



Empyema

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Empyema is a pyogenic intracranial infection of an extra-axial space. It probably occurs secondary to retrograde thrombophlebitis of emissary veins adjacent to the site of infection. In infants, empyemas occur more commonly as a complication of bacterial meningitis. In adults, empyemas can be seen after craniotomy, in the setting of severe sinusitis or mastoiditis, or after trauma. It is important to differentiate simple (reactive) effusions from infected effusions, because empyemas, especially if subdural, are a neurosurgical emergency.

Imaging Features

Empyema presents as a rim-enhancing fluid collection with associated meningeal inflammation and possible cerebritis/abscess. Findings on CT and MR parallel each other.

- CT:
 - Non-contrast: Intermediate density extra-axial fluid collection that is slightly more dense than CSF, but not as dense as blood products.
 - Contrast-enhanced: Rim-enhancing collection superficial to a cerebral or cerebellar hemisphere
 - If subdural—crescent-shaped, confined by dural reflections, and does not cross midline
 - If epidural—lens-shaped, crosses midline, and terminates at the sites of skull sutures
- MR:

- T1 Post-contrast:
 - Rim-enhancing extra-axial collection
- T2:
 - High signal intensity of the fluid collection
 - If complicated by adjacent thrombophlebitis then there will be abnormal bright signal in the involved vessel indicating occlusion or slow flow (“loss of the flow void”)
- FLAIR:
 - Intermediate signal intensity (compared to CSF, which should be completely suppressed and black)
- DWI/ADC:
 - The collection restricts diffusion (high signal DWI, low signal ADC).
- MRA/MRV:
 - Vascular complications include vasospasm, thrombophlebitis and mycotic aneurysm. Thrombophlebitis occurs more commonly with subdural empyema. Vascular complications may result in arterial or venous ischemia/infarct and/or intracranial hemorrhage.
 - Contrast-enhanced Angiography: Focal narrowing, aneurysm, or lack of opacification (occlusion) of the vessel.
 - Non-contrast Angiography: Narrowing, aneurysm, or absence of flow-related signal.

