Diagnostic accuracy of contrast enhanced magnetic resonance imaging in ring enhancing brain lesions: A correlative study

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Abstract

Background: Ring enhancing brain lesions (REBL) are commonly encountered in the routine diagnostic radiology practice. Contrast Enhanced Magnetic Resonance Imaging (CEMRI) is the usual imaging modality involved in the diagnosis of REBL. However, the diagnostic accuracy of CEMRI in REBL is still not evaluated extensively. This is mainly due to the lack of clinical follow up of patients diagnosed with REBL. **Objectives:** This study aims to calculate the diagnostic accuracy of CEMRI in ring enhancing brain lesions by close follow up of clinical progression and final diagnosis of the condition and correlating it with the CEMRI findings. **Materials and Method:** This study is based on hundred consecutive cases from the archive of our department and the follow up obtained using clinical, histopathological or serological data from the Medical Records Department of our hospital. The findings were analyzed using simple statistical methods and parameters were obtained to calculate the diagnostic accuracy of CEMRI. **Results:** Based on our study REBLs showed a male predominance. The diagnostic accuracy of CEMRI for ring enhancing brain lesions is 96.5%. Most common REBL is tuberculoma, followed by neurocysticerosis. The sensitivity, specificity, positive and negative predictive values and diagnostic accuracy of CEMRI in each REBL were identified separately. In our study CEMRI has got the greatest diagnostic accuracy in metastasis (98.1%) and least with tuberculoma (92.6%). **Conclusion:** In our study CEMRI shows a good diagnostic accuracy in the diagnosis of REBL. CEMRI may be considered as an ideal modality with good accuracy rate, to diagnose ring enhancing brain lesions in the present scenario.
Keywords: Ring enhancing brain lesions, Diagnostic accuracy, Magnetic resonance imaging, Tuberculoma, Metastasis, Neurocysticercosis.

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INTRODUCTION

Ring enhancing lesions (REBLs) in the brain due to various causes are commonly encountered in the daily practice of diagnostic radiology. Contrast enhanced magnetic resonance imaging (CEMRI) is the current investigation of choice for the diagnosis of ring enhancing brain lesions[1]. The various causes of ring enhancing brain lesions are depicted in the table 1[2].

Table 1: Causes of multiple ring enhancing lesions of the brain[2]

Bacterial	Parasitic
Pyogenic abscess	Neurocysticercosis
Tubercuoma and tuberculous abscess	Toxoplasmosis
Mycobacterium avium-intercellulare infection	Amoebic brain abscess
Syphillis	Echinococcosis
Listeriosis	Cerebral sparganosis
Fungal	Chagas' disease
Cryptococcosis	**Neoplastic**
Actinomycosis	Metastasis
Nocardiosis	Primary brain tumour
Zygomycosis	Primary CNS lymphoma
	Inflammatory and Demyelinating
Histoplasmosis	
Coccidiodomycosis	Multiple sclerosis

Aspergillosis	Acute disseminated encephalomyelitis
Mucormycosis	Sarcoidosis
Rhodococcosis	Neuro-Behcet's disease
Paracoccidioidomycosis	Whipple's disease
	Systemic Lupus Erythematosus

On neuroimaging, these lesions appear as hypodense or isodense mass lesions on non-contrast computed tomography studies. After contrast administration, there is a ring- or a homogeneous disk-like enhancement within the region of hypodensity (which could represent perilesional edema). MRI shows varied signal intensity patterns on T1 and T2 weighted sequences, including high signal on diffusion weighted images[4] depending on the etiology and ring like enhancement on post contrast images[3]. The enhancing lesions are often of variable size and are usually surrounded by a varying amount of perifocal vasogenic edema[4]. Typically, the ring-enhancing lesions are located at the junction of the gray and white matter, but they could be located in the sub-cortical area, deep in the brain parenchyma or may even be superficial.[2] CEMRI serves as a versatile imaging modality in this regard[5]. Variety of appearance of ring enhancing lesions depending on its etiology, in CEMRI aids in narrowing down the differentials[6]. However, the diagnostic accuracy of CEMRI in ring enhancing brain lesions based on clinical follow up is not extensively investigated. This study aims to identify the various causes of REBL, its gender predominance and most importantly the diagnostic accuracy of CEMRI in the diagnosis of various REBL. The findings in the study would help in better understanding of utility of CEMRI in REBL and its weak points.

