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Original Article

Computed Tomography Characteristics of Intracranial Ring-enhancing Lesions

Bobby Varkey[1], M R Raman[2], S Vivek[3], Rabinath Prabhu[4]

[1]Senior Resident, Department of Radiodiagnosis, Pushpagiri Medical College, Thiruvalla, Kerala, India, [2]Assistant Professor, Department of Surgery, Al Azhar Medical College and Super Speciality Hospital, Thodupuzha, Kerala, India, [3]Associate Professor, Department of Community Medicine, Al Azhar Medical College and Super Speciality Hospital, Thodupuzha, Kerala, India, [4]Professor, Department of Radiodiagnosis, Justice K S Hegde Medical Academy, Mangalore, Karnataka, India

Abstract

Introduction: Ring-enhancing computed tomography (CT) lesions are those which consist of focal area of hypodensity on plain CT scan on which contrast administration shows ring-like enhancement. CT scan has largely replaced previous radiological procedures such as plain roentgenograms, pneumoencephalogram, cerebral angiography, and myelography.

Purpose: The purpose of the study was to determine the various CT morphological characteristics of ring-enhancing lesions in various intracranial pathological entities.

Materials and Methods: This is a cross-sectional study conducted in the department of radiology in a tertiary care center in Mangalore, Karnataka, from July 2015 to November 2016. A total of 30 patients were included in this study whose CT scan showed ring-enhancing lesion or lesions after contrast administration and with a final diagnosis following surgery or complete cure. The morphological features of the lesions observed were tabulated and analyzed using SPSS software version 16. Various morphological features are expressed as percentages.

Conclusions: CT morphology characteristics of ring lesion are strongly suggestive of the diagnosis such as tuberculoma, brain abscess, glioma, metastases, and nerocysticercosis; however, they have to be corroborated by clinical history, laboratory investigation, and histopathological examination to arrive at a definite diagnosis.

Key words: Computerized tomography, Contrast, Intracranial, Morphology, Ring-enhancing lesion

INTRODUCTION

Ring-enhancing computed tomography (CT) lesions are those which consist of focal area of hypodensity on plain CT scan on which contrast administration shows ring-like enhancement. Central necrosis and peripheral organization produces ring lesions. The ring may be single or multiple, small or large, usually uniform, and complete but can be irregular and in complete. Differential diagnosis of ring-enhancing lesions includes primary brain tumors, metastatic brain tumors, abscess, granuloma, resolving hematoma, brain infarct, multiple sclerosis, and primary central nervous system (CNS) lymphoma in patients with AIDS. The diagnosis of these brain lesions has been greatly improved by the introduction of CT; patients have the advantage of imaging the brain parenchyma for the presence of focal lesions without the use of any invasive procedures. In the present scenario, CT has become principal diagnostic test in establishing the diagnosis of brain pathology, especially abscess by virtue of its accuracy, reliability, safety, and wide availability in determining the location and size of each lesion.[1]

This study was conducted with the objective to determine the CT morphological characteristics of ring-enhancing lesions in various intracranial pathological entities in patients presenting with CNS symptoms.

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MATERIALS AND METHODS

A cross-sectional study was conducted in a tertiary care center in Mangalore, Karnataka, during the time period

Corresponding Author: Dr. M R Raman, Department of Surgery, Al Azhar Medical College and Super Speciality Hospital, Ezhalloor, Thodupuzha - 685 605, Kerala, India.

of July 2015–November 2016. The study population was patients whose CT scan showed ring-enhancing lesion or lesions after contrast administration.

Study Subjects

Patients with intracranial ring-enhancing lesions in contrast CT scans after informed consent (from patients/bystanders), in whom a final diagnosis was reached either by surgery, biopsy, or from total healing response to antituberculous or cysticidal drugs or steroid therapy, were included in the study, while patients in whom contrast could not be administrated were excluded from the study.

Study Tool

- Whole-body CT scanner – Spiral CT (512 × 512 matrix)
- Contrast media – non-ionic contrast media
- IV cannula and syringes 5 ml, 10 ml, and 20 ml
- Emergency drugs such as inj. avil, hydrocortison, adrenaline, etc.

Technique of Examination (CT)

The usual CT examination was done by scanning the head in a series of axial slices at 10–15 degrees to the Reid's baseline in all patients with 5 mm thick slices in infratentorium and 8–10 mm thick slices in supratentorium. Occasionally, however, additional slices and intermediate slices were also scanned. Both plain and contrast-enhanced scans were done. Contrast enhancement was achieved by giving bolus injection of non-ionic contrast media intravenously.

