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Radio Diagnosis

Role of Contrast Enhanced MRI to Differentiate Between Neoplastic from Non-Neoplastic Ring Enhancing Brain Lesions

Dr. Pramod Sakhi[1], Dr. Shilpi Gupta[2*], Dr Kumud Julka[1], Dr Bhavana Saraf[3]

[1]Professor, Department of Radio diagnosis, Sri Aurobindo Medical College & P.G Institute, Indore, MP, India
[2]Consultant, Department of Radio diagnosis, Sri Aurobindo Medical College & P.G Institute, Indore, MP, India
[3]Assistant professor, Department of Radio diagnosis, Sri Aurobindo Medical College & P.G Institute, Indore, MP, India

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***Corresponding author:** Dr. Shilpi Gupta
Consultant, Department of Radio diagnosis, Sri Aurobindo Medical College & P.G Institute, Indore, MP, India

Abstract **Original Research Article**

Introduction*:** Ring enhancing lesions in MRI of the brain can be caused by different pathological conditions. The common lesions are being some primary brain tumours, abscess, granuloma, resolving haematoma and infarct. Gadolinium compounds, which are paramagnetic IV contrast media for brain imaging, are especially helpful for identification of extra-axial tumours and intra-axial lesions associated with disrupted blood-brain barrier. The enhancing ring of an abscess is usually thinner and more uniform than that found in the neoplasm. Granulomatous abscesses tend to have a thicker ring than pyogenic abscesses and have less surrounding edema. Demyelinating disorders revealed nodular pattern and incomplete ring-enhancing pattern. Infarcts often show gyral enhancement. Enhancement is uniform in immune competent patients while ring-like in immunocompromised patients. Tuberculomas on contrast administration appear as nodular or ring-like enhancing lesions. ***Aims: To evaluate the role of magnetic resonance imaging in distinguishing neoplastic from non-neoplastic ring enhancing brain lesions. ***Material and methods***: Forty patients with various ring enhancing lesions in the brain were detected by MRI. The age range of the patients was 13 to 63 years. Routine sequences of T1, T2 and FLAIR spin echo sequences with IV contrast were carried out. Signal intensities on unenhanced T1- and T2- weighted images for enhanced and unenhanced solid portions, enhancement patterns, margins, cortical involvement, mass effect, and presence of vasogenic edema were studied. ***Result*** : MRI showed 20% of cases were non-neoplastic ring enhancing brain lesions in comparison with 25% revealed by histopathology.65% cases diagnosed by MRI as neoplastic ring enhancing brain lesions in comparison with =75% cases revealed by histopathology. Sensitivity of MRI in the detection of secondary neoplastic ring enhancing brain lesions was 80% and specificity was 81.8%. Percentage of primary brain tumor revealed by MRI was 60% while histopathological result was 67%. Sensitivity of MRI in the detection of primary neoplastic ring enhancing brain lesions was 81.8% and specificity was 66.6%. Accuracy of MRI in differentiation between primary and secondary ring enhancing brain lesions was 65%. ***Conclusion***: Ring enhancing brain lesions were accurate in acceptable percentage in narrowing differential diagnosis and illustrating causes of these lesions. The accuracy of differentiation the neoplastic from non-neoplastic ring enhancing brain lesions was 85%. The new imaging modalities very important to give final result in the differentiation of ring enhancing brain lesions include diffusion-perfusion weighted MRI, functional MRI and nuclear imaging.

Keywords: MRI, Ring Enhancing Lesion, Abscess, Neoplastic, Glioblastoma Multiformis, Gadolinium, Metastasis.

INTRODUCTION

Ring enhancing lesions in MRI of the brain can be caused by different pathological conditions. The common lesions being some primary brain tumours, abscess, granuloma, resolving haematoma and infarct. Less common conditions being thrombosed vascular malformation and demyelinating disease such as Multiple Sclerosis. Uncommon causes being thrombosed aneurysm and other primary brain tumours such as primary CNS lymphoma in AIDS etc [1]. Routine MRI studies of the brain are performed in T1 and T2 axial planes and either T1 sagittal or T2 coronal planes. Slices that are 5 to 10 mm thick are routinely used, but thinner slices with 2- to 4-mm thickness are needed in the evaluation of sellar and posterior fossa regions. Gadolinium compounds, which are paramagnetic IV contrast media for brain imaging, are especially helpful for identification of extra- axial tumours and intra-axial lesions associated with

disrupted blood-brain barrier. The regular dose is about 0.1 mmol/kg of body weight, but in a case with equivocal findings or solitary metastasis, a dose of 0.2 to 0.3 mmol/kg of body weight is advisable [2, 3]. Enhancement suggests breakdown of the blood-brain barrier.

