www.jmscr.igmpublication.org
Impact Factor 5.244
Index Copernicus Value: 83.27
ISSN (e)-2347-176x ISSN (p) 2455-0450
crossref DOI: https://dx.doi.org/10.18535/jmscr/v4i11.69

IGM Publication
Journal Of Medical Science And Clinical Research
An Official Publication Of IGM Publication

Original Article

Evaluation of Intracranial Ring Lesions by Diffusion-Weighted Imaging and in Vivo Proton Magnetic Resonance Spectroscopy

Authors
Varun Garg (Senior Resident)[1], Gidugu Venkata Ramdas (Associate Professor)[2], Gavinder Singh Bindra (Associate Professor)[3], Amit Mittal (Prof And Head)[4], Samita Singal (Assistant Prof)[5], Rajnish Kumar Chaudhary (Senior Resident)[6], Rikki Singal (Prof)[7]
[1,4,5]Dept of Radiodiagnosis and Imaging, [2,3,6]Dept of Neuro - Surgery, [7]Dept of Surgery
M.M. Institute of Medical Sciences and Research, Mullana, (Distt-Ambala), Haryana, India
Corresponding Author
Samita Singal
Dept of Radiology, M. M. Institute of Medical Sciences and Research, Mullana, (Distt -Ambala) Pin Code - 133207, Haryana, India Email: *amitmittalrad@yahoo.co.in, Mobile no -08059931477*

ABSTRACT –
AIMS & OBJECTIVES: *To assess the combined role of diffusion weighted imaging and spectroscopy in differentiating ring enhancing intracranial cystic lesions.*
MATERIALS AND METHIODS: *The study was conducted from Oct 2011 to Sep 2013. Thirty (30) patients having ring enhancing intracranial cystic lesions were included in the study. 1.5 tesla MRI ACHEIVA (Phillips) with routine MRI sequences with diffusion weighted imaging (DWI) and ADC mapping followed by ADC value in the center of lesion was used. Proton Magnetic resonance spectroscopy was performed on these patients followed by T1W contrast. The radiological diagnosis was correlated with histopathological examination in 12 patients and the remaining were evaluated clinical parameters and blood tests by the clinicians.*
RESULTS: *Infective lesions were characterized by decreased Ch/NAA and decreased/ near normal Ch/Cr ratio as compared to ring enhancing cystic neoplastic lesions. Elevated lactate and lipid peaks were found to be characteristic for Tuberculomas. Cystic neoplastic lesions could be differentiated from infective lesions. Cerebral abscesses differed on the basis of elevated lactate and amino acid peaks. Brain abscesses showed high signal intensity in DWI and reduced ADC in the centre of lesion as compared to cystic neoplastic lesions.*
CONCLUSIONS: *The combined role of MRI with MRS and Difusion weighted imaging is found to be useful in accurate evaluation and differentiation of intra cranial cystic ring enhancing lesions. Reduced ADC value with diffusion restriction is highly suggestive of brain abscess while in absence of restriction; magnetic resonance spectroscopy is useful in distinguishing abscess from other infective lesions and cystic neoplasms.*
KEYWORDS: *ring enhancing cystic neoplastic lesions, brain abscess, diffusion weighted imaging, magnetic resonance spectroscopy.*

INTRODUCTION

MR (Magnetic Resonance) and CT (Computed Tomography) studies of the brain reveal cystic lesions whose aetiology is varied.[1] Cystic intracranial lesions are either true cysts, pseudocysts, benign dermoid or epidermoid cysts

(containing keratin), pseudocystic neoplastic or inflammatory lesions with necrotic or of intercellular myxoid or proteinaceus material.[2] A non invasive investigation to differentiate the lesions will help avoid unnecessary intervention The first line of neuro-imaging by CT and MRI findings reveal a solid and cystic appearance. It is not enough to differentiate cystic or necrotic tumor from abscess, low grade glioma from high grade glioma or metastasis, and Epidermoid from arachnoid or other cysts.[1] Diffusion-weighted (DW) imaging and calculation of apparent diffusion coefficients (ADCs) have been used to distinguish the normal white matter areas from necrosis, cyst formation, edema, and solid enhancing tumor and demarcation of tumors owing to directional dependence of molecular diffusion.[2,3] The current study is performed to evaluate the efficacy of Diffusion weighted imaging & apparent diffusion coefficient values in combination with MRS and MRI in diagnosing the various intracranial cystic lesions.