Methodology

In this study, pre-operative neuroradiological examinations were performed on all patients. As a rule, all patients (with CNS symptoms) underwent a diagnostic CT scan (plain and after contrast medium administration). All these patients also underwent complete hemogram, ESR, chest X-ray, and routine urine analysis. Patients underwent further relevant tests such as Mantoux test, electroencephalography, abdominal ultrasound, and CT scan for reaching a definite final diagnosis.

Statistical Analysis

The observations made were tabulated and analyzed using SPSS software version 16. Various morphological features are expressed as percentages.

RESULTS

A total of 30 patients were included in this study whose CT scan showed ring-enhancing lesion or lesions after contrast administration. In this study, 43 lesions were detected in the CT films of the selected 30 study subjects.

Out of the 30 study subjects, 21 (70%) were male and 9 (30%) were female. In this study, maximum patients belonged to the age group of 11–20 years (26%). All age groups showed the male preponderance for all lesions [Table 1].

Most commonly diagnosed lesions in this study were metastases (8 cases) followed by tuberculoma and gliomas (7 cases each). Abscesses were diagnosed in 6 cases. Neurocysticercosis was least common (only 2 cases) in this study. All metastatic lesions (8 cases) showed multiple rings and all cysticercal (2 cases) lesions were as single ring. Majority of gliomas (6 cases) were single lesion. Single tubercular lesions (6 cases) were more than multiple (1 case). However, abscesses (single-3, multiple-3) were evenly distributed.

Based on the size of the lesion, most of the lesions (24) were <10 mm at the time of investigation. Five tubercular lesions were <10 mm and three were more than 10 mm. Six abscesses were <10 mm and three were more than 10 mm. Most of the gliomas were more than 10 mm at the time

Table 1: Distribution of intracranial lesion (diagnosis, *n*=30) according to age and sex of the study subjects

Age	Sex	Tuberculoma (7)	Abscess (6)	Glioma (7)	Metastases (8)	Cysticercosis (2)
<10 (1)	Male	1	-	-	-	-
	Female	-	-	-	-	-
11–20 (8)	Male	2	1	-	-	1
	Female	2	1	1	-	-
21–30 (3)	Male	1	2	-	-	-
	Female	-	-	-	-	-
31–40 (5)	Male	1	2	2	-	-
	Female	-	-	-	-	-
41–50 (6)	Male	-	-	1	2	-
	Female	-	-	1	1	1
51–60 (4)	Male	-	-	-	2	-
	Female	-	-	1	1	-
>60 (3)	Male	-	-	1	2	-
	Female	-	-	-	-	-

of diagnosis and only 2 lesions were 5–10 mm size. Nine metastatic lesions were <10 mm and 7 lesions were more than 10 mm. All cysticercal lesions were 5–10 mm of size.

On analyzing the lobes where the lesions were present, 38 lesions were located in the cerebral hemispheres and 5 lesions were in the cerebellum. Frontal and parietal lobes were most commonly involved (14 lesions each) followed by temporal (7 lesions); occipital lobe involvement was least common (3 lesions). Tubercular lesions were most common in parietal lobe (4 lesions). Abscesses frequently involved frontal (4 lesions) and parietal (3 lesions) lobes. Gliomas were distributed in frontal (2 lesions), temporal (3 lesions), and parietal (2 lesions) lobes, and in one case, it was in cerebellum. Majority of metastatic lesions (10) were in frontal and parietal lobes and 3 lesions were in the cerebellum. All cysticercal lesions were in frontal lobes.

In this study, lesions/rings occurred more frequently in subcortical (46.51%) location followed by corticomedullary junction (37.20%) and only 7 lesions were located in the cortex. Tubercular lesions mainly in subcortical in location (4) and 2 lesions each were in cortical and corticomedullary in location. Abscesses mostly (8) involved subcortical (4) and corticomedullary (4) area. Most of the gliomas (6) were in subcortical location. In metastases, subcortical area was involved in 6 lesions and corticomedullary junction was involved in 7 lesions. Only in 3 cases, cortex alone was involved. All cysticercal lesions involved corticomedullary junction. The CT characteristics of tuberculoma, abscess, glioma, metastases, and neurocysticercosis are given in Table 2.