MATERIAL AND METHODS

This was a retrospective descriptive study. All the patients were referred to the Department of Radiology at our hospital for Contrast Enhanced MRI brain and the data was archived in the PACS of our department. The study was conducted during the period of 2013-2014. A total of 100 consecutive patients of all ages and both sexes, with ring enhancing intracranial lesions detected on MR imaging with clinical/imaging follow up were included in the study. All the MRI scans in this study were performed using 1.5 T MRI scanner (Signa HDxt, GE Medical systems, Milwaukee, USA). A head coil was used and the MRI protocol consisted of axial diffusion weighted images, sagittal T1W images and axial T2W, T2W FLAIR and T2*GRE images of the brain apart from axial T1W post contrast images. The images were reported by a team of experienced radiologists in our department. These patients were followed up for the confirmation of diagnosis. Histopathological or serological evidence like CSF antigen as in the case of neurocysticercosis were obtained. Resolution of the lesion on treatment as evident on follow up imaging studies were also considered as diagnosis confirmation. In cases were differential diagnosis was given in the MRI report, the first differential is assumed as MRI diagnosis. Statistical analysis was done using SPSS software. Sensitivity, specificity, positive predictive and negative predictive values were extracted from 2×2 contingency tables of results.[7]

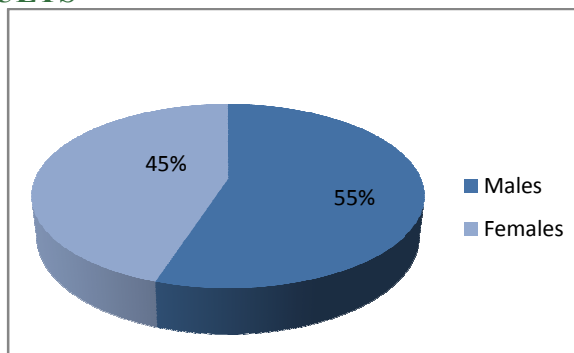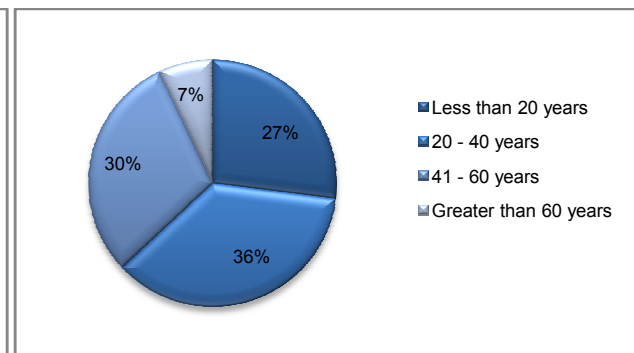## RESULTS

Figure 1: Gender Distribution

Figure 2: Age Distribution

A total of hundred patients who underwent MRI in our department were considered for the study. The age of the patients with REBLs studied ranged from 3 to 75 years. 55 (55%) were males and 45 (45%) were males (fig.1). Four age groups were formed for convenient statistical analysis viz. (1) Less than 20 years, (2) 20 to 40 years, (3) 41 to 60 years and (4) Greater than 60 years. The age distribution of patients in our study is as depicted in figure 2. Maximum number of patients were in the age group of 20-40 years (36%) and least in the age group of greater than 60 years (7%).

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Table 2: Spectrum of ring enhancing brain lesions in this study

Lesion	No. of confirmed cases
Tuberculoma	55
Neurocyticercosis	29
Metastasis	13
Pyogenic Abscess	1
CNS Lymphoma	1
Cavernoma	1

