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Original Research Article

MR Spectroscopy in Evaluation of Cerebral Tumors

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Conflict of interest: Nil

Abstract:

Background: Intra axial brain tumors are a significant health problem and present several limiting challenges. These lesions include primary neoplasm (high and low grade), secondary (metastatic)neoplasm, lymphoma, tumefactive demyelinating lesions, abscesses and encephalitis. Weare witnessing a shift in imaging from merely providing anatomical information towards providing information about tumor physiology.

Aim/Objectives:

1. To determine biochemical markers of intra axial brain tumors using MR spectroscopy.
2. To evaluate role of MR spectroscopy in diagnosing and grading of intra axial brain tumor with histopathological co-relation.
3. To evaluate role of MR spectroscopy in determining the infiltrative nature of the intra axial brain tumor.

Materials and Methods: The main source of data for the study: Patients from the Chalmeda Anand Rao Institute of Medical Sciences, Karimnagar. All patients referred to the, Department of Radiodiagnosis with clinically suspected brain tumors in a period from July 2022 to June 2023 will be subjected for the study.

Results: The tumors showed decreased NAAC and Cr contents and a high cho signal. The Lac-Lip signal was high in grade III astrocytomas, glioblastomas. Reports that Cho/Cr ratio and Cho/NAA ratio increases with glioma's whereas NAA/Cr decreases were confirmed with histopathological correlation. 20% of the patients with intra axial brain tumor were between 31 to 40 years of age. 73.33% of the patients were having intra axial brain tumors in supratentorial location. In this study majority of the patients i.e., 43.33% had hypointense signal on T1.

Conclusion: Accurate grading of gliomas on the basis of MRS alone may be difficult. Combining MRS with conventional and other advanced MR imaging techniques, grading becomes more precise.

Keywords: MRS-Magnetic Resonance Spectroscopy, NAA–N-acetyl aspartate, Cr-creatinine, Cho– choline, Lip– lipid, Lac–lactate, GBM – Glioblastomas.

Introduction

Intra axial brain tumors are a significant health problem and present several imaging challenges. These lesions include primary neoplasm (high and low grade), secondary (metastatic) neoplasm, lymphoma, tumefactive demyelinating lesions, abscesses and encephalitis. We are witnessing a shift in imaging from merely providing anatomical information towards providing information about tumor physiology. Imaging plays an integral role in intracranial tumor management. Magnetic resonance (MR) imaging in particular has emerged as the imaging modality most frequently used to evaluate intra cranial tumors, and it continues to have an ever expanding, multifaceted role. In general, the role of MR imaging in the workup of intra axial tumors can be broadly divided into tumor diagnosis and classification, treatment planning, and post treatment surveillance. In addition to conventional MR imaging techniques, a variety of advanced techniques have found their place in clinical practice or are the subject of intense research. These advanced techniques offer more than the anatomic information provided by the conventional MR imaging sequences. They generate physiologic data and information on chemical composition, The current advanced techniques include perfusion imaging, diffusion weighted imaging (including diffusion tensor imaging) MR spectroscopy, blood oxygen level-dependent (BOLD) imaging, and the largely experimental molecular imaging[2].

Aim/Objectives

- To determine biochemical markers of intra axial brain tumors using MR spectroscopy.

- To evaluate role of MR spectroscopy in diagnosing and grading of intra axial brain with histopathological co-relation.
- To evaluate role of MR spectroscopy in determining the infiltrative nature of the intra axial brain tumor.

Materials and Methods

This hospital based prospective study, included 30 patients. All patients referred to the, department of Radio diagnosis with clinically suspected brain tumors in a period from July 2022 to June 2023 will be subjected for the study, in chalmeda Anand Rao Institute of Medical Sciences, Karimnagar.

Inclusion Criteria

The study includes

- All patients with known history of intra axial brain tumors.
- All patients with incidentally diagnosed intra axial brain tumor by CT.
- Clinically detected cases and Cases of all age groups irrespective of sex.

Exclusion Criteria

The study will exclude

- Cases with benign lesions after histopathology confirmation.
- Patient having history of claustrophobia and clinically unstable.
- Patient having history of metallic implants insertion, cardiac pacemakers and metallic foreignbody in situ.

Method

The MR scan was performed MR GE Signa HDxt. It possesses Ultra-compact, Super conducting, Active shielded super conducting magnet with a magnetic field strength of 1.5 T. SENSE coils was used for acquisition of images.

Statistical Analysis

Data was entered in Microsoft excel data sheet and analysis was done by using EPI INFO 7 software. Descriptive statistics, frequencies and proportions were calculated and tabulated.

OPEN EPI software was used to calculate sensitivity, specificity, negative predictive value, positive predictive value and diagnostic accuracy to test the validity of MR Spectroscopy with respect to histopathological examination.

Fisher exact test was the test of significance for categorical data, $p < 0.05$ was considered as statistically significant.

Results

Table 1: Distribution of Age among the study population

Age	No of Patients
0-10	5
11-20	4
21-30	1
31-40	6
41-50	5
51-60	2
61-70	4
71-80	3

20% of the patients with intraaxial brain tumor were between 31 to 40 years of age. The youngest patient was 11 months old with ependymoma and the oldest was 75 years old female with metastasis.