DISCUSSION

Brain Abscess

In our study, males (5) were predominant. In the literature also, brain abscess is more common in males than females.[2] All the patients in our study were below 40 years of age. It is in accordance with the literature.[2,3] Half of the patients in this study had single lesion. However, in the literature, the incidence of single lesion is more than multiple lesions.[3] The CT appearance of abscess varies according to the stage of disease. Various reports correlate CT findings differently either after surgery or autopsy.[4,5]

Gliomas

However, Whelan and Hilal reported that ring enhancement is not synonymous with a well-formed capsule.[6] Glioblastoma is the most common primary malignant tumor of brain. Ring enhancement after contrast enhancement is a characteristic of malignant gliomas.[7,8] In our study also, all glioblastomas showed ring enhancement. All patients were above 40 years with slight male predominance (M: F=3:2). In our study, 80% of lesions were located in the supratentorial compartment. In our study, most of

Table 2: Computed tomography characteristics of the intracranial lesions (subjects=30 and total lesions=43) studied

Location (total)	Features	Tuberculoma, *n* (%)	Abscess, *n* (%)	Glioma, *n* (%)	Metastases, *n* (%)	Cysticercosis, *n* (%)
Wall enhancement	Regular (12)	3 (37.5)	3 (33.3)	1 (25)	4 (25)	1
	Irregular (31)	5 (62.5)	6 (66.6)	7 (87.5)	12 (75)	1
Surrounding edema	Mild (10)	2 (28.5)	2 (22.2)	2 (25)	2 (12.5)	2
	Moderate (14)	4 (57.1)	3 (33.3)	3 (37.5)	4 (25)	Nil
	Severe (6)	1 (14.2)	1 (11.1)	2 (25)	2 (12.5)	Nil
Outline	Well defined (13)	3 (37.5)	5 (55.5)	1 (12.5)	3 (18.7)	1 (50)
	Ill defined (30)	5 (62.5)	4 (44.4)	7 (87.5)	13 (81.25)	1 (50)
Wall thickness	Thin (15)	3 (37.5)	4 (44.4)	2 (25)	5 (31.25)	1 (50)
	Thick (28)	5 (62.5)	5 (55.5)	6 (75)	11 (68.75)	1 (50)
Mass effect	Present (23)	5 (71.5)	4 (44.4)	7 (87.5)	6 (87.5)	1 (50)
	Absent (7)	2 (28.5)	2 (22.2)	Nil	2 (12.5)	1 (50)
Side of lesion	Right (10)	3 (37.5)	2 (22.2)	3 (37.5)	2 (12.5)	Nil
	Left (13)	3 (37.5)	4 (44.4)	4 (50)	Nil	2 (100)
	Bilateral (7)	1 (12.5)	Nil	Nil	6 (87.5)	Nil
Midline shift	Present (15)	1 (14.3)	3 (50)	6 (75)	5 (81.25)	Nil
	Absent (15)	6 (85.7)	3 (50)	1 (12.5)	3 (18.75)	2 (100)
Density	Isodense (10)	4 (50)	1 (11.1)	1 (12.5)	4 (25)	Nil
	Hypodense (21)	2 (25)	7 (77.7)	4 (50)	6 (37.5)	2 (100)
	Hyperdense (12)	2 (25)	1 (11.1)	3 (37.5)	6 (37.5)	Nil
Associated findings	Nodular (3)	Nil	Nil	1 (12.5)	2 (12.5)	Nil
	Hydrocephalus (7)	1 (14.3)	Nil	3 (12.5)	3 (18.75)	Nil
	Hemorrhage (2)	Nil	Nil	1 (12.5)	1 (6.25)	Nil
	Calcification (1)	1 (14.3)	Nil	Nil	Nil	Nil
	Cyst (4)	Nil	Nil	2 (25)	1 (6.25)	1 (50)
Enhancement	Homogenous (17)	3 (37.5)	4 (44.4)	2 (25)	6 (37.5)	2 (100)
	Heterogenous (26)	5 (62.5)	5 (55.5)	6 (75)	10 (62.5)	Nil

the lesions (60%) were of mixed density. These findings agree with the result of Steinhoff who reported that mixed attenuation was the most frequent presentation with 38.5 to 65.3% incidence.[9] There was no associated calcification in gliomas in this study.

