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Original Article

Magnetic Resonance Imaging Evaluation of Hippocampus with T2 Relaxation Time

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Abstract

Objective: The objective of the study is to acquire the data of hippocampal volumes (HV) and T2 relaxation times, to assess and compare qualitative and quantitative evaluations in determining hippocampi in patients with divergent durations of intractable epilepsy, and to initiate an imaging protocol based on the production of these techniques. The foremost magnetic resonance imaging (MRI) features of hippocampal sclerosis (HS) are volume loss and increased T2 weighted signal intensity. Minor abnormalities may be missed without careful quantitation. In this study, hippocampal T2 was calculated along the entire length of the hippocampus on adjacent slices and used, with quantitative measures of HV and distribution of atrophy, to better describe the range of HS.

Methods: A total of 50 patients with temporal lobe epilepsy (TLE), 20 patients with extratemporal localization-related epilepsy and extratemporal lesions, and 30 control subjects were studied using MRI T2 relaxometry and volumetry.

Results: In controls and patients, HT2 was higher in the anterior than the posterior hippocampus. Patients with bilateral hippocampal involvement had an earlier onset of epilepsy than patients with unilateral HS.

Conclusions: Calculation of regional abnormalities of hippocampal T2 relaxation along the length of the hippocampus gives the advance improvement to the MRI assessment of the hippocampi in patients with TLE and is corresponding to the volumetric and morphological data.

Key words: Epilepsy, Seizure disorder, Imaging hippocampus, Magnetic resonance imaging hippocampus, T2 relaxation time

INTRODUCTION

Hippocampal sclerosis (HS) is the most recurrent pathologic condition underlying intractable temporal lobe epilepsy (TLE). Epilepsy is a known neurological disease specified by repeated seizures. Even though epilepsy is well manageable with antiepileptic drugs, there still exist about 30% of epilepsy patients who are not responding to optimal treatment. The majority of the patients have better results after surgery, and this constantly determined by the presurgical assessment by electroencephalography and magnetic resonance imaging (MRI) (Figure 1).[1]

Mesial temporal sclerosis (MTS) is a specific pattern of hippocampal neuronal loss accompanied by gliosis and atrophy. The etiology is unknown, but there is a relationship between MTS and prolonged febrile seizures earlier in life, complicated delivery and developmental processes. In 15% of patients another developmental abnormality can be found, mostly focal cortical dysplasia. This is called dual pathology. MTS is the most common cause of partial complex epilepsy in adults and is also the most common etiology in young adult patients undergoing surgery. Surgical removal of visible MRI changes associated with unilateral MTS leads to seizure freedom in up to 80% of cases (Figure 2).[2-5]

Unilateral HS is the most recurrent pathological condition in TLE, and up to 65% of cases of TLE can be assigned

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to pathology arising entirely in the hippocampus. Visual (qualitative) assessment of T2-weighted changes (hyper intense signal on T2-weighted images and atrophy) was the advance method that described an interlink among hippocampal pathology and MR-detectable signal abnormality. Hippocampal volume loss is a delicate and important pointer of HS in the clinical setting of epilepsy, and hippocampal volumetric study can quantify atrophy in TLE patients. T2 relaxometry is another quantitative technique to describe the frequency and severity of T2 abnormality. Hippocampal T2 relaxation time increases in patient of HS. The main goal of this study is to assess and differentiate the comparative value of visual evaluation, hippocampal volumetry, and T2 relaxometry independently and in composition, in the identification of HS. An important issue is whether these techniques give complementary or redundant information about the hippocampus. We also focus to provide normative MR Hippocampal volumetric data in Indian population as well as to initiate a multimodal MR imaging protocol