Table 2: Distribution of Location

Location	No of Patients
Supratentorial	22
Infratentorial	6
Both	2

73.33% of the patients were having intra axial brain tumors in supra tentorial location. It was observed that most common location for intra axial brain tumor is supratentorium.

Table 3: Distribution of sample based on signal characteristics on T1WI

	No of Patients
Isointense	6
Hypointense	13
Hyperintense	-
Heterointense	11

In this study majority of the patients i.e., 43.33% had hypointense signal onT1.

Table 4: Distribution of sample based on signal characteristics on T2WI

	No of Patients
Isointense	2
Hypointense	-
Hyperintense	10
Heterointense	18

Table 5: Distribution of sample based on blooming on T2GRE, with in the brain tumor

	No of Patients
Present	14
Absent	16

Table 6: Distribution of sample based on perilesional edema

	No of Patients
Present	24
Absent	6

In this study it was observed that majority of tumors i.e.80% showed perilesional edema. Itis evident that most of the brain tumors present with perilesional edema.

Table 7: Distribution of sample based on degree of contrast enhancement of brain tumor

	No of Patients
Mild	6
Moderate	5
Intense	19
Absent	-

In this study it was observed that majority of brain tumors i.e. 63.33% had intense post contrast enhancement. It is evident that most of brain tumors show intense enhancement on post contrast study.

Table 8: Distribution of sample based on solid/cystic component of the brain tumor

	No of Patients
Solid/cystic	19
Solid	11
Cystic	-

In this study it is observed that majority of brain tumors i.e., 63.33% had both solid andcystic component in the form of necrosis. And in 36.67% of brain tumors there was no necrotic component.

Table 9: Distribution of sample based on characteristics of tumor margins

	No of Patients
Well defined	16
Ill defined	14

In this study it is observed that majority of brain tumors i.e.,53.33% were well defined and46.67% were ill defined with no definite tumor margins.

Discussion

Age distribution

Patients from all age group were included in our study. Brain neoplasms were most commonly found in 31-40(n=6) years age group.

The second most common age group was 41-50 (n=5) and 0-10 (n=5) years age group. P A McKinney studied the incidence of brain neoplasms in all age group and found that primary brain neoplasms occur most commonly in 7th decade (61). Difference in our study is due to small sample size.

Sex distribution

Out of 30 patients in our present study, incidence of brain neoplasms was more in males73.33%(n=22).

Location of tumors

In present study of 30 cases, 73.33% (n=22) neoplasms were supratentorial, 20%(n=6) were infratentorial and 6.67%(n=2) were both supra and infratentorial in location. Supra tentorial tumors were more common than infratentorial tumors in our study.

Gliomas

In present study, glioma cases were reported as low grade (diffuse infiltrative astrocytoma) or high grade astrocytoma (anaplastic astrocytoma and glioblastoma multiformae), oligodendroglioma, ependymoma and gliomatosis cerebri according to

the MR characterization of tumors. Both conventional sequences and different parameters of MR spectroscopy was used to optimize for better results. Glioma constituted 70% (n=21) out of the total 30 cases in our study and was the most common brain neoplasm found in our study. Out of 21 cases of gliomas diagnosed on MRI, 12 were GBM, 3 were anaplastic astrocytoma, 2 were diffuse infiltrative astrocytoma, 1 case of oligodendroglioma, 2 cases of gliomatosis cerebri and 1 case of ependymoma. In present study 20 out of 21 (95%) cases of glioma had perilesional edema. The only case which did not show perilesional edema was ependymoma (n=l). All GBM showed intense enhancement, anaplastic astrocytoma showed moderate enhancement, and diffuse infiltrative astrocytoma cases had minimal enhancement. Oligodendroglioma, ependymoma and one case of gliomatosis cerebri showed intense enhancement whereas the other case of gliomatosis cerebri showed mild enhancement. Our findings are in agreement with study conducted by R Felix, WSchorner et al.6 In present study, all GBM and anaplastic astrocytoma cases and 1 case of Oligodendroglioma were heterogenous lesion with both solid and necrotic component. The 2 cases of diffuse infiltrative astrocytoma and1case of ependymoma were solid lesions showing no necrotic center. In cases of gliomatosis cerebri, one case was solid and the other was heterogenous with solid and necrotic component.

Histopathology was done in 20 cases of glioma. MRI findings were correlated with histopathology of the tumor in 16 out of 20 cases. First case which did not correlate was of diffuse infiltrative astrocytoma which on histopathology turned out to be an aplastic astrocytoma. Second case was of GBM, which on histopathology turned out to be lymphoma. The third case was of GBM, which on histopathology turned out to be anaplastic astrocytoma. The fourth case was of anaplastic astrocytoma which on histopathology turned out to be anaplastic oligodendroglioma. Histopathology was not done in one case of brain stem glioma.