MATERIALS AND METHODS

The present prospective study was carried out by the department of neurosciences and the department of Radiodiagnosis at Maharishi Markandeshwar Institute of Medical Sciences And Research, Mullana (Ambala), Haryana. 30 patients having intracranial cystic lesions with varying perifocal edema and rim enhancement on CT (Computed tomography) and/or MRI (Magnetic resonance imaging) were included in the present study. All 30 patients who presented with cystic intracranial lesion on routine CT or MRI with varying perifocal edema and rim enhancement on post contrast study were included in the study. [the] exclusion Criteria - unfit to undergo MRI and inadequate studies precluding correct identification and interpretation were excluded, in whom MRI was contraindicated. Informed consent was obtained from the patients or from the nearest kin of the patients included in this study. A complete clinical, neurological and diagnostic workup was performed and recorded in all the cases. The radiologist reporting was blinded to the clinical details. MRI was done on Achieva 1.5 T MRI (Philips, Netherland) equipped with circularly polarized sense head coil and an actively shielded whole-body magnetic field gradient set. The head of the patient was fixed to prevent movement during and in between acquisition of images. First, all routine MRI sequences i.e. TlW1 Axial, T2W1 Axial, FLAIR Axial, T2 sagittal, were done. Then diffusion weighted imaging (DWI) with ADC mapping was done and ADC value was calculated in the lesion. Then spectroscopy was done with single voxel or multivoxel volume-selective water suppressed stimulated-echo acquisition mode (STEAM) and point-resolved spectroscopic (PRESS) sequences in all cases. Then T1 contrast (Gadopentetate Dimeglumine 0.1mmol/kg body weight) in axial, sagittal and coronal planes was done on MRI. Provisional diagnosis was made on routine MR imaging. Then diagnosis was made by combining the findings of routine MR imaging, diffusion weighted imaging and spectroscopy. The radiological diagnosis was correlated with histopathological examination and clinical follow up.

OBSERVATIONS & RESULTS

Thirty patients were evaluated, whose age group ranged from 12 to 72 years. The highest incidence of ring enhancing lesions was found in 41-50 years age group accounting for 36.6%. Most of the tuberculomas were found in age group of 11-20yrs. Most cases of GBM were found in age group of 41-50yrs. Most of the metastasis were found in >60 yrs age group. Thirty patients were evaluated of which 22 (73.3%) were males and 8 (26.6%) were females. The overall incidence of lesions was high among males in our study. All the ring enhancing lesions were found more in males as compared to females. Of the total 14 cases of tuberculomas, 71.4% were males. Of the total 8 cases of GBM, 62.5% were males. Of the total 4 cases of metastasis, 75% were males. Of the total 3 cases of abscess, 100% were males. Fever was the most common presenting complaint in 73.3 % of cases. Headache (56.6%) and seizure

(63.3%) were the other presenting complaints. Total of thirty patients were evaluated- Maximum number of ring enhancing lesions were found in occipital lobe (30%) followed by frontal lobe (26.6%). 92.8% of the tuberculomas showed peripheral edema. 66.6% of the abscesses showed peripheral edema. 100% cases of GBM and metastasis showed peripheral edema. 19(63.3%) patients had a single lesion. 2-4 lesions were noted in 8 (26.6%) cases and > 4 RELs were seen in 3 (10%) cases. Maximum number of patients (66.6%) had lesion size ranging between 2-4 cm. 20% patients had lesion size measuring less than 2cms. 13.3% of the total patients had lesion size measuring more than 4cms.

