



ROLE OF MAGNETIC RESONANCE SPECTROSCOPY (MRS) IN VARIOUS RING ENHANCING LESIONS IN BRAIN

Radiodiagnosis

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ABSTRACT

Aim and objective: To study the role of MR spectroscopy in the evaluation and differential diagnosis of various ring enhancing lesions in the brain with multi-voxel proton MR spectroscopy.

Materials and methods: It is the prospective observational study carried out on 42 patients from June 2016 to Aug 2018 at Department of Radiodiagnosis at AVBRH, DMIMS, Savangi, Wardha. Appropriate MRI sequences with spectroscopy and multiplanar imaging has been performed on patients with intracranial ring enhancing lesions.

Result and Conclusion: Total 42 patients were taken. Most common lesions seen were tuberculoma (38%) followed by brain metastasis (34%), neurocysticercosis (16%) and pyogenic brain abscess (12%). On MRS, Tuberculoma was differentiated from NCC by high Cho: Cr ratio > 1.1 and high lipid lactate peak. Special peaks like amino acids, acetate, aspartate and succinate were seen in pyogenic brain abscess while alanine and succinate were present in NCC. High choline peak and high Cho: Cr ratio were seen in brain metastases.

KEYWORDS

Ring enhancing lesions, spectroscopy, neuroimaging, metabolites, peaks,

INTRODUCTION:

Intracranial ring-enhancing lesions in brain are one of the most frequently found lesions in neuroimaging (1). While considering ring enhancing lesions, shape, wall thickness and size of ring-enhancing lesions along with surrounding perilesional edema as well as clinical history of the patient should be taken into consideration. It will help in accurately diagnosing the conditions and early initiation of treatment (2). There are multiple causes of intracranial ring enhancing lesions (3). Those include tuberculoma, neurocysticercosis, brain abscesses, encephalitis, lymphoma, neoplasms, demyelinating lesions, primary tumours, secondary metastasis etc. Most of these lesions are found at the gray - white matter interface. They can also be located in the sub-cortical area in the brain. Among various infective causes, tuberculosis is the commonest in India followed by neurocysticercosis (NCC). In non-infective causes, neoplastic diseases come. Secondary metastasis of systemic neoplasm also comes in differential diagnosis of ring enhancing lesions in the brain. Smooth and thin rims are characteristic imaging feature of cerebral abscesses. Such patients can be successfully managed with antibiotic therapy or antitubercular therapy as soon as diagnosis is made. Therefore, it should be detected early and treated appropriately. In routine, MRI brain is very sensitive in the identification of ring enhancing lesions although it lacks some specificity. Proton Magnetic Resonance Spectroscopy (MRS) is quite advanced imaging technique. It is found to be very useful in the diagnosing these lesions. Tumour grading is being done with the help of histopathologic examination after biopsy done with open or stereotactic neurosurgical procedure. MR spectroscopy also has a prognostic implication.

MATERIALS AND METHODS:

Prospective observational study carried out on 42 patients from June 2016 to Aug 2018 at Department of Radiodiagnosis at AVBRH, DMIMS, Savangi, Wardha. MRI was done on GE MRI 1.5 tesla with phase array coil. Contrast study was done by intravenously injecting gadolinium based contrast agent. Routine sequences like T1, T2, FLAIR and DWI were taken along with 2D PRESS with TE of 35 and 144.

INCLUSION CRITERIA:

- Patients with intracranial ring enhancing lesions, which are detected on contrast MR studies and are taken up prospectively.
- Patients of all age groups irrespective of sex.

EXCLUSION CRITERIA:

- Patients with primary brain tumors
- Patient having claustrophobia.
- Patient with prior history of any metallic implant or contrast allergy.

MRS DIAGNOSTIC PARAMETERS:

Various metabolites peak used in diagnosing ring enhancing lesion brain: choline peak at 3.2 ppm, lipid peak at 1.3 ppm, lactate peak at 1.3 ppm and reduced NAA peak at 2.0 ppm while creatine peak obtained at 3.0 ppm. Special peaks (alanine at 1.48 ppm, acetate at 1.92 ppm, succinate at 2.4 ppm, aspartate at 2.6 ppm, AA at 0.9 ppm) were also noted.

RESULTS:

Forty-two patients were evaluated, whose age group ranged from 11 to 80 years. The highest incidence of these ring enhancing lesions were found in 51 - 60 years age group accounting for 23.8% of cases and least incidence was seen in age group of > 71 years constituting 4.8%.