Diffuse infiltrative astrocytoma

Diffuse infiltrative astrocytoma are grade 2 astrocytomas. There were three patients with diffuse astrocytoma in our study. Two of them were seen in the age group of 11-20 years and another case was of 47 year old. On conventional MR sequences, lesions were hypointense on T1WI and hyperintense on T2WI. Lesions were solid to solid and cystic. They showed minimal enhancement. No blooming were observed on T2 GRE sequence.On MRS three tumors showed increased choline peak, reduced NAA, increased ml peak and reduced creatine peak. There was increased cho/creatine ratio of 2.03(±0.42), increased cho/NAA ratio of 1.9(±0.34) and reduced NAA/creatine peak at 0.9(±0.33). ml/creatine ratio was higher at 0.80(±0.25). Both cases showed no choline peak in perilesional edema outside the tumor margin.

One of the case did not correlate histopathologically, it was diagnosed as anaplastic astrocytoma. However, we got diagnostic accuracy of 96.3% and a significant association between MRS and histopathology findings with p=0.00854 ($p<0.05$ being significant). We got 100%sensitivity and 96% specificity. Our findings were similar to study done Mauricio Castilloaet al [16].

Anaplastic astrocytoma

Anaplastic astrocytomas are grade 3 astrocytomas. Two patients with anaplastic astrocytoma were evaluated in our study. One was seen in a child of 11years and one in an adult of 37years.On conventional MR sequences, lesion was hypointense on T1W and hyperintense on T2W imaging. Both the cases showed blooming on T2 GRE suggestive of bleed. On MRSI both the tumors showed increased choline peak, reduced NAA, reduced ml peak and reduced creatine peak. There was increased cho/creatine ratio of 4.5(±0.55), increased cho/NAA ratio of 2.5(±0.22) and reduced NAA/creatine peak at 0.9(±0.33). ml/creatine ratio was lower at 0.33(±0.15). Two of the cases showed increased choline peak with raised cho/creatine ratio in perilesional edema probably due to tumoral infiltration. Our findings were similar to study done by Magalhaes A, Godfrey W et al [63] and Mauricio Castilloaet al.[16]

Glioblastoma Multiformae

GBM are grade 4 astrocytomas. 12 patients with Glioblastoma Multi formae were evaluated in our study. All GBM cases were found in adults between 3rd to 8th decade.On conventional MR sequences, all cases were heterogeneously hypointense on T1W and heterogeneously hyperintense on T2W imaging. Blooming was a prominent feature observed in all cases. On MRSI all tumors showed increased choline peak, reduced NAA, reduced ml peak at 3.6ppm and reduced creatine. There was increased cho/creatine ratio of 6.5(±0.55), increased cho/NAA ratio of 3.5(±0.22) and reduced NAA/creatine peak at 0.8(±0.33). ml/creatine ratio was lower at0.15(±0.15). All the cases showed increased choline peak with raised cho/creatine ratio in perilesional edema probably due to tumoral infiltration.

Oligodendroglioma

Oligodendroglial tumors can be low grade/grade 2 oligodendroglioma or grade 3 anaplastic oligodendroglioma based on WHO grading system. In our study we evaluated two patients with oligodendroglioma, one of which was misdiagnosed as GBM on MRI. Both were histopathologically proven as anaplastic oligodendroglioma. Both the tumors were found in adults in 2nd and 4th decade. On

conventional MR sequences, lesion appeared heterogeneous to hypointense tumor onT1W and heterogeneous to hyperintense on T2W. One of the cases showed ill-defined margins, having both solid and necrotic component. Cortical bone thinning was noted inboth the cases. Foci of blooming were observed on T2 GRE sequence due to calcification.

On MRSI the three tumors showed increased choline peak, reduced NAA, increased lipid lactate peak and reduced creatine peak. There was increased cho/creatine ratio of 2.38(±0.42), increased cho/NAA ratio of 1.9(±0.34) and reduced NAA/creatine peak at 0.9(±0.33). Both cases showed choline peak in perilesional edema outside the tumor margin. We got specificity of 100% and sensitivity of 50%. Diagnostic accuracy of 96.3%. Our study is similar with the study done by Spampinato MV, Smith JK, Kwock L etal [20].

Conclusion:

Accurate grading of gliomas on the basis of MRS alone may be difficult. Combining MRS with conventional and other advanced MR imaging techniques, grading becomes more precise. Some features of tumors on conventional MRI (e.g. contrast enhancement, surrounding edema, signal heterogeneity, necrosis, hemorrhage and midline crossing) suggest a high grade.

MRS is complementary and helpful for glioma grading. High grade gliomas demonstrate marked elevation of Cho, decreased NAA and presence of Lac and Lip. Myo is high in low grade gliomas and decreases with increasing grades of tumors. From our study we can conclude that in vivo MR spectroscopy can be used as a reliable method for glioma grading. It is useful in discrimination between WHO grade II and grade HI, IV astrocytomas as well as other intraaxial brain tumors such as gliomatosis cerebri, Ependymoma, medulloblastoma, oligodendroglioma, lymphoma, metastasis and choroidplexus papilloma. Our study also demonstrates that spectroscopic MR measurements in the peritumoral region can be used to demonstrate differences in solitary metastases and high-grade gliomas and also peritumoral infiltrative nature of certain intraaxial brain tumor.

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