Original Research Article

Role of MR spectroscopy in evaluation of patients with temporal lobe epilepsy

Arunan Murali[1*], T Bhasker Raj[2], Venkata Sai[3], Sheila Elangovan[4], J Saranya[5]

[1]Associate Professor, [2,3]Professor, [4]Sr. Lecturer, [5]Resident, Department of Radiology, Sri Ramachandra Medical College and Research Institute, Porur, Chennai600116, Tamil Nadu, INDIA.
Email: dr.arunan@gmail.com

Abstract

Background: Temporal lobe epilepsy is the most frequent cause of focal and refractory seizures. MRS pectroscopy detects abnormalities that are invisible to conventional MRI. It has demonstrated consistent metabolic abnormalities in temporal lobe epilepsy. **Aim:** To evaluate the role of MR spectroscopy in evaluation of patients with temporal lobe epilepsy. **Material and Methods:** A total of 15 patients of either sex with temporal lobe epilepsy were selected for the study. 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 multivoxel MR spectroscopy was performed with 10mm voxel positioned over the temporal lobe including bilateral hippocampus. **Results:** Twelve of the 15 patients with temporal lobe epilepsy had normal MR scans. The mean NAA value of right and left hippocampus of TLE patients were minimally reduced when compared to that of the reference mean. The mean Choline value of right hippocampus of was minimally increased and that of left hippocampus was significantly increased when compared to reference mean value of the right and left hippocampus respectively. **Conclusion:** Multi Voxel Magnetic Resonance Spectroscopy of bilateral hippocampus can be used as an important, additional and supplementary diagnostic tool in the assessment of TLE.
Key Words: Epilepsy, Temporal lobe, MR spectroscopy, Nacetyl aspartate.

[*]**Address for Correspondence:**
Dr. Arunan Murali, Department of Radiology, Sri Ramachandra Medical College and Research Institute, Porur, Chennai600116, Tamil Nadu, INDIA.
Email: dr.arunan@gmail.com
Received Date: 19/03/2018 Revised Date: 16/04/2018 Accepted Date: 12/05/2018
DOI: https://doi.org/10.26611/1013626

Access this article online

Quick Response Code:

Website: www.medpulse.in

Accessed Date: 17 May 2018

INTRODUCTION

Epilepsy is a familiar neurological disease characterized by recurrent seizures. These seizures are transient signs due to abnormal, excessive or synchronous neuronal activity in the brain. The temporal lobe is the most epileptogenic region of the brain and the temporal lobe epilepsy (TLE) is the most common form of partial epilepsy. TLE is the most frequent cause of focal and refractory seizures.[1] MRS is a noninvasive technique capable of providing metabolic information about different tissues. It also enables tissue characterization on a biochemical level surpassing that of conventional magnetic resonance imaging.[2] It detects abnormalities that are invisible to conventional MRI because metabolic abnormalities often precede structural changes.[3] MRS 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.[4] The present study was carried out to evaluate the role of MR spectroscopy in evaluation of patients with temporal lobe epilepsy.

MATERIAL AND METHODS

A population of 15 patients of either sex with temporal lobe epilepsy who presented themselves in Radiology department whose reports and image data were collected retrospectively during the study period.

How to cite this article: Arunan Murali, T Bhasker Raj, Venkata Sai, Sheila Elangovan, J Saranya. Role of MR spectroscopy in evaluation of patients with temporal lobe epilepsy. *MedPulse – International Journal of Radiology.* May 2018; 6(2): 38-41.
http://www.medpulse.in/Radio%20Diagnosis/

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

Patient preparation: Patient was well explained about the procedure and was asked to remove the metal objects and screened with metal detector. Informed written consent was obtained from the patient. 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 contraindications 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. The patients 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.

Patient Positioning: 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.

Image Planning: A three plane localizer was taken in the beginning to localize and the other sequences planned. Coronal high resolution slices planned on the sagittal plane. The position block plane angled perpendicular to the long axis of the hippocampus. The positioning block in the other two planes were checked. An appropriate angle given perpendicular to the midline of the brain. The whole temporal lobe covered with sufficient Slices.

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 multivoxel 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.

Planning Image for Spectroscopy

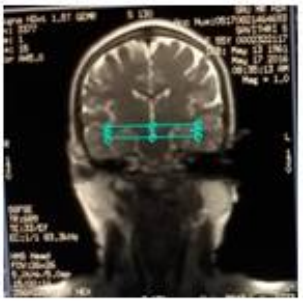

Figure 1:

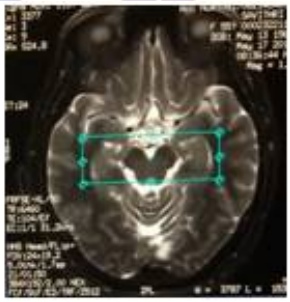

Figure 2:

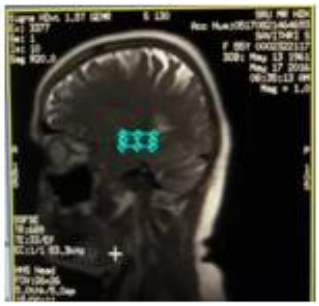

Figure 3:

The resonances of importance were identified NAA (Nacetylaspartate) 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 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 15 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. Of the three abnormal MR scans, 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.

