Characteristic Radiographic Features of MOG Antibody-Associated Disease (MOGAD)

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Objectives

1. Describe the spectrum of clinical phenotypes associated with MOGAD, including distinguishing features across the age spectrum
2. Identify key radiographic features that distinguish MOGAD from other neuroinflammatory disorders, with an emphasis on MRI findings across clinical phenotypes

MOGAD Overview

- Antibody-mediated CNS demyelinating disorder characterized by attacks of immune-mediated demyelination predominantly targeting the optic nerves, brain and spinal cord[1]
- Although overlap can occur between demyelinating disorders, MOGAD has distinct clinical and radiographic phenotypes which should prompt early evaluation for MOGAD
- Identification of characteristic features is essential to early diagnosis of MOGAD

MOGAD Overview

- Prevalence of MOGAD estimated at 2.5/100,000 people[2]
- No apparent sex difference or racial predisposition in the incidence of MOGAD[2]
- MOGAD appears to be monophasic in up to 50% of affected individuals[2]
- Diagnosis is made via identification of serum MOG IgG positivity via cell-based assay in the correct clinical setting

Clinical-Radiographic Phenotypes

Phenotypes include:

- Optic neuritis
- Myelitis
- ADEM (Acute Disseminated Encephalomyelitis)
- Cerebral monofocal or polyfocal deficits
- Brainstem or cerebellar deficits
- Cerebral cortical encephalitis[1,3]

Clinical-Radiographic Phenotypes

Clinical Radiographic Phenotypes vary with age:

- Extensive CNS involvement more commonly seen in children (e.g. ADEM or multifocal involvement)[1]
- Localized CNS involvement predominantly seen in adults (e.g. optic neuritis, myelitis)[1]

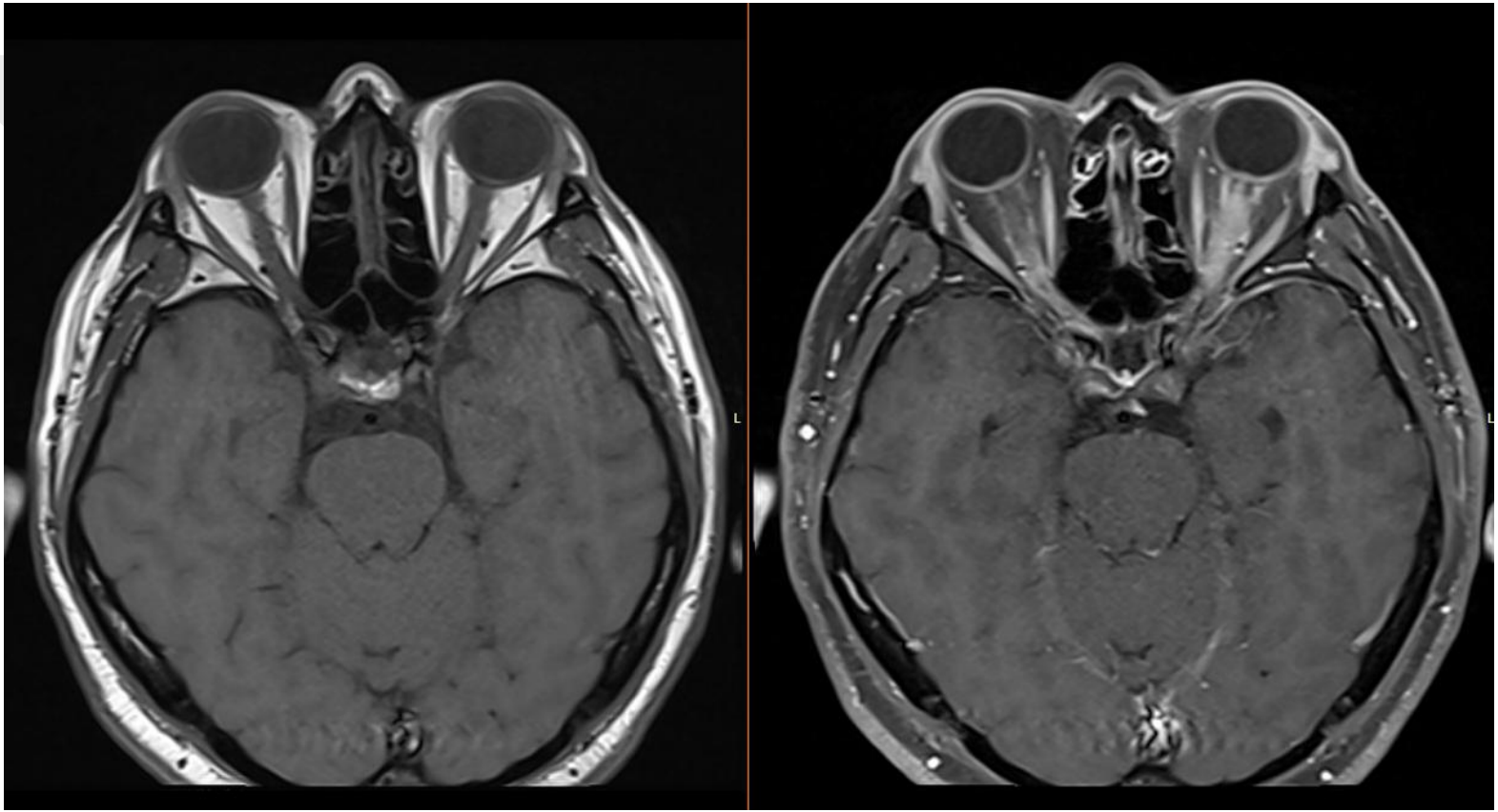
Clinical-Radiographic Phenotypes

- In adults, isolated **optic neuritis** is the most common phenotype (50-65%), often with bilateral simultaneous involvement, followed by myelitis (20-40%)[1]
- **ADEM** is the most common manifestation of MOGAD in children[1]
- The most common **overall** presentation in children and adults is optic neuritis[1]

Optic Neuritis

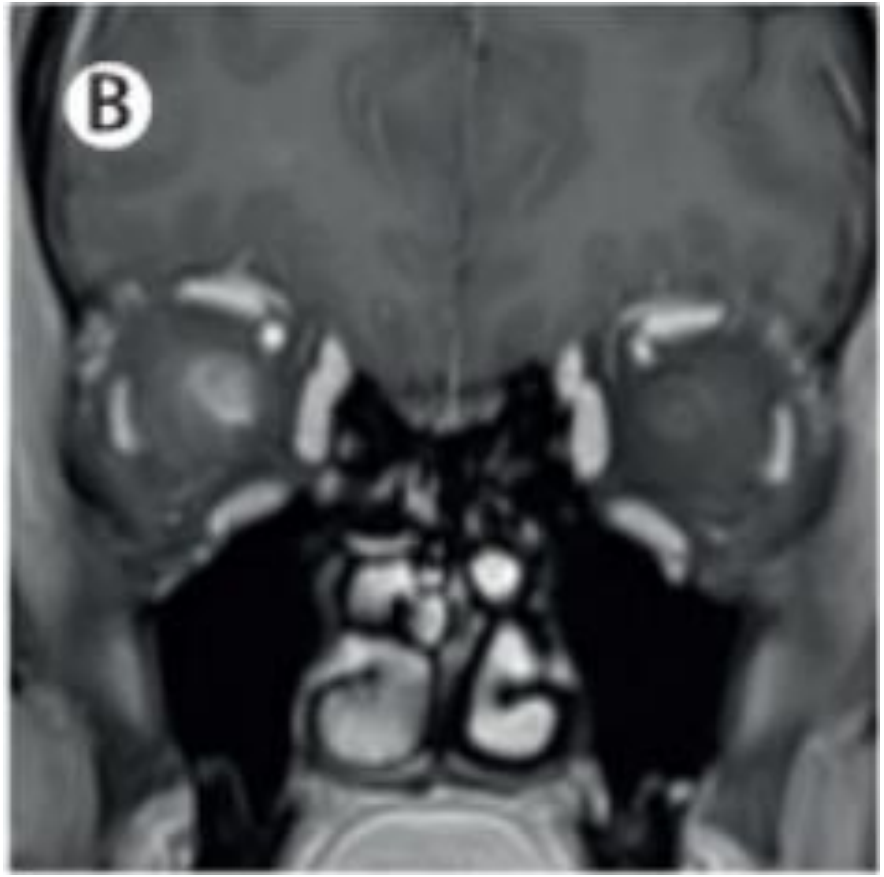
- Can be unilateral, but often **bilateral or rapidly sequential**[1,4]
- Often **long-segment** (greater than half the length of the optic nerve)[1,4]
- Often involves the **anterior** portion of the optic nerve
- Optic disc edema often seen, may be accompanied by peripapillary hemorrhage[1]
- Optic nerve sheath involvement (**perineuritis**) is common[1,4]

