# A study to find the characteristic imaging findings of various ring-enhancing lesions using MR imaging

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DOI: https://doi.org/10.17511/ijmrr.2020.i02.04

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**Introduction:** Multiple ring-enhancing lesions are one of the most commonly encountered neuroimaging abnormalities. A study was conducted to find the characteristic imaging findings of various ring-enhancing lesions on MRI. **Materials and Methods:** It was a prospective study conducted in the department of radiodiagnosis, GSL Medical College. All age groups of both gender with cerebral ring-enhancing lesions detected in contrast MR studies were taken up for spectroscopy. Patients with a history of claustrophobia and individuals with metallic implants insertion, cardiac pacemakers, and metallic foreign body in situ were excluded. The MRI scan was performed MRI PHILIPS ACHIEVA HDxt 1.5 T, the active shielded superconducting magnet of 1.5telsa magnetic field using SENSE coils for the acquisition of images. **Results:** Out of 30 study participants, under <45 years category tuberculoma was the common (37%) lesion whereas in >45 years category metastases was common (15%), 44% were female and 56% were males. Depicts T1 signal intensity showed hypointense signal intensity on T1W sequence in 65 (95.5%) cases. Only 4.6% of cases showed isointense signal intensity on T1W image. T2 signal intensity in 73.5% of cases showed hyperintense signal intensity. **Conclusions:** MRI is an excellent, non-ionizing imaging modality with multiplanar imaging capabilities for excellent grey-white matter differentiation.

**Keywords:** Lesion, Participant, Gender, Age

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| Indra Neil Mekala, Assistant Professor, Department of Radiodiagnosis, GSL Medical College, Rajahmundry, Andhra Pradesh, India. Email: gslcentralresearchlab@gmail.com | Ramachandra V, Mekala IN, Mataparthy AC, Chandra TJ. A study to find the characteristic imaging findings of various ring-enhancing lesions using MR imaging. Int J Med Res Rev. 2020;8(2):159-163. Available From https://ijmrr.medresearch.in/index.php/ijmrr/article/view/1171 | |

# Introduction

Multiple ring-enhancing lesions are one of the most commonly encountered neuroimaging abnormalities. Widely available imaging Techniques, computed tomography (CT) and magnetic resonance imaging (MRI) are used to detect these lesions. A wide range of etiologies may present as cerebral multiple ring-enhancing lesions [1,2]. On neuroimaging, these lesions appear as

Hypodense or isodense mass lesions on non-contrast CT studies. After contrast administration, there is a ring or a homogeneous disk-like enhancement within the region of hypodensity. The enhancing lesions are often of variable sizes and are usually surrounded by varying amounts of vasogenic edema. 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 [3]. Magnetic resonance spectroscopy (MRS) provides information about the possible extent and nature of changes on a routine MRI scan by analyzing the presence and / or ratio of tissue metabolites such as NAA, creatine, choline, and lactate etc. Widespread usage of faster MRS applications with a higher signal-to-noise ratio (SNR) and spatial resolution, allows us to detect functional metabolic changes, which provides more data to understand the exact nature of the tumor and the morphological and physiological changes occurring in surrounding brain parenchyma. Longitudinal studies have demonstrated that HMRS is useful in monitoring disease progression and treatment effects. MR spectroscopy also has a prognostic implication [4]. With these as the study was conducted with an aim to find the characteristic imaging findings of various ring-enhancing lesions on MRI.

## Materials and Methods

**Setting:** The study was conducted in the department of radiodiagnosis, GSL Medical College, Rajahmundry.

**Study period and study design:** Study was conducted from January 2014 to December 2014. It was a Hospital-based It was a prospective study.

**Study method:** Random sampling was considered in this study.

**Inclusion criteria:** All the age groups of both gender with cerebral ring-enhancing lesions detected in contrast MR studies were taken up for spectroscopy. All patients with incidentally diagnosed ring-enhancing lesions by CT.

**Exclusion criteria:** Patients with a history of claustrophobia and individuals with metallic implants insertion, cardiac pacemakers, and metallic foreign body in situ were excluded from the study.

**Study population:** Patients of both gender of all age groups who were referred to the department of Radiodiagnosis with clinically suspected and identified on neuroimaging of cerebral ring-enhancing lesions.

**Ethical issue:** The study protocol was approved by the institutional ethics committee.

All those patients who were included in the study were provided with a consent form in the local language and patients were explained about the diagnostic modalities. Written consent was obtained from those patients who voluntarily willing to participate in the study. The MRI scan was performed MRI PHILIPS ACHIEVA HDxt 1.5 T possesses an Ultra-compact, Superconducting, Active shielded superconducting magnet of 1.5telsa magnetic field using SENSE coils for the acquisition of images. Conventional spin-echo sequences, axial T1, and T2 weighted. Coronal T2; SagittalT1; Post-contrast axial, coronal and sagittal; DWI; T2 GRE single and multi-voxel spectroscopy was performed at TEof144. The voxel is placed on the lesions that cover the maximum area of the lesion in both single and multivoxel. PRESS and T1post contrast sequence as localization sequence with 5mm thickness. Other sequences were used as and when required.

