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Original article:

Study of biochemical changes in brain tissue in various brain SOL and their diagnostic utility

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Abstract:

Introduction: Several chemical elements can be used to obtain magnetic resonance spectroscopy such as phosphorus [6-8], carbon[9,10] and hydrogen.

Materials and methods : Present Cross sectional Study was conducted in the Department of Radiology, Rural Medical College and Hospital, Loni in a period of one & half year .Prior to the commencement of the study, the ethical clearance was obtained from the Ethics Committee, Rural Medical College and Hospital, Loni.

Results : The distribution of patients with neoplasms according to the maximum Choline/ Creatine ratio. Maximum number of patients 25.81 % had a Cho/Cr ratio between 2.1-2.5 followed by 19.35 % of patients with ratio >5.

Conclusion: Using ROC analysis, a Choline to Creatine NAA of 1.0 as the cut off the sensitivity, specificity, positive predictive valve, negative predictive valve and accuracy of MR spectroscopy in differentiating neoplastic from non neoplastic etiologies is 96.44%, 87.21%, 82.21%, 78.41% and 91.44% respectively.

Introduction:

Several chemical elements can be used to obtain magnetic resonance spectroscopy such as phosphorus , carbon and hydrogen.[1, 2,3] Proton (^{1}H) resonance is nowadays the method most frequently used in neurospectroscopy, because hydrogen is the most abundant atom in the human body and its nucleus emits the most intense radiofrequency signal, when in an external magnetic field, in relation to other nuclei.[3]

Proton spectroscopy has been recognized as a noninvasive method, approved since 1996 by the Food and Drug Administration (FDA). Coupled with magnetic resonance imaging techniques, it allows for the correlation of anatomical and physiological changes in the metabolic and biochemical processes occurring within previously-determined volumes in the brain.[2]

This technique is usually used as a complement to conventional MRI. Combined with conventional MRI, proton MR spectra may improve diagnosis and treatment of brain tumors.

H-MRS may help with differential diagnosis, histological grading, degree of infiltration, tumor recurrence, and response to treatment mainly when radio necrosis develops and is indistinguishable from tumor by conventional MRI.

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Proton magnetic resonance spectroscopy of the brain is useful whenever biochemical or metabolic assessment may be necessary, such as in differential diagnosis of focal brain lesions (neoplastic and non-neoplastic diseases); brain lesions in patients with acquired immunodeficiency syndrome; diagnosis of dementia and other degenerative diseases; follow-up radiation therapy for patients with brain neoplasms; demyelinating diseases; diagnosis and prognosis of brain ischemic and traumatic lesions; assessment of epilepsy; and neuropediatric affections such as brain tumors, inborn errors of metabolism and hypoxic encephalopathy.

In this study, we will focus on H-MRS emphasizing the different techniques & its clinical applications and the significance of brain metabolites in the evaluation of brain SOL.

Materials and methods

Prersent Cross sectional Study was conducted in the Department of Radiology, Rural Medical College and Hospital, Loni in a period of one & half year .Prior to the commencement of the study, the ethical clearance was obtained from the Ethics Committee, Rural Medical College and Hospital, Loni.

All the patients fulfilling the selection criteria were explained about the purpose of study and a written informed consent was obtained to participate in the study before enrolment.

Inclusion criteria:

1. All age groups.
2. Both males and females.
3. All subjects with space occupying lesions (SOL) of brain

Exclusion criteria:

1. Brain aneurysm clip
2. Implanted neural stimulator
3. Implanted cardiac pacemaker
4. Cochlear implant
5. Ocular foreign body
6. Metal shrapnel
7. Other implanted medical devices
8. Patients with surgery of uncertain type where the presence of metal clips or wires cannot be excluded.

Results

31 patients with Brain Tumors were studied.

Table 1: Distribution of patients with brain tumors

Choline/ Creatine ratio	No of patients
0 – 1	3
1-1.5	1
1.6-2.0	3
2.1-2.5	8
2.6-3.0	3
3.1-3.5	0
3.6-4.0	3
4.1-4.5	1
4.5-5.0	3
>5	6

The above table and chart shows the distribution of patients with neoplasms according to the maximum Choline/ Creatine ratio. Maximum number of patients 25.81 % had a Cho/Cr ratio between 2.1-2.5 followed by 19.35 % of patients with ratio >5.