Optic Neuritis and Perineuritis



Axial T1 pre and post-contrast image with bilateral optic nerve and nerve sheath enhancement

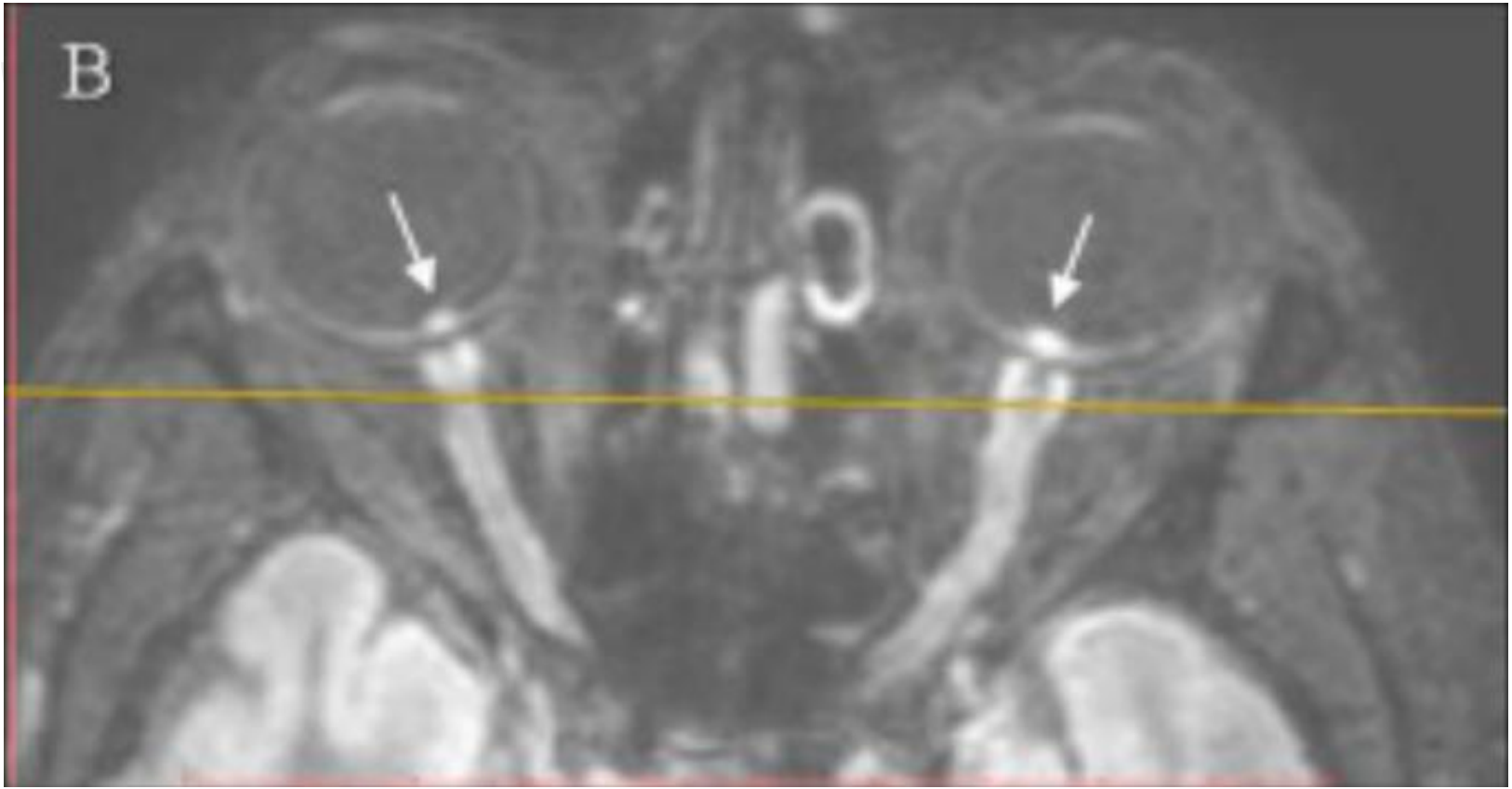
Optic Neuritis



Coronal T1-post contrast image with right optic nerve enhancement

Banwell et al., *The Lancet* 2023

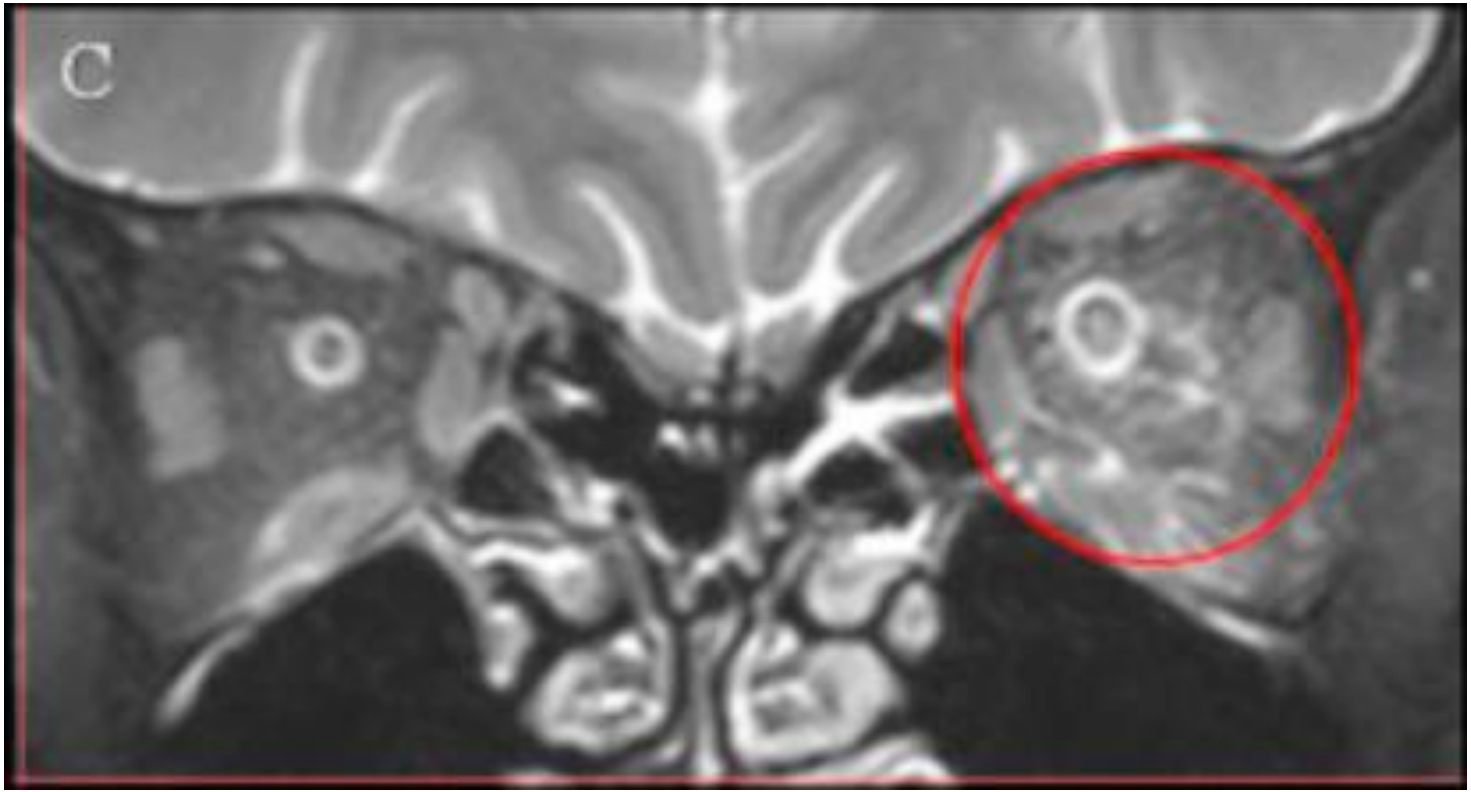
Papillitis



Axial FLAIR demonstrating bilateral swelling of the optic nerve heads

Deneve et al., *Journal of Neuroradiology,* 2019

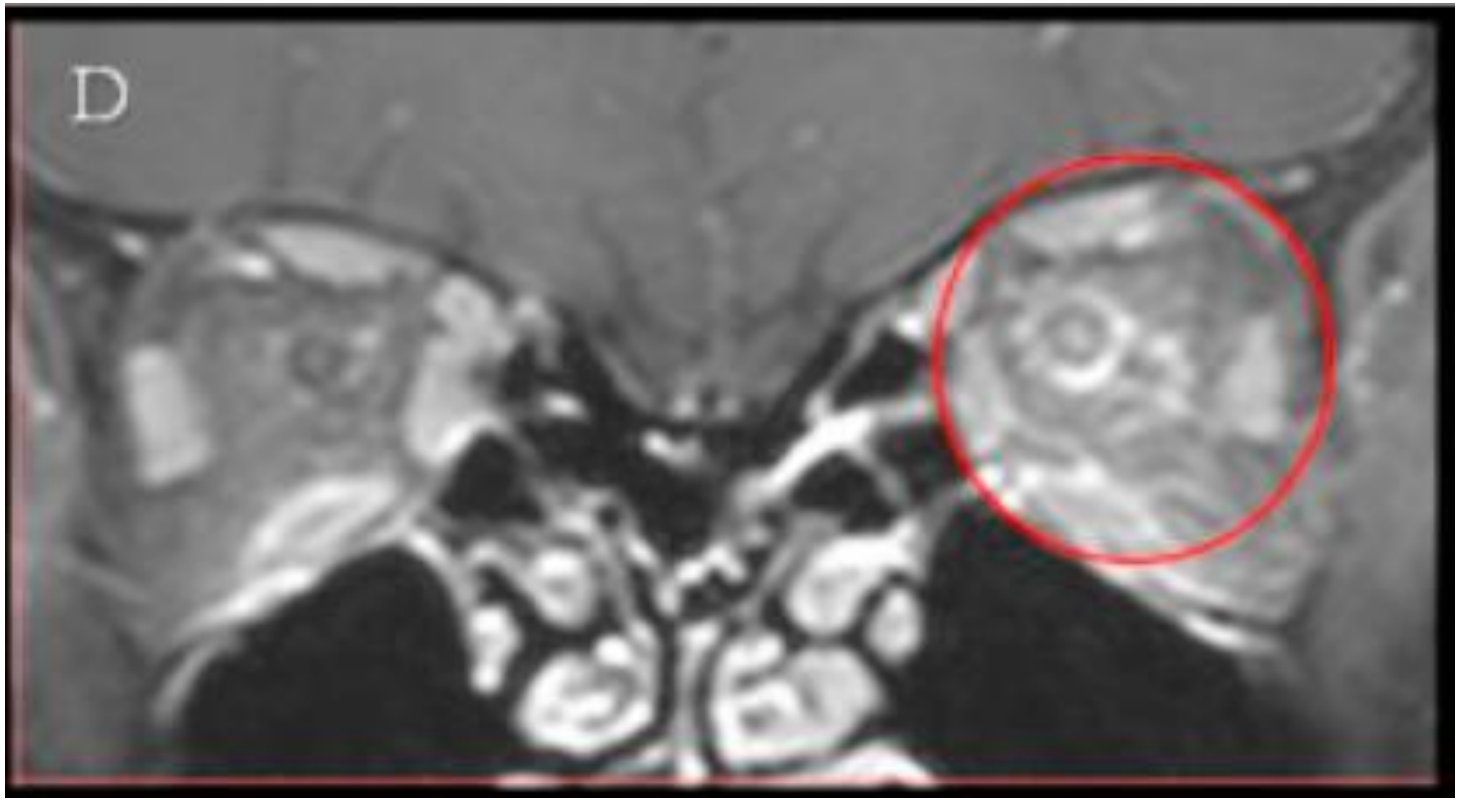
Optic Neuritis: intra-orbital fat involvement



Coronal T2 STIR MR orbit with T2 hyperintensity of the left optic nerve and inflammation of the surrounding intraorbital fat

Deneve et al., *Journal of Neuroradiology*, 2019

Optic Neuritis and Perineuritis



