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Original Article

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Role of Magnetic Resonance Imaging in the Evaluation of Ring Enhancing Lesions in Brain in Comparison with Magnetic Resonance Spectroscopy

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ABSTRACT

Purpose: Aim and Objectives of study was to assess the role of MRI in the evaluation of ring enhancing lesions of brain and to assess utility of MR spectroscopy in differentiating various ring enhancing lesions of brain. **Methods**: The study was carried out in the department of radiodiagnosis. The study was carried out over a period of 16 months and included 50 patients with ring enhancing lesions detected on contrast MR brain. **Results**: Out of 50 cases in our study, majority of lesions were tuberculoma followed by metastasis and NCC. Majority of patients were females in age group 40-60 years. Headache was the most common presenting symptoms. Majority of lesions were multiple (62%) and (60%) smaller in size (<2cm). Overall sensitivity and accuracy of MR were 81.54%, 92.76% and MRI+MRS were 91.27% and 96.80% respectively. **Conclusion**: MRI along with MRS has emerged as the most sensitive modality in the characterization of various intracranial ring enhancing lesions. MRS aids in MR diagnosis based on various metabolites leading to near accurate diagnosis.

Key Words: *MRI (Magnetic Resonance Imaging), MRS (Magnetic Resonance Spectroscopy), Metabolites, Ring enhancing Lesions, Accuracy*

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INTRODUCTION

'Ring-enhancing lesion' (REL) is used to represent variety of infective and non-infective processes, displaying a distinct contrast enhancement pattern acquiring shape of ring on cross sectional neuro-imaging[1]. Highest incidence of ring enhancing intra cerebral lesion in the world reported is that of gliomas (40%) followed by metastatic tumors (30%), brain abscesses (8%) and multiple sclerosis (6%) respectively[2].

In Indian series, the incidence of various ring enhancing lesions was tuberculoma accounting for 46.6%, followed by GBM (20%), metastasis (13.3%) and abscesses (10%). Tuberculosis continues to be the leading cause of ring-enhancing lesions in the Indian subcontinent as compared to tumors in the Western world[3,4].

Computed tomography and magnetic resonance imaging (MRI) are common imaging techniques used to diagnose these lesions. Routine brain MR sequences are very sensitive in the identification of ring enhancing lesions, but it lags some specificity[5]. Therefore, advanced MR techniques as proton Magnetic Resonance Spectroscopy (1HMRS), Perfusion weighted imaging and Diffusion tractography imaging (DTI) have been employed in the differential diagnosis of these lesions[5].

MATERIAL AND METHODS

The study was conducted in the Department of Radiodiagnosis and patients with ring enhancing lesions detected on contrast MR Brain and all patients with incidentally diagnosed ring enhancing lesion on CT were included in the study. Patients in whom MRI was contraindicated and patients who were not willing to be part of the study or didn't gave written informed consent were excluded from the study. Study population comprised of 50 patients. All patients were subjected to imaging after taking written informed consent on 1.5 T MRI scanner. Sequences taken were TlW1, T2W1, FLAIR, SWI, diffusion weighted imaging (DWI) with ADC mapping, T1 MPREG pre-contrast and post-contrast was done using head coil, in axial, coronal and sagittal planes.

Then MR spectroscopy single voxel and multiple voxel in various TE was done. Provisional diagnosis was made on routine MR imaging. Then final diagnosis was made by combining the findings of routine MR imaging and spectroscopy. The scans were analysed and findings were recorded on pre-structured proforma for the study. Descriptive statistical analysis was carried out to identify the characteristics and features of the collected samples. Microsoft excel was used to prepare the master charts. MR diagnosis correlated with final discharge diagnosis (histopathological /follow up) and sensitivity, specificity, and accuracy of MR+MR spectroscopy calculated.

