Original Article

Cross-sectional Observational Study to Determine Morphology of the Hippocampus in Seizures Disorder by Magnetic Resonance Imaging in a Tertiary Care Hospital

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Background and Objective : Approximately 2-5% of the World's population experiences a seizure in their lifetime and underlying cause which may be revealed by brain MRI. Hippocampus is a structure frequently involved in epilepsy and its morphological imaging is crucial in the diagnostic management of epileptic patients. The objective is to assess the MRI findings in hippocampus with seizures disorder patients.

Materials and Methods : The current study is a cross sectional observational study. All patients referred to the Department of Radio-diagnosis with clinically suspected seizures were evaluated with 1.5T Siemens Magnetom Essenza MRI. MR Imaging protocol of seizures was used for evaluation. The changes in hippocampus were evaluated.

Conclusion : With its high spatial resolution, excellent inherent soft tissue contrast, multiplanar imaging capability and lack of ionizing radiation, MR imaging has emerged as a versatile tool in the evaluation of patients with seizures. In our study, MRI shows Partial Loss of Hippocampal Striations (PLHS) in 14 cases (23.33%) out of total 60 cases included. MRI also revealed hippocampal atrophy and secondary signs of hippocampal sclerosis in 11 patients (18.33%) out of 60 patients. Hence, we conclude that in our study PLHS in adult population is much more common than the classic signs of hippocampal sclerosis (increased signal intensity and volume loss).

[*J Indian Med Assoc* 2024; **122(6):** 28-31]

***Key words* : Temporal Lobe Epilepsy, Hippocampal Morphological Changes, Mesial Temporal Sclerosis, Seizures, MRI.**

A seizure is a paroxysmal change in neurologic function brought on by abnormally high levels of neuronal electrical activity[1]. Epilepsy is chronic condition characterized by recurrent seizures by an acute systemic or neurologic insult[1]. An epileptic seizure explained as a clinical manifestation of abnormal, excessive neuronal activity arising in the gray matter of the cerebral cortex[2]. The incidence of epilepsy is approximately 0.3 to 0.5% and prevalence of epilepsy is estimated to be 5 to 10 persons per 1000[3]. The incidence is higher in children and elderly persons than in young adults.

Because of its excellent soft tissue contrast, ability to depict anatomy in detail, freedom from the beam - hardening artefact that occurs with CT and capability for multiplanar imaging, MR imaging has emerged as the most valuable tool for preoperative localization of epileptogenic focus[1]. Several studies have been reported with 72% to 90% sensitivity and 75% to 100% specificity to detect MR abnormality in Temporal Lobe Epilepsy (TLE).

Editor's Comment :

- Mesial Temporal Sclerosis (MTS) is the most common cause of medically intractable partial complex epilepsy in adults.
- Identifying MTS is crucial because surgery is the most effective treatment option.
- MR imaging, with its high spatial resolution, excellent soft tissue contrast, multiplanar imaging and absence of ionizing radiation, has become a versatile tool for evaluating seizure patients.
- This study suggests that in adults, Partial Loss of Hippocampal Striations (PLHS) is more prevalent than the classic signs of hippocampal sclerosis, such as increased signal intensity and volume loss.

The most frequent cause of focal epilepsy is known to be Temporal Lobe Epilepsy (TLE). In 70% of cases, TLE is accompanied with hippocampus (mesial temporal) sclerosis, which on pathology results in neuronal death and gliosis[1].

Hippocampal sclerosis is best seen on MRI using thin coronal sections on T2-weighted or T2 Fluid Attenuated Inversion Recovery (FLAIR) sequences.

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Received on : 27/07/2023
Accepted on : 28/11/2023

Atrophy and a high signal intensity that is localised to the hippocampus are classical signs of hippocampal sclerosis. Temporal lobe volume loss, choroidal fissure dilatation, narrowing of collateral white matter, forniceal asymmetry and atrophic mamillary body are secondary MR findings. A highly sensitive characteristic of hippocampal sclerosis was recently proposed as Partial Loss of Hippocampal Striation (PLHS)[1].