Table 1: Number of patients as per gender (n=42)

Sex	No. of cases	Percentage
Male	22	52
Female	20	48
Total	42	100

Our study included 22 males (52%) and 20 females (48%) with M: F ratio of 1.1:1

Table2: Incidence of various ring enhancing lesions (n=42)

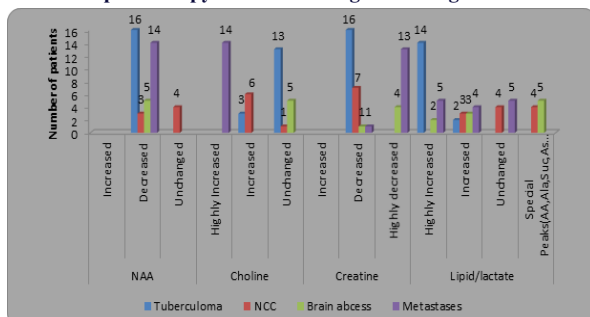
Lesions	Number of cases		Percentage
Tuberculoma	11	16	38
Caseating with liquefied center	5		
Caseating with non liquefied center			
Metastasis	14	34	
Neurocysticercosis			
Stage 1: Vesicular	2	7	16
Stage 2: Degenerating	2		
Stage 3: Granular nodular	2		
Stage 4: Calcified	1		
Brain abscess	5		12
Total	42		100

Out of the 42 patients who were evaluated with ring enhancing lesions in the brain, tuberculomas 16 patients (38%) was the most common pathology followed by metastasis 14 (34%) patients, Neurocysticercosis 7 (16%) patients and brain abscess 5 (12%) patients. Among tuberculoma patients, 11 patients were having caseating tuberculoma with liquefied centre and five patients were having caseating tuberculoma with non liquefied centre. Out of seven cases of NCC, two patients were having stage I NCC, two patients with stage II NCC, two patients with stage III NCC and one patient with stage IV NCC. All five cases of brain abscess were pyogenic only.

Table 3: Metabolites on MR Spectroscopy in various Ring enhancing lesions brain (n=42)

METABOLITES		PATHOLOGIES			
		Tuberculoma (n=16)	NCC (n=7)	Brain abscess (n=5)	Metastases (n=14)
NAA	Increased	-	-	-	-
	Decreased	16	3	5	14
	Unchanged	-	4	-	-
Choline	Highly Increased	-	-	-	14
	Increased	3	6	-	-
	Unchanged	13	1	5	-
Creatine	Increased	-	-	-	-
	Decreased	16	7	1	1
	Highly decreased	-	-	4	13
Lipid lactate	Highly Increased	14	-	2	5
	Increased	2	3	3	4
	Unchanged	-	4	-	5
Special-peaks (AA,Ala,Suc,Asp,Ace)		-	4	5	-

Graph 1: Distribution of patients showing different metabolites on MR Spectroscopy in Various Ring enhancing lesions brain

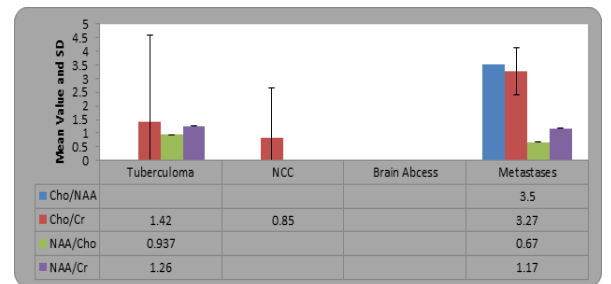


From the above findings, it can be estimated that NAA was decreased in all sixteen patients of tuberculoma, three patients of NCC, all five patients of pyogenic brain abscess and fourteen patients of brain metastases. Choline was highly increased in all 14 cases of brain metastasis, increased in six cases of NCC and three cases of tuberculoma. While Creatine was highly decreased in 13 cases of brain metastases and four cases of pyogenic brain abscess. It is decreased in 16 cases of tuberculoma, seven cases of NCC and one patient of pyogenic abscess. Lipid-lactate was highly increased in 14 cases of tuberculoma, 2 cases pyogenic brain abscess and five cases of metastases. Special peaks (Ala, Suc, Asp, AA, and Ace) were seen in all five cases of brain abscess and four cases of NCC.