OBSERVATIONS & RESULTS

Majority of Patients in our study was in age group 40-60 years (44%) followed by 10-30 years (32%). Mean age of patients in our study group was 39 years. Female preponderance was observed in our study with 54% patients being females. Headache alone was the most common presenting symptom present in 26% of patients. Headache with seizure was observed as presenting complaint in 24% of patients.

All patients were subjected to MRI brain and distributed into groups on the basis of multiplicity and size of lesions. Most of the lesions (62%) were multiple in number. Majority of REL in our study were < 2 cm in size (60%), whereas >4cm sized lesions accounted for 24%. On basis of conventional MRI sequence morphology (T1, T2 FLAIR, T1 Contrast, DWI) lesions were characterized and provisional MR diagnosis was made.

Table 1: Signal characteristics of lesions on conventional MRI sequences

S. No.	Provisional diagnosis	T1 Morphology	T2 Morphology	T1 Contrast	DWI
1	Tuberculoma (19)	2-Hyperintense 11-Hypointense 6-Isointense	12-Hyporintense 6-Iso-intense 1-Hyperintense	4-Disc 1-Irregular 1-Nodular 12- Ring 1-Open ring	17-No restriction 2-Restriction
2	NCC (6)	5-Hypointense 1-Isointense	5-Hyperintense 1-Isointense	5- Thin rim 1- Irregular rim	6-No restriction
3	Abscess (2)	2-Hypointense	2-Hyperintense	1-Irregular rim 1-Thin rim	2-Restriction
4	Toxoplasmosis (1)	1-Hypointense	1-Hyperintense	1-Eccentric Ring	1-Restriction
5	Metastasis (14)	12-Hypointense 1-Isointense 1-Hyperintense	12-Hyperintense 2-Hypointense	10-Nodular ring 4-Thick ring	10-No restriction 4-Restriction
6	Glioma (3)	3-Hypointense	3-Hyperintense	1-Irregular rim 2-Nodular ring	1-No restriction 2-Restriction
7	GBM (2)	2-Isointense	2-Hyperintense	2-Irregular nodular rim	1-No Restriction 1-Restriction
8	Brain stem glioma (1)	1-Isointense	1-Hyperintense	1-Nodular ring	1-Intermediate
9	Pilocytic astrocytoma (1)	1-hypo-intese	1-hyperintense	1-Irregular ring enhancing	1-intermediate
10	Demyelination (1)	1-Hypointense	1-Hyperintense	1-Open ring	1-No restriction
	Total	50	50	50	50

Tuberculoma was most common ring enhancing lesion diagnosed in our study (38%). Majority were iso to hypointense on T1 (90%) and iso to hypointense on T2(>90%). Variable enhancement patterns were observed with thin ring having most common. On DWI majority showed no restriction (>90) with ADC values 1034 to 1245x10-6 mm2/s. Metastasis was 2nd most common pathology observed (28%).

Majority were multiple hypointense on T1 and hyperintense on T2 and revealed nodular enhancement pattern on T1 contrast. NCC was 3rd most common pathology observed (12%). Majority were hypointense on T1 and hyperintense on

T2 with different pattern of enhancement. All lesions showed no restriction on DWI with ADC values 1505 to 1656x10-6 mm2/ s of core with presence of hypointense scolex.

Table 2: MRS characteristic of various intracranial lesions

Lesion	MR Spectroscopy Characteristics
Non-Neoplastic	↓ Ch/NAA and ↓/near normal Ch/Cr ratios
Tuberculoma	Lip/Lac peak, ↑ Ch, reduced NAA
NCC	↑ Ch, Lac, Suc, reduced NAA
Abscess	Acet, Ala, Lac, Absent Ch, and NAA
Demyelination	Reduced NAA, ↑Ch/NAA
Toxoplasmosis	↑Ch, ↑Lip, ↑Lac, ↑NAA
Neoplastic	↑Ch/NAA, ↑ Ch/Cr ratios
Metastasis	↑ Ch/NAA and ↑ Lip, Lac and Choline is not elevated in surrounding edema
Glioma	↑ Ch/NAA and high Choline in surrounding edema
Brain Stem Glioma	↑Ch/NAA, ↑ Lac, ↑ Lip
Pilocytic astrocytoma	↑Ch, ↑Ch/NAA
GBM	↑Ch/Cr,↑Ch/NAA

Neoplastic lesions had high Ch/NAA and high Ch/Cr ratio. Tuberculoma showed lip/lac peak and reduced NAA. Abscess revealed high Amino Acid level, absent Ch and NAA.

