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ORIGINAL ARTICLE

EVALUATION OF RING ENHANCING LESIONS IN THE PATIENT UNDERGOING BRAIN CT SCAN

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ABSTRACT

Introduction: *Ring enhancing lesions in CT of the brain can be caused by different pathological conditions. The common lesions being some granulomas, primary brain tumors, abscess etc. CT remains essential for the investigation of ring enhancing lesions of brain.*

Methods: *A cross-sectional study was performed on a total of 60 patients undergoing brain CT scans and found to have ring enhancing lesion(s) on contrast administration.*

Results: *The result of the study revealed that ring enhancing lesions was more common in man than women (34 out of 60 patients; 56.7%) The overall male to female ratio was 1.3:1. The age of the patients ranged from 7 to 77 years with peak incidence of lesion was found in >40 years of age comprising 28 patients (46.7%) followed by 21 to 30 age groups constituting 12 patients (20%). Single ring enhancing lesions were most common lesions comprising about 49 cases (81.67%). Neurocysticercosis (NCC) was the most common cause of ring enhancing lesions of brain comprising about 38 patients (63.3%) followed by glioblastoma multiforme (GBM) comprising about 9 patients (15%).*

Conclusions: *CT plays an important role in the diagnosis of ring enhancing lesion and their causes. Neurocysticercosis (NCC) was the most common cause of ring enhancing lesions followed by glioblastoma multiforme (GBM).*

Keywords: *Computed tomography, Neurocysticercosis, Ring enhancing lesions*

INTRODUCTION

The advent of x-ray computed tomography (CT) has had a great impact on medicine, primarily because CT solves a fundamental limitation of radiography, superimposition of imaged structures. Contrast enhances certain images of the CT scan and better enables the radiologist to evaluate the images. Contrast uptake in the form of 'ring enhancement' on CT brain is found in diverse conditions with damage to blood brain barrier.

Ring enhancing lesions in the brain imaging is a common feature in Indian sub-continent. Without clinical history, ring enhancing lesions in brain CT quite often than not may be confusing between neoplastic and non-neoplastic conditions. The size, shape, wall thickness of ring enhancing lesions, the extent of surrounding edema and importantly clinical history and age of the patient taken into consideration may help to distinguish the condition.[1,2]

In the pre-computerized era, the cause of epilepsy often remained obscured. The CT has helped accurately not only localizing the site of the lesion but also the type of lesion especially with administration of contrast agent. Even with the advent of Magnetic Resonance Imaging (MRI), in patients with "ring enhancing" lesion thin (2 to 5mm) slice contrast CT is a cost-effective alternative to MRI.[2,3]

Ring enhancing lesions are a common problem seen worldwide and in all age groups. The lesions were first reported by Tandon and Bhargav in 1980 and at that time these CT lesions were presumed to be tuberculomas.[4] In one of the earlier Indian study such lesions were diagnosed in as many as 26% of patients undergoing CT scans.[5]

The differential diagnosis of ring enhancing lesions largely depends on the immune status of the patient. In the immunocompetent hosts, tumors (both primary and secondary) and pyogenic abscesses remain the most

likely diagnosis; abscess caused by atypical organisms and demyelinating diseases must also be considered. In the immunocompromised hosts, the leading diagnoses are toxoplasmosis and primary CNS lymphoma. Furthermore, the patients are at risk for abscesses, from both pyogenic and atypical organisms and the tumors. Tuberculous brain abscess should be considered in endemic regions in both immunocompetent and immunocompromised hosts.[6]

In general, abscesses possess a thin, uniform ring, which is thinner on the medial border and a smoother outer margin; satellite lesions are often present.[7] By contrast, neoplasms have thicker, more irregular rims. Ring enhancing lesions seen in demyelinating diseases tend not to be perfect rings, but rather incomplete rings, hence termed as "open ring sign".[8]

METHODOLOGY

A cross-sectional study was conducted over six months from September 2022 to March 2023 at the National Medical College and Teaching Hospital in Birgunj, Nepal. The study focused on patients with ring enhancing brain lesions on contrast-enhanced computed tomography. Before the study, ethical clearance was obtained from the ethical committee, and all patients provided informed consent. A total of 60 patients with ring enhancing brain lesions were recruited, and personal information such as age and gender was collected.

The patients undergoing brain CT scans and found to have ring enhancing lesion(s) on contrast administration regardless of their age, sex and presenting clinical symptoms formed the inclusion criteria while patients lost on follow up and patients with homogenous nodular enhancement and streaky or patchy enhancement without definite rim pattern were excluded from the study.