Coronal contrast-enhanced T1 MR orbit with enhancement of the intra-orbital left optic nerve and optic nerve sheath extending into the surrounding orbital fat

Deneve et al., *Journal of Neuroradiology*, 2019

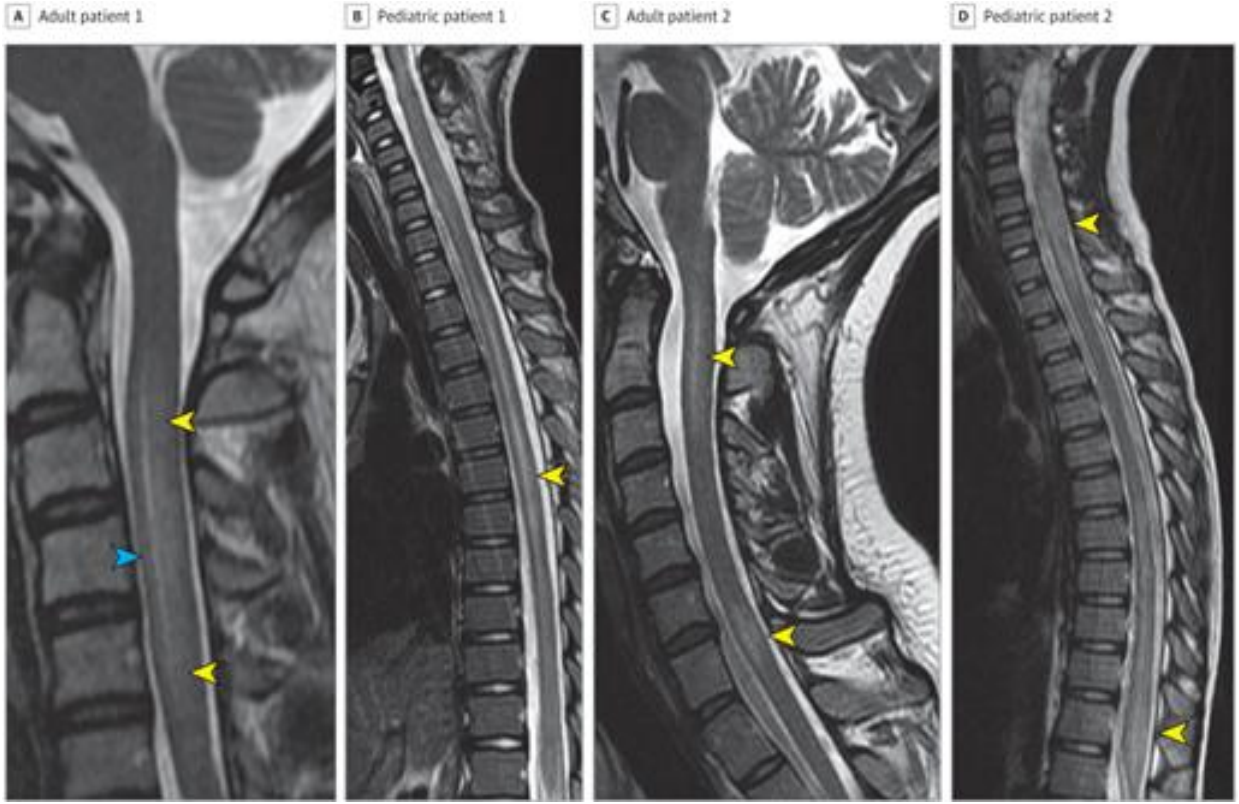
Myelitis

- Often **longitudinally extensive**: >3 vertebral segments in length[6]
- Short, eccentric lesions are possible[6]
- Can involve either the cervical/thoracic cord or both[6]
- Predilection for the **conus medullaris**[6]
- Often involves the **central** cord on axial view[1,6]

Myelitis

- **H-sign** on axial imaging is characteristic: T2 signal restricted to spinal cord gray matter[6]
- Associated with **T2 resolution** over time[6]
- Often non-enhancing but may demonstrate faint, patchy enhancement[6]