All patients were followed up and final diagnosis was established either by treatment response or Histopathological Diagnosis.

Table 3: Comparison of MR Diagnosis with final discharge diagnosis.

S.No.	Lesions	Provisional MR diagnosis (T1, T2, DWI,T1 contrast)	Final MR diagnosis with MR Spectroscopy	Final Diagnosis (H/P; T/t response)
1	Tuberculoma	19 (FP=2, FN=3)	19(FP=1, FN=2)	20
2	NCC	6(FP=1, FN=2)	7(FP=1, FN=1)	7
3	Abscess	2(FP=1, FN=0)	2(FP=1, FN=0)	1
4	Toxoplasmosis	1(FP=0, FN=1)	2(FP=0, FN=0)	2
5	Metastasis	14(FP=3, FN=2)	12(FP=0, FN=1)	13
6	Primary brain Neoplasia	7(FP=2, FN=2)	7(FP=1, FN=1)	6
7	Demyelination	1(FP=0, FN=0)	1(FP=0, FN=0)	1
	Total	50	50	50

Statistical analysis was done and sensitivity, specificity, PPV, NPV and accuracy of MRI and MRI+MR Spectroscopy in diagnosing common ring enhancing lesion was calculated.

Table 4: Statistical Analysis of MRI

Lesion	Sensitivity	Specificity	PPV	NPV	Accuracy
Tuberculoma	85.00%	93.10 %	89.47 %	90.00 %	89.80%
NCC	71.43 %	97.67 %	83.33 %	95.45 %	94.00 %
Abscess	100%	97.96 %	50.00 %	100%	98.00 %
Metastasis	84.62%	91.89 %	78.57%	94.44 %	90.00%
Primary brain neoplasia	66.67%	95.45%	66.67 %	95.45 %	92.00 %

Table 5: Statistical Analysis of MRI+MRS

Lesion	Sensitivity	Specificity	PPV	NPV	Accuracy
Tuberculoma	95.00%	96.67 %	95.00%	96.67 %	96.00%
NCC	85.71%	97.67 %	85.71%	97.67 %	96.00 %
Abscess	100 %	97.96 %	50.00 %	100 %	98.00 %
Metastasis	92.31%	100%	100%	97.37 %	98.00%
Primary brain neoplasia	83.33 %	97.73 %	83.33 %	97.73 %	96.00 %

Overall accuracy of MRI in diagnosing tuberculoma in our study was 89.8% which increased to 96% with addition of MRS.

DISCUSSION

A total of 50 patients having RELs and fulfilling inclusion and exclusion criteria were evaluated in our study by conventional MRI sequences and MR spectroscopy. Mean age of patients in our study group was 39 years with highest incidence in the age group 40-60 years (44%) followed by 30-40 years (16%). As we had 13 (26%) cases of metastasis and 20 (40%) cases of tuberculosis in our study majority of patients with RELs were elderly in the age group of 40-60 years. Similar incidence was reported by Garg V. et al. [4] in 2016 in their study, the highest incidence of RELs were found in 41-50 years age group accounting for 36.6%. In our study, female preponderance was observed with 54% patients being females and 46% males. Elsadway ME et al. [5] evaluated 25 patients with RELs and found 15 (60%) of them were males and 10 (40%) were females.