The final diagnosis of the cases were based on histopathological reports (n=12), clinical diagnosis (known primary n=4; clinical findings n=4) and response to therapy (n=10). Table 1 shows the final diagnosis of various ring enhancing lesions in 30 patients. The highest incidence amongst various ring enhancing lesions was that of tuberculoma accounting for 46.6% followed by GBM and metastasis. The least incidence was that of NCC accounting for 3.3% in our study. A total of 30 patients were evaluated presenting with various types of ring enhancing lesions. The diagnosis was made on MRI. This was followed by application of DWI and PMRS individually. Finally, combination of MRI, DWI and PMRS was done. This was correlated with final diagnosis.

MRI diagnosed 12 cases of tuberculoma, 10 cases of GBM, 5 cases of metastasis, 2 cases of abscess and 1 case of NCC. 1 case of abscess was falsely diagnosed as metastasis. 2 cases of tuberculoma were falsely diagnosed as GBM. For tuberculoma, sensitivity and specificity of the MRI was 87.5% and 100% respectively. For GBM, sensitivity and specificity of the MRI was 100% and 91.6% respectively. For metastasis, sensitivity and specificity of the MRI was 100% and 96.2% respectively. For abscess, sensitivity and specificity of the MRI was 75% and 100% respectively. For NCC, sensitivity and specificity of the MRI was 100% and 100% respectively.

On combination of MRI and DWI, 12 cases of tuberculoma, 8 cases of GBM, 4 cases of metastasis, 3 cases of abscess and 1 case of NCC were diagnosed. 2 cases of tuberculoma were diagnosed as abscess as they had strongly reduced ADC in the centre of the lesion. For tuberculoma, sensitivity and specificity of the MRI+DWI was 87.5% and 100% respectively. For GBM, sensitivity and specificity of the MRI+DWI was 100% and 100% respectively. For metastasis, sensitivity and specificity of the MRI+DWI was 100% and 100% respectively. For abscess, sensitivity and specificity of the MRI+DWI was 100% and 93.1% respectively. For NCC, sensitivity and specificity of the MRI+DWI was 100% and 100% respectively.

On combination of MRI and PMRS, 13 cases of tuberculoma, 9 cases of GBM, 4 cases of metastasis, 3 cases of metastasis and 1 case of NCC were diagnosed. 1 case of tuberculoma was falsely diagnosed as GBM as it had elevated Ch/Cr and Ch/NAA ratios. For tuberculoma, sensitivity and specificity of the MRI+SPECTROSCOPY was 93.3% and 100% respectively. For GBM, sensitivity and specificity of the MRI+SPECTROSCOPY was 100% and 95.6% respectively. For metastasis, sensitivity and specificity of the MRI+SPECTROSCOPY was 100% and 100% respectively. For abscess, sensitivity and specificity of the MRI+SPECTROSCOPY was 100% and 100% respectively. For NCC, sensitivity and specificity of the MRI+SPECTROSCOPY was 100% and 100% respectively.

On combination of MRI with DWI and PMRS, 15 cases of tuberculoma, 8 cases of GBM, 4 cases of metastasis, 2 cases of abscess and 1 case of NCC were diagnosed. 1 case of abscess was falsely diagnosed as tuberculoma as ADC value was not significantly reduced. PMRS showed characteristic lipid peak with resonance at 0.7 ppm. For tuberculoma, sensitivity and specificity of the MRI+SPECTROSCOPY+DWI was 100% and 94.1% respectively. For GBM, sensitivity and specificity of the MRI+SPECTROS-COPY+DWI was 100% and 100% respectively.