Metastatic tumors are the most common intracranial neoplasm in adults. Lung cancer, breast cancer and melanoma account for the majority of patients with metastasis in the brain. Metastatic lesions are typically subcortical, occurring in or near the grey - white matter junction, and are usually associated with severe perilesional edema. MRI typically reveals mild T1 hypo intensity with T2 hyper intensity and fluid-attenuated inversion recovery hyperintensity at the site of the lesion. After contrast administration, a nodular ring pattern of enhancement is seen. By MR spectroscopy diagnostic accuracy in differentiating similar appearing brain lesions ranges from 85-92% and when combined with conventional MR imaging and DW imaging diagnostic accuracy 97.7%, sensitivity 95.2% and specificity 100% [4].

Gliomas represent 40% to 45% of all intracranial tumors. Glioblastoma multiforme (GBM) (WHO grade IV) is the most common primary tumor of the CNS, accounting for more than half of all intracranial gliomas [5]. As their name implies, these highly malignant tumors have a variegated histologic appearance with interspersed areas of hypercellularity, cellular pleomorphism, endothelial proliferation, and intratumoral necrosis [6]. Virtually all glioblastoma are associated with edema in the surrounding peritumoral white matter, usually graded as moderate or severe [7-9]. Tumour necrosis is a hallmark of GBM and appears on MRI as areas of non-enhancing T1 hypointensity. Intratumoural haemorrhage contributes to the heterogeneous MR appearance of GBM with areas of high signal on T1W images and low signal on T2W images.

Brain abscess is caused by inflammation and collection of infected material, coming from local (like ear infection) or remote (ex; lung, heart, kidney) infectious sources, within the brain tissue [10]. The enhancing ring of an abscess is usually thinner and more uniform than that found in the neoplasm. Granulomatous abscesses tend to have a thicker ring than pyogenic abscesses and have less surrounding edema. Infarcts often show gyral enhancement, occasionally mimicking ring enhancement. Resolving hematoma may have a dense centre with ring like enhancement and much less surrounding edema [11-13]. In demyelinating disorders, multiple enhancing ring lesions are encountered in several acute demyelinating disorders. Most of them demonstrate a nodular pattern. Some of them demonstrate incomplete ring-enhancing pattern [14].

Radiation necrosis is a late complication of radiotherapy or gamma knife surgery, and can present as an enhancing mass lesion difficult to distinguish from recurrent tumor on conventional imaging [15]. Primary cerebral lymphoma (PCL) has tripled in incidence over the past 2 decades. This is partly due to a rise in patients with AIDS but PCL has also increased in immunocompetent patients. PCL appears as a single (less frequently multiple) lobulated enhancing mass, often abutting an ependymal or meningeal surface and involving basal nuclei. Enhancement is uniform in immunocompetent patients and ring-like in immunocompromised patients, in whom PCL frequently contains areas of central necrosis [16].

Tuberculomas are frequently encountered brain lesions in tropical countries. Intracranial tuberculoma can occur with or without tuberculous meningitis. A non-caseating tuberculoma usually appears Hyperintense on T2- weighted and slightly hypointense on T1-weighted images. A caseating tuberculoma appears iso- to Hypointense on both T1-weighted and T2-weighted images, with an iso- to Hyperintense rim on T2- weighted images. Tuberculomas on contrast administration appear as nodular or ring-like enhancing lesions [17].

AIM

To evaluate the role of magnetic resonance imaging in distinguishing neoplastic from non-neoplastic ring enhancing brain lesions.

MATERIAL AND METHODS

Forty patients with various ring enhancing lesions in the brain were detected by MRI between May 2022 to March 2023. The age range of the patients was 13 to 63 years. Descriptive statistics for the entire group include age, sex and prevalence of each brain ring enhancing lesion. The statistical indices used were sensitivity, specificity and accuracy on MRI and were compared with that obtained by histopathology. MR imaging was performed with MRI of (Seimens 1.5 Tesla MR). Routine sequences of T1, T2 and FLAIR spin echo sequences with IV contrast were carried out. Signal intensities on unenhanced T1- and T2- weighted images for enhanced and unenhanced solid portions, enhancement patterns, margins, cortical involvement, mass effect, and presence of vasogenic edema were studied.