Headache alone was the most common presenting symptom present in 26% of patients. Similarly, seizure alone presented in 24% of patients. Headache with seizure as presenting complaint in 24% of patients. Mahato PS et al.[3] evaluated that out of a total of 40 patients, 23 (57.5%) patients presented with headache.

Majority of patients in our study had multiple intra cranial ring enhancing lesion (62%). Mahato PS et al. [3] in their study found sixty percent patients had multiple lesions. In contrary, Kumar et al. [6] found 22 patients (32%) had multiple lesions. Our findings were also supported by Devgan Aaina et al. [7] who reported 31(31%) patients had solitary lesions, whereas 69 (69%) patients had multiple lesions. Majority of REL in our study were <2 cm in size (60%), lesions of size greater than 4 cm accounted for 24%. In case of multiple lesions, size of the maximum number of lesions which were falling in one category were considered.

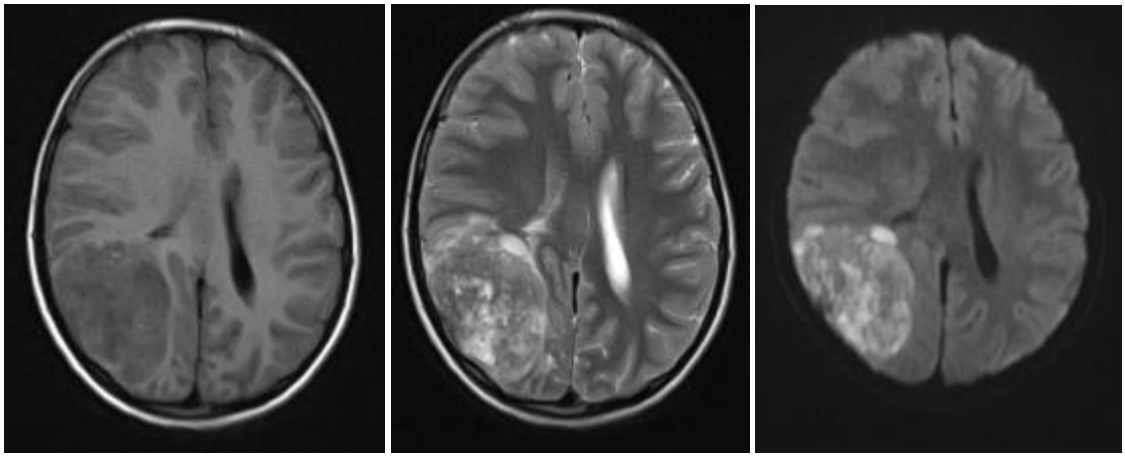
Majority of non-neoplastic/infective lesions were <2 cms in size whereas neoplastic lesions and high-grade gliomas were >4cms in size on presentation. Similar findings seen in study done by Archana R. et al.[8] reported majority 28 (70%) of them showed RELs < 2 cm, similar to our study lesions of size between 2-4 cm was seen in 8 (20%) and only in 4 (10%) lesions size is greater than 4 cm. Out of 50 cases, 20(40%) were tuberculoma, 13(26%) were metastasis, 7(14%) were NCC, 2(4%) were toxoplasmosis, 2 (4%) were glioma, 2(4%) were GBM, one was abscess and one was pilocytic astrocytoma, one was brain stem glioma and one was demyelination.

T2 signal intensity, DWI, and MRS plays a very important role in characterization of ring enhancing lesions. Pattern of signal intensity on T2 and FLAIR, DWI, T1 contrast and MRS help to differentiate between benign and malignant lesions. Smooth ring enhancement is most common feature of non-neoplastic lesions and Irregular nodular type of ring enhancement is the most common feature noted in most of the neoplastic lesions.