For metastasis, sensitivity and specificity of the MRI+SPECTROSCOPY+DWI was 100% and 100% respectively. For abscess, sensitivity and specificity of the MRI+SPECTROSCOPY+DWI was 75% and 100% respectively. For NCC, sensitivity and specificity of the MRI+SPECTROSCOPY+DWI was 100% and 100% respectively.

For tuberculoma, sensitivity and specificity of the MRI+DWI was 87.5% and 100% respectively. For GBM, sensitivity and specificity of the MRI+DWI was 100% and 100% respectively. For metastasis, sensitivity and specificity of the MRI+DWI was 100% and 100% respectively. For abscess, sensitivity and specificity of the MRI+DWI was 100% and 93.1% respectively. For NCC, sensitivity and specificity of the MRI+DWI was 100% and 100% respectively.

For tuberculoma, sensitivity and specificity of the MRI+SPECTROSCOPY was 93.3% and 100% respectively. For GBM, sensitivity and specificity of the MRI+SPECTROSCOPY was 100% and 95.6% respectively. For metastasis, sensitivity and specificity of the MRI+SPECTROSCOPY was 100% and 100% respectively. For abscess, sensitivity and specificity of the MRI+SPECTROSCOPY was 100% and 100% respectively. For NCC, sensitivity and specificity of the MRI+SPECTROSCOPY was 100% and 100% respectively.

For tuberculoma, sensitivity and specificity of the MRI+SPECTROSCOPY+DWI was 100% and 94.1% respectively. For GBM, sensitivity and specificity of the MRI+SPECTROSCOPY+DWI was 100% and 100% respectively. For metastasis, sensitivity and specificity of the MRI+SPECTRO-SCOPY+DWI was 100% and 100% respectively. For abscess, sensitivity and specificity of the MRI+SPECTROSCOPY+DWI was 75% and 100% respectively. For NCC, sensitivity and specificity of the MRI+SPECTROSCOPY+DWI was 100% and 100% respectively.

DISCUSSION

In this study, the highest incidence amongst various ring enhancing lesions was that of tuberculoma accounting for 46.6%, followed by GBM (20%), metastasis (13.3%) and abscesses (10%). The high incidence of tuberculoma was due to high incidence of tuberculosis in this region. Mishra et al[1] conducted a study on 52 patients presenting with ring enhancing lesions had high incidence of infective lesions as compared to malignant lesions. Of the total 14 cases of tuberculomas, 71.4% were males, 62.5% of the total 8 cases of GBM were males. In cases of metastasis, 75% were males. All three cases of abscesses were males. All the ring enhancing lesions were found more prevalent in males as compared to females in accordance with the study done by Mishra et al[1].In our study, 86.6% of the ring enhancing lesions showed surrounding edema. Perilesional edema was seen in 92.8% of the tuberculomas and 66.6% of the abscesses. All the cases of GBM and metastasis showed peripheral edema. 19(63.3%) patients presented with a single lesion. 2-4 lesions were noted in 8 (26.6%) cases and more than 4 ring enhancing lesions were seen in 3 (10%) cases. Maximum number of patients (66.6%) had ring size ranging between 2-4 cm. 20% of the patients had ring size measuring less than 2cms and 13.3% of the total patients had ring size measuring more than 4cms.

Pal et al[4] conducted a study on 194 cases to evaluate the role of conventional MR imaging and in vivo proton magnetic resonance spectroscopy for evaluation of pyogenic brain abscesses and concluded that presence of AA`s on in vivo (1) H-MR spectroscopy was a sensitive marker of pyogenic abscess but its absence does not rule out pyogenic etiology. Presence of acetate with or without succinate favours anaerobic bacterial origin of abscess. In our study comprising of 30 patients, 3 patients were finally diagnosed as brain abscesses. 3 cases were diagnosed as abscess on application of spectroscopy due to presence of lactate/lipid, AA`s and acetate with or without succinate. We reported sensitivity and specificity of PMRS as 100% and 100% respectively for detection of brain abscesses. The sensitivity and specificity was not in accordance with above mentioned literature due to less number of cases

of abscesses in our study. Adc values and spectroscopic features of particular lesions Tuberculoma, the inflammatory granulomas present a diagnostic dilemma. Common causes of inflammatory granulomas include neurocystice-rcosis followed by tuberculosis, cerebral abscess and fungal lesions.