After thorough clinical history and examination all the participants underwent contrast enhanced CT scan of brain. First non-enhanced CT was done using 5x5mm sections. This was followed by contrast administration using non-ionic contrast media (Omnipaque 300mg/mL) at a dose of 1-2mL/kg body weight. CT was performed after 3-5 minutes of the contrast administration. Axial head CT was performed with angulation of the gantry parallel to the orbitomeatal line, defined as passing through the lateral canthus and middle of the external auditory canal. To avoid radiation through the eyes when performing axial head CT, a 15–20 degrees angulation of the gantry to the canthomeatal line was done. After obtaining the initial scout scan, CT was done from the base of skull to the vertex with initial 5mm axial sequential scan for posterior fossa and 10mm axial sequential scan for the rest of the brain. Whenever required, thinner slices were also taken. Features of the ring enhancing lesions including number, site, shape, size, pattern of ring enhancement, edema and mass effect were noted.

A data capture sheet was utilized to record all the measurements obtained in the research study. The data was analyzed using the Statistical Package for Social Science (SPSS) version 25.0, which involved the utilization of descriptive statistics, chi square test and Pearson product moment correlation to evaluate the relationships between variables. Statistical significance was considered at a P-value of less than 0.05.

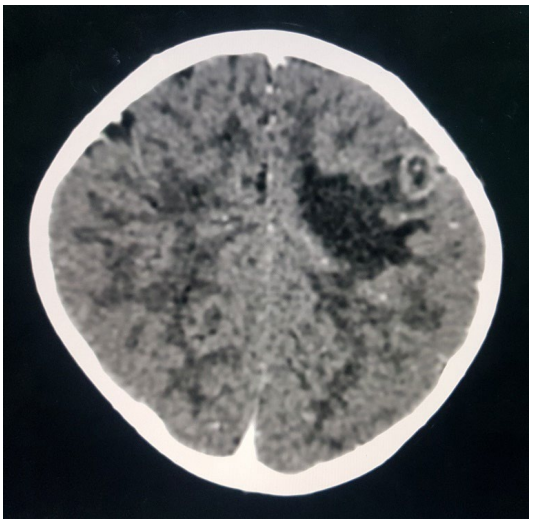

Figure 1: Contrast enhanced CT scan of brain shows ring enhancing lesion in left parietal lobe with marked perilesional edema.

RESULTS

A total of 60 patients were evaluated with ring enhancing lesions of brain that came for CT brain during the study period from September 2022 to March 2023. Patients were evaluated with detailed history and clinical examination prior to CT study.

Table 1: Frequency distribution based on age and sex of patients

Age Group (Years)	Sex		Total	Inference
	Male	Female		
< 10	1	2	3	
11-20	4	2	6	
21-30	7	5	12	χ^2=1.673
31-40	5	6	11	df=4
>40	17	11	28	
Total	34	26	60	p=0.796

Table 1 shows that out of 60 patients there were 34 (56.7%) males and 24 (43.3%) were females with male and female ration of 1.3:1. The peak incidence of ring

enhancing lesion were >40 years age group in which male was dominant comprising 17 (60.7%) patients followed by 21 to 30 age group comprising about 7 males (58.3%) and 5 females (41.7%). Chi square test shows p value of 0.796 which is statistically not significant.

Table 2: Radiological diagnosis for ring enhancing lesions of brain

Radiological Diagnosis	Frequency	Percentage
NCC	38	63.3
Abscess	5	8.3
GBM	9	15.0
Metastasis	5	8.3
Tuberculoma	3	5.0
Total	60	100.0

Table 2 shows that NCC was predominantly the most common ring enhancing lesions of brain comprising 38 patients (63.3%) followed by primary brain tumor (glioblastoma multiforme) comprising 9 patients (15%). Brain abscess and metastasis were found in equal proportion comprising 5 patients (8.3%) each. Tuberculoma was only found in 3 patients (5%).

Table 3: Number of lesions according to the ring enhancing brain lesions

Radiological diagnosis	Number		Total	Inference
	Single	Multiple		
NCC	30	8	38	
Abscess	5	0	5	
GBM	9	0	9	χ^2=5.349
Metastasis	3	2	5	df=4
Tuberculoma	2	1	3	
Total	49	11	60	p=0.253

Table 3 shows that most of the lesions presented with ring enhancing lesions were single while 8 out of 38 cases with NCC, 2 out of 5 patients with metastasis and 1 out of 3 patients with tuberculoma presented with multiple lesions. Chi square test was done which showed p value of 0.253, which was statistically not significant.

