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Study of Utility of Magnetic Resonance Spectroscopy in Brain Tumours

KEYWORDS: MR Spectroscopy, Brain Tumours, MRI.

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ABSTRACT *Background: Brain Tumours are difficulty to diagnose, especially early in their course. Potential usage of MR Spectroscopy needs to be explored for the same.*

Objective: To study the utility of MR Spectroscopy in diagnosis & typing of brain tumours

Methodology: 35 eligible participants were recruited and MR Spectroscopy was performed, along with conventional MRI. The diagnosis was confirmed with histopathological examination.

Observations: The overall accuracy of MR Spectroscopy in diagnosis of brain tumours was 82.8%. The accuracy was 100% in low grade gliomas, schwannomas and medulloblastoma.

Conclusion: MR Spectroscopy has a definite complimentary role in better tissue characterization of different brain tumours.

INTRODUCTION

Brain tumours comprise a diverse group of neoplasms that vary in their behaviour depending on factors such as cell of origin, site of occurrence, morphology and pattern of spread. Their prognosis, thus, depends largely on early detection; which is a challenge in itself.

Various imaging modalities have been used towards early detection. MR Spectroscopy has been shown to be promising for detection & sub-classification of brain tumours by various researchers [1-6]. The brain's inaccessibility and yet almost perfect magnetic field homogeneity permit MR imaging of great sophistication.

A basic step in MR spectroscopy is localization of the region of interest in all three spatial dimensions. This can be performed using two methods: single-voxel spectroscopy (SVS) or chemical-shift imaging (CSI). In clinical practice, SVS is the easier and faster technique for obtaining metabolic information. While interpreting MR Spectroscopy, reduction in NAA level and NAA/Cr ration is typically observed in brain tumours, indicating decreased viability and number of neurons. If NAA level is normal it is unlikely to be a tumour.

Keeping in mind the potential of MR Spectroscopy in early detection of brain tumours, the present study was undertaken with the purpose of studying the utility of brain tumour via MR Spectroscopy.

METHODOLOGY

Type of Study- Observational Study

Study Setting- Tertiary Care Hospital

Study Period- January 2015-December 2015

Sample Size- 35 Consecutive patients suspected of having brain tumour recurrence vs. post

RT/treatment changes included.

Study Instrument- 1.5 Tesla, Philips MR Achieva. (Std head coil for brain MRI and MRS)

Participant Selection-
Inclusion criteria-

Signs/symptoms suggestive of brain tumours.

Diagnosed c/o brain tumours.

All patients undergoing MRI brain and detected to have brain tumour.

Exclusion criteria-
Contraindications to undergo MRI

Lost to follow up.
Conventional MR images were acquired during the same procedure to allow exact comparison of the results. All the patients were subsequently followed up for confirmation of diagnosis by biopsy or surgery.

All the patients provided written informed consent to participate in the study. The results were used for research purposes only.

RESULTS

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Majority of patients in the study (31.4%) belonged to 21–30 year age group with slight male preponderance (51.4%). Most common presenting complaint was headache, seen in 62.8% of the patients, followed by seizures (48.5%).

Study of metabolite ratios revealed that mean Cho/Cr ratio was high in gliomas, metastasis, meningiomas, medulloblastoma, pitutory macroadenomas and schwannomas while it was normal in DNTs and craniopharyngiomas. Highest Mean Cho/Cr value was seen in Metastasis (3.58). Mean Cho/NAA ratio was high in all the lesions, with highest values seen in the meningiomas (7.84) and Gliomas (4.66). Mean NAA/Cr ratio was below normal in gliomas, metastasis, meningiomas, medulloblastoma, and pitutory macroadenomas and schwannomas lowest values seen in the meningiomas (0.53) and Gliomas (0.67). Mean NAA/Cr was highest in trigeminal schwannomas (1.79) and craniopharyngiomas (1.71). (Table 1)

Table No. 1: Average Metabolite Ratios in the various lesions
(Normal Values: Cho/Cr < 1.5; Cho/NAA < 0.8; NAA/Cr > 1.6)

Brain Tumours	No of Patients	Cho/Cr (Mean & SD)	Cho/NAA (Mean & SD)	NAA/Cr (Mean & SD)
Gliomas	11	2.47(0.91)	4.66(2.99)	0.67(0.17)
Metastasis	8	3.58(0.72)	3.89(0.58)	0.91(0.32)
Meningiomas	6	3.17(0.63)	7.84(1.77)	0.53(0.07)
DNET*	2	0.93(0.24)	0.96(0.19)	0.98(0.35)
Pituitary Macroadenoma	2	2.49(0.81)	3.13(0.70)	0.83(0.29)
Trigeminal Schwannoma	1	2.79(0.14)	1.40(0.10)	1.79(0.11)
Acoustic Schwannoma	2	3.07(0.23)	2.78(0.21)	1.26(0.09)
Medulloblastoma	3	2.38(0.07)	1.42(0.09)	1.03(0.06)

*** Dysembryoplastic Neuroepithelial Tumour**

As for other metabolites, Lactate was seen in 75% of metastases, 66.6% of all high grade Gliomas, 33.3% of medulloblastomas and 33.3% of meningiomas. Lipid peak was found in the high grade Gliomas, metastases, meningiomas and medulloblastomas particularly in grade IV gliomas (83.3%). Alanine was seen in 66.6% of all the meningiomas, but not in any other malignancy. There was absence of lactate and lipid resonance in pitutory macroadenomas, DNET and schwannomas. (Table 2)