The final diagnosis-confirmed cases in the study group is as described in table 2, with tuberculoma forming the maximum number of cases (55%) followed by neurocysticercosis (29%) and metastasis (13%).
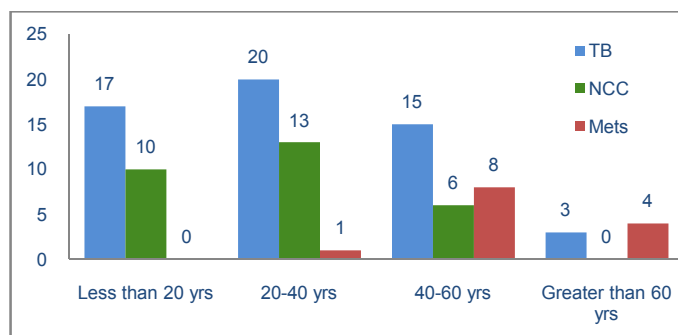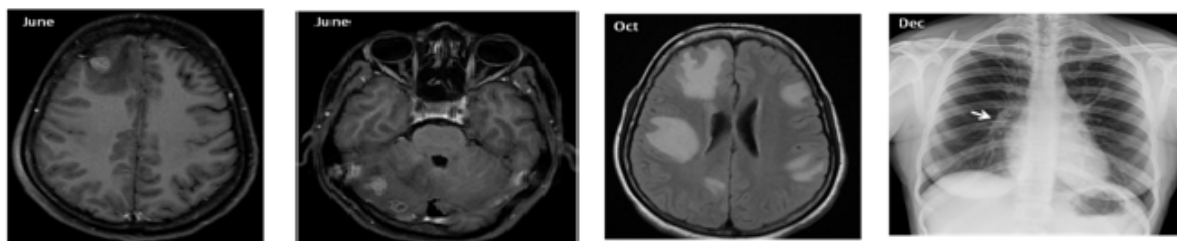

Figure 3: Age distribution of various ring enhancing brain lesions

Age distribution of various ring enhancing brain lesions are as shown in figure 3. Tuberculosis and NCC were seen maximum in the age group of 20-40 years (59.0 % and 38.0 %, respectively). Metastasis was seen most in the age group greater than 60 years (58.0 %). The sensitivity, specificity, Negative and Positive predictive values and accuracy of MRI for tuberculoma, NCC and metastasis were analyzed (table 3).

Table 3: Statistical measures of performance for MRI in various ring enhancing brain lesions

REBL	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Tuberculoma	94.8	90.0	91.7	93.8	92.6
Neurocysticercosis	98.2	96.0	90.7	94.8	97.1
Metastasis	86.8	100	100	97.7	98.1

MRI was most sensitive in diagnosis of neurcysticercosis and was most specific in case of metastasis. Metastasis was the most frequent lesion misdiagnosed as tuberculoma. Most common lesion misdiagnosed as neurocysticercosis was tuberculoma. **The overall accuracy of MRI in the diagnosis of ring enhancing brain lesions was derived as 96.5 %.**

Figure 4: 35 yr old lady presented with fever and headache, started on ATT elsewhere. Initial MRI (figures a and b) – tuberculomas. Follow up MRI after 5 months (fig 3c) shows increased no of lesions – possibilities given - MDR TB in view of poor response to ATT or metastasis. Chest radiograph (fig 3d) shows subtle right hilar prominence (arrow). Histopathology of brain lesion revealed metastatic adenocarcinoma with the immunoprofile favouring a primary lung adenocarcinoma.
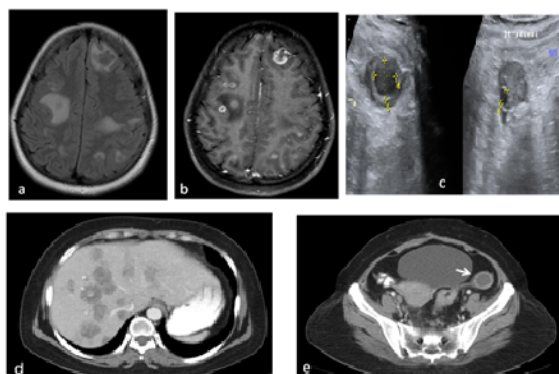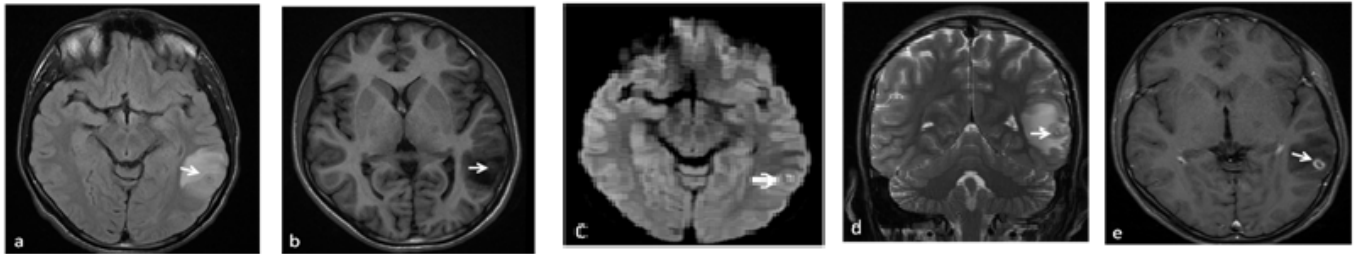