RESULTS

This study appeared among forty cases, the MRI with contrast revealed 8 cases of non-neoplastic ring enhancing brain lesions and 26 cases as neoplastic brain lesions, compared with histopathological study that revealed 10 cases of non-neoplastic lesions and 30 cases as neoplastic lesions. (Table 1).

Table 1: Distribution of ring enhancing brain lesions according to MRI & histopathological findings

Modality	Non- neoplastic	%	Neoplastic	%	No definitive Diagnosis
MRI	8	20%	26	65%	6 [15%]
Histopathology	10	25%	30	75%	

MRI showed 20% of cases were non-neoplastic ring enhancing brain lesions in comparison with 25% revealed by histopathology. 26 cases (65%) diagnosed by MRI as neoplastic ring enhancing brain lesions in comparison with 30 cases (75%) revealed by histopathology.

Table 2: Neoplastic cases by MRI compared with histopathological results

Neoplastic	Primary brain tumor	%	Metastasis	%
MRI	18	60%	8	26%
Histopathology	20	67%	10	33%

Sensitivity of MRI in the detection of secondary neoplastic ring enhancing brain lesions was 80% and specificity was 81.8%. Percentage of primary brain tumor (Glioblastoma multiform) revealed by MRI was 60% while histopathological result was 67%. Sensitivity of MRI in the detection of primary neoplastic ring enhancing brain lesions was 81.8% and specificity was 66.6%. Accuracy of MRI in differentiation between primary and secondary ring enhancing brain lesions was 65%.

Table 3: distribution of non-neoplastic cases according to the causes

Non-neoplastic	Abscess	Hematoma	Radiation necrosis
MRI	6	2	
Histopathology/ clinical follow-up	6	2	2

This study illustrated the causes of non-neoplastic ring enhancing brain lesions diagnosed by MRI were 8 cases as following: 6 cases of abscess, 2 cases resolving haematoma. Follow up, histopathological and clinical findings results revealed 10 cases of non-neoplastic brain lesions as 6 cases of pyogenic abscess, 2 cases of resolving haematoma and 2 cases radiation necrosis.

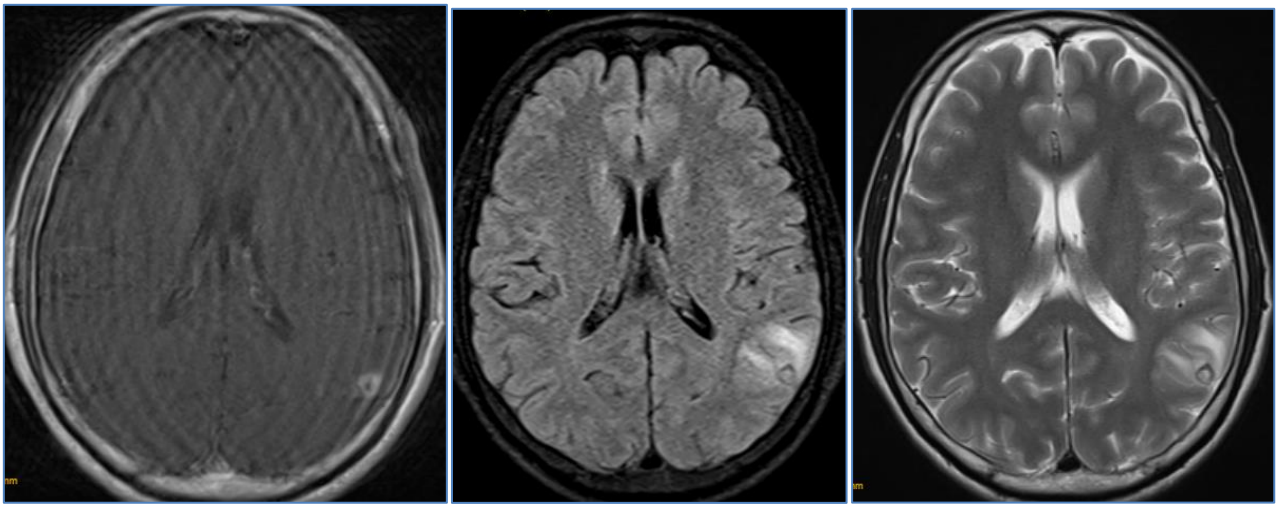

Fig. 1: T1 C+, FLAIR, T2WI MRI images respectively showing Tuberculoma.