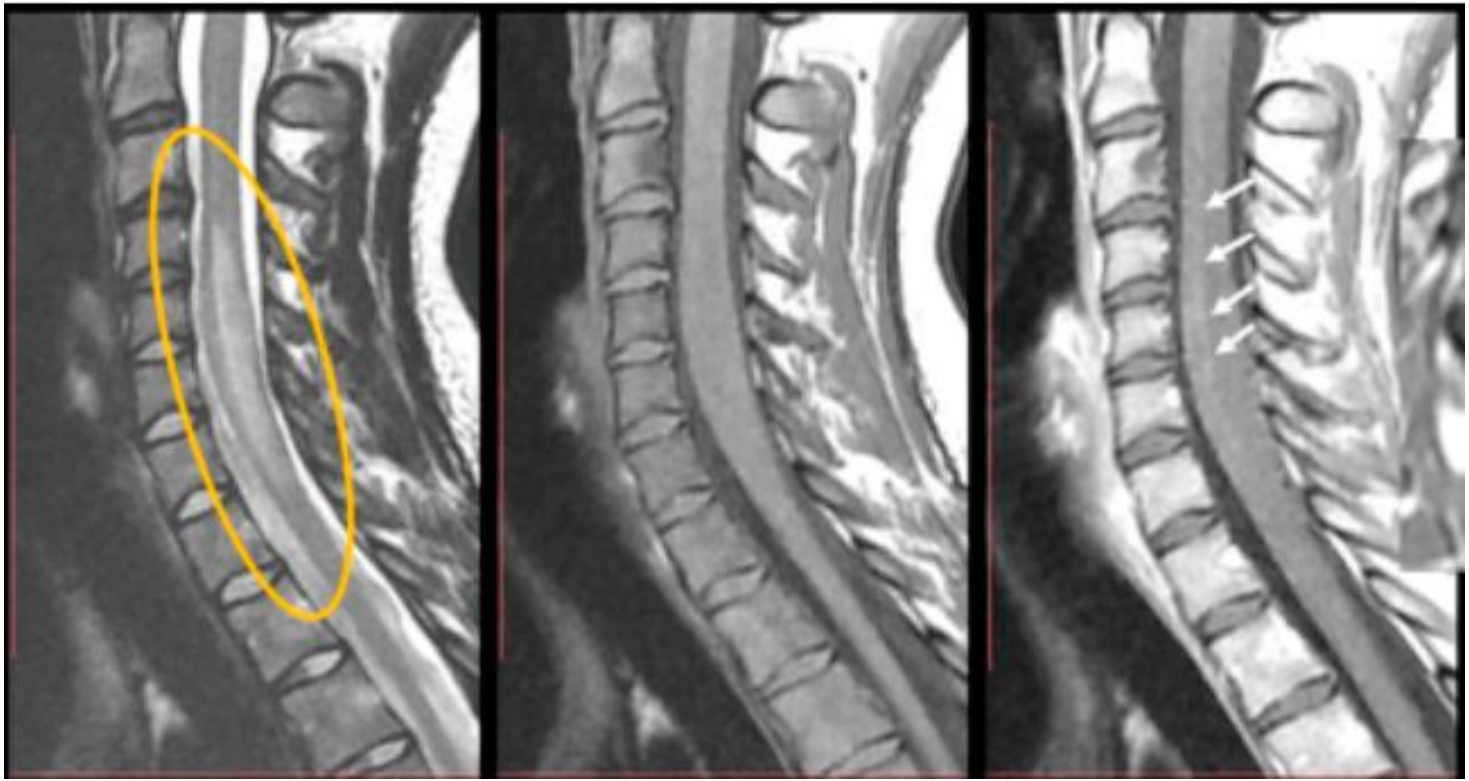
Myelitis



Sagittal T2-weighted images with longitudinally extensive T2 lesions of the spinal cord

Dubey et al., *JAMA Neurol.* 2019

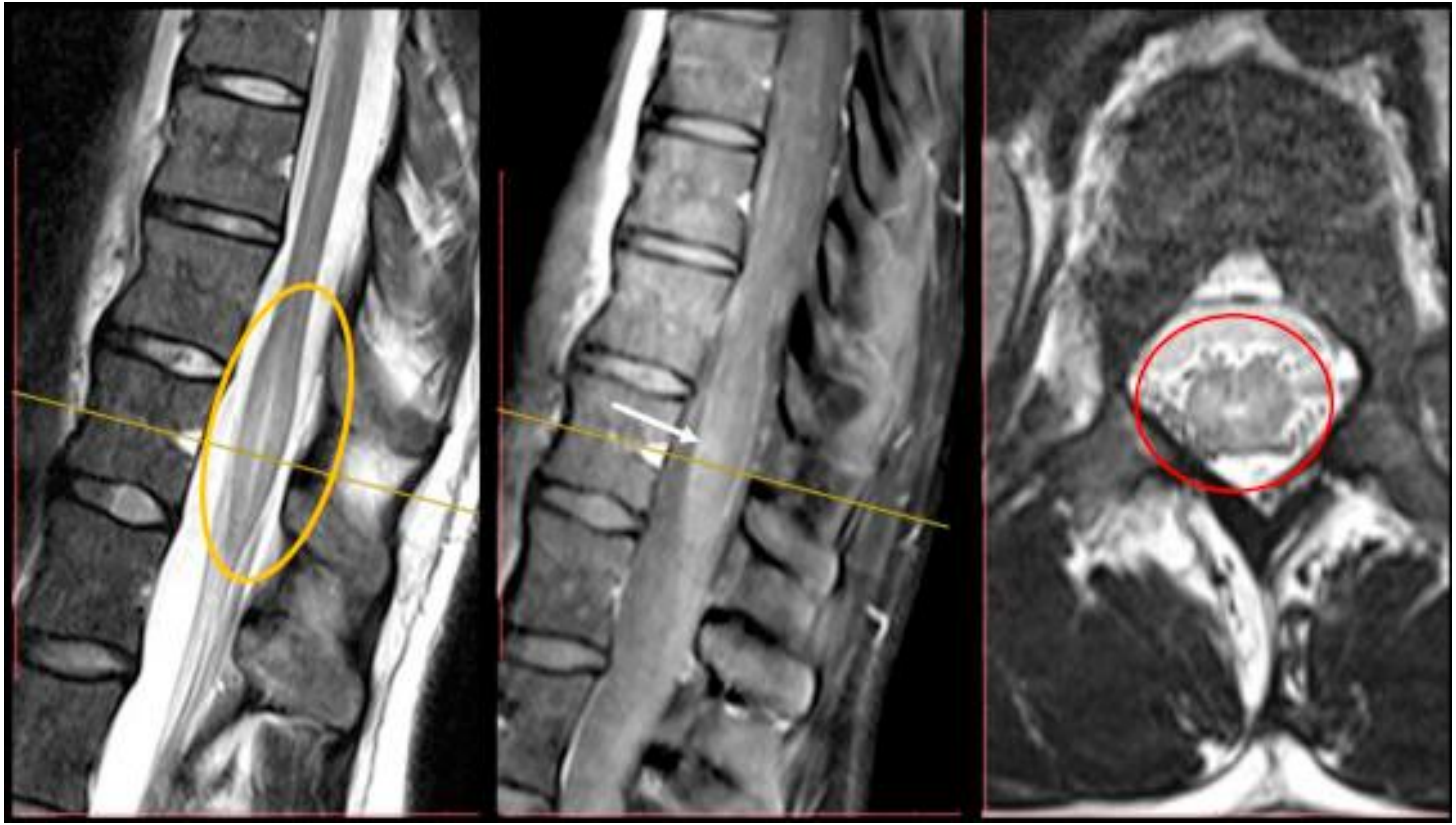
Myelitis



A) Sagittal T2-weighted B) Sagittal T1-weighted and C) sagittal T1-post contrast images with a longitudinally extensive T2 hyperintense lesion which is T1 isointense and associated with “pencil-thin” ependymal enhancement