Figure 5: 34 yr old lady with headache and vomiting and altered sensorium. T2 FLAIR (a) and T1 post contrast (b) images show multiple intraparenchymal ring enhancing lesions in the bilateral cerebral hemispheres MRI reported as suggestive of Tuberculomas with differential of multiple metastases. Ultrasound of left adnexa (c) revealed a thick walled cystic lesion. Axial post contrast CT of abdomen (d) and pelvis (e) show multiple liver metastasis and the left ovarian lesion.

Figure 6: 25 yr old male with new onset seizures. Axial T2 FLAIR (a), T1 FLAIR (b) and coronal T2 FRFSE (c) images show left inferior temporal focal edema and a well defined thick walled lesion with T2 hyperintense and T1 hypointense center and T1 hyperintense and T2 hypointense periphery showing central restriction on DWI (c). The lesion shows thick ring enhancement on post contrast T1 image (e). MRI was reported as ?tuberculoma in view of thick enhancing wall and central diffusion restriction. However, CSF antigen for neurocysticercosis were positive and the patient responded to albendazole therapy
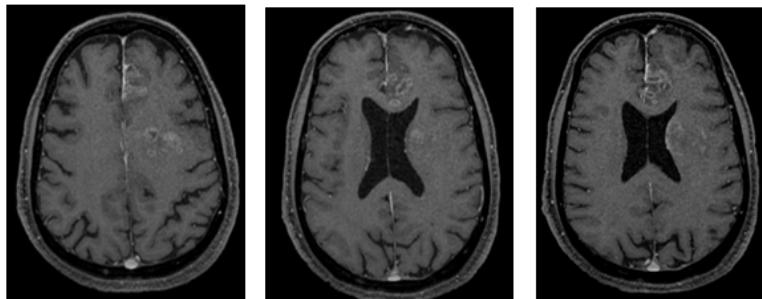

Figure 7: 65 year old male presented with seizures: Left frontal ill defined confluent ring enhancing lesions with adjacent leptomeningeal enhancement. TB Vs mets with leptomeningeal spread was given as possibilities on MRI. The lesion turned out to be as metastasis from adenocarcinoma lung

DISCUSSION

Most common ring enhancing lesion encountered was tuberculoma (55.0 %) followed by NCC (29.0%) and metastasis (13.0%). This is in correlation with various similar studies like that of Seth R *et al*[8] where they found that tuberculomas and neurocysticercosis comprises majority of REBLs in MRI. Infective processes like tuberculomas and NCC were found common in younger age group[9] where as metastasis was more common in older age group[10]. Accuracy rate for CEMRI was maximum for metastasis (98.0 %) followed by NCC (97.0 %) and tuberculoma (92.0%). CEMRI showed good sensitivity and specificity in the diagnosis of ring enhancing lesions. CEMRI showed reduced sensitivity in case of metastasis (86%). These findings are similar to that of the conclusions made by Behin A *et al*[10] and Sze G *et al*[11] where CEMRI was considered as superior modality to detect ring enhancing brain lesions including metastasis. Most common misdiagnosis by CEMRI encountered in this study was 'diagnosing' metastasis as tuberculoma.[12] This is in correlation with study conducted by Chatterjee S *et al*[13] where they hypothesized that the use of diffusion and perfusion MRI would make differentiation of both tuberculoma and metastasis as these two pathologies can manifest as solitary or multiple ring-enhancing intra-axial lesions that are difficult to differentiate by conventional magnetic resonance imaging. In our study also CEMRI showed difficulty in differentiating tuberculoma Vs neurocysticercosis as in various other studies in the literature. Garg *et al*[14] reported a case of CNS tuberculosis presenting as neurocysticercosis.

