Original Research Article

A comparative study of MR spectroscopy parameters in temporal lobe epilepsy patients and healthy individuals

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Abstract

Background: MR spectroscopy has been shown to be useful in the preoperative evaluation of patients with temporal lobe seizures.MR spectroscopy has demonstrated consistent metabolic abnormalities in temporal lobe epilepsy. The reason for decreases in *N*-acetylated compounds are thought to be related to neuronal hippocampal cell loss as observed in hippocampal sclerosis. **Aim:** To compare MR spectroscopy parameters in temporal lobe epilepsy patients and healthy individuals. **Material and Methods:** A total of 25 patients with temporal lobe epilepsy and with seizure disorder were studied. MR imaging of the temporal lobes was performed on a clinical 1.5 Tesla MRI system employing standardized epilepsy protocol. The resonances of importance were identified NAA(N-acetylaspartate) at 2 ppm, Cr (Creatinine) at 3 ppm and Cho (Choline) at 3.2 ppm. Then the metabolite ratios namely NAA/ Cho, NAA/ Cr, NAA/Cr +Cho, and Cho/Cr were calculated. **Results:** The mean Choline value of right hippocampus of TLE patients was minimally increased and that of left hippocampus was significantly increased when compared to reference mean value of the right and left hippocampus respectively. The mean NAA/Cho+Cr value of the right and left hippocampus of TLE patients was minimally increased when compared to the reference mean value. **Conclusion:** A significant decrease in NAA/Cr in the diseased hippocampus was observed as compared with the control subjects. Thus, Multi Voxel MR Spectroscopy of bilateral hippocampus can be used as an important diagnostic tool in the assessment of Temporal Lobe Epilepsy.
Key Words: Temporal lobe epilepsy, Multi Voxel MR Spectroscopy, hippocampus, NAA/Cr level.

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INTRODUCTION

Magnetic resonance (MR) spectroscopyis a non invasive technique capable of providing metabolic information about different tissues. It detects abnormalities that are invisible to conventional MRI because metabolic abnormalities often precede structural changes.[1] MR spectroscopy has been shown to be useful in the preoperative evaluation of patients with temporal lobe seizures.[2-4] MR spectroscopy has demonstrated consistent metabolic abnormalities in temporal lobe epilepsy. Specifically, proton MR spectroscopy may help to identify the epileptogenic hippocampi by showing low levels of *N*-acetyl aspartate (NAA).The reason for decreases in *N*-acetylated compounds are thought to be related to neuronal hippocampal cell loss as observed in hippocampal sclerosis.[5] In this study an attempt was made to compare MR spectroscopy parameters in temporal lobe epilepsy patients and healthy individuals.

MATERIAL AND METHODS

A total of 25 individuals of either sex were studied. These were patients with temporal lobe epilepsy who presented themselves in Radiology department. The reports and

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image data were collected retrospectively during the study period.

Inclusion Criteria

- EEG proven cases of temporal lobe epilepsy (TLE)
- Patients having seizure disorder

Exclusion Criteria

- First trimester pregnancy
- Abnormalities in brain
- Claustrophobic patients
- Metallic implants within 6 months

Informed written consent was obtained from all included individuals. They were well explained about the procedure and was asked to remove the metal objects and screened with metal detector. Exclusive MRI screening was done, that is all patients for the MRI scan were screened with metal detector before the procedure to avoid complications due to any implants. Possible contra-indications were checked. Metallic jewelers, tattoos, make up, eye shadows etc., were removed prior to MR examinations as it could cause probable RF burns due to high RF absorption locally. They were educated about the possibility of an increase in the body temperature, blood pressure and heart rate. Frequent interactions with the patients during the MR examinations were encouraged and continuous contact with them was enabled through squeeze ball. Patients with cardiac pacemakers, neuro stimulators, metallic implants and first trimester pregnancy were excluded. Patients were positioned on the MRI examination table in the supine position. Head was positioned in the head matrix coil; patients were immobilized with pads and velcro bands. Centred the laser beam localizer over the glabella. A three plane localizer was taken in the beginning to localize and the other sequences planned.

Procedure: MR imaging of the temporal lobes was performed on a clinical 1.5 Tesla MRI system employing standardized epilepsy protocol. The temporal lobes and bilateral hippocampus were evaluated by oblique coronal T2 weighted FSE and T1 weighted SPGR sequences. Subsequently multi-voxel MR spectroscopy was performed with 10mm voxel positioned over the temporal lobe including bilateral hippocampus. Following voxel positioning, shimming was done over the volume of interest. 95% water suppression was ensured and achieved. Spectra was acquired using a spin- echo sequences with an echo time (TE) of 144 milliseconds. The repetition time (TR) was 1000 milliseconds with angle excitation. The resonances of importance were identified NAA (N-acetylaspartate) at 2 ppm, Cr (Creatinine) at 3 ppm and Cho (Choline) at 3.2 ppm. Then the metabolite ratios namely NAA/ Cho, NAA/ Cr, NAA/Cr +Cho, and Cho/Cr were calculated. The values of the various parameters derived from multi- voxel spectroscopy were analyzed.