Table No.2: Other Metabolites detected by Spectroscopy in brain tumours

Tumour	Total	Lactate	Lipids	Alanine
Gr.II Glioma	3	2	0	0
Gr.III Glioma	2	2	2	0
Gr.IV Glioma	6	4	5	0
Metastasis	8	6	9	0
Meningiomas	6	2	3	4
DNET	2	0	0	0
Pitutory Macroadenoma	2	0	0	0
Trigeminal Schwannoma	1	0	0	0
Acoustic Schwannoma	2	0	0	0
Medulloblastoma	3	1	1	0

The mean Cho/Cr ratio was highest in grade IV gliomas (3.27) and lowest in grade II gliomas (1.48). The Cho/Cr and Cho/NAA ratios show increase with increasing grade of malignancy, with maximum mean Cho/Cr ratio (3.27) and Cho/NAA ratio (7.96) seen in the Grade IV gliomas. NAA/Cr ratio was lower in the higher grade gliomas than in the low grade gliomas, lowest in grade IV gliomas (0.45).

Comparison of the Spectroscopy findings in Gliomas and Metastasis showed the mean Cho/Cr ratio was found to be higher in the metastasis (3.58) than in the gliomas (3.27 in grade IV Gliomas). However the Cho/NAA ratio in the high grade gliomas (7.96 in grade IV Gliomas) was greater than in the metastasis (3.89). In general there was considerable overlap of metabolite ratios in the high grade gliomas and metastatic lesions. While Lactate peaks were seen in both gliomas and metastasis, there was higher incidence of prominent Lipid peaks in the grade IV gliomas (88.88%).

Incidence of recurrence after radiotherapy was found to be higher in case of grade IV gliomas (33.3%) than in the lower grade gliomas.

The overall accuracy of MR Spectroscopy in diagnosis of brain tumours was 82.8%. The accuracy was 100% in low grade gliomas, schwannomas and medulloblastoma.

Table No. 3: Accuracy of MR Spectroscopy in diagnosis of brain tumours.

Brain Tumours	No of Patients diagnosed by MR Spectroscopy	Final Histopathological Diagnosis	Accuracy
Grade II Gliomas	3	3	100%
Grade III Glioma	2	1	50%
Grade IV Glioma	6	5	83.3%
Metastasis	8	7	87.5%
Meningiomas	6	5	83.3%
Pitutory Macroadenoma	2	1	50%
DNET*	2	1	50%
Trigeminal Schwannoma	1	1	100%
Acoustic Schwannoma	2	2	100%
Medulloblastoma	3	3	100%
TOTAL	35	29	82.8%

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DISCUSSION

In this study majority of patients were in the age group of 20 to 40 years. Thirteen patients had GBM and 18 patients grade II/III astrocytoma. There was a majority of medulloblastomas in the 0 to 10 age group. In the age group 20 to 40 years maximum anaplastic astrocytomas were seen. GBM pre dominated in the age group above 40 years. These findings differ from Keith Smith et al [6], where anaplastic astrocytomas had their peak incidence in the 5th & 6th decades of life. The above findings matched the findings of Castilo et al [3] in that GBM was the most common tumor in the age group above 60 years.

The present study proves that MVS is more useful as compared to SVS in evaluating tumour bed heterogeneity. SVS confirm the findings of MVS in 32 out of 49. It could not confirm the findings of MVS in the remaining 17 patients because of various reasons. These findings are in accordance with Sanghvi et al [7] who found that SVS cannot help in delineating target volumes for secondary irradiation.

In this study, almost all patients who were thought to have tumor recurrence had elevated choline levels with decreased NAA and Cr levels. They had reversal of Cr/Cho and NAA/Cho ratios. The findings are in accordance with Mishra et al [8]. They had concluded that elevated choline values and reversed Cho/Cr values were reliable indicators of tumor regrowth.

Reduced NAA and Cr values were found in the tumor bed, which could either reflect tumor recurrence or post treatment changes. Also the peaks of both lipids and lactate were higher after RT than before. The findings match the findings of Isobe et al.

A generalized reduction of brain metabolite i.e. NAA, Cr, Choline and Lipids were found to reflect delayed cerebral necrosis due to radiation therapy. In this study, delayed cerebral necrosis was found only in 2 patients and both of these patients were previously diagnosed cases of GBM. It was probably because of increased doses of RT that are given to GBM patients.

Present study also concluded that MRI cannot reliably differentiate between post treatment changes and tumor recurrence. It is because both will reveal similar patterns of contrast enhancement on post gadolinium scans. As a result, new areas of post contrast enhancement could represent successful tumor destruction with necrosis of surrounding tissue, tumor recurrence in the original site, or a combination of both. MRI was able to differentiate tumor recurrence from post RT changes in 13 patients based on appearance of the lesion on various sequences and on comparison with old scans. If an enhancing focus develops in the periventricular white matter, particularly capping the ventricles or within the corpus callosum, radiation necrosis is likely. The finds are similar to that found by Fountas et al. [9]

Our study also concludes that it is better to run SVS on areas appearing suspicious on MVS. A diagnosis of raised choline should preferably not be given based on MVS alone.

This study matched the findings of Poptani et al [10] & Harting et al [11] that PET imaging of brain tumors with FDG is helpful in stratifying and detection of early recurrence of tumor following surgery and RT. PET was done on 8 patients, which revealed focal increased uptake of tracer. In these patients Spectroscopy had suggested tumor recurrence. Disadvantage is the relative high background due to normal grey matter glucose utilization that can conceal amounts of tumor tissue.

In conclusion it can be said that MR Spectroscopy has a definite complimentary role in better tissue characterization of different brain tumours.

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