Tuberculoma

In our study, there was predominance of lesion in the male (M:F=5:2, 71%:29%). All the cases were under 40 years. According to the studies in India, approximately 20% of intracranial tumors are tuberculoma, more than half occurring in children and 75% below the age of 25 years.[10,11] Most of the lesions (4) were located in the parietal lobe in our study and it was solitary in 3 cases. It is reported that most common site of involvement is cerebral hemispheres and basal ganglion and these are usually solitary however multiple lesions can occur in 10 – 35% of cases.[12] Considering the number of lesions, Bhargava and Tendon report an incidence of multiple lesions in 55% of cases[13] while Weisberg *et al.* have reported solitary lesions in about 66% of cases.[14]

Our study showed that 50% of lesions were isodense, similar results were reported by Welcham (71.4%).[15] In our series, majority of cases showed irregular wall enhancement (5), ill-defined outline (5), thick wall (5), and heterogeneous enhancement (5). A study by Welchman reported 1.6% incidence of calcification in intracranial tuberculomas.[15]

Neurocysticercosis

There was 1 male (12 years) and 1 female patient (45 years) in this study. In the study by Morgado *et al.*, there was no sex predilection in adults, whereas in children, M:F ratio was 1:2.[16] In all our cases, lesions were situated in the supratentorial compartment involving the corticomedullary junction. Almeida-Pinto *et al.* have also reported a similar distribution of disease.[17]

One lesion showed regular enhancement, well-defined outline thin wall and other lesions showed irregular wall enhancement and thick wall. Both the lesions were parenchymal. According to Carbajal *et al.*, CT showed ring-like enhancement in some stages of the disease and all were parenchymal.[18]

Metastases

CT is a safe investigative tool for the diagnosis of brain metastases in patients with malignant tumors. In our study, all the patients were above 40 years, metastatic lesions were more common in males than females (3:1). Same results were reported by Simionescu.[19]

All eight patients showed multiple lesions. Seven lesions were more than 10 mm size. On non-enhanced CT scan, 6 lesions were hypodense and hyperdense respectively and 4 lesions were isodense. In the literature also, these lesions are iso or hyperdense.[20,21] In this study, 2 lesions showed nodule and 1 lesion showed hemorrhage and cyst, respectively, and patients had associated hydrocephalus. Deck *et al.* studied 1100 patients with CT scan, of which 57 showed evidence of intracranial metastases and 14 showed evidence of hydrocephalus.[22] In our study, we did not encounter any calcification similar to other studies.[20,21] All 8 patients (100%) showed cerebral edema in our study. Potts *et al.* reported approximately 90% of lesions showed marked necrosis. Surrounding edema was usually moderate or marked.[23]

CONCLUSIONS

In this study, the most common etiology for ring-enhancing CT lesions are metastases (26.6%) followed by tuberculoma (23.3%) and glioma (23.3%), abscess accounted for 20.2% and neurocysticercosis accounted for 6.6% of lesions.

Considering the CT characteristics of tuberculoma, 62.5% of lesions were <10 mm in size. Single lesions were more than multiple. About 50% of lesions were seen in parietal region. About 62.5% of lesions showed irregular wall enhancement, ill-defined outline, thick wall, and heterogeneous enhancement on contrast. All abscesses were present below 40 years. About 66.6% of lesions were <10 mm and single cases were more than multiple. Lesions mostly involved subcortical and corticomedullary (44.4%) regions, 66.6% of lesions showed irregular wall enhancement, 55.5% of lesions had well-defined outline, 44.4% had thin wall, and 55% of lesions showed heterogeneous contrast enhancement. Majority (75%) of gliomas were more than 10 mm and single lesions were more than multiple, 75% of lesions involved subcortical region, 87.5% of lesions showed irregular wall enhancement with ill-defined outline, and 75% of lesions showed heterogeneous enhancement. In this study, metastases were diagnosed after 40 years. All cases showed multiple lesions, 62.5% of lesions involved the frontal and parietal regions, 43.5% were in corticomedullary junction, 75% of lesions showed irregular wall enhancement, 68.75% of lesions showed thick wall, and 62.5% showed heterogeneous enhancement. In the two cases of neurocysticercosis, both the lesions were single, located in frontal lobe and involved corticomedullary junction. All lesions were <10 mm in size, showed homogenous enhancement. One case was cystic in nature.