**Statistical analysis:** All the statistical analysis is done using SPSS software version 21 and MS excel 2007. Descriptive statistics in the form of mean, percentage were used.

## Results

During the study period, a total of 30 participants were included in the study. Age-wise the participants were divided in to <45years and >45 years categories which were 71% (48) and 29% (20) respectively. Under <45 years category, abscess was diagnosed in 13% (9) members, gliomas in 3% (2) cases, neurocysticercosis in 18% (12) cases, tuberculoma in 37% (25). Whereas in >45 years category, Glioblastoma multiforme was diagnosed in 3% (2) cases, glioma in 1.5% (1), metastases in 15% (10) cases, neurocysticercosis in 3% (2) cases and tuberculoma in 7.4% (5) cases. Totally, abscess was diagnosed in 13% (9) cases, glioblastoma multiforme in 3% (2), gliomas in 4.5% (3), metastases in 15% (10), neurocysticercosis in 20% (10) and tuberculoma was diagnosed in 44% (30) cases (Table 1). Gender wise 44% (30) were female participants and 56% (38) were male and the male-female ratio was 1.27. Among females, an abscess was diagnosed in 9% cases, glioblastoma

Multiforme, gliomas in 1.5% (1) each receptively, metastases in 4.4% cases, neurocysticercosis in 13% and tuberculoma in 15% (10) cases. Among the male, an abscess was diagnosed in 4.4% cases, glioblastoma multiforme in 1.5% (1), gliomas in 3%, metastases in 10% cases, neurocysticercosis in 7% and tuberculoma in 30% (20) cases (Table 2). Depicts T1 signal intensity showed hypointense signal intensity on T1W sequence in 65 (95.5%) cases. Only 3 (4.6%) out of 68 (100%) cases showed isointense signal intensity on T1W image. T2 signal intensity out of which 50(73.5%) cases showed hyperintense signal intensity on T2W images and 17(25%) cases showed hypointense signal intensity, all the 17 cases were tuberculomas. Only 1 (1.5%) case showed heterogeneous signal intensity on T2W sequence.

**Table-1: Age-wise incidence of various pathological lesions present as ring-enhancing lesions among the study participants; n (%).**

| Lesion | Age | | Total |
|---|---|---|---|
| | < 45 years | > 45 years | |
| Abscess | 9 (13) | 0 | 9 (13) |
| Glioblastoma multiforme | 0 | 2 (3) | 2 (3) |
| Gliomas | 2 (3) | 1 (1.5) | 3 (4.5) |
| Metastases | 0 | 10 (15) | 10 (15) |
| Neurocysticercosis | 12 (18) | 2 (3) | 14 (20) |
| Tuberculoma | 25 (37) | 5 (7.4) | 30 (44) |
| Total | 48 (71) | 20 (29) | 68 (100) |

**Table-2: Gender wise distribution of various pathological lesions among the study participants; n (%)**

| Lesion | Female | Male | Total |
|---|---|---|---|
| Abscess | 6 (9) | 3 (4.4) | 9 (13) |
| Glioblastoma multiforme | 1 (1.5) | 1 (1.5) | 2 (3) |
| Gliomas | 1 (1.5) | 2 (3) | 3 (4.4) |
| Metastases | 3 (4.4) | 7 (10) | 10 (15) |
| Neurocysticercosis | 9 (13) | 5 (7) | 14 (21) |
| Tuberculoma | 10 (15) | 20 (30) | 30 (44) |
| Total | 30 (44) | 38 (56) | 68 (100) |