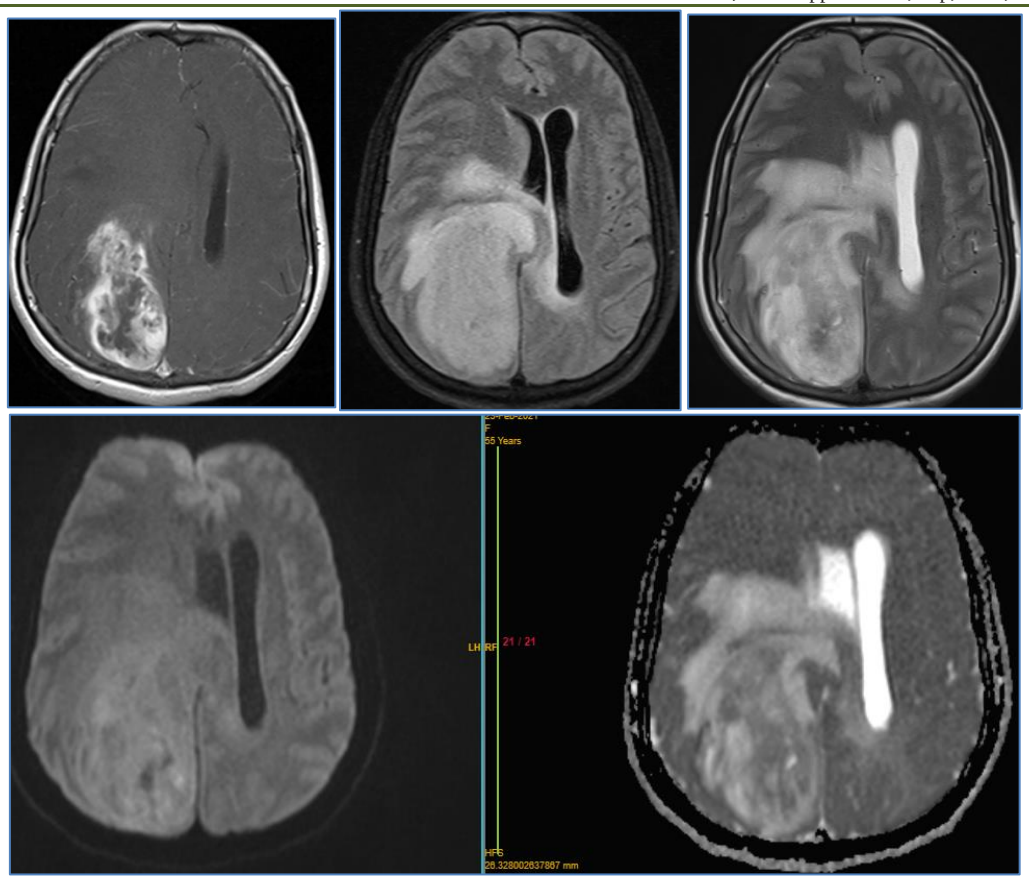

Fig 2: T1 C+, FLAIR, T2WI, DWI/ ADC MRI images respectively showing Glioblastoma Multiforme.