This study has been undertaken to study the hippocampal changes in seizure disorder by MRI (Figs 1-4).

Aims and Objectives

(1) To assess the spectrum of MRI findings in hippocampus of brain in patients with seizures.

(2) To determine the proportion of Partial Loss of Hippocampal Striations (PLHS) in case of seizures disorder and its diagnostic value.

Materials and Methods

Source of Data :

Study place : Sapthagiri Institute of Medical Sciences and Research Centre, Bengaluru.

Study subjects : Patients presenting with seizures and in the age group of 18years to 65 years were enrolled in this study after obtaining written informed consent.

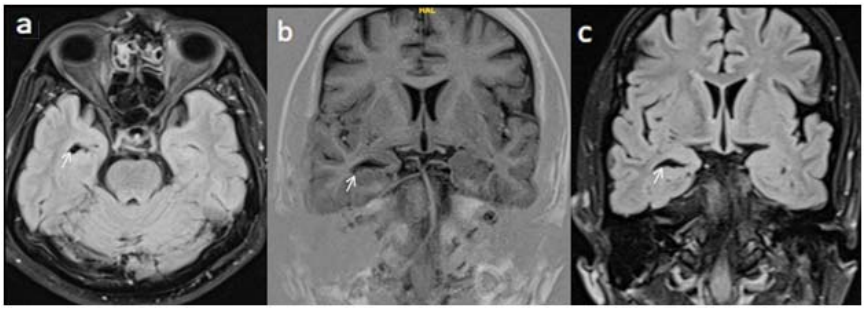

Fig 1 — (a) Axial FLAIR, (b) T1 oblique Coronal, (c) FLAIR oblique coronal showing loss of striations on the right side with loss of volume in right hippocampus

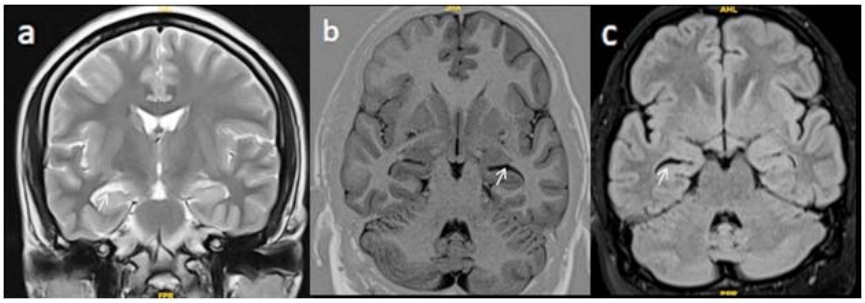

Fig 2 — (a) T2 coronal, (b) T1 inversion recovery oblique Coronal, (c) FLAIR oblique coronal showing loss of striations on the right side with loss of volume in right hippocampus

Study design : Cross-sectional observational study.

Imaging Protocol :

Visualization of hippocampal gray matter is important for diagnosis of hippocampal sclerosis. So, the accurate distinction of gray matter from white matter and of gray matter from CSF, is essential. Inversion-recovery (IR) images [3500/26 (TR/TE); inversion time: 300 ms, section thickness: 5 mm] in tilted axial and coronal planes give optimal anatomical definition of the hippocampal gray matter. The IR sequence was chosen because it provides details of internal structure of hippocampus and demonstrates decreased signal on T1W images in gliotic areas.We used an asymmetrical field of view with a 256 X 128 matrix to reduce scanning time to 7.5minutes per sequence[17].

Sample size :

Using the simple following formula to calculate sample size,

n= 4pq/ d2

Where- n= sample size

P= expected prevalence or proportion

d= margin of error at 15% (standard value of 0.05)

q=100-p

Hence, sample size for the study=4*33*67/ (15)2= 8844/225=39.30

According to the prevalence by using the above formula calculated sample size is 39.3.

60 patients were taken up for the study.

