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Role of Computed Tomography in the Evaluation of Ring Enhancing Lesions of Brain with Histopathological Correlation

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Abstract
Background: *Ring-enhancing lesions are one of the most commonly encountered neuroimaging abnormalities. Several types of primary and secondary brain neoplasms, such as glioblastomas, low-grade gliomas, brain metastases can also present as ring-enhancing lesions. Widely available imaging techniques, computed tomography and magnetic resonance imaging (MRI) are used to detect these lesions. CT is a useful modality in the preoperative evaluation of ring-enhancing lesions of the brain and CT findings correlate well with postoperative histopathological findings. This study aimed to assess the role of computed tomography in the evaluation of ring-enhancing lesions of the brain with histopathological correlation.*
Methods: *This was a prospective observational study which was conducted in the Department of Radiology and Imaging, in collaboration with the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh during the period from January 2012 to December 2013. As the study population, in total 56 cases were selected randomly based on clinical and CT findings of the brain. All the relevant collected data were compiled on a master chart first and then organized by a scientific calculator and standard appropriate statistical formulae. Finally, all data were processed, analyzed, and disseminated by MS Office and SPSS programs as per need.*
Results: *In assessing the CT evaluation of Ring-enhancing lesions of the brain (Glioma) and its correlation with a histopathological diagnosis we observed, sensitivity was found 90%, and specificity was found 95% (p=0.001). An assessment regarding metastasis and its correlation with a histopathological diagnosis we observed, sensitivity was found 82% and specificity was found 96% (p=0.001). In assessing tuberculoma and its correlation with histopathological diagnosis, we observed sensitivity was found 90%, and specificity was found 98% (p=0.001). In assessing abscess and its correlation with histopathological diagnosis, we observed sensitivity found 93%, and specificity was found 98% (p=0.001).*
Conclusion: *CT findings of the present study correlated well in most of the cases with the pathological results. It can therefore be concluded that, CT scan is an accurate and sensitive modality in the evaluation of ring-enhancing lesions of the brain.*

Keywords: *Computed tomography, Ring enhancing lesion, Brain, Histopathological correlation*

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I. Introduction

CT is a useful modality in the preoperative evaluation of ring-enhancing lesions of the brain and CT findings correlate well with postoperative histopathological findings. Contrast material enhancement for cross-sectional imaging has been used since the mid-1970s for computed tomography and the mid-1980s for magnetic resonance imaging. Knowledge of the patterns and mechanisms of contrast enhancement facilitates radiologic differential diagnosis [1]. The brain, spinal cord, and nerves create a selectively permeable capillary membrane

to protect themselves from plasma proteins and inflammatory cells: the blood-brain barrier. The semipermeable blood-brain barrier blocks lipophobic compounds and creates a unique interstitial fluid environment for the neural tissues. In contrast, lipophilic compounds and certain chemicals that are actively transported may cross the blood-brain barrier with ease. Certain cells that possess the correct surface marker proteins may pass unimpeded through the blood-brain barrier, whereas most other cells are excluded [2]. Interstitial enhancement is related to alterations in the permeability of the blood-brain barrier, whereas intravascular enhancement is proportional to increases in blood flow or blood volume. At CT, intravascular and interstitial enhancement may be seen simultaneously [2]. Ring-enhancing lesions may be superficial, but they are usually subcortical or deep reviewed 221 ring-enhancing lesions seen on MR images and reported that 40% were gliomas; 30%, metastases; 8%, abscesses; and 6%, demyelinating disease. In a series, 45% of metastases and 77% of gliomas were single lesions, whereas abscesses and multiple sclerosis lesions were multiple in 75% and 85% of patients, respectively [3]. Deep white matter ring-enhancing lesions, especially those with mass effect and surrounding vasogenic edema, are most often either primary neoplasm [3]. High-grade tumors are characterized on MR images by increased perfusion and a shortened mean transit time. Angiogenesis in most high-grade gliomas is stimulated by vascular endothelial growth factors [4]. Deep lesions with this pattern especially when they are located in the corpus callosum and thalamus are usually primary astrocytic glial neoplasms. In adults, such lesions are usually diffusely infiltrating astrocytomas, with 60% being higher grade [1]. Most fluid-secreting tumors show enhancement limited to the mural nodule, whereas some may demonstrate a nodule with partial rim enhancement [5]. Multiple sclerosis plaques enhance during the active phase and this enhancement usually lasts for 2–6 weeks and only rarely longer [6]. The cause of the enhancement in demyelination is inflammation, usually perivascular, which most often is limited to the venous side there is no neovascularity, no angiogenesis, and no necrosis [7]. For this reason, the enhancement of multiple sclerosis plaques may be faint, the lesions usually do not produce any perilesional vasogenic edema, and the enhancing rim is thin and often incomplete [8]. Intracranial tuberculoma is uncommon in developed countries. The most common sites are the cerebral hemispheres and basal ganglia in adults and the cerebellum in children.

