Assessment of a Ring-Enhancing Intracranial Mass: Abscess or Tumor?

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Patient J.B.: HPI

HPI:

• 53 yo woman with h/o non-Hodgkin’s Lymphoma 4 years ago s/p chemotherapy treatment.

• P/W HA, progressive Right-sided weakness X 36 hours, and slurred speech with word-finding difficulties.

• Denied fever, chills, N/V, diarrhea, productive cough.
Patient J.B.: CT Head Showing Diffuse Edema

Subcortical white matter hypodensity.

Loss of gray-white junction.

Effacement of sulci.

These findings are suggestive of diffuse edema.

Courtesy Dr. Rafeeque Bhadelia
Patient J.B. CT Head Showing Ovoid Lesion

Ovoid lesion with an isoechoic rim.
Patient J.B. had an MRI to better evaluate the abnormality seen on her Head CT.
Patient J.B.: MRI Showing A Hypointense Area

Area of Hypointensity.
Patient J.B.: MRI Showing A Ring-Enhancing Lesion

Enhancement in the sulci and subdural space.

Ring of enhancement around an area of hypointensity.

Next, let’s take a look at the FLAIR images…
Patient J.B.: MRI #1 Showing Vasogenic Edema and Mass Lesion

Vasogenic edema.

Left parieto-occipital mass.

MRI T2 FLAIR

Courtesy Dr. Rafaeque Bhadelia
Patient J.B.: MRI #2 Showing Vasogenic Edema and Mass Lesion

Vasogenic edema.

Parieto-occipital mass.

Courtesy Dr. Rafeeqe Bhadelia
Given our patient’s history, what is the differential diagnosis for this lesion?

How can we determine the differential?
Assessment of Intracranial Lesions

• Intraaxial or Extraaxial?
  - Intraaxial masses are completely surrounded by brain.
  - Metastases
  - Intracranial hemorrhages
  - Primary intracranial tumors (i.e. glioblastoma)
  - Abscesses
  - Extraaxial masses have a broad dural surface.
  - Subdural and epidural hematomas
  - Meningiomas
  - Neuromas
  - Dermoid or Epidermoid cysts

• Solitary or Multiple?
  - Solitary – due to a localized process.
  - Multiple – due to systemic or widespread disease.
Assessment of Intracranial Lesions Cont.

- **Involvement of the Gray Matter, White Matter or Both?**
  - Gray matter lesions ➔ infarct, trauma or encephalitis.
  - White matter expansile lesion associated with vasogenic edema ➔ tumor, abscess, or hematoma.
  - White matter expansion with gray matter involvement means cytotoxic edema is present ➔ infarct, trauma, or encephalitis.

- **Distribution?**
  - Vascular vs. traumatic vs. encephalitis.

- **Pattern of Contrast Enhancement?**
  - Enhancement = breakdown of the blood-brain barrier. Consider malignancy, infarct, encephalitis, hemorrhage, or abscess.
Our patient’s lesion appears to be intraaxial, solitary, involving the white matter and has surrounding vasogenic edema. It also exhibits ring-enhancement and associated leptomeningeal and pachymeningeal enhancement.
What is the differential diagnosis for a ring-enhancing brain lesion?
Differential Diagnosis of Ring-Enhancing Lesions

- Metastasis
- Abscess
- Gliomas
- Infarct
- Contusion
- Demyelination
- Radiation necrosis
DDX of Ring-Enhancing Lesions Cont.:

• Review of 221 cases by Schwartz et al. → 40% gliomas, 30% metastases, 8% abscesses, 6% demyelinating disease.

• 45% of metastases and 77% of gliomas were single lesions.

• Multiple lesions seen in 75% of abscess cases and 85% of MS cases.

• Deep white matter lesions with mass effect and vasogenic edema were usually primary neoplasms or abscesses.
Imaging Characteristics

- Gliomas
- Metastatic Disease
- Abscesses
Imaging Characteristics: Gliomas on MRI

- **CT or MRI**
  - Expansile mass with central necrosis.
  - Large surrounding region of vasogenic edema.

- **Ring Enhancement**
  - Thick irregular.
  - Shaggy inner margin.
  - Multilocular ring patterns.

- **Noncontrast CT**
  - Typically heterogeneous.
  - Lobulated.
  - Marked surrounding white matter edema.
  - Calcifications occasionally.
  - Necrosis and hemorrhage common.