# Discussion

Magnetic resonance imaging (MRI) is a non-invasive, multiplanar, and highly accurate method with better inherent contrast that demonstrates the lesion accurately. MRI provides an accurate assessment of the brain changes in various ring-enhancing lesions, for accurate diagnosis and introduction of immediate treatment. Out of the 68 patients who were evaluated, tuberculomas 30 (44.1%) is the most common pathology followed by NCC 14 (20.5%), abscesses 9 (13.2%), metastasis 10 (14.7%) and primary brain tumors 5 (7.3%).In a study conducted by Schwartz et al., 40% of cases were gliomas. The higher incidence of tuberculomas is probably due to the higher prevalence of tuberculosis in India [5]. Sixty-eight patients were evaluated, whose age group was divided into below 45 years and above 45 years. The highest incidence of ring-enhancing lesions (RELs) was found in below 45 years age group accounting for 70.5% of cases and less commonly in the above 45 age group constituting 29.5%. Sixty-eight patients were evaluated of which 38 (55.9%) were males and 30 (44.1%) were females. Out of sixty-eight cases, tuberculomas were seen in 30 (44%) patients. In this, 25 cases were in <45 yrs age group and 20 were men. Single lesions were seen in 13 cases (43%) and both conglomerate and multiple lesions were seen in 57%. They were seen as conglomerate lesions which are hypointense on both T1 and T2 weighted images. These lesions show iso to hyperintense ring on 12 cases. Diffusion-weighted imaging showed partial or complete restriction seen in 77%. Tae Kyung Kim et al. stated in intracranial tuberculoma, granulomas showed slightly hyperintense rim on T1 weighted images. Granulomas showed slightly heterogenous iso or hypointensity with small markedly hypointense foci [6]. Gupta RK et al. Mentioned that there was not much difference in ADC values between tuberculomas and tubercular abscesses [7]. The present study was compared with Jayasundar et al., which concluded that the presence of lipid can be used for differentiating tuberculomas from both non-specific IG and NCC [8]. Whereas Vasudev MK et al., concluded that intracranial tuberculomas are characterized by relatively short T2 relaxation times compared to normal gray matter, decreased MTR, and no restriction of diffusion [9]. Neurocysticercosis was seen in 20.5% cases, most of them presented with seizures, and very few presented with other complaints like headache, vomiting, and ataxia, etc. All the cases were <45 years, 9 were female. The present study findings were compared with Amaral L et al. which concluded that MR imaging is sensitive and specific in the analysis of different forms of NCC and differentiating other etiologies [10]. Whereas Chang KH et al., stated MRI is superior to CT in the evaluation of CNS parasitic infections [11]. HR Martinez R Rangel-Guerra et al., mentioned that MR is sensitive in diagnosing active NCC [12]. Haris M, Gupta RK et al. stated that post-contrast perfusion indices such

Ask (trans) and v (e) helps in differentiating infective from neoplastic brain lesions [13]. The current study doesn't have any pregnant women as compared to Savita R Singhal et al., reported NCC presenting in the second trimester of pregnancy with convulsions [14]. Kumar et al. stated the Cho/Cr ratio was less than 1.1 in all NCC and more than 1.2 in all tuberculoma which was similar to the present study findings [15]. Halmes et al. described the appearance of abscesses on MR. The current study correlated our findings with those described and distinguishes the edema, central necrosis, and the characteristic pattern of peripheral enhancement of the abscess capsule [16]. The current study findings correlated with Zee CS et al., which studied and concluded MRI-DWI helps in early diagnosis of cerebral abscesses and evaluation of treatment outcome [17]. The current study findings were similar to Tsui EY et al., which concluded that conventional MRI along with DWI and MRS establishes diagnosis [18]. Mishra AM et al., which stated restricted diffusion on DWI with reduced ADC is highly suggestive of brain abscess [19]. Out of sixty-eight cases, two were GBM. Both patients were < 45yrs, presented with seizures, headache, and vomiting. Single lesions were identified in both cases. Midline shift was seen in both cases. All the cases were hypointense on T1 and hyperintense. Diffusion restriction present in both cases. On contrast administration, all the cases showed complete, thick, and irregular ring enhancement. Most of the cases showed high Choline and reduced NAA levels. The present study findings were compared and similar to Tsougos I et al., which stated that Peritumoral N-acetyl aspartate (NAA)/creatine (Cr), choline (Cho)/Cr and Cho/NAA helps in differentiating glioblastomas from intracranial metastases [20]. Whereas Hung Wen Kao et al. mentioned that DWI may serve as an early surrogate marker of therapeutic efficacy by implying persistent cellular density in the tumors where high cellularity may impede free water diffusion, resulting in a reduction of apparent diffusion coefficient (ADC) values. Generally, lower ADC values correspond to increased cellularity and high-grade gliomas. Improved analysis methods indeed enhance the role of DWI as a biomarker of tumor cellularity for the diagnosis and monitoring treatment response. Advanced MR imaging technique along with conventional MR can potentially help evaluate the underlying key histopathological features of gliomas by showing the physiologic changes and metabolic activities, thus

improving diagnosis and tumor grading provides a better understanding of the tumor behavior and treatment response [21].

## Limitations

Due to the small sample size, the current study results cannot be generalized. Hence further studies with a large sample size needed.

## Conclusion

MRI is an excellent, non-ionizing imaging modality with multiplanar imaging capabilities for excellent grey-white matter differentiation and identifying the precise anatomical location and the exact extent of lesions. The data so far indicated MRI findings of selected ring-enhancing lesions were significantly correlated with the age of patients. Also, this study found that benign RELs were seen predominantly in less than 45 years of age.

## What does the study add to the existing knowledge

The ring-enhancing lesions can be diagnosed by MRI, which is an excellent imaging technique.

## Author's contribution

**Dr. V Ramachandra:** Literature survey, paper writing, data analysis **Dr. Indra Neil Mekala:** Complete idea, statistical analysis, paper writing **Dr. Anish Chandra Mataparthy:** Benchwork, sample collection, literature search, paper writing **Dr. T Jaya Chandra:** Data analysis, paper writing, statistical analysis

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