Differential diagnosis of ring enhancing lesions in contrast enhanced CT and MRI with histopathological corelation: Indian study

Poster No.: C-1234
Congress: ECR 2013
Type: Educational Exhibit
Authors: B. Murali¹, A. J. B. Baxi², V. Spv¹; ¹Hyderabad, AP/IN,
²Hyderabad, An/IN
Keywords: CNS, CT, MR, Comparative studies, Infection, Pathology
DOI: 10.1594/ecr2013/C-1234

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys’ fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Learning objectives

1. To analyze and evaluate 'ring-enhancing' appearance as a sign in the differential diagnosis of neurological lesions in the brain.
2. To distinguish between neoplastic and non-neoplastic peripheral enhancing or ring like lesions on contrast enhanced CT or MRI
3. Clinical and pathological correlation of ring lesions with patients mode of presentation, etiological factors, outcome and mode of management.

Background

Forty patients diagnosed with ring enhancing lesions on CT and MRI studies, admitted to Care Hospitals, Hyderabad, India were included in this retrospective study.

Neuroimaging studies were done with multi detector computed tomography (MDCT) or 1.5 T magnetic resonance imaging (MRI) with contrast as was indicated. Ancillary investigations like X-ray chest, USG of abdomen, and CT scan of chest, abdomen was done whenever the clinical situation demanded.

Imaging findings OR Procedure details

Ring Enhancing Lesions:

May be single or multiple, unilocular or multilocular

Causes:

- **Bacterial**- Tuberculoma, Pyogenic abscess
- **Fungal**- Histoplasmosis, Aspergilosis, Nocardiosis, Mucormycosis
- **Parasitic**- Neurocysticersosis, toxoplasmosis, Amebic abscess, Echinococcosis
- **Neoplastic**- Primary brain tumors, Metastasis Primary CNS Lymphoma in AIDS
- **Demyelination**- Multiple sclerosis, Tumefactive demyelination
- **Others**- Subacute infarct, Resolving hematoma, Cavernous hemangioma, Radiation necrosis, Aneurysm with central hthrombus, post operative, ADEM, Sarcoidosis

- **Pattern of contrast enhancement**: Fig.1,2.
• Benign:
  • Round and convex
  • Smooth, uniform
  • Thin (<20mm)
• Malignant:
  • Undulating
  • Irregular, variable
  • Thick (>20mm)

• Tuberculoma: Fig. 3, 4.
Intracranial tuberculoma can occur with or without tuberculous meningitis. Multiple tuberculomas are common with miliary pulmonary tuberculosis. The enhancing lesions usually ranges from 1 mm to 2 cm.

CT:
° Hypodense to hyperdense round or lobulated nodule/mass with moderate to marked edema
° Ca++ uncommon (approximately 20%)
° TBM: Isodense to hyperdense basal exudate effaces CSF spaces, fills basal cisterns, sulc
° CECT
° Tuberculoma: Solid or ring-enhancing T
° "Target sign": Central Ca++ or enhancement
° TBM: Prominent leptomeningeal and basal cistern enhancement (fig.4)
° Ependymitis: linear periventricular enhancement
° Ventricular dilatation due to hydrocephalus may be seen
° Often, low-attenuating focal infarcts in the deep gray matter nuclei, deep white matter, and pons; these resul
from associated vasculitis.

**MRI:**

° Non-caseating tuberculoma: Hyperintense on T2 and slightly hypointense on T1-weighted images

° Caseating tuberculoma: Iso- to hypointense on both T1 and T2-weighted images, with an iso- to hyperintense rim on T2-weighted images.

° **CEMR:** Nodular or ring-like enhancing lesions

° **Magnetization transfer MRI:** A higher number of tuberculomas is seen on the magnetization transfer magnetic resonance images compared with routine spin echo images. Magnetization transfer MRI has also been found to be effective in the reliable differentiation of tuberculomas from cysticercosis

**Neurocysticercosis:** Fig. 5, 6.

• Caused by the larva of *Taenia solium*, is the most common parasitic infection of the central nervous system. The lesion can be located anywhere within the CNS, though the parenchymal corticomедullary junction is the most common site in the brain. Imaging reveals the four distinct stages of neurocysticercosis which are pathognomonic. Usually, the lesions are <20 mm in diameter. Calcified eccentric scolex is often seen in a cysticercal lesion. The lesions are often multiple and most often do not have extensive edema.

