study which involved 30 male and 7

female patients had lesions in the supratentorial region. These findings do not concur with our observations.

In this study, one patient had astrocytoma in the left frontal lobe. In T2WI and FLAIR the lesion showed up as intra-axial, cortical-based heterogenous lesion that was well-defined and mostly hyperintense without perilesional edema. The lesion exhibited a hypointense signal on gradient echo imaging. After contrast treatment, there was no discernible improvement. When compared to conventional MRI, Fellah *et al*.[19] research on 50 patients with oligodendrogliomas and oligoastrocytomas the multimodal MR imaging (Diffusion, Perfusion and Spectroscopy) was more accurate in grading thesetumors.

Meningioma was found in the left sphenoid convexity of a patient who had seizure. The lesion was identified as well-defined extra-axial dural-based lesion in the left sphenoid convexity with strong enhancement and a dural tail at its edge. According to Alshoabi *et al*.[20] research on 50 patients with meningioma of the brain and spine, meningioma is more common in female patients over the age of 40, with the majority of the cases being convexity meningioma in the brain. The findings of this study are comparable to those of our investigation, since the patient in our study who displayed signs of sphenoid convexity meningioma was a female patient in her70s. One patient in the current study had a right parietal lobe cerebral abscess. Well-defined area appearing isointense to hypointense on T1W, hyperintense on T2W and perilesional edema in the right parietal lobe. DWI revealed diffusion restriction. Peripheral rim enhancement of the lesion was noticed after contrast injection. A lipid peak was observed on an increased lactate MR spectroscopy. When evaluating the effectiveness or failure of the draining of an abscess, Fabiola Cartes-Zumelzu's[21] study of seven patients with pyogenic brain abscesses found that DWI is superior to normal conventional contrast enhanced MR imaging.

CONCLUSION

MRI is a valuable tool for managing patients with focal seizures, generalized seizures, refractory epilepsy, focal neurological deficits and early or late epilepsy. Partial seizures are more likely to cause structural problems. MRI is helpful for pre-operative planning and post-operative monitoring and is superior for evaluating epilepsy cases, acute cerebrovascular disease, developmental cortical abnormalities and vascular malformations without radiation exposure.

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