- **MRI**
  - Tumor Nidus shows T1 and T2 prolongation (dark on T1 and bright on T2).
Companion Patient #1: Gliomablastoma Multiforme on MRI

MRI T1 with contrast

Expansile mass with central necrosis.

Surrounding vasogenic edema and mass effect.

Shaggy irregular ring-enhancement.

Smirniotopoulos J G et al. “From the Archives of the AFIP: Patterns of Contrast Enhancement in the Brain and Meninges.” Radiographics 2007;27:525-551
Imaging Characteristics: Metastatic Disease

• Intraaxial Metastases
  ➢ Lung, breast, melanoma, and colon carcinomas.

• Extraaxial Metastases
  ➢ Breast carcinoma, lymphoma, prostate carcinoma, lung carcinoma, and neuroblastoma.

• CT/MRI
  ➢ Classic appearance ➔ multiple foci at gray–white matter junction.
  ➢ Hypodense on CT.
  ➢ Hypointense on T1WIs.
  ➢ Variable signal intensity on T2WIs.
  ➢ Marked vasogenic edema surrounding each lesion.
  ➢ Intense nodular or ring enhancement.
Companion Patient #2: Metastatic Breast Cancer on MRI

MRI T1 with contrast

Ring-enhancing lesions near the cortex, deep gray matter, or the gray matter–white matter junction.

Smirniotopoulos J G et al. “From the Archives of the AFIP: Patterns of Contrast Enhancement in the Brain and Meninges.” Radiographics 2007;27:525-551
Imaging Characteristics: Abscess

• On Contrast-enhanced CT and MR
  ➢ Well defined rim of enhancement.
  ➢ Thin (2-7mm), uniformly convex, smooth inner and outer margins (late abscess).
  ➢ Capsule is isointense or hyperintense to white matter on T1.
  ➢ Capsule is hypointense to white matter on T2.

• Area of Central Necrosis
  ➢ Low density on CT.
  ➢ Low signal on T1.
  ➢ High signal on intermediate images, FLAIR images, and T2.

• Prominent surrounding vasogenic edema usually present.
Companion Patient #3: Intracranial Abscess on MRI

MRI T1 with contrast

Thin rim of enhancement with smooth inner margin.

Area of low signal representing central necrosis.

Smirniotopoulos J G et al. “From the Archives of the AFIP: Patterns of Contrast Enhancement in the Brain and Meninges.” Radiographics 2007;27:525-551
Companion Patient #3: Intracranial Abscess on MRI

MRI T2

Abscess wall.

Surrounding vasogenic edema and mass effect.

Smirniotopoulos J G et al. “From the Archives of the AFIP: Patterns of Contrast Enhancement in the Brain and Meninges.” Radiographics 2007;27:525-551
Notice the **abscess** wall is dark on T2, this is in contrast to the **Glioblastoma** where the wall of the lesion in bright on T2.

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Smirniotopoulos J G et al. “From the Archives of the AFIP: Patterns of Contrast Enhancement in the Brain and Meninges.” Radiographics 2007;27:525-551
Is the Mass a Tumor or an Abscess?

• Despite these differences distinguishing between a necrotic tumor and cerebral abscess is often difficult with CT or conventional MRI.

• Diffusion Weighted Imaging (DWI) and Apparent Diffusion Coefficient (ADC) mapping can help differentiate the two.

• Proton MR Spectroscopy - improving the accuracy of diagnosis with MR.
DWI and ADC

• DWI
  - Restricted motion of water molecules appears bright (CSF will be black).
  - As intracellular water increases (i.e. cytotoxic edema) → increased restriction of molecules relative to extracellular water → brighter on DWI.
  - With tumor, trauma, and infection, both intracellular and extracellular water may increase → gives an ambiguous appearance on DWI.

• ADC Maps
  - Accounts for T2 effects of extracellular edema and “subtracts” them out.
  - Bright on DWI and dark on ADC = true restricted diffusion.
Necrotic Tumor vs. Pyogenic Abscess: Differentiation by DWI and ADC

• Necrotic Tumor
  ➢ Decreased signal intensity on DW images.
  ➢ Increased signal intensity on ADC maps.

• Pyogenic Abscess
  ➢ Increased signal intensity on DW images.
  ➢ Markedly decreased signal intensity on ADC maps.
Now let’s return to our patient, J.B....
Patient J.B.: DWI and ADC Weighted MRI Scans

We can see from our patient’s images that the lesion is bright on the DWI (showing increased signal), and dark (indicative of low signal) on the ADC map. This is consistent with an abscess.