**CT:**

• Vesicular stage (viable larva): Cystic lesion with a central hyperdense "dot" (nodule), representing the scolex. No edema or enhancement

• Colloidal vesicular stage (degenerating larva): Degenerating larva induces edema. Hyperdense cyst with thicker ring-enhancing fibrous capsule

• Granular nodular (healing) stage: Mild edema. As the lesion heals, it becomes isodense or mildly hyperdense with a calcified scolex. Involuting enhancing nodule and edema are both characteristic.
• Nodular calcified stage: The final stage. Shrunken, calcified nodule without edema or enhancement
• Subarachnoid lesions: Multiple isodense cysts without scolex, may cause meningitis
• Intraventricular cysts: not well seen on CT, may see hydrocephalus

MRI:
• Vesicular stage: Cystic lesion isointense to CSF on T1 T2 and FLAIR. May show discrete, eccentric hyperintense scolex No surrounding edema
• Colloidal vesicular stage: Cyst is mildly hyperintense to CSF on T1,T2 and FLAIR (useful to detect intraventricular cysts)
• Surrounding edema, mild to marked
• Granular nodular stage: Thickened, retracted cyst wall; edema decreases
• Nodular calcified stage: Shrunken,hypodense Ca++ lesion
• T1 and FLAIR useful to detect intraventricular cyst
• T2* GRE: Useful to demonstrate calcified scolex
• DWI: Cystic lesion typically isointense to CSF

CMR
• Vesicular stage: No enhancement typical, May see discrete, eccentric scolex enhancement
• Colloidal vesicular stage: Thick peripheral enhancement with enhancing marginal nodule (scolex)
• Granular nodular stage: May have nodular or ring-enhancement
• Nodular calcified stage: Small calcified lesion, rare minimal enhancement
• Intraventricular cysts may cause ventriculitis and/or hydrocephalus.

• Abscess:Fig.7
• Most abscesses occur in the supratentorial region in the frontal or parietal lobes at the gray-white interface.Up to 14% occur infratentorially. Brain abscess has:
  • Thin uniform wall (2-7mm),
  • Smooth inner and outer margins
  • Convex all around
  • Homogeneous center
  • Rim of surrounding Edema

MRI:
• Capsule is isointense or hyperintense to white matter on T1 and hypointense on T2
• Area of Central Necrosis- Low signal on T1,high signal on FLAIR and T2 (low density on CT)
• Restricted Diffusion
• MRS :Central necrotic area shows, alanine ,succinate and acetate peaks
• Contrast#enhanced CT and MR:
• Well defined rim of enhancing capsule with low density/intensity center

- **Necrotic Tumor vs. Pyogenic Abscess: Differentiation by DWI and ADC**
  - Necrotic Tumor: Decreased signal intensity on DWI. Increased signal intensity on ADC maps
  - Pyogenic Abscess: Increased signal intensity on DWI Markedly decreased signal intensity on ADC maps

- **Glioma:** Fig.8
  - Most of the tumors are large in size, are often located deep in the white matter. Primary brain tumors frequently cross the midline.
  - CT or MRI: Expansile mass with central necrosis
  - Large surrounding vasogenic edema
  - CT:
    - Typically heterogeneous
    - Lobulated
    - Calcification, occasionally
    - Necrosis and hemorrhage
  - **MRI:**
    - Tumor Nidus, hypointense on T1 and hyperintense on T2
    - T1 hyperintensity, if hemorrhage is present
  - **CE CT / MR:** Ring enhancement
    - Thick irregular.
    - Shaggy inner margin.
    - Multilocular ring patterns.
    - Large enhancing cystic wall with a brightly enhancing mural nodule (Pilocytic astrocytoma)

- **Metastasis:** Metastatic lesions are single or multiple, typically subcortical, occurring in or near the gray matter-white matter junction, and are usually associated with severe perilesional edema.
  - **CT**
    - Iso to hypodense, Hyperdense if hemorrhagic
    - Intense nodular or ring enhancement
  - **MRI**
    - **T1:**
      - Typically iso to hypointense
      - Hyperintense - Hemorrhagic metastases and Melanoma have intrinsic high signal
      - Enhancement - Punctate, or ring-enhancing, usually intense. Delayed sequences may show additional lesions, CE MR is the current standard for small metastases detection.
  - **T2 and FLAIR**
    - Typically hyperintense
• **Ganglioglioma**: Fig.10.
  - Partially cystic, enhancing, cortically-based mass in child/young adult with temporal lobe epilepsy
  - Location - Most commonly, temporal lobe
  - Typically 2-3 cm in adults, Larger 4-6 cm in children
  - Calcification (35-50%)
  - **CT**: Variable density
    - 40% hypodense, 30% mixed hypodense (cyst), isodense (nodule)
    - 15% isodense or hyperdense
  - **CECT**
    - Approximately 50% enhance
    - Varies, rim or nodular
  - **MRI**:
    - TIWI-Hypointense to isointense to gray matter
    - May see associated cortical dysplasia
    - T2WI- Hyperintense mass typical
    - 2* GRE: May show Ca++ as areas of "blooming"
    - Contrast CT/MR-
      - Variable enhancement, nodular or ring-like