Hence, it is clear from this study that CT scan is useful in detecting multiplicity of lesions, mass effect on surrounding brain structures, and hydrocephalus. We conclude that

CT morphology characteristic of ring lesion is strongly suggestive of the diagnosis; however, they have to be corroborated by clinical history, laboratory investigation, and histopathological examination to arrive at a definite diagnosis.

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ETHICAL APPROVAL

Approval taken from the Institutional Ethics Committee.

REFERENCES

1. Claveria LE, du Boulay GH, Moseley IF. Intracranial infections: Investigation by computerized axial tomography. Neuroradiology 1976;12:59-71.
2. Seydoux C, Francioli P. Bacterial brain abscesses: Factors influencing mortality and sequelae. Clin Infect Dis 1992;15:394-401.
3. Osenbach RK, Loftus CM. Diagnosis and management of brain abscess. Neurosurg Clin N Am 1992;3:403-20.
4. Enzmann DR, Britt RH, Yeager AS. Experimental brain abscess evolution: Computed tomographic and neuropathologic correlation. Radiology 1979;133:113-22.
5. Zimmerman RD, Weignarten K. Neuroimaging of cerebral abscess. Nueroimaging Clin North Am 1991;1:1-16.
6. Whelan MA, Hilal SK. Computed tomography as a guide in the diagnosis and follow-up of brain abscesses. Radiology 1980;135:663-71.
7. Yamada K, Goto S, Kochi M, Ushio Y. Stereotactic biopsy for multifocal, diffuse, and deep-seated brain tumors using Leksell's system. J Clin Neurosci 2004;11:263-7.
8. Butler AR, Horii SC, Kricheff II, Shannon MB, Budzilovich GN. Computed tomography in astrocytomas. A statistical analysis of the parameters of malignancy and the positive contrast-enhanced CT scan. Radiology 1978;129:433-9.
9. Steinhoff H, Lanksch W, Kazner E, Grumme T, Meese W, Lange S, *et al*. Computed tomography in the diagnosis and differential diagnosis of glioblastomas. A qualitative study of 295 cases. Neuroradiology 1977;14:193-200.
10. Okazaki H. Neoplams and related lesions. In: Fundamentals of Neuropathology. 2nd ed, New York: Igaky-Shoin; 1989. p. 203-74.
11. Wood M, Anderson M. Chronic Meningitis. Neurological Infections; Major Problems in Neurology. Vol. 16. Philadelphia, PA: WB Saunders; 1998. p. 169-248.
12. Decastro CC, Hesselink JR. Tuberculosis. Neuroimaging Clin North Am 1991;1:19-39.
13. Bhargava S, Tandon PN. Intracranial tuberculomas: A CT study. Br J Radiol 1980;53:935-45.
14. Weisberg LA. Cerebral CT in intra cranial inflammatory disease. Arch Neural 1980;37:137-42.
15. Welchman JM. Computerised tomography of intracranial tuberculomata. Clin Radiol 1979;30:567-73.
16. Morgado C, Gomes LB, de Campos JG. Neurocysticercosis. An imaging analysis of 35 cases. Acta Med Port 1994;7:269-75.
17. Almeida-Pinto J, Veiga-Pires JA, Stocker A, Coelho T, Monteiro L. Cysticercosis of the brain. The value of computed tomography. Acta Radiol 1988;29:625-8.
18. Carbajal JR, Palacios E, Azar-Kia B, Churchill R. Radiology of cysticercosis of the central nervous system including computed tomography. Radiology 1977;125:127-31.
19. Simionescu MD. Metastatic tumors of the brain: A follow-up study of 195 patients with neurosurgical considerations. J Neurosurg 1960;17:361-73.
20. Alexander E 3rd, Loeffler JS. The case for radiosurgery. Clin Neurosurg 1999;45:32-40.
21. Davis PC, Hudgins PA, Peterman SB, Hoffman JC Jr. Diagnosis of cerebral metastases: Double-dose delayed CT vs contrast-enhanced MR imaging. AJNR Am J Neuroradiol 1991;12:293-300.
22. Deck MD, Messina AV, Sackett JF. Computed tomography in metastatic disease of the brain. Radiology 1976;119:115-20.
23. Potts DG, Abbott GF, von Sneidern JV. National cancer institute study: Evaluation of computed tomography in the diagnosis of intracranial neoplasms. III. Metastatic tumors. Radiology 1980;136:657-64.

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