Hypointensity on T2 with partial or complete restriction on DWI images and lip/lac peak on MRS is more in favour of Tuberculoma. The sensitivity and specificity of MRI for tuberculoma was 85%, 93.10% respectively and MRI+MRS is 95% and 96.67% respectively. Solanki RN et al [9], in their study concluded that, for tuberculoma sensitivity, specificity, PPV, NPV of MRI was 94%, 100%, 100% and 98% respectively and for tuberculoma, sensitivity, specificity, PPV, NPV and accuracy of the MRI + Spectroscopy was 94%, 100%, 100% and 98% respectively. Metastasis are well defined hyperintense lesions on T2, irregular ring enhancement pattern which show high choline peak and reduced NAA on MRS. Sensitivity and specificity of MR for metastasis was 84.62% and 91.89% and MR with MRS was 92.31 and 100% respectively. Garg V. et al. [10] in 2016 found that for metastasis, sensitivity and specificity of the MRI was 100% and 96.2% respectively. On combination of MRI and PMRS, for metastasis, sensitivity and specificity of the MRI and MR spectroscopy was 93.3% and 100% respectively, similar to our study.

NCC are hyperintensity on T2 with no diffusion restriction, presence of scolex, different pattern of ring enhancement on T1 contrast and no lip/lac peak, and Ch/Cr ratio not elevated on MRS which is similar to the study performed by Kumar et al. [6] and Jayasunder et al.[10] Hypointense rim on T2 with complete diffusion restriction on MRS may show Lactate and Amino Acids, absent Cho, NAA more in favor of abscesses. The PPV and NPV of MRI for abscess is 50% and 100% and sensitivity and specificity of MRI+MRS for abscess is 100% and 97.96%.

Majority of primary brain tumors were heterogeneously hyperintense on T2, mixed diffusion restriction, irregular, nodular or thick wall ring enhancement of T1 contrast. MRS spectroscopy reveals high to very high Ch, Ch/NAA, Ch/Cr ratios. For primary brain tumors sensitivity and specificity of MRI and MRI+MRS is 66.67%, 95.45% and 83.33% and 97.73% respectively. Study done by Solanki RN et al. [9] found in their study, the sensitivity and specificity of MRI in tumors are 89% and 87% respectively. The sensitivity and specificity on MRI+MRS in tumors are 100% and 97% respectively.



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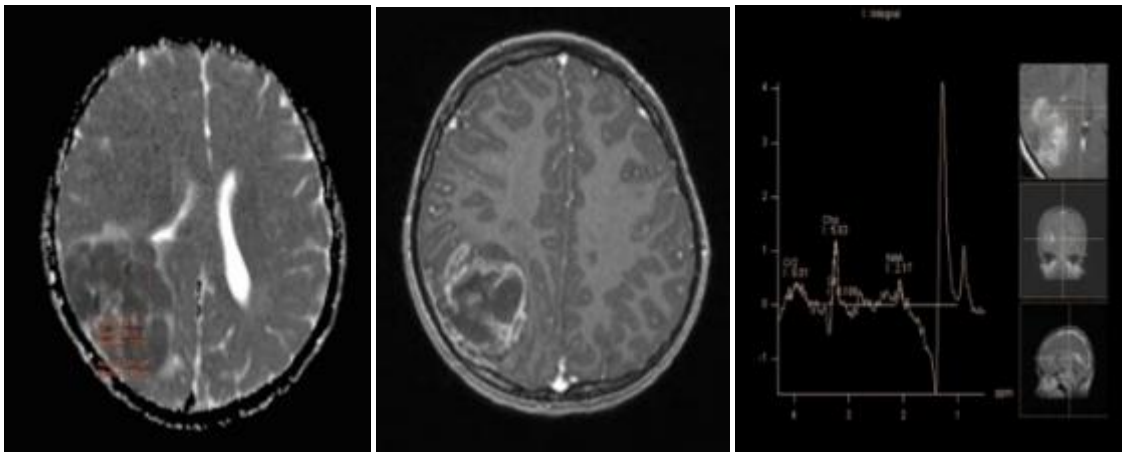
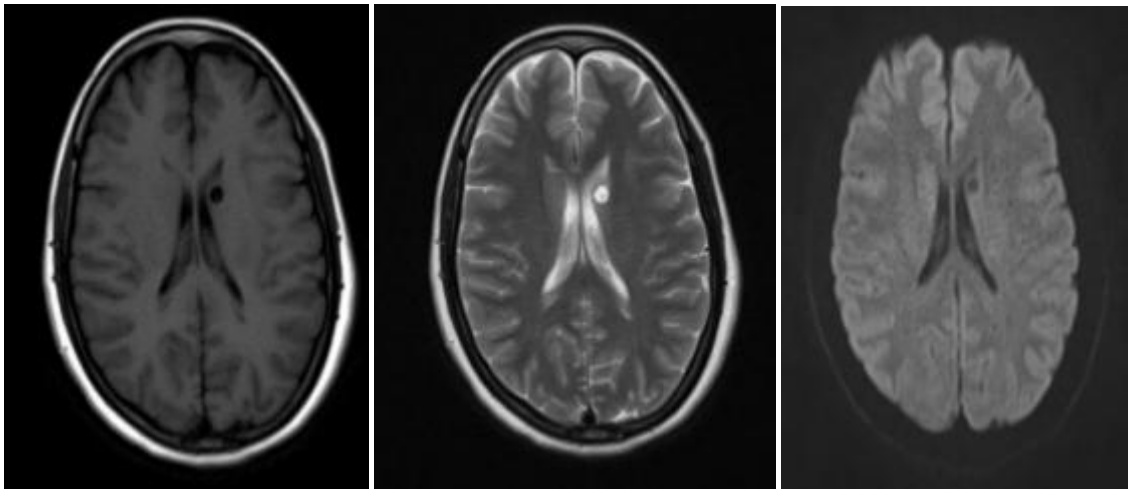