Deneve et al., *Journal of Neuroradiology*, 2019

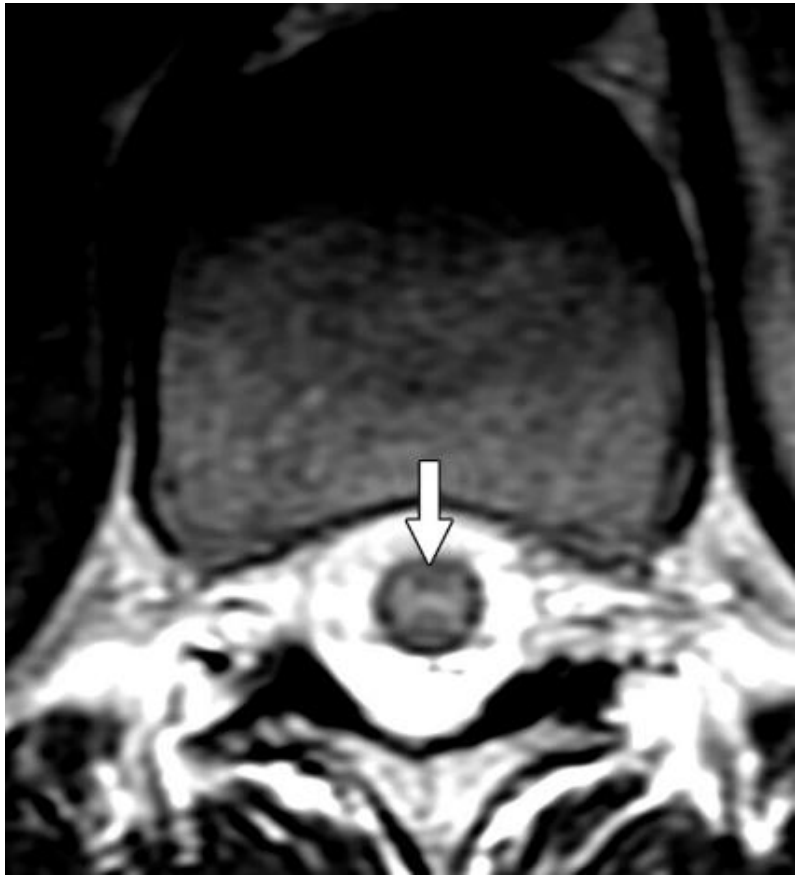
Conus Myelitis



A) Sagittal T2-weighted B) Sagittal T1 fat-suppressed C) Axial T2-weighted images with a short-segment lesion of the lumbar cord and conus

Deneve et al., *Journal of Neuroradiology*, 2019

H-Sign



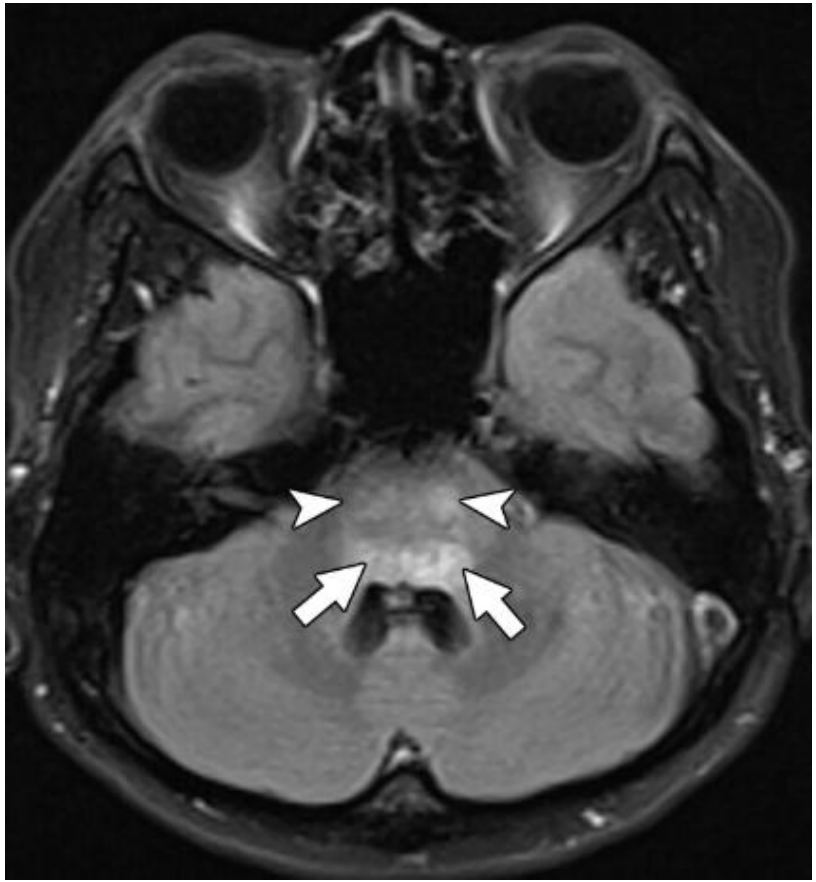
Axial T2-weighted MR image of the spinal cord with hyperintense lesions restricted to the gray matter

Shahriari et al., *American Journal of Roentgenology*, 2021

Cerebral, Brainstem or Cerebellar Lesions

- Typically large, **“fluffy”**, and **poorly demarcated** with **ill-defined margins**[1]
- Predilection for supratentorial white matter, juxtacortical/cortical regions, deep gray nuclei, middle cerebellar peduncle, periventricular (4th ventricle)[1]
- Supratentorial lesions can involve the white matter, deep gray nuclei and cortex[1]
- May be monofocal or multifocal
- Often associated with heterogenous, nodular enhancement[1]

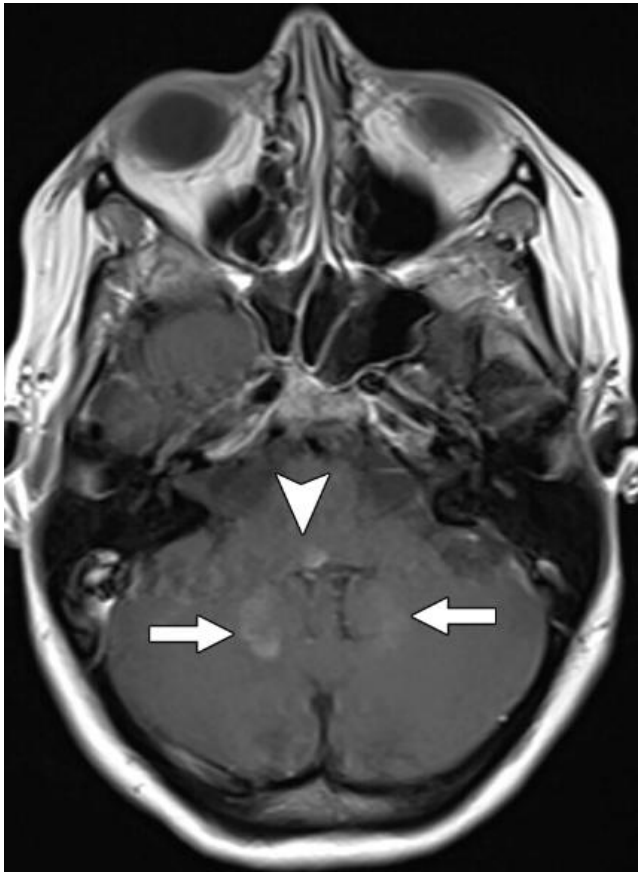
Brainstem Lesions



Axial T2 FLAIR magnetic resonance image demonstrating poorly demarcated FLAIR hyperintensities affecting the central and dorsal pons

Shahriari et al., *American Journal of Roentgenology,* 2021

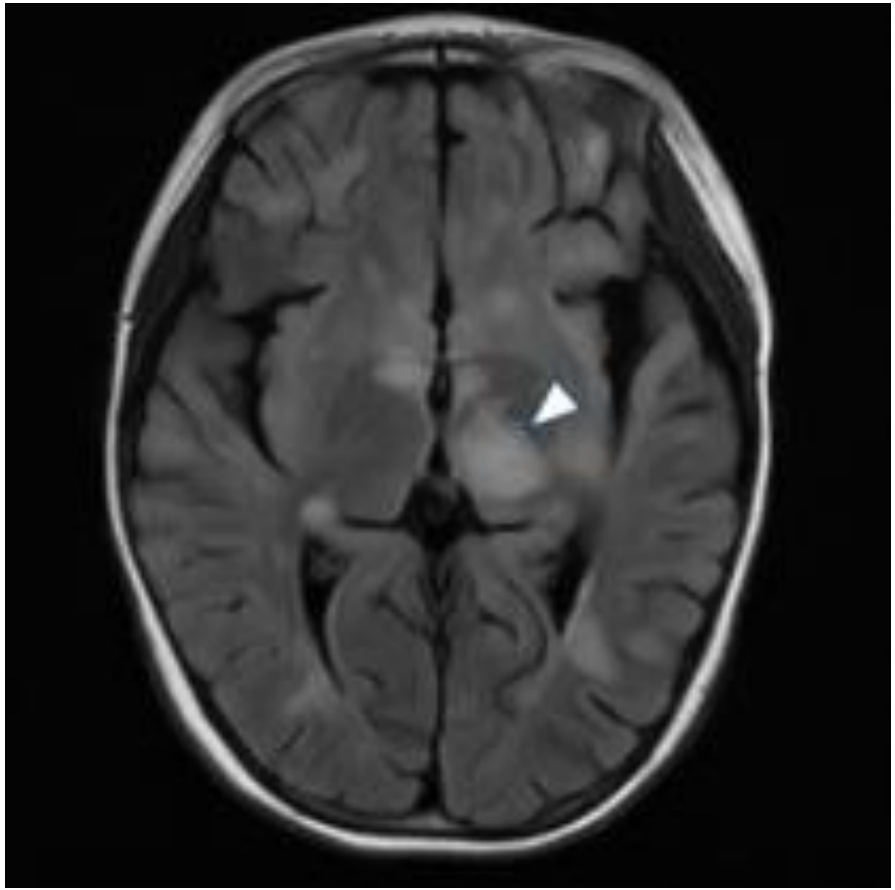
Brainstem Lesions



Axial contrast-enhanced FLAIR image demonstrating heterogeneous nodular enhancement of dorsal pontine and cerebellar lesions