• **Demyelinating disorders**: Fig.11,12
  - Hypodense on CT
  - Multiple enhancing ring lesions are encountered in several active demyelinating disorders.
  - Open or incomplete ring enhancement. Rim is hypointense on T1. Fig 11.
  - No mass effect
  - Little or no vasogenic edema
  - Tumefactive demyelinating lesions are large (usually 2 cm) Fig 12.
  - Vessel-like structures running through the center of lesions on dynamic T2*

• **Resolving hematoma**: Fig.13
  - **CT-Hypo/Hyperdense with mild edema and mass effect**
  - **MRI-Deoxy-Hb:** Isointense on T1 and hypointense on T2
  - Extracellular methemoglobin (subacute): Bright on T1- and T2
  - Hypointense foci "bloom" of T2*GRE
  - **CECT/MRI** Uniform rim of enhancement

**Images for this section:**
Fig. 1: Appearance of ring enhancement in benign and malignant lesions.
Fig. 2: Different pattern of ring enhancement in brain.
Fig. 3: Tuberculomas: Multiple small confluent ring enhancing lesions with perilesional edema.
Fig. 4: Tuberculous Meningitis: CECT shows leptomeningeal and multiple small ring enhancement.

Fig. 5: Multiple Neurocysticercosis: Sagittal T1 contrast shows different stages of cysticercal lesions.
Fig. 6: Cysticercosis: Ring enhancing lesion in high parietal lobe with eccentric hyperintense "dot" (Vesicular stage)
Fig. 7: Pyogenic Abscess: Contrast CT show a large smooth peripheral enhancing lesion in left temporal lobe. Note - the inner and outer wall are smooth suggest benign lesion.
Fig. 8: Pilocytic Astrocytoma: Cystic right cerebellar lesion showing with rim enhancement and focal nodular homogenous enhancement.
**Fig. 9:** Hemangioblastoma: MRI large right cerebellar cystic mass with vascular mural nodule and rim enhancement.
**Fig. 10:** Ganglioglioma: Young patient presented with temporal lobe epilepsy. Coronal T1 CEMR shows a small ring enhancing lesion in left medial temporal lobe proved to be ganlioglioma.
Fig. 11: Multiple sclerosis: Sagittal T2 shows MS plaques with typical perpendicular orientation at callososeptal interface (Dawson finger’s) and subcortical white mater. Contrast T1 sagittal and axial images show typical enhancing plaques in brain and cervical cord.
Fig. 12: Incomplete ring sign: Open or incomplete ring enhancement. The rim is hypointense on T1 -Tumefactive demyelination

Fig. 13: Resolving Hematoma:Axial CT shows hyperdense hematoma.CEMR shows enhancement around the hematoma.
**Fig. 14:** Difference between Benign and malignant lesions: CECT shows smooth, uniform, thin ring enhancement in abscess and irregular, undulating, thick wall enhancement in tumor.
Conclusion

This work provides a comprehensive overview of spectrum of the classic patterns of ring enhancing lesion in the brain.

Ring-enhancing lesions of the brain remain a diagnostic challenge. An attempt has been made to establish the etiological diagnoses of ring-enhancing lesions of the brain using neuroimaging (CT and MRI) and by clinical findings with histopathological correlation.

Our study establishes the role of TB as the leading cause of ring-enhancing lesions in the Indian setup as compared to tumors in the Western world. It might serve a basis for early recognition and intervention in these patients. Often, diagnostic challenge is stiffer than expected, and exact diagnosis is not forthcoming even after radiological evaluation. In a majority of such cases, biopsy of the brain lesions remains the only option to establish early diagnosis.

On the basis of our experience we suggest that in patients with multiple ring-enhancing lesions of the brain a CSF examination and imaging of chest should always be performed. The work-up of these patients should include clinical evaluation, imaging and laboratory tests.

References


Young RJ, Sills AK, Brem S, Knopp EA. Neuroimaging of Metastatic Brain Disease. Neurosurgery 2005;57:S4-10-S4-23


**Personal Information**

Belman Murali MD, Sr.Consultant Radiologist, Dept. of Radiology, Care Hospitals, hyderabad, India.

drbelmanmurali@gmail.com

Srpathi Pandit Vidyasagar DMRD, DNB, Sr.Consultant Radiologist, Dept. of Radiology, Care Hospitals, hyderabad, India.

spvvs007@gmail.com

Ameya Jagadish Baxi DMRD, DNB, Consultant Radiologist, Dept. of Radiology, Care Hospitals, hyderabad, India.

ameyabaxi@gmail.com