Table 1: Metabolites parameters from the right hippocampus of patients with TLE

SN	NAA	Cho	Cr	NAA/Cho	NAA/Cr	Cho/Cr	NAA/Cho+Cr
1	2.0	3.2	3.1	0.5	2.6	1.5	3.1
2	2.0	3.2	3.0	0.5	0.5	1.1	3.1
3	2.0	3.2	3.1	1.6	1.4	0.9	3.0
4	1.9	3.3	3.0	1.4	1.1	0.7	3.2
5	2.1	3.2	3.0	0.4	0.9	1.9	2.9
6	1.9	3.1	3.0	0.9	0.6	0.6	3.1
7	1.9	3.1	2.9	1.2	0.8	0.7	3.1
8	1.9	2.1	2.9	0.9	0.9	1.0	3.1
9	1.9	3.2	3.0	1.2	1.3	1.0	3.1
10	1.9	3.1	3.0	1.1	0.6	0.6	3.1
11	2.0	3.2	3.0	1.3	1.4	1.0	3.0
12	2.0	3.3	3.0	0.7	0.7	1.0	3.1
13	3.0	3.0	3.2	1.3	0.5	0.3	2.0
14	2.0	3.2	3.0	0.9	1.5	1.6	3.1
15	2.0	3.2	3.0	1.1	1.7	1.5	3.1

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.

Table 2: Metabolites parameters from the left hippocampus of patients with TLE

SN	NAA	Cho	Cr	NAA/Cho	NAA/Cr	Cho/Cr	NAA/Cho+ Cr
1	2.0	3.1	3.0	1.8	2.1	1.1	3.0
2	2.0	3.2	3.0	1.9	0.5	0.2	3.0
3	2.1	3.2	3.1	1.5	1.4	0.9	3.0
4	2.0	3.2	3.0	0.8	0.8	0.9	3.0
5	2.0	3.2	3.0	1.4	1.9	1.2	3.0
6	1.9	3.1	2.9	0.9	0.5	0.6	3.1
7	1.9	3.1	3.0	0.9	0.7	0.8	3.1
8	2.0	3.8	3.2	1.2	0.3	0.1	3.5
9	1.9	3.1	3.0	0.8	1.3	1.5	3.1
10	1.9	3.2	3.0	1.4	0.4	0.3	3.1
11	2.0	3.2	3.0	1.4	1.3	0.9	3.0
12	2.1	3.3	3.0	1.7	1.3	0.7	2.9
13	2.0	3.0	3.2	0.8	0.5	0.6	3.1
14	1.9	3.2	2.9	5.9	1.2	0.2	3.2
15	2.0	3.2	3.0	0.9	1.5	1.5	3.1

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. 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.

Table 3: Mean values of the metabolites of right and left hippocampus of TLE

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

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

MRS provides in vivo biochemical information. The peaks on the spectra obtained correspond with various metabolites, normal and abnormal, which may be identified precisely. Although peaks from nonidentical molecules may overlap, in clinical practice, this is not usually an issue where brain metabolites are concerned, particularly when scanning at 1.5 T (at higher field strengths this is not necessarily the case).[2] This study addresses the significance of Multi voxel magnetic resonance spectroscopy in patients with TLE. It was found that NAA level of bilateral hippocampus was reduced in TLE patients when compared to control patients. An increased choline level was observed in TLE patients. NAA/Cho+Cr level 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 TLE patients. Conelly *et al*[5] investigated 25 cases of TLE using single voxel ^{1}H MRS. Lateralization was possible in 18 cases using the NAA/Cho + Cr ratio (72%). The mean NAA/Cho + Cr ratios were significantly less in patients with TLE. Burtscher and Holtas[6] stated that, the ratio of reduction of NAA to Cr + Cho was more important than the absolute decreased intensity value of NAA alone. The critical level

of ratio reduction of Nacetyl aspartate in relation to Creatine+Choline (NAA/Cr+Cho) was considered pathognomonic if below 0.71 in unilateral cases of temporal lobe epilepsy as compared to the contralateral normal side. 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 Nacetyl 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 increase with increased seizure onset. The reduction in NAA was quite small in TLE patients; however, the voxel sizes used in this study was 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 Nacetyl aspartate signal reduction, it appears to be a good indicator in epileptic focus and could therefore be useful diagnostic marker.

CONCLUSION

Multi Voxel Magnetic Resonance Spectroscopy of bilateral hippocampus can be used as an important, additional and supplementary diagnostic tool in the assessment of TLE.

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Source of Support: None Declared
Conflict of Interest: None Declared