Shahriari et al., *American Journal of Roentgenology*, 2021

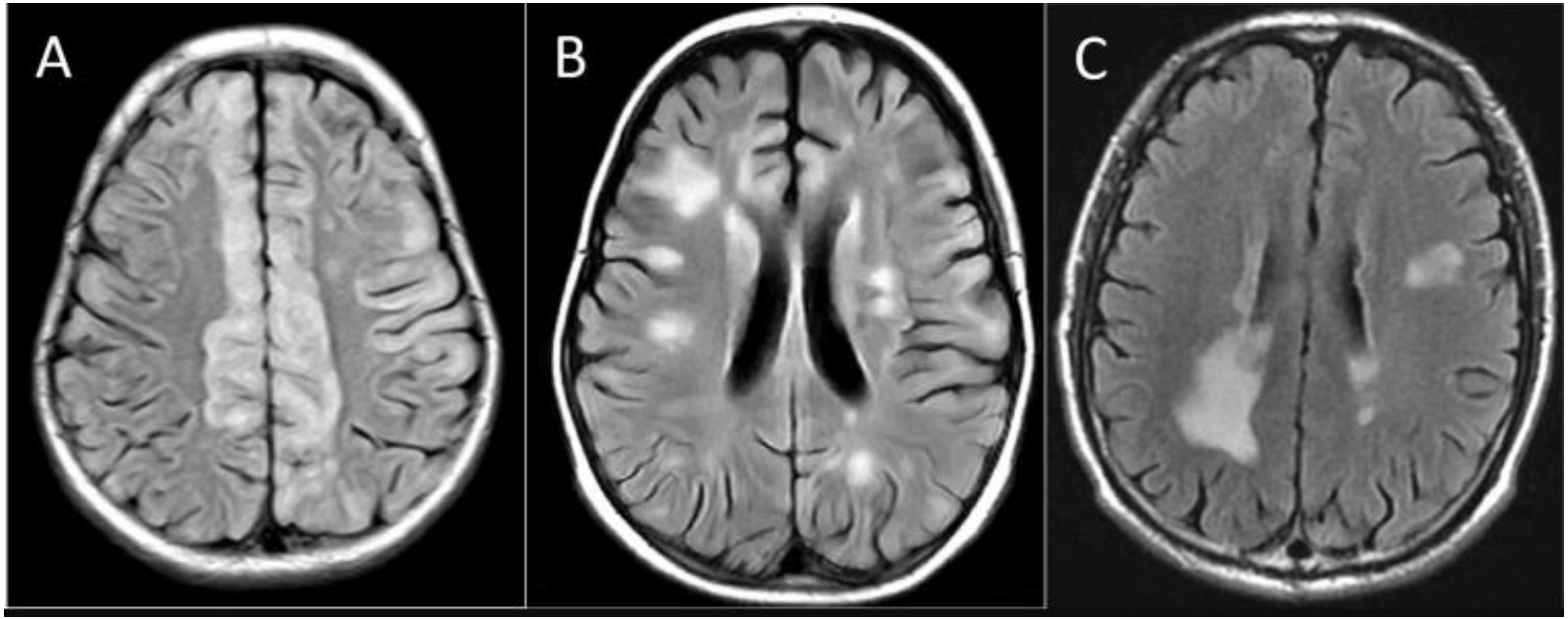
Supratentorial Brain Lesions



Axial T2 FLAIR MR image demonstrating patchy T2 FLAIR hyperintensities in the left thalamus and periventricular regions

Wang et al., *Clinical Radiology*, 2025

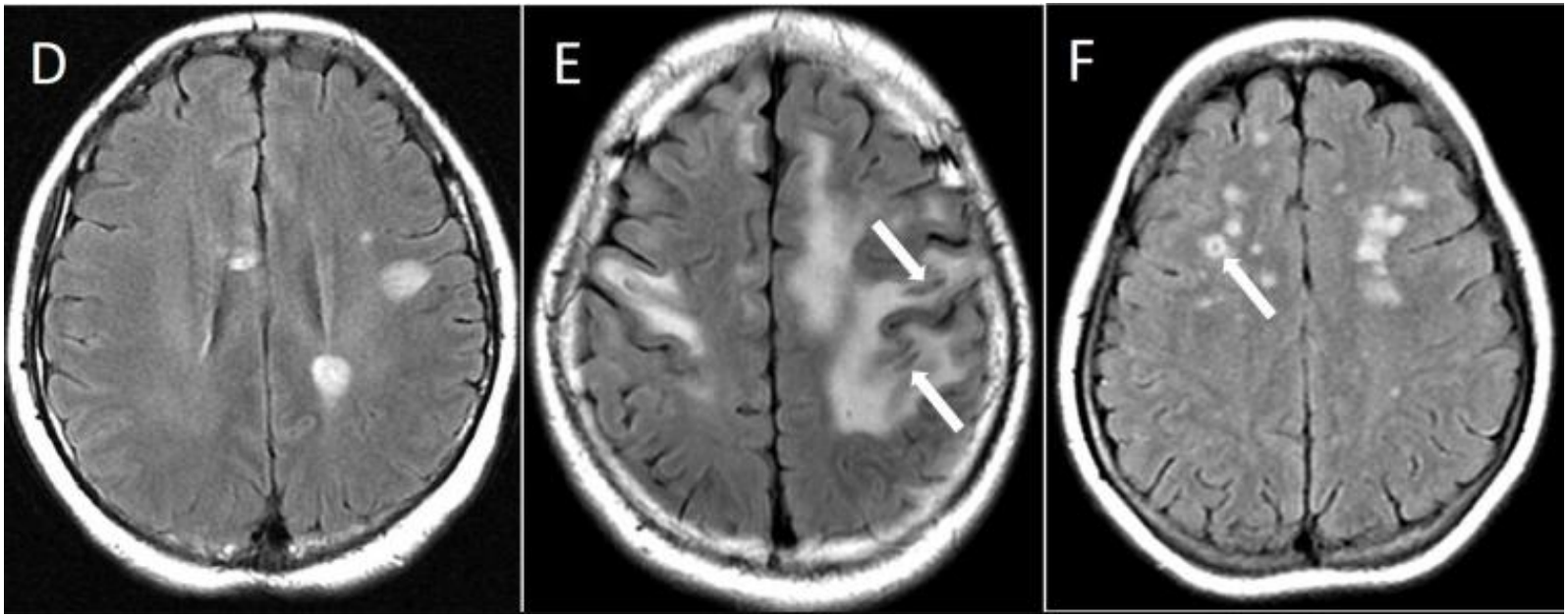
Supratentorial Brain Lesions



Axial T2 FLAIR images with the various morphologies of MOGAD lesions appearing gyriform, plaque-like or fluffy with ill-defined borders

Wang et al., Clinical Radiology, 2025

Supratentorial Brain Lesions



Axial T2 FLAIR images with the various morphologies of MOGAD lesions appearing plaque-like and nodular

Wang et al., Clinical Radiology, 2025

Acute Disseminated Encephalomyelitis (ADEM)

- Clinical syndrome presenting with acute/subacute encephalopathy, focal neurologic deficits in the context of cerebral and/or brainstem lesions[1]
- More often seen in children with MOGAD and is the typical first manifestation in children[3]
- MOG-IgG is detected in approximately 50% of children with ADEM[3]