D E F

Fig.1(A-F): *Axial MRI images showing mass lesion in right parietal lobe which is hypo intense on T1WI(A), Heterogeneously iso to hyperintense on T2WI(B), showing diffusion restriction on DWI with low ADC values (C, D) and ring enhancement on T1 contrast. MR spectroscopy showing High Lipid peak, decreased NAA and Cr with mildly raised Choline(F). Imaging and spectroscopic findings are characteristics of tuberculoma.*



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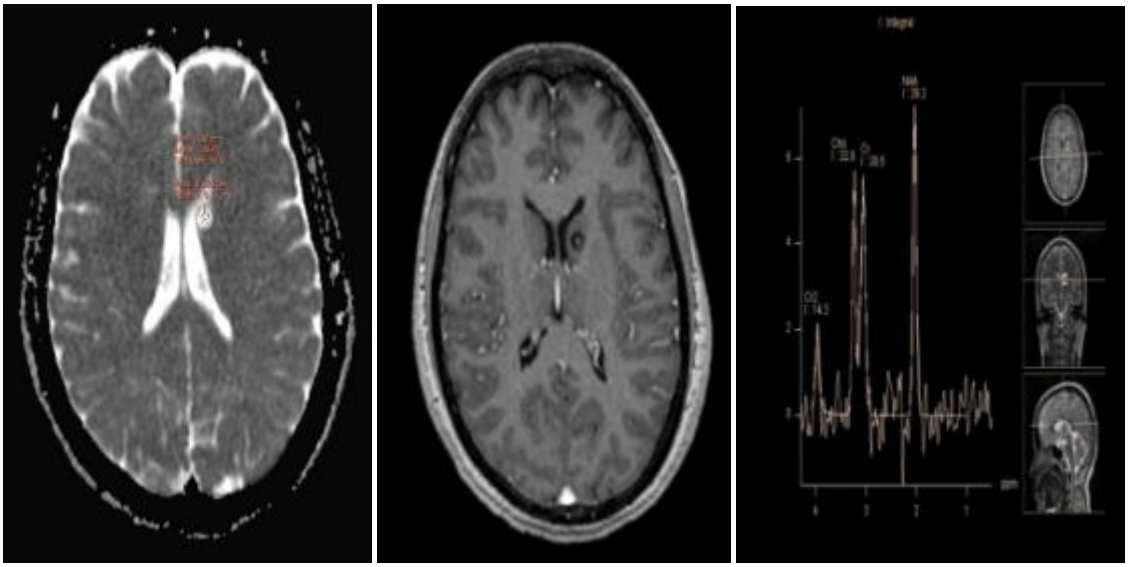
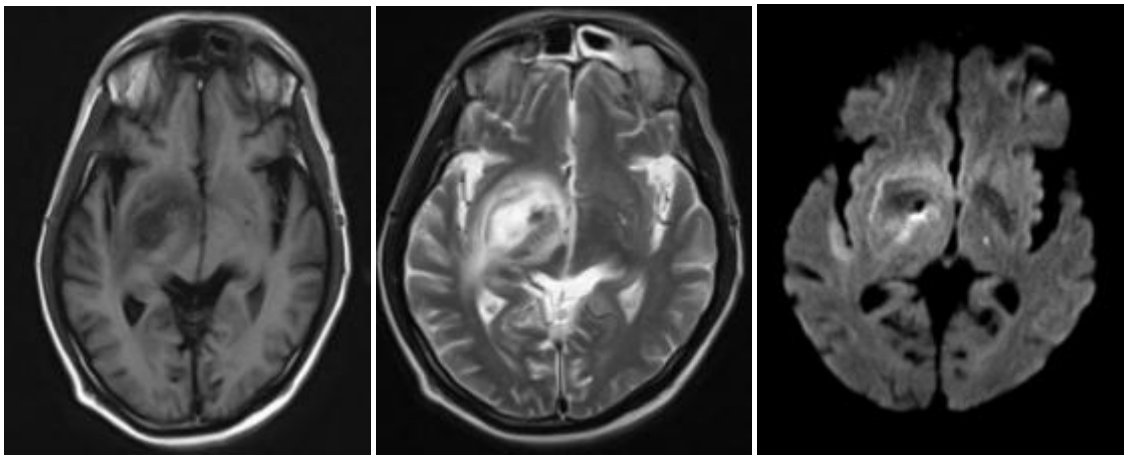