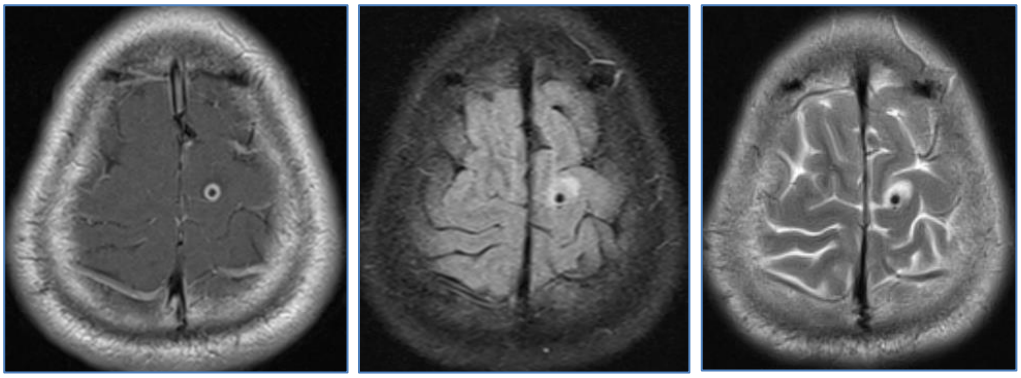

Fig 3: T1 C+, FLAIR, T2WI MRI images respectively showing calcified Neurocysticercosis.

DISCUSSION

This study revealed that among the fourty cases of ring enhancing lesion 8 cases were diagnosed by MRI (20%) as non- neoplastic ring enhancing brain lesion, compared with 10 cases diagnosed as non-neoplastic lesions by histopathology (25%). 26 cases diagnosed as neoplastic ring enhancing brain lesions by MRI (65%), compared with 30 cases diagnosed as non-neoplastic lesions by histopathology (75%). MRI according to this percentage revealed sensitivity 80% and specificity 86.6% in detection of non-neoplastic lesions. Sensitivity of MRI in detection of neoplastic ring enhancing brain lesions was 86.6% and specificity was 80%. Accuracy of MRI in differentiation of neoplastic ring enhancing brain lesions from non-neoplastic lesions was 85%. Study by Ronald L. Wolf who used a strategy was on the basis of conventional MR imaging, diffusion-weighted MR imaging, perfusion MR imaging, and proton MR spectroscopy to classify intra axial masses, the accuracy and sensitivity of the strategy, were 90% and 97% respectively for discrimination of neoplastic from non-neoplastic diseases. [18], another study done by Sarah. H. O'Connell revealed Conventional MR Imaging: Diagnostic accuracy 61.4%, Sensitivity 61.9% and specificity 60.9%. By MR spectroscopy diagnostic accuracy in differentiating similar appearing brain lesions ranges from 85-92% and when combined with conventional MR imaging and DW imaging diagnostic

accuracy 97.7%, sensitivity 95.2% and specificity 100% [4]. Other studies which used positron emission tomography (PET) can provide dynamic information regarding the metabolism of a lesion, which may be useful for differentiating tumors from abscesses**,** sensitivity in this modality reaches to 90% [19, 20].

This study revealed 65% of cases as neoplastic cause of ring enhancing brain lesions, while histopathology revealed 75%. In comparison with another study by K. M. Schwartz, B. J. Erickson and C. Lucchinetti that revealed 70% were neoplastic depending on the T2 weighted pattern. Study by S. H. O'Connell also revealed 70% of cases were neoplastic**.** Therefore, the results of those studies were relatively similar to this study. By MRI, the metastases represent 26% of neoplastic ring enhancing intracranial lesions, and primary tumour (glioma) represents 60%. Sensitivity of MRI in the detection of secondary neoplastic ring enhancing brain lesions was 80% and specificity was 81.8%. Sensitivity of MRI in the detection of primary neoplastic ring enhancing brain lesions was 81.8% and specificity was 66.6%. The accuracy of MRI in differentiation between primary from secondary ring enhancing brain lesions was 65%. Other two studies by K. M. Schwartz, B. J. Erickson and C. Lucchinetti [21]. And S. H. O'Connell revealed 40% gliomas, 30% metastases, these results also were very close to our results. This study revealed 10% of cases as abscesses, while the other two studies by K. M. Schwartz, B. J. Erickson and C. Lucchinetti and S. H. O'Connel**l** revealed 8% of ring enhancing brain lesions were abscesses.

CONCLUSION

1-This study that depended on magnetic resonance imaging with contrast in evaluation of ring enhancing brain lesions was accurate in acceptable percentage in narrowing differential diagnosis and illustrating causes of these lesions.

2-The accuracy of differentiation the neoplastic from non-neoplastic ring enhancing brain lesions was 85% and histopathology stills the standard reference in doubtful cases.

3-The new imaging modalities very important to give final result in the differentiation of ring enhancing brain lesions include diffusion-perfusion weighted MRI, functional MRI and nuclear imaging.

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