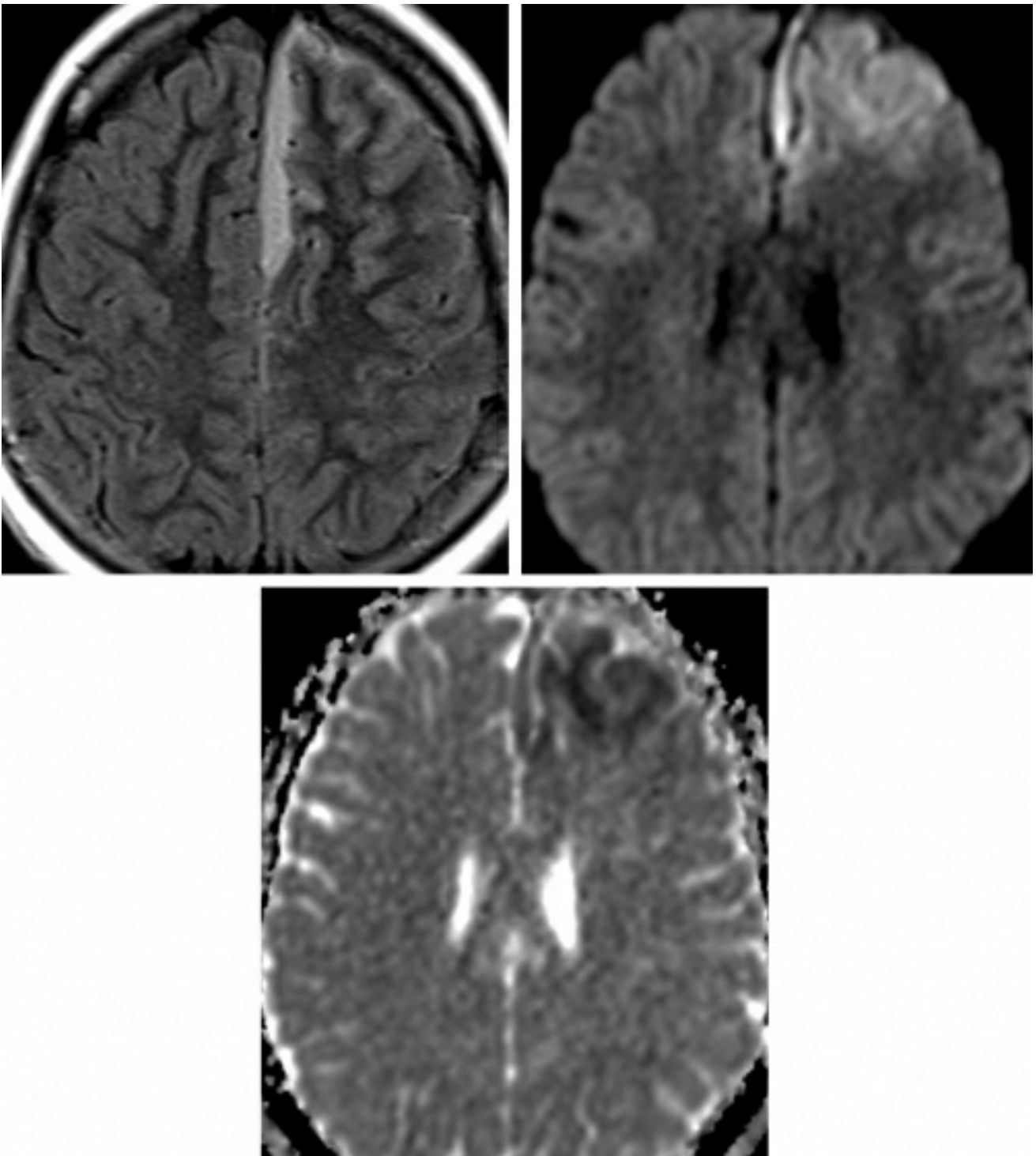


Figure 1: 10 year-old male with meningitis and subdural empyema. A subdural empyema in the left parafalcine subdural space is intermediate in signal intensity on FLAIR image (top row left) reflecting incomplete suppression of this fluid compared to CSF because of the cellular debris within the infected fluid. Also notice the subtly increased signal in the left frontal lobe cortex and leptomeninges likely representing a combination of cerebritis and early changes of ischemia and meningitis, respectively. The parafalcine collection also

demonstrates DWI hyperintensity (top row right) and ADC hypointensity (bottom row) representing the typical restricted diffusion in these collections. There is also restricted diffusion in the left frontal parenchyma that likely represents ischemic sequela of the empyema.