Table 4: Size of the lesions according to the causes

Radiological diagnosis	Size		Total	Inference
	<2cm	>2cm		
NCC	38	0	38	
Abscess	1	4	5	
GBM	0	9	9	χ^2=46.867
Metastasis	2	3	5	df=4
Tuberculoma	2	1	3	
Total	43	17	60	p=0.0001

Table 4 shows that all cases diagnosed with NCC have less than 2cm sized lesion while all cases diagnosed with GBM had more than 2cm sized lesions. In 5 patients diagnosed with metastasis 3 had more than 2cm sized lesions and 4 out of 5 patients diagnosed with abscess had more than 2cm sized lesions. Also 1 out of 3 patients with tuberculoma had more than 2cm sized lesion. The p value was 0.0001 which is statistically significant.

DISCUSSION

Ring enhancing lesions are a common problem seen worldwide and in all age groups. The advent of CT has had great impact in detecting and also in accurate diagnosis of these lesions. Contrast uptake in the form of ring enhancement is found in diverse condition with damage to the blood brain barrier.

In this study neurocysticercosis was the commonest cause of both single and multiple ring enhancing lesions. Glioblastoma multiforme and metastasis were respectively second to neurocysticercosis as a cause of single and multiple ring enhancing lesions. Rudresh et al.[8] in a similar study also noted neurocysticercosis to be the commonest cause for ring enhancing lesions in all age group (52%) followed by tuberculoma (20%). Majority of the lesions were single (91%) as was also noted in our study (63%).

However, Garg et al.[9] found tuberculoma to be the commonest cause of single ring enhancing lesion followed by neurocysticercosis and metastasis as the commonest cause of multiple ring enhancing lesions, both in contradiction to our study. But lung carcinoma was found to be the commonest primary malignancy with brain secondaries in both studies. But in contrast to the above studies, glioblastoma multiforme as a cause of single ring enhancing lesion was quite significant in this study and found to be the second most common cause.

The size of the single ring enhancing lesions was of significance in the differentiation of diagnosis. Neurocysticercosis measured less than 2cm in diameter whereas the solitary tuberculomas was more than 2cm in diameter. However, in patients with multiple tuberculomas, the tuberculomas were less than 2cm in size.

In a study of biopsy proven lesions, Chandy and Rajshekhar[10] reported that amongst 31 consecutive cases of ring enhancing lesions (25 of them were cysticercosis and 6 tuberculomas), all cysticercosis granulomas were less than 2cm in size. In comparison, all tuberculomas were greater than 2cm in size. Moreover 96% of cysticercosis had irregular outline with no mass effect or midline shift, in contrast to 5 out of 6 tuberculomas which were irregular in outline and 4 out of 6 had evidence of midline shift on CT. Presence of calcification and peri-focal edema was seen in both and was not a differentiating feature. In this study, it contradicts with the above findings only

30 out of 38 patients with cysticercosis granulomas had regular outline but all patients had less than 2cm in size with mild perilesional edema and no midline shift. All the patients with tuberculoma had regular outline and 2 out of 3 patients had moderate edema with midline shift.

The diagnosis of pyogenic abscess with ring enhancement did not pose much difficulty as the patients were toxic and symptomatic. CT demonstrated the lesions which were more than 2cm in size showing smooth and thin-walled regular enhancement with significant perilesional edema and mass effect.

Primary brain tumors (e.g., glioblastoma multiforme) similarly were larger at diagnosis but with much intralesional homogeneity. In contrast to abscess, the enhancement pattern was nodular ring enhancement with thick irregular wall. There was also much edema and mass effect but the patients were less symptomatic than patients with brain abscess.[11]

CONCLUSION

Male predominance for ring enhancing lesions was noted in this study. Single ring enhancing lesions were the most common findings. Most of the single ring enhancing lesions was less than 2cm in size and infective pathologies were the most common cause. Neurocysticercosis was most common cause followed by brain abscess. Neoplastic diseases were common non-infective causes. Glioblastoma multiforme was second only to neurocysticercosis. Among multiple ring enhancing lesions, infective pathologies i.e. neurocysticercosis was still the most common cause followed by metastasis whose commonest primary was lung. Most of the infective pathologies had regular pattern of enhancement. Mild edema was noted in less than 2cm size lesions while moderate to severe edema in more than 2cm size lesions. Mass effect was only presented in more than 2cm size lesions. Neurocysticercosis was the commonest cause of seizure in patient presenting with ring enhancing lesions.

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