It is reported that there was a trend toward a higher lactate peak in high-grade gliomas. found that increase in lactate/Cr ratio correlated with degree of malignancy. It was observed that areas of tumor that showed significant enhancement on T1-weighted SE MR images obtained after injection of contrast material were markedly hyperintense on diffusion-weighted images and had a lower apparent diffusion coefficient (ADC) than the ADCs for non enhancing tumor and peritumoral edema. Cystic or necrotic portions of tumor showed the most signal suppression on diffusion-weighted images and were associated with the highest ADCs. The findings in our study are consistent with the above mentioned literature Bulakbasi et al[5] .

Luthra et al[6] also studied various brain abscesses and found elevated lipid/lactate levels of 1.3 ppm and amino acid levels of 0.9 ppm with or without the presence of succinate, acetate, alanine and glycine in majority of the cases. In our study, the ADC value of the central area of abscess ranged between .476X10^{-3} mm ^{2}/sec to .543X10^{-3} mm ^{2}/sec with the mean value of .50X10^{-3} mm ^{2}/sec with S.D of .03X10^{-3} mm ^{2}/sec. The Ch/Cr ratio ranged between 1.11-1.12 with a mean value of 1.1 with S.D of .007. The Ch/NAA ratio varied from .69-.71 with mean value of .7 with S.D of .01. The NAA/Cr ratio varied from 1.7-1.9 with mean value of 1.8 with S.D of .1. The lipid/Cr ratio ranged from 2.1- 2.3 with mean value of 2.2 with S.D of .1. The lactate/Cr ratio ranged from 2.5-2.9 with mean value of 2.7 with S.D of .28. The characteristic feature found in brain abscess was amino acid peak with resonance at 0.9ppm. These findings were in agreement with previous studies done by Mishra et al[1], Luthra et al[6]

Gliomas and metastasis are the most frequent brain tumors. In our study 8 cases of GBM and 4 cases of metastasis were evaluated and it was observed that that neither spectroscopic results nor ADC values were helpful in differentiating GBM from metastasis which is in conformity with Eun Ja Lee[7]. While comparing DWI and in vivo PMRS to differentiate brain abscess from necrotic brain tumor, Lai et al[8] showed that DWI requires less imaging time, can differentiate brain abscesses from cystic tumors and is superior to PMRS when contamination from adjoining tissue or acquisition time may create limitations. In our study, it was observed that Ch/Cr (p value .0001) followed by Ch/NAA (p value .0012) ratios were elevated and were statistically significant in differentiating GBM from abscess. We also similarly found no statistically significant difference in lipid and lactate levels between the two lesions. Therefore, in our study abscess could be differentiated from GBM by elevated Ch/Cr and Ch/NAA levels in the later with significantly reduced ADC value in the centre of the abscess. The findings are consistent with the above mentioned literature. Most studies mentioned restricted diffusion in brain abscesses.

Shetty et al[9] concluded that diffusion weighted MRI sequence can help in differentiating between the metastatic and infective ring enhancing lesions like abscesses. In our study, it was observed that Ch/Cr (p value<.0001) and Ch/NAA (p value=.0001) ratios were statistically significant in differentiating the two REL`s. Ch/Cr and Ch/NAA ratios were significantly elevated in case of metastasis. Lipid and lactate levels were elevated in both the REL`s and had statistically had no significance in differentiating the two. An important finding in our study was the amino acid peak at 0.9ppm in abscess which was consistent with the previous study done by Lai et al[8]. ADC values were also statistically significant in differentiating the two lesions as these were significantly reduced in the centre of the abscess. Therefore, abscess could be differentiated from metastasis by significantly elevated Ch/Cr and Ch/NAA ratios in the later with significantly reduced ADC value in the centre of the abscess. Presence of amino acid peak at .9ppm in abscess

was another significant finding which was helpful in differentiating the two lesions. The findings are consistent with the previous literature.