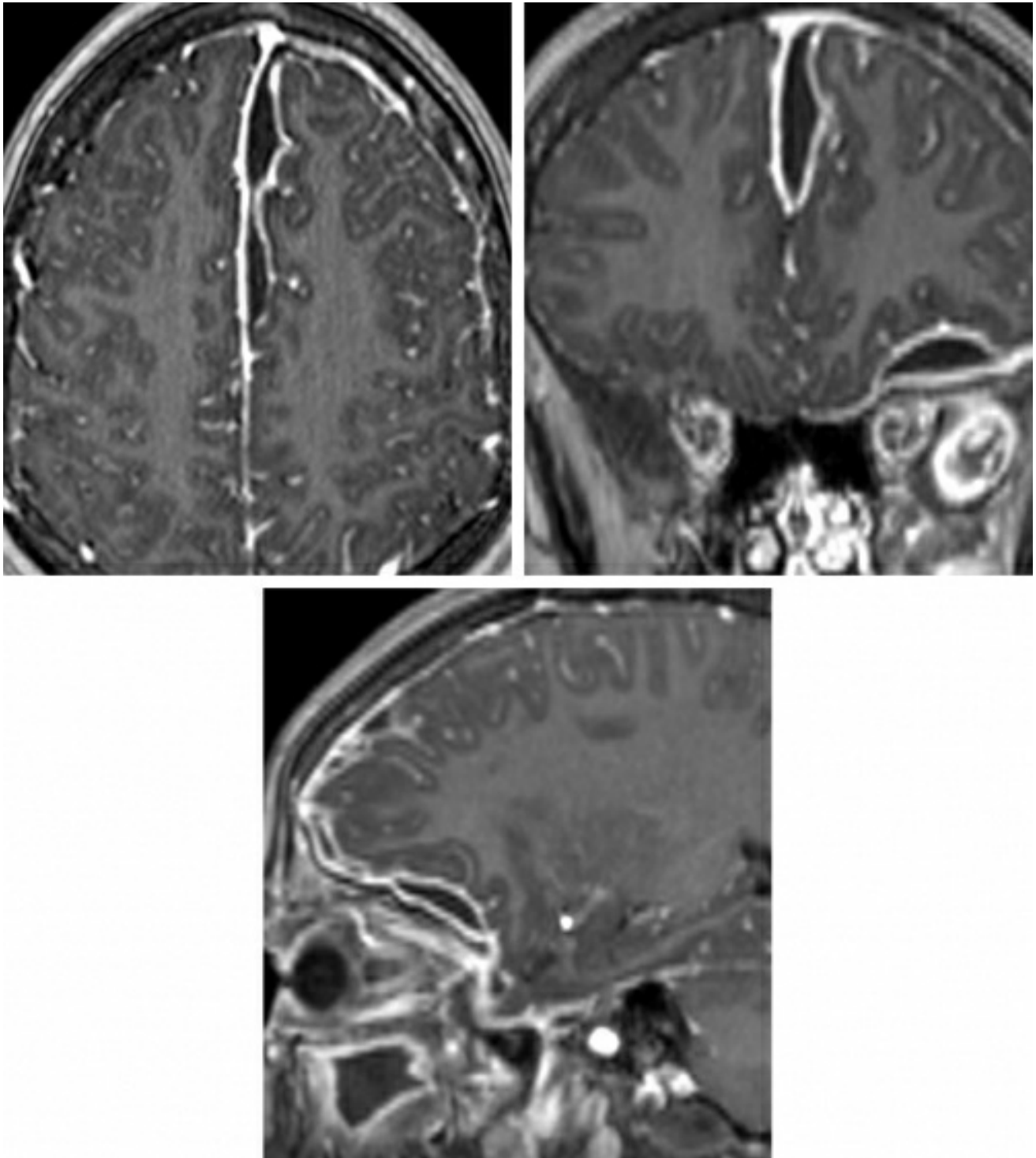


Figure 2: The T1 post-contrast sequences show loculation and avid peripheral enhancement of this same subdural collection

along the falx and along the inferior surface of the left frontal lobe. Also notice the thickening and enhancement of the adjacent meninges.

Differential Diagnosis

- Subdural or epidural hematoma
 - On CT, acute blood (days 1-3) is more dense than the adjacent grey matter but gradually becomes less dense. Blood is usually isodense in the subacute phase (3-21 days) and hypodense in the chronic phase (> 21 days), eventually falling to the density of CSF.
 - MRI
 - Extra-axial hemorrhage often demonstrates restricted diffusion, strongly mimicking empyema.
 - Similar to CT, there is a typical evolution of the appearance of blood products depending on the stage of hemoglobin metabolism (based on differences in magnetism of hemoglobin at different stages of metabolism).
 - The most sensitive sequence is FLAIR, which shows increased signal of blood products compared to CSF (at all stages), which is also similar to empyema.
 - In the absence of prior imaging for comparison, then differentiating empyema from hemorrhage may depend on the clinical scenario – fever, sepsis, post-surgical history favoring empyema and trauma, severe hypertension, use of anticoagulant/antiplatelet agents, or coagulopathy favoring hemorrhage.
- Simple effusion (reactive)
 - Classically these reactive effusions have signal more similar to CSF than the infected fluid (dark T1, bright T2,

dark FLAIR) and usually have no restricted diffusion.

- Subdural hygroma
 - CSF within the subdural space resulting from a rent in the dura
 - Signal intensity and density will be the same as CSF on all sequences, including lack of restricted diffusion
 - No abnormal surrounding enhancement

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