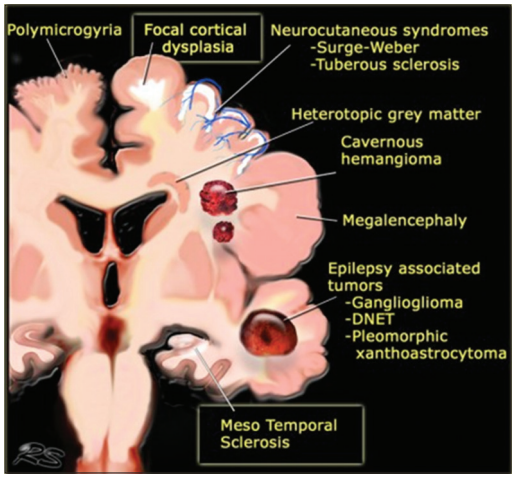
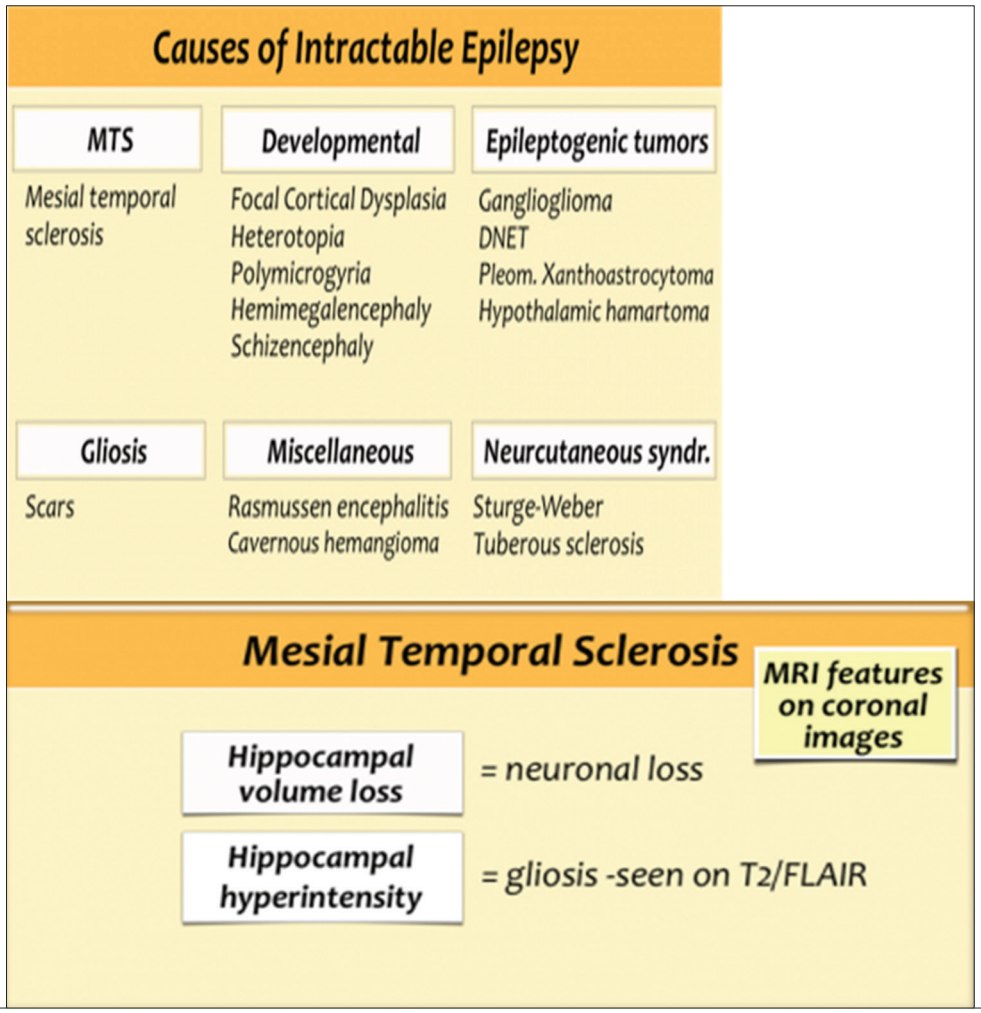


Figure 1: Common causes of epilepsy



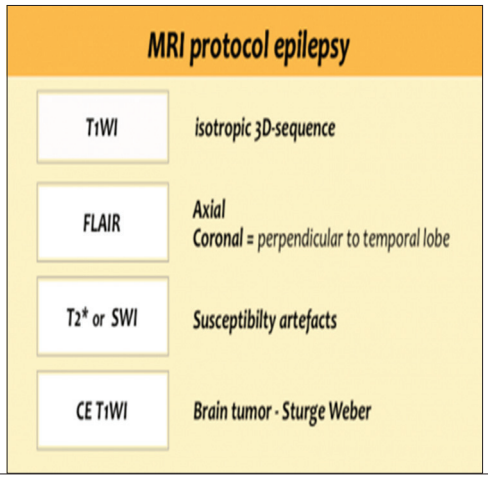
The table also summarizes epileptogenic lesions that are detected in patients with uncontrollable seizures. Mesial temporal sclerosis is the most common cause of intractable epilepsy. In medication refractory epilepsia, the most common location of the epilectogenic lesion is temporal lobe (60%), frontal lobe (20%) and parietal lobe (10%), periventricular (5%), and occipital (5%)

Figure 2: Mesial temporal sclerosis

depending on the presentation of these techniques. Raise in signal on T2-weighted MRI is a characteristic of HS (Figure 3).