D E F

Fig. 2 (A-F): *Axial MRI images showing a well-defined small cystic lesion seen in left caudate nucleus. The lesion is hypo intense on T1 WI (A), hyper intense on T2 WI (B), no restriction on DWI and low ADC values (C, D). Post contrast T1 image showing thin smooth wall ring enhancement (E). MR spectroscopy showing elevated lactate (1.33ppm), NAA (2.0ppm) and reduced Cho, Cr (3.0ppm), Ch/Cr ratio =1(F). MR and MR spectroscopy finding suggest NCC.*



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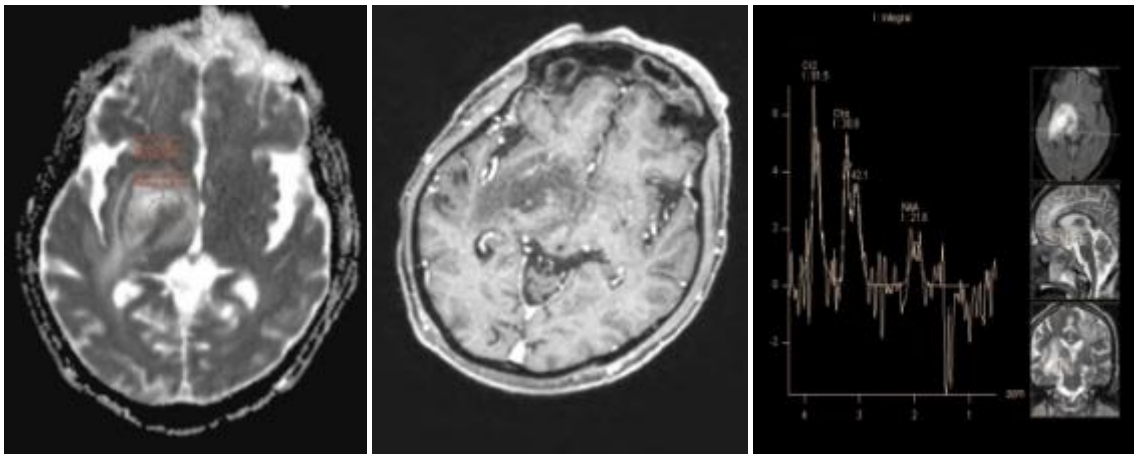