Table 4: Metabolites ratios in various ring enhancing lesions brain (n=42)

Pathologies	Metabolite ratios							
	Cho/NAA		Cho/Cr		NAA/Cho		NAA/Cr	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Tuberculoma	-	-	1.42	0.20	0.93	0.19	1.26	0.26
NCC	-	-	0.85	0.09	-	-	-	-
Brain Abscess	-	-	-	-	-	-	-	-
Metastases	3.50	3.16	3.27	1.82	0.67	0.45	1.17	0.86
Mean	3.50	3.16	2.01	1.50	0.81	0.36	1.22	0.61
p-value	-		F= 14.42, p=0.0001,S		F=4.56, p=0.041,S		F=0.18, p=0.67,NS	

Graph 2: Below graph shows Metabolites ratios in various ring enhancing lesions brain.



The calculated Cho: Cr and NAA: Cho ratios showed significant difference between tuberculoma, NCC and metastases. P value calculated for Cho: Cr and NAA: Cho ratio found to be significant P (< 0.05) among tuberculoma, NCC and metastases patients. While calculated NAA: Cr ratio between tuberculoma, NCC and metastases patients showed P (> 0.05) which is not significant in our study. No ratios were calculated for brain abscess.

DISCUSSION:

Magnetic resonance imaging is a highly accurate, noninvasive, multiplanar imaging with better inherent contrast for demonstrating any abnormal lesion accurately. MRI along with MRS provides an accurate and early assessment of brain changes in various ring enhancing lesions, thus leading to accurate diagnosis and introduction of early treatment. Most common lesions seen in our study were tuberculoma (38%) followed by brain metastasis (34%), neurocysticercosis (16%) and brain abscess (12%). 51-60 years (23.8 %) was the most common age group involved while less incidence (4.8 %) is seen in >71 years age group. Headache (50%) followed by seizure (45.2%) was the most common presenting complaint. Other complaints were hemiparesis, fever, vomiting and ataxia. Most of the cases presented with bilateral (50%) involvement followed by right side (28.6%), left side (19%) and midline location (2.4%). Most (52.4 %) of the ring enhancing lesions brain were of size 2-4 cm while (35.7 %) lesions were of size < 2 cm and only in (11.9 %) lesions size is greater than 4 cm. Most (23.8 %) lesions were located in Frontotemporo-occipital region in the brain followed by other areas of brain. Three lesions (7.1%) located in cerebellum and one lesion (2.4 %) located in intraventricular in midline location. Maximum (47.6 %) lesions were hypointense on T1W images rest were homogeneously hypointense, heterogeneous, hypo- iso intense and some are hyperintense. Among all patients, 27 cases (64.3 %) were hyperintense on T2W images. Ten patients (23.8 %) showed heterogeneous hyperintensity on T2W1 while five patients (11.9 %) were hypointense on T2WI. In our study, 28 patients (66.7 %) showed complete/partial diffusion restriction on DWI and 14 patients (33.3%) showed no diffusion restriction.

Out of 16 cases of tuberculoma, 11 (69 %) cases were caseating with liquefied centre and hyperintense on T2WI, rest other five (31 %) cases were caseating with non-liquefied centre and showed hypointensity on T2WI. Lipid lactate peak on MRS was seen in all cases of tuberculoma (4). Cho: Cr ratio was >1.1 in all cases of tuberculomas and there was a slight decrease in NAA: Cr and NAA: Cho ratio⁽⁵⁾.

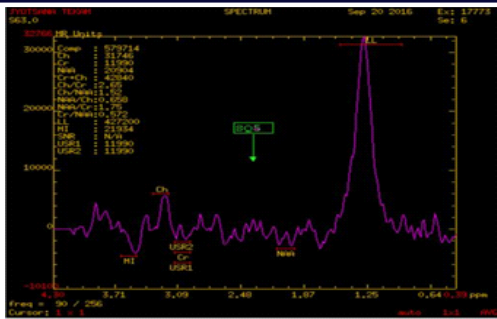


Fig 1: MRS showing high lipid-lactate peak at 1.3ppm, with reduced NAA and Cho: Cr ratio of 1.6 in tuberculoma

Out of 7 cases of NCC, 2 cases were of stage I NCC, 2 cases of stage II NCC, 3 cases of stage III NCC, one case of stage IV NCC. Six out of seven patients were hypointense on T1WI. Six patients showed hyperintensity on T2WI and one calcified NCC lesion was hypointense on T2WI. On DWI, five patients showed diffusion restriction. Three patients of NCC (stage II and III) showed slight reduction in NAA peak and six patients showed slight increase choline peak and Lipid-lactate peak on MRS. While four cases showed amino acid, alanine and succinate peaks (6). Cho: Cr ratio was less than 1.1 in all cases of NCC⁽⁵⁾.