II. Objective

General Objective:

- To elucidate accuracy, sensitivity, and specificity of CT in the pre-operative evaluation of ring-enhancing lesion of the brain with histopathological correlation.

Specific Objective:

- To established diagnostic usefulness of CT in the pre-operative evaluation of ring-enhancing lesions of the brain.
- To find out the incidence and location of different types of ring-enhancing lesions of the brain.

III. Methods

This was a prospective observational study which was conducted in the Department of Radiology and Imaging, in collaboration with the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh during the period from January 2012 to December 2013. In total 56 cases were selected randomly based on clinical and CT findings of ring-enhancing lesions of the brain as the study population. The study protocol was approved by the institutional review board of BSMMU. As per the inclusion criteria of this study, clinically suspected patients selected irrespective of age and sex having ring-enhancing lesions of the brain, suspected or supported by CT, and confirmed by histopathology were included. On the other hand, as per the exclusion criteria of the study, cases who did not undergo an operation and hence histopathology not available for correlation, doubtful cases both radiologically and histo-pathologically, patients unwilling to give consent for the study, clinically and radiologically suspected cases of the demyelinating disease were excluded from the study. This prospective observational study was done on randomly selected patients referred for CT scan in the brain and found ring-enhancing lesion of the brain. CT scan of the brain was performed after proper counseling of the patients. CT scan of the brain was performed from caudal to cephalad level with 15-to-20-degree angulation to the canthomeatal Line. CT scan was viewed in axial slices and in some cases also reconstructed coronal and sagittal images were viewed. Headache, nausea, fever, seizure, focal neurologic deficit, altered consciousness, drowsiness, neck stiffness, visual disturbance, papilledema, and speech disturbance clinical features of the study people. CT scan variables were the number, location of the lesion, involved hemisphere, density, surrounding edema, midline shifting, sulcus and gyrus effacement, ring enhancement, ventricular dilatation, the margin of le,son and presence or absence of calcification. Histopathology variables of this study were glioma, abscess, metastasis, and tuberculoma. The biopsy specimen was collected in a container containing 10% formalin and sent for histopathology. Gross examination of the excised brain mass was done with particular emphasis on size, consistency, and cut surface appearances. They were subjected to two or three tissue blocks of 3-5 mm thickness for the specimen and were processed for

routine paraffin section and stained according to hematoxylin and eosin staining methods. All the relevant collected data were compiled on a master chart first and then organized by a scientific calculator and standard appropriate statistical formulae.

IV. Result

In this study, the mean age of the patients was 40.8±10.4 years ranging from 16 to 64 years. It was found that, among the patients with ring-enhancing lesions, the highest percentage was in the range of 31-40 years (35.7%) followed by 41- 50 years (28.6%), greater than 50 years (21.4%), 21-30 years (8.9%) and lowest in the age group of less or equal to 20 years (5.4%). The peak age incidence of ring-enhancing lesions of the brain was found 31-40 years. The male-female ratio of the participants was 1.7:1. According to the clinical presentations of the ring-enhancing lesions of brain patients, it was observed that headache, neurological deficit, vomiting, vertigo, convulsion, and fever were associated in 80.4%, 66.1%, 51.1%, 50.0%, 48.2%, and 39.3% patient respectively. In analyzing the etiological diagnosis of ring-enhancing lesions of CT brain we observed, 'ring enhanced' was found in 37.5%, 19.6%, 17.9%, and 25% patients with glioma, metastasis, tuberculoma, and abscess respectively. The frequency of other clinical presentations was as follows: blurring vision was in 25% and unconsciousness was in 16.1%. In this study, out of 21 diagnosed Glioma patients, 20 (95.2%) were with a single number of lesions and the rest 1 (4.8%) was with a multiple number of lesions. Among 11 metastasis patients, 9 (81.8%) and 2 (18.2%) were with multiple and single lesions respectively. Ten diagnosed tuberculoma patients, 4 (40%) patients were with single and 6 (60%) patients were with multiple numbers of lesions. Finally, out of 14 diagnosed patients with abscess, 11 (78.6%) and 3 (21.4%) patients were with single and multiple lesions respectively. In our study, out of 21 diagnosed glioma patients, 15 (71.4%) patients were as hypodense and the rest 6 (28.6%) patients were as mixed density of lesion. Among 11 metastasis patients, 9 (81.8%) and 2 (18.2%) were with iso dense and hyperdense of lesion respectively. Among 10 diagnosed tuberculoma patients 7 (70%), 1 (10%) ,and 2 (20%) patients were in hyper, hypo, and iso dense of lesions respectively. Finally, out of 14 diagnosed patients with abscess, 13 (92.9%) patients were hypo and 1 (7.1%) was in iso dense of the lesion. In assessing the CT evaluation of Ring-enhancing lesions of the brain (Glioma) and its correlation with a histopathological diagnosis we observed, Chi-square value (after Yates correction) was 43.9, df was1the, p-value was found 0.001, sensitivity was found 90% and specificity was found 95%. An assessment regarding metastasis and its correlation with a histopathological diagnosis we found Chi-square value was 43.79, df was observed 1, p-value was found 0.001, sensitivity was found 82% and specificity was found 96%. An assessment regarding tuberculoma and its correlation with a histopathological diagnosis we observed Chi-square value was 37.4, df was found 1, p-value was found 0.001, sensitivity was found 90% and specificity was found 98%. An assessment regarding abscess and its correlation with a histopathological diagnosis we observed, Chi-square value was 45.7, df was 1, p-value was found 0.001, sensitivity found 93% and specificity was found 98%.