Statistical Analysis :

Data analysis will be carried out using statistical software called SPSS V.20. The results were expressed in the form of descriptive and inferential statistics.

Results

A total of 60 patients were taken up for study. In that 42 patients were Male and 18 were Females. 30% of the patients (18 patients) were in the age group of 21-30 years. 53 of the 60 patients presented with generalized tonic clonic seizures with 3 patients presenting with focal seizures and 2 patients presenting with

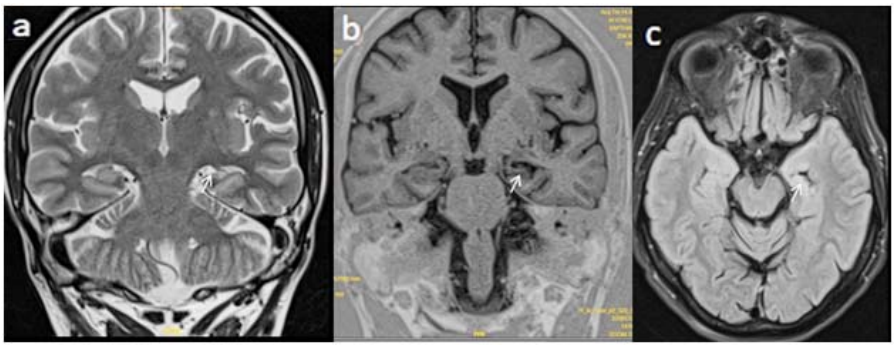

Fig 3 — (a) T2 coronal, (b) T1 inversion recovery oblique coronal, (c) FLAIR showing loss of striations on the left side with loss of volume in left hippocampus

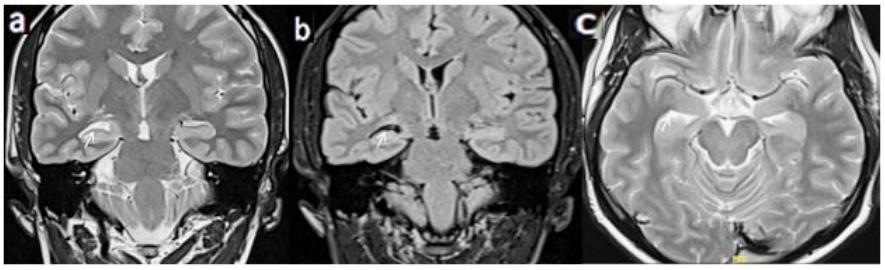

Fig 4 — (a) T2 coronal, (b) FLAIR oblique Coronal, (c) T2 axial showing loss of striations on the right side with loss of volume in right hippocampus

absence seizures. Partial loss of hippocampal striations were seen in 23.3% of cases (14 patients). Hippocampal atrophy was seen in 18.3% of cases (11 patients). Secondary signs of mesial temporal sclerosis were seen in 18.3% of cases (11 patients). Classic signs of Mesial Temporal Sclerosis (MTS) was seen in 21.6% of cases (13 patients).

Discussion

Mesial Temporal Sclerosis (MTS) is most common cause of medically intractable partial complex epilepsy in adults. MTS can be bilateral in up to 3-10%. Pathologically, it is characterized by hippocampal gliosis and neuronal loss. Different postulates have been put forward. One hypothesis holds that in individuals with a genetic predisposition, prolonged febrile seizures cause hippocampal injury. However, difference between cause and effect is not clear, because a child may have prolonged febrile seizures due to MTS secondary to a prenatal / perinatal insult or genetic predisposition.

MRI findings can be divided into primary, secondary signs and changes in other structures.

Primary Signs :

- Increased T2 / FLAIR signal intensity in the hippocampus.
- Partial loss of hippocampal striations.
- Hippocampal atrophy and volume loss.
- Loss of the internal architecture of the hippocampus (Interdigitations).

Secondary Signs (Temporal lobe findings) :

- Dilatation of the ipsilateral temporal horn
- Temporal lobe atrophy
- Collateral white matter atrophy.