RESULTS

MR images of the 25 included patients were reviewed. Out of these 25 patients, 10 were controls and remaining 15 were patients with TLE.

Control Subjects: MR images of the control subjects showed no abnormalities. MR spectroscopy was normal in all these patients (Fig.1)). Hence, reference values for all the parameters namely NAA, Cr, Cho, NAA/Cr, NAA/Cho, Cho/Cr, NAA/Cho+ Cr were calculated as mean value from the pooled values of these control subjects.

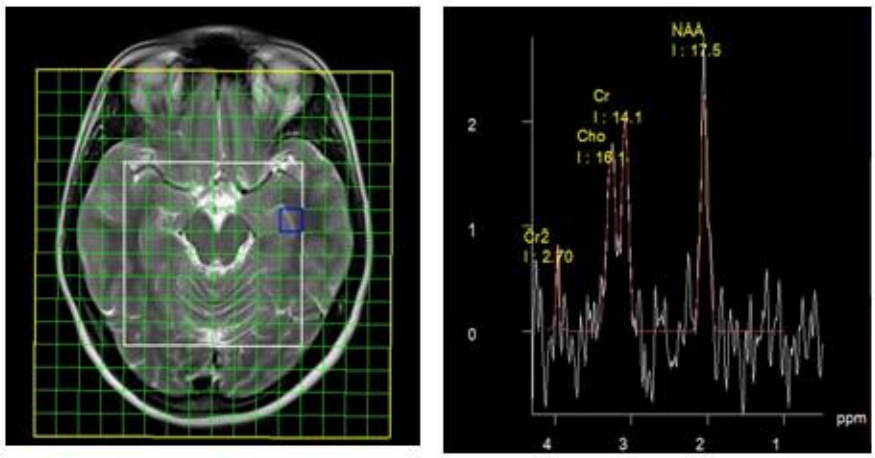

Figure 1: MR Spectroscopy of the left hippocampus of the control subject

Temporal Lobe Epilepsy (TLE) Subjects: MR images of 15 TLE patients were reviewed. These included 6 males and 9 females. The mean duration of Temporal Lobe Epilepsy was 32 years (ranges 9 to 64 years).

Twelve of the fifteen patients with temporal lobe epilepsy had normal MR scans. Temporal lobe and hippocampal volumes were normal. There was no significant asymmetry of the hippocampi demonstrated. Twelve patients had normal routine MR coronal images done for specific hippocampal evaluation (Fig. 2).

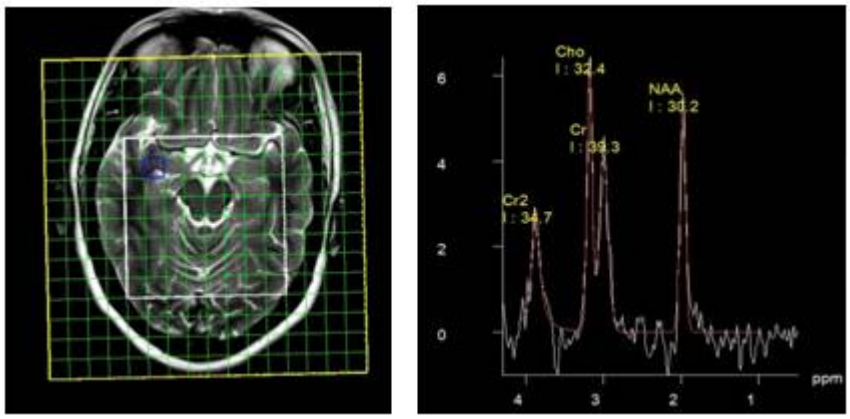

Figure 2: MR Spectroscopy of the left hippocampus of the TLE subject

One patient's MRI was suggestive of Posterior Reversible Encephalopathy Syndrome (PRES). One patient's MRI features were suggestive of abnormalities in cortical formation, with normal signal intensities and normal volume of bilateral hippocampi. One patient's MRI revealed symmetrical altered signal intensities in bilateral hippocampi. There was no evidence of volume loss. Multi voxel spectroscopy of all 12 patients were normal with no significant difference in the metabolites NAA, Cho, Cr, NAA/Cho, NAA/Cr, Cho/Cr, NAA/Cho+Cr on comparison with reference values of the control subjects. Multi voxel spectroscopy of patients with Posterior Reversible Encephalopathy Syndrome (PRES) shows minimal reduction in NAA and minimal increase in Cho levels on bilateral hippocampus. Multi voxel spectroscopy of patients with cortical abnormalities showed minimal reduction in NAA and minimal elevation of Choline at the site of cortical dysplasia. Multi voxel spectroscopy of the patient with hippocampal hyper intensities showed minimal reduction in NAA/Cho+ Cr of right hippocampus with no significant variations in NAA and Cho levels. The reference mean values of the chemical metabolites of control patients were compared to those of the patients with Temporal lobe epilepsy from table 1 and 2.