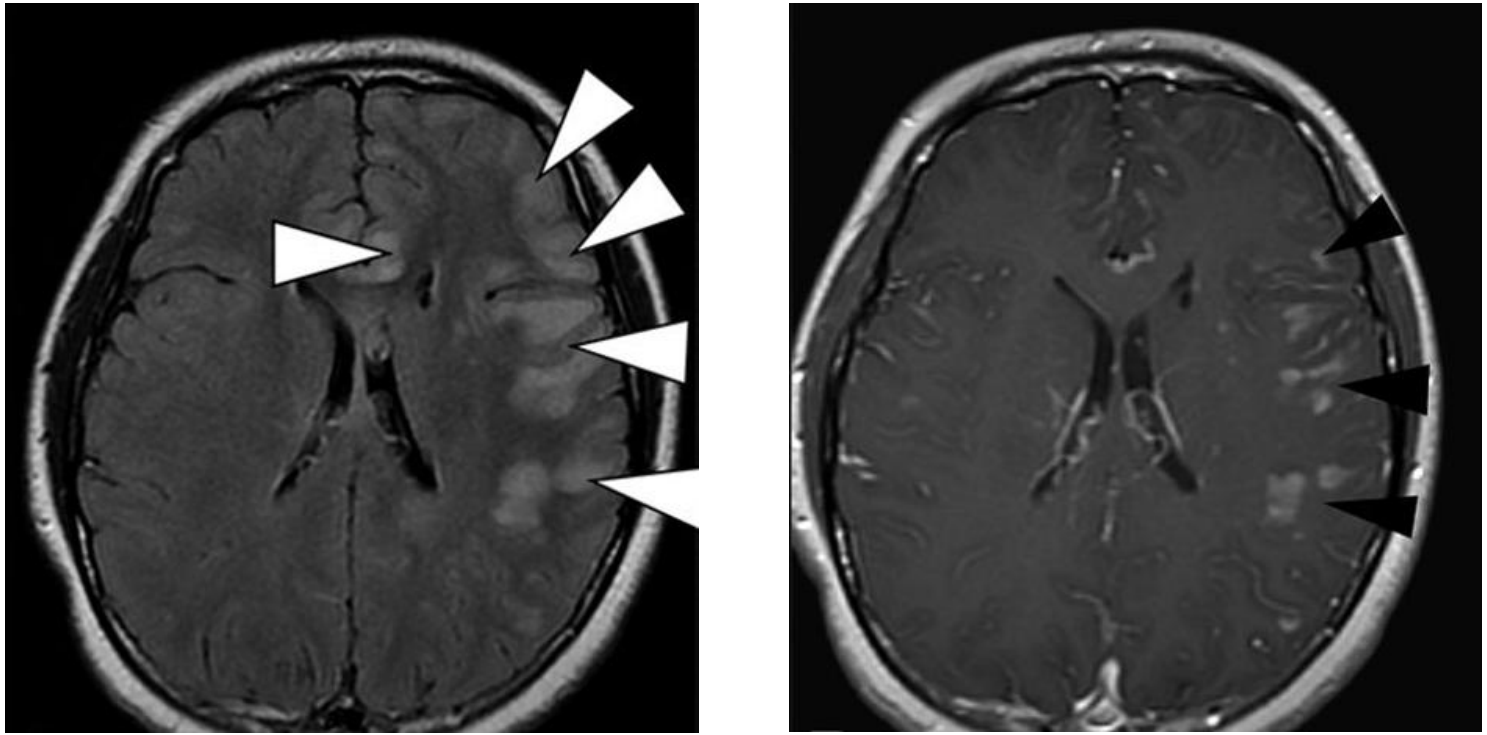
ADEM

- May occur with or without accompanying myelitis or optic neuritis[1]
- Radiographically characterized by **diffuse T2 lesions involving both grey and white matter**[1-3]
- Lesions are often large, poorly-demarcated, and multifocal[1]

ADEM

- **Basal ganglia** are commonly affected, often asymmetrically[1]
- Extensive cortical involvement also common
- **Evolution of radiographic abnormalities** is characteristic[1]
- Some lesions may disappear while new lesions may appear throughout the attack

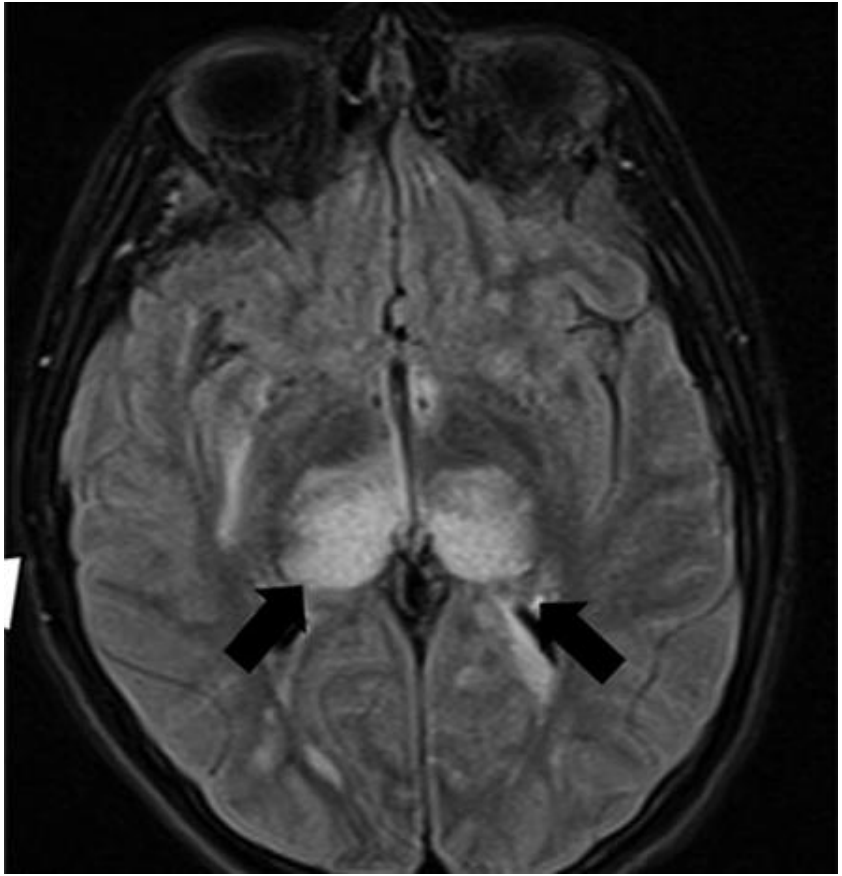
ADEM



Axial T2 FLAIR image with hyperintensities with ill-defined borders involving the left frontal white matter and axial T1 post-contrast image demonstrating associated nodular enhancement

George et. al, *American Journal of Neuroradiology*, 2024

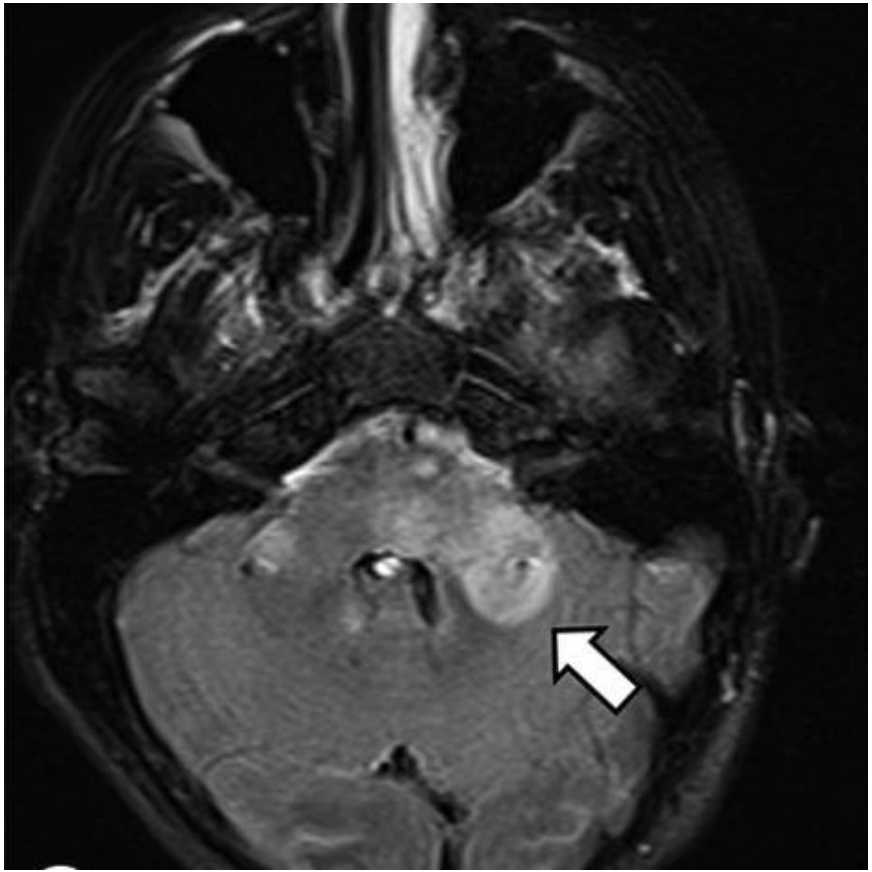
ADEM



Axial T2 FLAIR MR images demonstrating T2 FLAIR hyperintensities with ill-defined borders involving the bilateral thalami