In our study, it was observed that ADC value was a significant variable that was helpful in differentiating the two REL`s. ADC value was significantly reduced in case of abscess. Another significant variable that was helpful in differentiating the two was the Lipid/Cr ratio. Lipid levels were significantly elevated in case of tuberculomas. Ch/Cr, Ch/NAA and Lactate/Cr ratios were not significant in differentiating the two REL`s. The findings in our study are consistent with previous study done by Luthra et al[6] who did comparative evaluation of tubercular and pyogenic brain abscesses using diffusion MR imaging and MR spectroscopy and found that the presence of amino acid peak was hallmark of pyogenic brain abscess

CONCLUSION

MRI along with DWI and MRspectroscopy play an important role in the diagnosis of various ring enhancing intracranial cystic lesions. We conclude that cystic intraparenchymal ring-enhancing lesions with Hyperintensity on DWI and low ADC values are probably abscesses. If the lesion is hypointense and has a high ADC value, PMRS is mandatory to distinguish a brain abscess from other lesions like GBM, metastasis and tuberculomas.

BIBLIOGRAPHY

1. Mishra AM, Gupta RK, Jaggi RS , Reddy JS, Jha DK , Husain N, et al. Role of Diffusion-Weighted Imaging and In Vivo Proton Magnetic Resonance Spectroscopy in the Differential Diagnosis of Ring-Enhancing Intracranial Cystic Mass Lesions. J Comput Assist Tomogr 2004;28:540-7.
2. Sener RN. Longstanding tectal tumors: proton MR spectroscopy and diffusion MRI findings. Comput Med Imaging Graph2002; 26 :25 –31[Medline]
3. Sinha S, Bastin ME, Whittle IR, Wardlaw JM. Diffusion tensor MR imaging of high-grade cerebral gliomas. AJNR Am J Neuroradiol2002; 23 :520 –527.
4. D. Pal, A. Bhattacharyya ,M. Husain et al. In Vivo Proton MR Spectroscopy Evaluation of Pyogenic Brain Abscesses: A Report of 194 Cases. AJNR Am J Neuroradiol. 2010; 31: 360–66.
5. Nail Bulakbasi, Murat Kocaoglu, Cem Tayfun et al. Combination of Single-Voxel Proton MR Spectroscopy and Apparent Diffusion Coefficient Calculation in the Evaluation of Common Brain Tumors. AJNR Am J Neuroradiol. 2003; 23: 225–233.
6. G. Luthraa, A. Parihara, K. Natha et al. Comparative Evaluation of Fungal, Tubercular, and Pyogenic Brain Abscesses with Conventional and Diffusion MR Imaging and Proton MR Spectroscopy. American Journal of Neuroradiology. 2007 28: 1332-1338.
7. Eun Ja Lee, David Mikulis, Dae Seob Choi, et al. Diagnostic Value of Peritumoral Minimum Apparent Diffusion Coefficient for Differentiation of Glioblastoma Multiforme From Solitary Metastatic Lesions. American Journal of Roentgenology. 2011;196: 71-76.
8. Ping H. Lai, Jih T. Ho, Wei L. Chen et al. Brain Abscess and Necrotic Brain Tumor: Discrimination with Proton MR Spectroscopy and Diffusion-Weighted Imaging. AJNR Am. J. Neuroradiol. 2002; 23:1369 - 1377.
9. Prakash Shetty, Aliasgar Moiyadi, Gouri Pantvaidya. Cystic metastasis versus brain abscess: Role of MR imaging in accurate diagnosis and implications on treatment. 2010; 6(3): 356-358.