D E F

Fig.3(A-F): Axial MRI images showing a lesion in right thalamo-ganglio-capsular region which is hypo intense on T1WI(A), heterogeneously hyperechoic on T2 WI(B), mild perilesional diffusion restriction with low ADC values (C, D), thin ring enhancement on T1 contrast(E). MR Spectroscopy showing reduced NAA and increased Cr and Choline with reduced Ch/Cr and Ch/NAA ratio(F). Imaging and spectroscopic findings are suggestive of toxoplasmosis.

CONCLUSION

MRI along with MRS has emerged as the most sensitive modality in the characterization of intracranial ring enhancing lesions. MRI being non-invasive and non-radiating is an ideal imaging modality. Better inherent contrast and multi planar capability of MRI are helpful in identifying precise anatomical location and the exact extent of lesions. MRS further increases specificity and accuracy based on various metabolites leading to accurate characterization of ring enhancing lesions.

REFERENCES

1. Fauci A(2008). Harrison's Principles of Internal Medicine, New York, McGraw Hill Medical, page 3429.
2. Schwartz KM, Erickson BJ, Lucchinetti C(2006). Pattern of T2 hypointensity associated with ring-enhancing brain lesions can help to differentiate pathology. Neuroradiology; 48:143-9.
3. Mahato PS, Dabhi AS, Thorat PB(2012). Clinical and investigative profile of ring-enhancing lesions on neuroimaging. Indian J Clin Pract;22: 512-8.
4. Garg V, Ramdas GV, Bindra GS, Mittal A, Singal S, Chaudhary RK et al(2016). Evaluation of Intracranial Ring Lesions by Diffusion-Weighted Imaging and in Vivo Proton Magnetic Resonance Spectroscopy. Journal of Medical Science and Clinical Research JMSCR;4(11):13929-34.
5. Elsadway ME, Ibrahim Ali H(2018). Verification of brain ring enhancing lesions by advanced MR techniques. Alexandria journal of medicine;54(2):167-71
6. Kumar N, Narayanaswamy AS, Singh KK(1995). Ring enhancing CT lesions - a diagnostic dilemma. J Assoc Physicians India; 43(6):391-3.
7. Devgan Aaina, Singh Sohan,Gauba Neelam, Singh Arvinder, Neki N.S(2018). Role of Magnetic Resonance Imaging in evaluation ring enhancing lesions in brain. International journal of current research; Vol (3): ISSN No.2455-944X
8. RR. Archana, P. Sunil Kumar, Anurudh Kishore(2018). Role of MRI in evaluation of ring enhancing lesions of brain in correlation with MR spectroscopy. International Journal of Contemporary Medicine Surgery and Radiology; 3(4):C33-C37.
9. Solanki N. Rajendra, Shah Vidhi, Vaghela Digish, Shah Harshad(2017). Characterization of Intracranial mass lesions with in vivo Proton MR Spectroscopy. J. Evid.Based Med. Healthc;4(81):4805-4817.
10. Jayasundar R, Singh VP, Raghunathan P, Jain K, Banerji AK(1999). Inflammatory granulomas: evaluation with proton MRS NMR Biomed; 12(3):139-44.