Table 1: Mean values of the metabolic parameters of right and left hippocampus of control subjects

Hippocampus	NAA	Cho	Cr	NAA/Cho	NAA/Cr	Cho/Cr	NAA/Cho+Cr
Right side	2.1	3.0	3.0	1.5	1.7	1.1	2.8
Left side	2.1	2.8	3.0	1.1	1.2	1.2	2.8

The mean NAA value of right and left hippocampus of Temporal Lobe Epilepsy (TLE) patients were minimally reduced when compared to that of the reference mean.

Table 2: Mean values of the metabolic parameters of right and left hippocampus of TLE subjects

Hippocampus	NAA	Cho	Cr	NAA/Cho	NAA/Cr	Cho/Cr	NAA/Cho+Cr
Right side	2.0	3.1	3.0	0.9	1.0	1.0	3.0
Left side	1.9	3.2	3.0	1.3	1.0	0.7	3.0

The mean Choline value of right hippocampus of Temporal Lobe Epilepsy (TLE) patients was minimally increased and that of left hippocampus was significantly increased when compared to reference mean value of the right and left hippocampus respectively. Moreover, the mean NAA/Cho+Cr value of the right and left hippocampus of Temporal Lobe Epilepsy (TLE) patients was minimally increased when compared to the reference mean value. However, the mean Creatinine value of both right and left hippocampus of the Temporal Lobe Epilepsy (TLE) patients was the same as that of the reference mean value. The mean NAA/Cho value of right hippocampus of Temporal Lobe Epilepsy (TLE) patients was significantly reduced and that of left hippocampus was minimally increased when compared to that of the reference mean values. The mean values of both NAA/Cr and Cho/Cr of the bilateral hippocampus of Temporal Lobe Epilepsy (TLE) patients were minimally reduced in compared to the reference mean value of NAA/Cr and Cho/Cr respectively.

DISCUSSION

MR spectroscopy has been used to examine patients with hippocampal epilepsy.[2-4] In the affected hippocampus, MR spectroscopy may show decreases of NAA between 15% and 31% as compared with the unaffected hippocampus.[6] Accordingly, MR spectroscopy may correctly lateralize hippocampal epilepsy in more than 90% of patients.[6]Proton MR spectroscopy may also have a greater sensitivity in the detection of bilateral disease than any other noninvasive imaging technique.[6] In our study, the NAA level of bilateral hippocampus was reduced in TLE patients when compared to control patients. An increased Choline level was observed in Temporal Lobe Epilepsy (TLE) patients. NAA/Cho+Cr was increased in TLE patients when compared to control patients. Creatinine level remained unchanged. NAA/Cr and Cho/Cr were decreased in TLE patients. NAA/Cho ratio was variable. NAA/Cr and NAA/ Cho both performed less well than NAA/Cho+Cr and NAA in Temporal Lobe Epilepsy (TLE) patients. Neuronal marker (NAA) – a non essential amino acid is the most visible metabolic peak of the ^{1}H spectrum; most sensitive magnetic resonance spectroscopy visible metabolite marker of pathological status. Reduced level of NAA is commonly referred to as a marker of "neuronal loss or dysfuntion". In this study, reduction of N- acetyl aspartate in the epileptogenic focus was detected in all the patients. A possible explanation for the reduction of signal is neuronal loss, because NAA is presumed to be a neuronal marker. It has been documented that neuronal loss may increased with increased seizure onset. The reduction in NAA is quite small in TLE patients; however, the voxel sizes used in this study is relatively large, so the spectra may contain appreciable contribution from normal brain. Comparison of NAA to NAA/Cr ratio, improves the accuracy of identifying epileptic foci. Reduced NAA levels probably reflects metabolic impairment due to repeated seizures. Regardless of the origin of the N-acetyl aspartate signal reduction, it appears to be a good indicator in epileptic focus and could therefore be useful diagnostic marker. The low NAA in the diseased hippocampus appears to reflect the decreased number of neurons in hippocampal sclerosis.[2-4] This observation was confirmed in our patients, who showed a significant decrease in NAA/Cr as compared with the control subjects.

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