Courtesy Dr. Rafeeqe Bhadelia
The finding of an abscess impacted the patient's management. Instead of waiting until Monday to have surgery on a presumed metastatic lymphoma lesion, she underwent immediate surgery over the weekend. Her lesion was cultured and it grew Streptococcus milleri.
Abscess: Pathogenesis

- Direct spread from contiguous site:
  - 20-60% of cases.
  - Results in single focus of infection.
  - Usual sources of infection - subacute or chronic sinusitis, mastoiditis, otitis media, dental infections.

- Hematogenous spread:
  - Results in multiple abscesses, most commonly located in distribution of the middle cerebral artery.
  - Form at gray-white matter junction.
  - Sites of primary infection – bacterial endocarditis (2-4% of cases), lung abscess and empyema, skin, pelvic or intraabdominal infections, esophageal dilation and endoscopic sclerosis of esophageal varices, cyanotic congenital heart diseases.
Abscess: Pathogenesis Cont.

• Abscess development occurs over several weeks.

• Early Cerebritis:
  ➢ Lesion is poorly demarcated and associated with localized edema.
  ➢ Imaging characteristics are non-specific.

• Late Cerebritis → Capsule Stage:
  ➢ Occurs 1-2 weeks after infection.
  ➢ Increase in necrosis centrally, few organisms present.
  ➢ Capsule formation with collagen and reticulin.
  ➢ Surrounding vasogenic edema.
  ➢ Characteristic ring-enhancement is now evident.
Abscess: Etiology

- Depends on primary site of infection, patient’s age and immune-status.
- Most common → Anaerobes.
- Post-surgical/trauma → Staphylococcus aureus.
- Immuno-Comprised Hosts → Toxoplasma gondii, Fungal, Listeria, Parasitic.
- Also Gram-Negative Rods, Pneumococcus, Streptococcus, Nocardia, and Actinomyces.
- Streptococcus milleri – common, it possesses proteolytic enzymes that predispose to tissue necrosis and the formation of abscesses.
- No identifiable source in approximately 25% of patients.
Abscess: Presentation and Treatment

• **Manifestations:**
  - Symptoms may be mild or severe.
  - Headache.
  - Varying degrees of lethargy, obtundation, nausea, vomiting, and fever.
  - Fever absent > 50% of the time.
  - Meningeal signs present in 30% of patients.
  - Focal neurologic deficits, papilledema, nuchal rigidity, and seizures may develop rapidly (few days).
  - Elevated WBC count.
  - CSF findings are nonspecific, and usually not obtained because of the risk of lumbar puncture in the setting of a brain mass.

• **Treatment:**
  - Surgical aspiration or excision followed by antibiotic therapy.
  - Corticosteroids perioperatively to reduce intracranial pressure and prevent brain herniation.
  - Anti-epileptics for seizure prevention.
  - Small abscesses < 2.5 cm may respond to antibiotics alone.
  - Mortality rates 0-30%.
  - Early diagnosis and treatment are important to reduce morbidity and mortality!
MR Spectroscopy

• Often still difficult to distinguish an abscess from a necrotic/cystic tumor or metastasis with MRI and DW techniques.

• Conventional MR Imaging:
  - Diagnostic accuracy 61.4%.
  - Sensitivity 61.9%.
  - Specificity 60.9%.

• MR Spectroscopy determines chemical makeup of brain lesions.

• MR Spectroscopy - diagnostic accuracy in differentiating similar-appearing brain lesions ranges from 85-92%.

• When combined with conventional MR imaging and DW imaging:
  - Diagnostic accuracy 97.7%.
  - Sensitivity 95.2%.
  - Specificity 100%.

• Can identify causative organism based on the spectroscopic pattern:
  - Can identify Anaerobes, obligate aerobes or facultative anaerobes, Streptococcus, Staphylococcus, or Mycobacterial species.
Summary

• Characteristics (location, number, distribution, enhancement pattern) of an intra-cranial lesion are helpful in narrowing the differential.

• Conventional MR and DW imaging help differentiate an abscess from a necrotic/cystic tumor or metastasis.

• MR Spectroscopy increases the diagnostic accuracy of conventional MR and DW imaging in the identification of similar-appearing brain lesions.
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References