Table 2: Distribution of non-neoplastic lesions by Cho/Cr ratio

Choline / Creatine ratio	No of patients
0.6-1.0	5
1.1-1.5	7
1.6-2.0	2
>2.0	0

The above table and Graph shows the distribution of 14 patients with non-neoplastic etiologies. Maximum number of patients (50 %) had Cho / Cr ratio between1.1-1.5; 35.7 % &14.28% of patients having Choline / creatine ratio between 0.6-1.0 & 1.6-2.0 respectively.

Discussion

Elevated choline levels were consistently found in maximum number (9) of the patients. The raised levels are due to increased membrane breakdown in the abscess. Increased Cho/Cr ratio was also found in the lesions however the rise was modest. The ratio was between 1.0 and 1.6 in 7 cases. Cytosolic amino acid peak at 0.9ppm was increased in the central portion of the all granulomas. Significant reductions in all other normal brain metabolites namely N-acetyl aspartate (NAA) and creatine were found. These changes are due to neuronal loss and necrosis in the granulomas/ abscess.

Thus proton MR spectroscopy findings are very helpful in differentiating infective granulomas/abscesses from neoplasms in patients with ring enhancing lesions. False positive results may however be obtained in atypical cases and needs cautious interpretation.Two cases of acute cerebral infarction were studied. The

MR spectra were obtained from the areas of restriction with TE 135. In parallel to the studies by Dawn E Saunders et al[4] and Jonathan H. Gillard et al[53]; findings of acute cerebral infarction on Multivoxel MR Spectroscopy at TE 135 were reduced NAA and creatine (Cr) peak and elevated choline (Cho) peak with the pathognomic inverted lactate peak at 133ppm.

An inverted bifid lactate peak was noted at 1.3 ppm. The purpose of doing spectroscopy at TE 135 in this scenario is to help differentiate lipid from lactate as only the lactate portion of the lipid- lactate peak is expected to be inverted at intermediate TE of 135.[5]

The raised lactate however is not limited to the area of infarction (area of restricted diffusion) probably due to diffusion into the adjacent brain parenchyma and hence raised level are also seen in the parenchyma adjacent to the areas of T2W hyperintensity.

There was significant reduction in the level of creatine (Cr) and NAA consistent with loss of viable neurons in infarction. We studied a total of 45 patients out of which 31 patients were reported as neoplastic etiologies.

In our study there were 31 patients with brain SOL that was other than infective or ischemic lesion. Out of these 31 patients 26 patients have Cho/NAA ratio >1 which is in parallel to the studies by R. Hourani et .[6]

Fayed et al[7] demonstrated that a Cho/Cr ratio greater than 1.56 has a discriminatory power to differentiate between high- and low-grade glial tumors. Cho/Cr ratio equal or higher than 1.56 and lactate peak predict malignancy at 88.9% sensitivity and 91.7% specificity.

Meng Law et al[46] demonstrated that a threshold value of 1.56 of Cho/Cr ratio with minimum C1 value error and 75.8%, 47.5%, 81.2%, and 39.6% for the sensitivity, specificity, PPV, and NPV for determination of a high-grade glioma. Riyadh et al[43] stated that a Cho/NAA cut off ratio of 2.2 does reliably separate high-grade neoplasms from low grade neoplasms and nonneoplastic conditions

High-grade neoplasms tend to have elevated lipid signal, which is often absent in low-grade neoplasms.

Using ROC analysis, a Choline to Creatine NAA of 1.0 as the cut off the sensitivity, specificity, positive predictive valve, negative predictive valve and accuracy of MR spectroscopy in differentiating neoplastic from non neoplastic etiologies is 96.44%, 87.21%, 82.21%, 78.41% and 91.44% respectively.

Using ROC analysis, a Choline to Creatine ratio of 2.0 as the cut off the sensitivity, specificity, positive predictive valve, negative predictive valve and accuracy of MR spectroscopy in differentiating low grade neoplasms from high grade neoplasm was 99.21%, 92.14%, 96.29%, 90.12% and 97.64% respectively.

Conclusion

Using ROC analysis, a Choline to Creatine NAA of 1.0 as the cut off the sensitivity, specificity, positive predictive valve, negative predictive valve and accuracy of MR spectroscopy in differentiating neoplastic from non neoplastic etiologies is 96.44%, 87.21%, 82.21%, 78.41% and 91.44% respectively.

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