Changes in Other Structures:

- Increased signal intensity and/or atrophy of the ipsilateral amygdale
- Atrophy of the ipsilateral mammillary body
- Atrophy of the ipsilateral fornix
- Atrophy of the contralateral cerebellar hemisphere
- Atrophy of the ipsilateral entorhinal area

Identification of MTS is important as surgery is only treatment option with a good outcome. MTS can be bilateral in upto 3-10% of cases although symptoms may be caused by an unilateral disease[2]. Patients presenting with seizures can have wide range of MR imaging abnormalities depending upon etiology. MRI can reliably identify and localize the intracranial abnormality so that further management can be planned accordingly.

MTS is a common structural abnormality seen in association with temporal lobe epilepsy. Coronal oblique T2W/FLAIR sequences obtained perpendicular to the long axis of the hippocampus is required for optimal evaluation of hippocampus.

MR images were examined for presence of unilateral hippocampal atrophy in all patients. Moreover, loss of internal architecture and increased T2 signals were only revealed in the sclerotic hippocampus.

The normalized volumes of the hippocampus were compared, and the results were made based on prominent volume decrease in sclerotic hippocampus[8-10].

In a study by, Anitha Sen, *et al*[β], the author opines that PLHS may be an easy technique for early detection of hippocampal sclerosis. PLHS is a sensitive indicator of hippocampal sclerosis. Classic signs of

hippocampal sclerosis was seen in 6% cases in this study whereas in our study classic signs were seen in 21.6% of cases.

In a study by, Paramdeep Singh, *et al*[4], where authors opine right hippocampal volume was slightly more than left with no effect of age or gender and concluded that quantitative techniques are more sensitive to diagnose bilateral and mild unilateral hippocampal abnormalities. In our study also there was no significant age or gender related changes in hippocampus.

In a study by, Graeme D, Jackson, *et al*[5], authors had proposed optimal imaging parameters and MR features of hippocampal sclerosis. Hippocampal sclerosis was diagnosed alone in 64% of patients (23.3% in our study). Hippocampal atrophy was seen in 83% (18.3% of cases in our study) and disruption of the internal hippocampal structure was seen in 89% (21.6% in our study). Our study results were less compared to the findings in this study.

In study by, Dongyan Wu, *et al*[6], the authors demonstrated that Mesial Temporal Lobe Epilepsy (MTLE) is most common form of focal epilepsy, which is frequently characterized by hippocampal sclerosis. Volume quantitative analysis in the hippocampus was conducted and group related volumetric difference was assessed. The results of their study are comparable to the results of our study.

In a study by, Yiran Duan, *et al*[7], author opines that Mesial Temporal Lobe Epilepsy is a neurological disorder associated with hippocampal atrophy. In this study they analyzed the morphologic patterns of hippocampal atrophy to better understand the underlying pathological and clinical characteristics of the condition. They observed significant reduction in unilateral hippocampal volume with a mean volume reduction of 28.38% as compared with healthy controls ($p<0.05$). In our study, volume reduction was seen in 18.3% of cases.

Limitations of the study : This study represents a limited experience from a single tertiary center.

Conclusion

Assessment of the patient presenting with seizure disorder is a common problem in clinical practice. Generalized seizures are the most common seizure and generalized tonic-clonic seizures are the most common seizure in sub-classification.

With its high spatial resolution, excellent inherent soft tissue contrast, multiplanar imaging capability and lack of ionizing radiation, MR imaging has emerged as a versatile tool in the evaluation of patients with seizures.

This study was carried out in 60 patients presenting with seizures by subjecting them to Magnetic Resonance Imaging to evaluate the spectrum of hippocampal abnormality.

In our study, MRI shows PLHS in 14 cases (23.33%) out of total 60 cases included.

MRI also revealed hippocampal atrophy and secondary signs of hippocampal sclerosis in 11 patients (18.33%) out of 60 patients.

Hence, we conclude that in our study PLHS in adult population is much more common than the classic signs of hippocampal sclerosis (increased signal intensity and volume loss).

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