T2 Relaxation Time Measurement

T2 relaxation times were measured using 16-echo sequence which is a multiple spin-echo sequence (TE: 22-352, TR: 3000, slice thickness: 5 mm, FOV: 230). 16 separate spin-echo images were obtained for each oblique coronal slice at echo times ranging from 22 to 352 ms. The T2 maps were acquired using a computer program that made a single exponential to the signal intensity data from equivalent pixels from all 16 echoes. The T2 relaxation time was then calculated for each pixel, and an image was constructed in which pixel intensity corresponded to the calculated T2 relaxation time. The mean hippocampal T2 relaxation time was calculated by manually marking a region of interest in the largest possible circular area within the anterior, middle, and posterior sections corresponding to the three sections of the hippocampus designated as hippocampal head, hippocampal body, and hippocampal tail, respectively, while evading boundaries where partial volume effects with cerebral spinal fluid might arise.



The table shows a dedicated epilepsy protocol. Some will also use Inversion Recovery and not use contrast on a routine base. T1WI-Superior for cortical thickness and the interface between gray and white matter. On T1WI look for gray matter occuring in an aberrant location as in gray matter heterotopia. FLAIR-Look very carefully for cortical and subcortical hyperintensities on the FLAIR, which can be very subtle. Since FLAIR may show false-positive results due to artefacts, the abnormalities should be confirmed on T2WI. T2* or SWI helpful when searching for hemoglobin breakdown products as in posttraumatic changes and cavernomas, or to look for calcifications in tuberous sclerosis, Sturge-Weber, cavernomas, and gangliogliomas

Figure 3: Dedicated epilepsy protocol

Normal control values for T2 relaxation time were acquired from control subjects using an identical protocol. Abnormal T2 values were considered when these were both outside the range of all normal control values and more than two standard deviations outside the mean value of control hippocampal T2 relaxation times.[6,7]

MATERIALS AND METHODS

MRI images of 50 patients with the age group of 18-65 years from January 2016 to May 2016 retrospective analysis with clinical suspicion of HS and with the history of epilepsy from Chettinad Hospital and Research Institute were included in the study. An informed consent will be obtained from the participating subjects. The patients referred to MRI brain were imaged in GE Signa 1.5 HDxt scanner with the routine brain protocol with an add up sequence of T2 multi-echo sequence with 16 echoes for the evaluation of the HS. The images obtained were subjected to radiological analysis and interpretation.

Sample Selection

Inclusion criteria

- Patients who have epilepsy,
- Patients with the history epilepsy and other neurological disorders.

Exclusion criteria

- Patients with any H/O metallic implants,
- Patients with known cardiac pacemaker,
- Pregnant women,
- Claustrophobic patients.

Image Acquisition and Image Processing

All our patients were imaged on 1.5 Tesla GE Signa HDxt scanner. An eight channel NVcoil was used. The data obtained were examined by the two radiologists independently for qualitative analysis.

RESULTS

We had included 50 patients for this research after getting informed consent. Out of 50 patients, T2 multi-echo sequence identified hippocampal defects in 12-14 patients. Hence, routine sequences of the brain in MRI with an add up sequence T2 multi-echo sequence is better for detection of major hippocampal defects in brain. A patient of age 29-year-old male came with the complaints of seizures, and the patient was referred for the MRI brain. First, the patient was screened with the routine sequences of MRI brain and then the additional sequence T2 multi-echo sequence was added.