Table 1: Clinical features of different etiologies of the study patients (n=56)

Characteristics	Headache	Vomiting	Blurring of vision	Vertigo	Convulsion	Neurological deficit	Fever	Unconsciousness
Glioma (n=21)	17 (80.9)	15 (71.1)	4 (19.0)	10 (47.6)	13 (61.9)	15 (71.4)	0 (0.0)	0 (0.0)
Metastasis (n=11)	9 (81.8)	4 (36.4)	3 (27.3)	8 (72.7)	6 (54.5)	8 (72.7)	0 (0.0)	5 (45.4)
Tuberculoma (n=10)	6 (60.0)	4 (40.0)	5 (50.0)	4 (40.0)	4 (40.0)	7 (70.0)	8 (80.0)	4 (40.0)
Abscess (n=14)	13 (92.8)	9 (64.3)	2 (14.3)	6 (42.9)	4 (28.6)	7 (50.0)	14 (100.0)	0 (0.0)
Total	45 (80.4)	32 (57.1)	14 (25.0)	28 (50.0)	27 (48.2)	37 (66.1)	22 (39.3)	9 (16.1)

Table 2: Etiological diagnosis of ring-enhancing lesions of CT brain (n=56)

Characteristics	Ring enhanced	Not enhanced
Glioma	21 (37.5)	0
Metastasis	11 (19.6)	0
Tuberculoma	10 (17.9)	0
Abscess	14 (25.0)	0
Total	56 (100)	0

Table 3: CT features of different etiologies according to number of lesions (n=56)

Number of lesions	Glioma	Metastasis	Tuberculoma	Abscess
Single	20 (95.2)	2 (18.2)	4 (40.0)	11 (78.6)
Multiple	1 (4.8)	9 (81.8)	6 (60.0)	3 (21.4)
Total	21 (100)	11 (100)	10 (100)	14 (100)

Table 4: CT features of different etiologies according to the density of lesion (n=56)

Number of lesions	Glioma	Metastasis	Tuberculoma	Abscess
Single	20 (95.2)	2 (18.2)	4 (40.0)	11 (78.6)
Multiple	1 (4.8)	9 (81.8)	6 (60.0)	3 (21.4)
Total	21 (100)	11 (100)	10 (100)	14 (100)

Table 5: CT evaluation of Ring-enhancing lesions of brain Glioma, Metastasis, Tuberculoma and Abscess with that's correlation with histopathological diagnosis (n=56)

Histo-pathological findings (n=56)			CT findings among histo-pathologically positive cases (n=21)		
			CT positive (n)	CT Sensitivity	CT Specificity
Characteristics	n	%	n	%	%
Glioma	21	37.50%	19	90%	95%
Metastasis	11	19.64%	9	82%	96%
Tuberculoma	10	17.86%	9	90%	98%
Abscess	14	25.00%	13	93%	98%