Limitations

Histopathological diagnosis was not available for all the cases in this study. Those cases with no final histopathological diagnosis were followed up for response to treatment and thus final diagnosis is assumed. MRI diagnosis is subjective in some cases and is dependent on the competence of the radiologist.

CONCLUSION

Ring enhancing brain lesions are common in India, especially in the background of tuberculosis. However, neurocysticercosis and metastasis also contribute to number of ring enhancing lesions encountered in the daily practice. Ring enhancing lesions of brain show male predominance. Infective lesions like tuberculosis and NCC are more common in younger age group, while metastasis is predominantly seen in the elderly. Even though there are instances of erroneous outcome contrast enhanced MRI is the most accurate tool for ring enhancing brain lesions in the current diagnostic armamentarium. Hence CEMRI may be considered as an

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ideal modality with good accuracy rate, to diagnose ring enhancing brain lesions.

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REFERENCES

1. Omuro AM, Leite CC, Mokhtari K, Delattre JY. Pitfalls in the diagnosis of brain tumours. Lancet Neurol 2006; 5:937-48.
2. Garg RK, Desai P, Kar M, Kar AM. Multiple ring enhancing brain lesions on computed tomography: an Indian perspective. J Neurol Sci 2008; 266:92-6.
3. Cunliffe CH, Fischer I, Monoky D, Law M, Revercomb C, Elrich S, et al. Intracranial lesions mimicking neoplasms. Arch Pathol Lab Med 2009; 133:101-23.
4. Schwartz KM, Erickson BJ, Lucchinetti C. Pattern of T2 hypointensity associated with ring-enhancing brain lesions can help to differentiate pathology. Neuroradiology 2006; 48:143-9.
5. Smirniotopoulos JG, Murphy FM, Rushing EJ, Rees JH, Schroeder JW. Patterns of contrast enhancement in the brain and meninges. Radiographics 2007; 27:525-51.
6. Luthra G, Parihar A, Nath K, Jaiswal S, Prasad KN, Husain N, et al. Comparative evaluation of fungal, tubercular, and pyogenic brain abscesses with conventional and diffusion MR imaging and proton MR spectroscopy. AJNR Am J Neuroradiol 2007; 28:1332-8.
7. Parikh R, Mathai A, Parikh S, Chandra Sekhar G, Thomas R. Understanding and using sensitivity, specificity and predictive values. Indian J Ophtalmol. 2008; 56:45–50.
8. Seth R, Kalra V, Sharma U, Jagannathan N. Magnetic resonance spectroscopy in ring enhancing lesions. Indian Pediatrics. 2010; 47(9):803–4.
9. Nussbaum ES, Djalilian HR, Cho KH, Hall WA. Brain metastases. Histology, multiplicity, surgery, and survival. Cancer. 1996;78:1781–8
10. Behin A, Hoang–Xuan K, Carpentier AF, Delattre JY. Primary brain tumours in adults. Lancet.2003; 361:323–31.
11. Sze G, Milano E, Johnson C, Heier L. Detection of brain metastases: comparison of contrast-enhanced MR with unenhanced MR and enhanced CT. AJNR Am J Neuroradiol. 1990; 11:785–91.
12. Kastrup O, Wanke I, Maschke M. Neuroimaging of infections of the central nervous system. Semin Neurol 2008; 28:511-22.
13. Chatterjee S, Saini J, Kesavadas C, Arvinda HR, Jolappara M, Gupta AK. Differentiation of tubercular infection and metastasis presenting as ring enhancing lesion by diffusion and perfusion magnetic resonance imaging. Journal of Neuroradiology. July 2010; 37(3):167-171.
14. Garg RK, Kar Am, Kumar T. Neurocysticercosis like presentation in a case of CNS tuberculosis. Neurology India. 48:260-262.