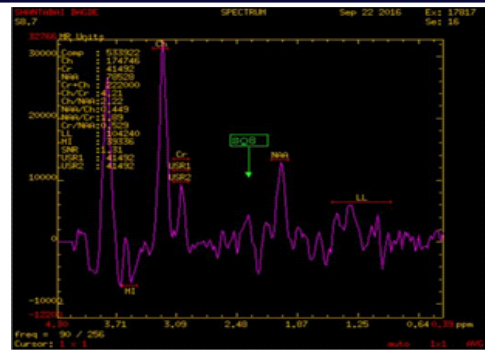


Fig 4: MRS showing choline peak at 3.2 ppm and small lipid-lactate peak at 1.3ppm with reduced NAA and creatinine in brain metastases while Cho: Cr ratio was 5.05.

CONCLUSION

Magnetic resonance spectroscopy (MRS) helps in differentiating and characterizing various ring-enhancing lesions in the brain, which leads to accurate diagnosis of the disease. Lipid/lactate peak on MRS was seen in tuberculoma. Tuberculoma can be differentiated from NCC by high Cho: Cr ratio >1.1 in tuberculoma. Tuberculoma can be differentiated from metastasis by high Cho: Cr ratio in metastasis > 2 compared to tuberculoma. Special peaks like amino acids, acetate, succinate and aspartate is seen in all cases of pyogenic brain abscess while amino acid, alanine and succinate was present in four cases of NCC. High choline peak in the contrast-enhanced portion was observed in metastatic lesion. MRI along with MRS has emerged as the most sensitive modality in the characterization of intracranial ring enhancing lesions.

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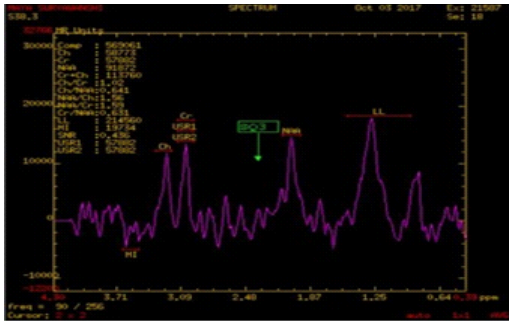


Fig 2: MRS showing amino- acid, succinate peaks at 0.9 and 2.4 ppm respectively with mild elevation of lipid-lactate and choline peaks and Cho: Cr ratio of <1.1 in stage II NCC

Out of the 42 patients, pyogenic abscess were found in all five cases (12 %). Three cases were heterogeneous on T1WI and two cases were hypointense on T1 weighted images. Hyperintensity on T2 weighted images was noted in all patients. All five cases showed complete diffusion restriction. MRS showed lipid and lactate peak in all five cases suggesting anaerobic glycolysis. It also showed special peaks like amino acids, aspartate and acetate in all five patients⁽⁷⁾.

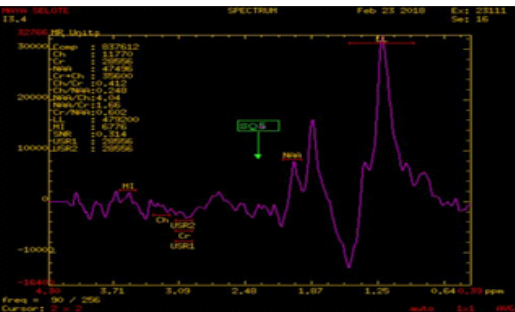


Fig 3: MRS of showing lipid-lactate peak at 1.3ppm, acetate peak at 1.92 ppm, amino acid peak at 0.9 ppm with reduced NAA and creatinine in pyogenic brain abscess.

In 14 patients of brain metastases, seven patients showed heterogeneously hyperintensity and remaining seven patients showed hyperintensity on T2WI. Primary malignancy was identified in nine patients {lung (6 cases), breast (1 case), kidney (1 case) and ocular (1 case)}. Twelve patients showed no diffusion restriction on DWI. All patients showed high choline peak in the contrast-enhanced portion and nine patients showed increased lipid lactate peak (8). All the cases showed high Cho: Cr and Cho: NAA levels and reduced NAA: Cr and NAA: Cho ratio on MRS imaging⁽⁹⁾.