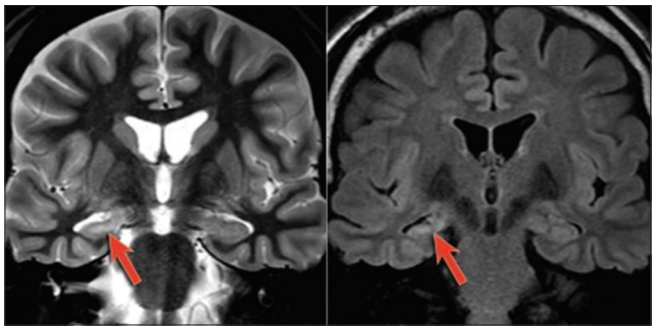


Figure 4: T2-weighted and fluid attenuated inversion recovery images are the most sensitive for detecting mesial temporal sclerosis. The high signal in the hippocampus reflects gliosis

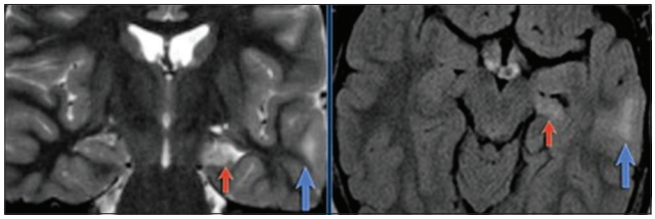


Figure 5: Dual pathology: Mesial temporal sclerosis and focal cortical dysplasia Images show mesial temporal sclerosis with a hyperintense and shrunken hippocampus (Red arrows), and secondary enlargement of the left temporal horn of the left laterale ventricle

DISCUSSION

Coronal T2-weighted (T2W) and fluid attenuated inversion recovery (FLAIR) images are the most sensitive for detecting MTS. On axial slices MTS is commonly overlooked. Bilateral MTS is difficult to detect due to the lack of comparison with the unaffected contralateral hippocampus. Notice the volume loss, which indicates atrophy and causes secondary enlargement of the temporal horn of the lateral ventricle. The high signal in the hippocampus reflects gliosis.

Mesial temporal sclerosis may occur in association with other pathology, especially focal cortical dysplasia. This is called dual pathology (Figure 4).

The images show MTS with a hyperintense and shrunken hippocampus (Red arrows), and secondary enlargement of the left temporal horn of the left laterale ventricle (Figure 5).

Also notice associated subcortical hyper intensity in the left temporal lobe indicating focal cortical dysplasia.

A 35-year-old patient with refractory TLE was included in the study. MR shows subtle hyperintensity of the left hippocampus on the axial FLAIR (Blue arrow) and atrophy

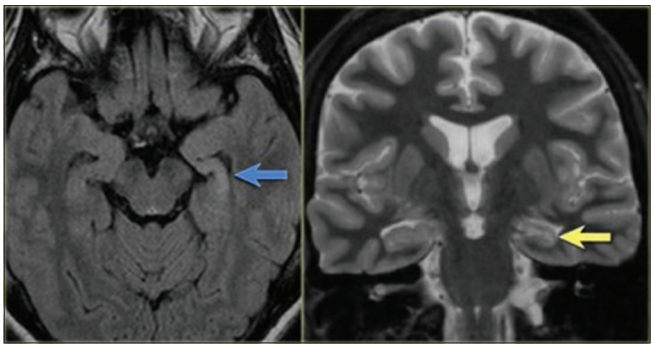


Figure 6: Left mesial temporal sclerosis. Subtle gliosis of left hippocampus (Blue arrow) and atrophy (Yellow arrow)

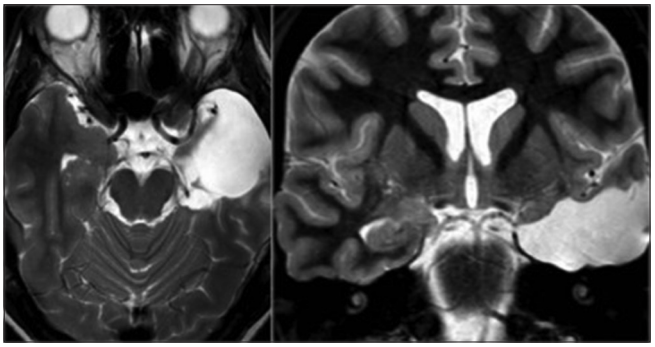


Figure 7: Left mesial temporal sclerosis treated with the amygdalo - hyppocampectomy

of the left hippocampus on coronal images (Yellow arrow) (Figure 6).

Hippocampus hyperintensity on T2W imaging or FLAIR images with volume loss is diagnostic for MTS in the appropriate clinical setting (Figure 7).

CONCLUSION

Calculation of regional abnormalities of hippocampal T2 relaxation along the length of the hippocampus gives the advance improvement to the MRI assessment of the hippocampi in patients with TLE and is corresponding to the volumetric and morphological data.

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