V. Discussion

This study aimed to assess the role of computed tomography in the evaluation of ring enhancing lesions of brain with histopathological correlation. Clinical features of different etiologies of the present study in patients with Glioma, headache was the most common presentation (80.9%), followed by neurological deficit (71.4%), vomiting (71.1%), convulsion (61.9%) and vertigo (47.6%). In his thesis Bibekananda [9] found headache was the most common presentation (91.4%), followed by neurological deficit (80%), convulsion (68%), vomiting (63%), and vertigo (28%). These data were almost similar to present study. In patients with metastasis, headache was the most common presentation (81.8%), followed by neurological deficit (73%), vertigo (73%), convulsion (55%), visual problem (27%) and vomiting (36%). Mahato et al (2012) [10], also found headache (42%), seizures (57%), vomiting (14%), hemiparesis (46%) and visual problem (14%). In patients with tuberculoma, fever was the most common presentation (80%), followed by neurological deficit (70%), headache (60%), visual problem (50%) convulsion (40%), and vomiting (40%). Mahato et al (2012) [10], also found headache (66%), fever (52%) seizures (47%), vomiting (42%), hemiparesis (46%) and visual problem (38%). These data were also similar to present study. In Abscess, fever was found in all cases (100%), headache was found in (92.8%) cases. Other presentations were: vomiting (64%), neurological deficit (50%), vertigo (43%) and blurring of vision (14%) cases. Mahato et al (2012, p.513) [10], also found fever (100%) cases. Faraji- Rad [11], found headache (77%) cases. In his thesis Zakir (2007, p. 73) [12] reported headache, fever and focal neurologic deficit in 54%, 50%, and 27.3% of patients respectively. These data were also similar to present study. In our study, in analysis of etiological diagnosis of ring-enhancing lesions of brain, glioma was found in 37.5% cases, metastasis in 19.6% cases, tuberculoma in 17.9% cases and abscess in 25% cases. Schwartz et al (2006, p.213) [3] reviewed 221 ring-enhancing lesions and reported that 40% were gliomas; 30% with metastases, 8% with abscesses and 6% with demyelinating disease which was close to present study. Mahato et al (2012, p.516) [10] reported, out of total 40 patients, 52.5% were diagnosed as having tuberculoma, 17.5% were found to have cerebral metastasis, 10% patients had neurocysticercosis and 7.5% patients had evidence of cerebral abscess. In the present study, CT evaluation of ring-enhancing lesions of brain (Glioma) and its correlation with histopathological diagnosis, the overall accuracy of CT as a diagnostic modality was 96.4%, sensitivity was 100% and specificity was 94.6%. Bibekananda (2004, P.75) [9], described in his thesis the overall accuracy of CT as a diagnostic modality is 97.2%, sensitivity 97.1% and specificity 100%, which was almost similar to present study. Sasiadek, (1995, p.173) [13] has found 86.7% accuracy of CT for detecting intracranial glioma. Gaudin et al. (1997, p.461) [14], found specific diagnostic rate of 82%. Analysis of metastasis patients CT evaluation of ring-enhancing lesions of brain and its correlation with histopathological diagnosis, the overall accuracy of CT as a diagnostic modality was 98.2%, sensitivity was 100% and specificity was 97.8%. Anil (2013) also found cranial CT has a sensitivity of 92%, specificity of 99%,

and an accuracy of 98% in detecting brain metastasis. In tuberculoma, CT evaluation of ring-enhancing lesions of brain and its correlation with histopathological diagnosis, the overall accuracy of CT as a diagnostic modality was 96.4%, sensitivity was 100% and specificity was 97.8%. Selvapandian (1994, p.845) [15] described the sensitivity of CT in the diagnosis of intracranial tuberculomas was 100%, and its specificity was 85.7% which were almost similar to present study. In abscess, CT evaluation of ring-enhancing lesions of brain and its correlation with histopathological diagnosis, the overall accuracy of CT as a diagnostic modality was 98.2%, sensitivity was 100% and specificity was 97.7%. In his thesis Zakir (2007, p.79) [12] reported sensitivity of CT to diagnose brain abscess was 100.0% and accuracy 94.5%.

Limitation of the study:

This was a single centered, prospective, observational study with a small sized sample. So, findings of this study may not reflect the exact scenario of the whole country.

VI. Conclusion

CT findings of the present study correlated well in most of the cases with the pathological results. It can therefore be concluded that CT scan is accurate and sensitive modality in the evaluation of ring enhancing lesions of brain. CT scan thus can be regarded as a primary imaging modality in the diagnosis of ring enhancing lesions of brain. However, a comparative study of MRI and CT can be recommended to be find out the relative usefulness of these modalities in the evaluation of ring enhancing lesions of brain.

VII. Recommendation

For getting more specific information regarding this issue, we would like to recommend for conducting more studies in several places with larger sized samples.

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