George et. al, *American Journal of Neuroradiology*, 2024

ADEM



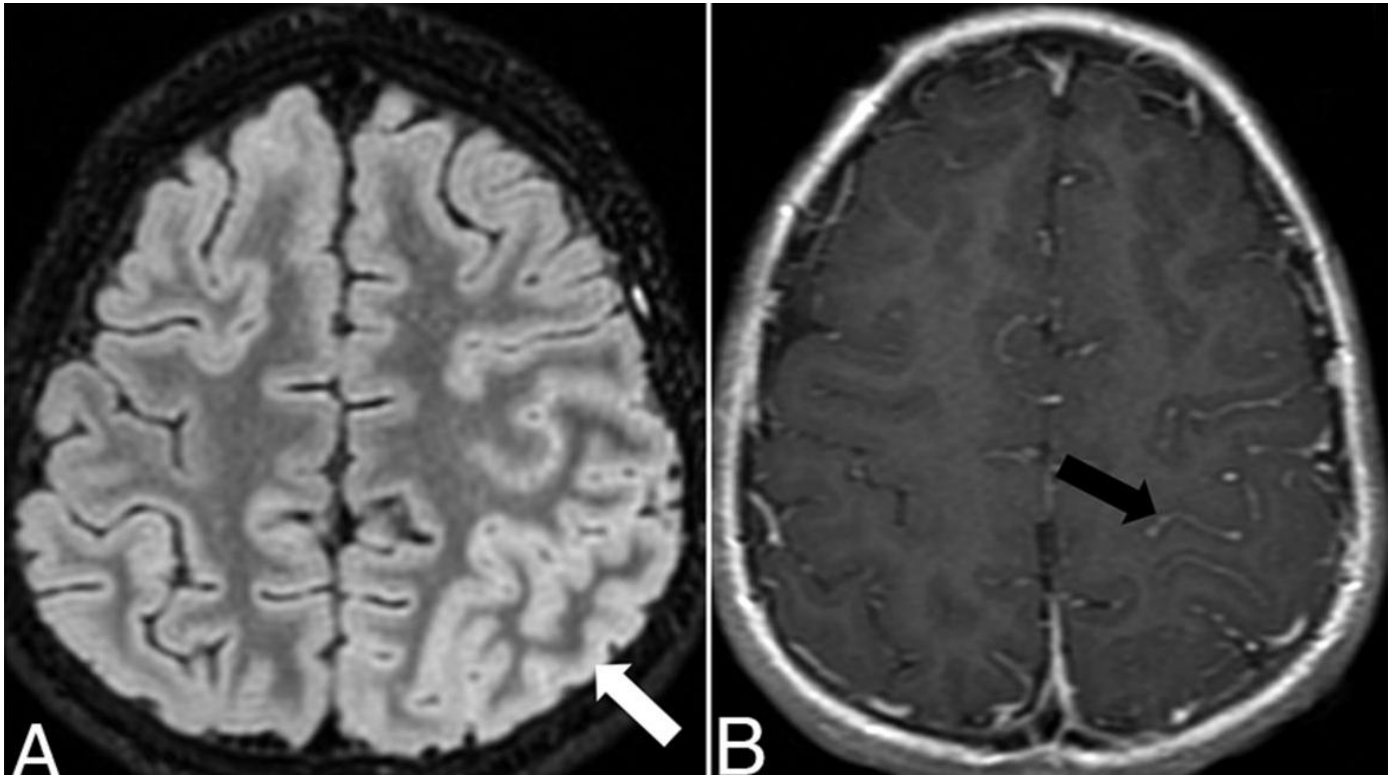
Axial T2 FLAIR MR images with hyperintensities with ill-defined borders involving the pons and left middle cerebellar peduncle

George et. al, *American Journal of Neuroradiology*, 2024

Cerebral Cortical Encephalitis

- Clinical syndrome presenting with encephalopathy, seizures and focal neurologic deficits
- Also termed as FLAMES: FLAIR hyperintense lesions in anti-MOG encephalitis with seizures[3]
- Radiographically characterized by cortical FLAIR hyperintensities often with associated leptomeningeal enhancement[3]
- Associated with seizures responsive to steroids[2]

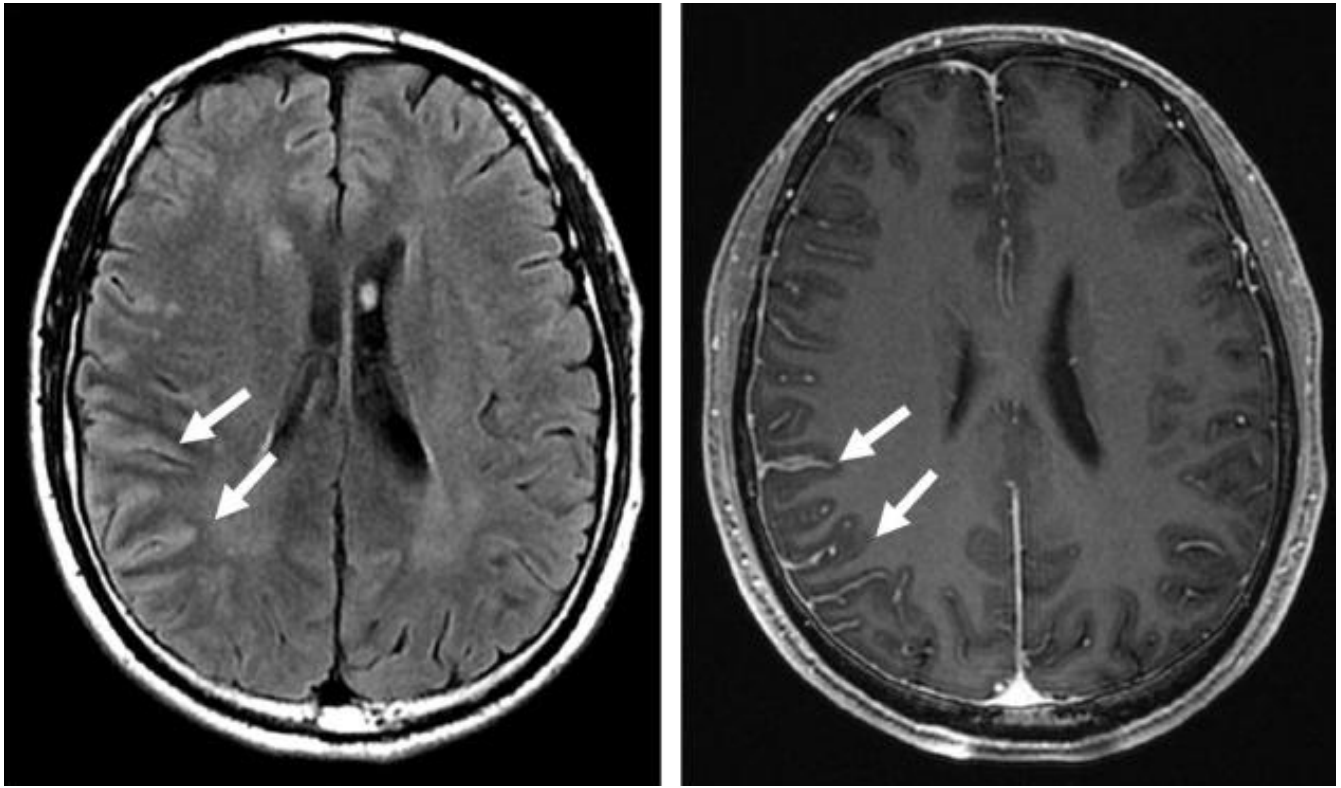
Cerebral Cortical Encephalitis



A) Axial T2 FLAIR MR image with cortical FLAIR hyperintensity involving the left parietal lobe
B) T1-post-contrast MR image with associated leptomeningeal enhancement

George et. al, *American Journal of Neuroradiology*, 2024

Cerebral Cortical Encephalitis



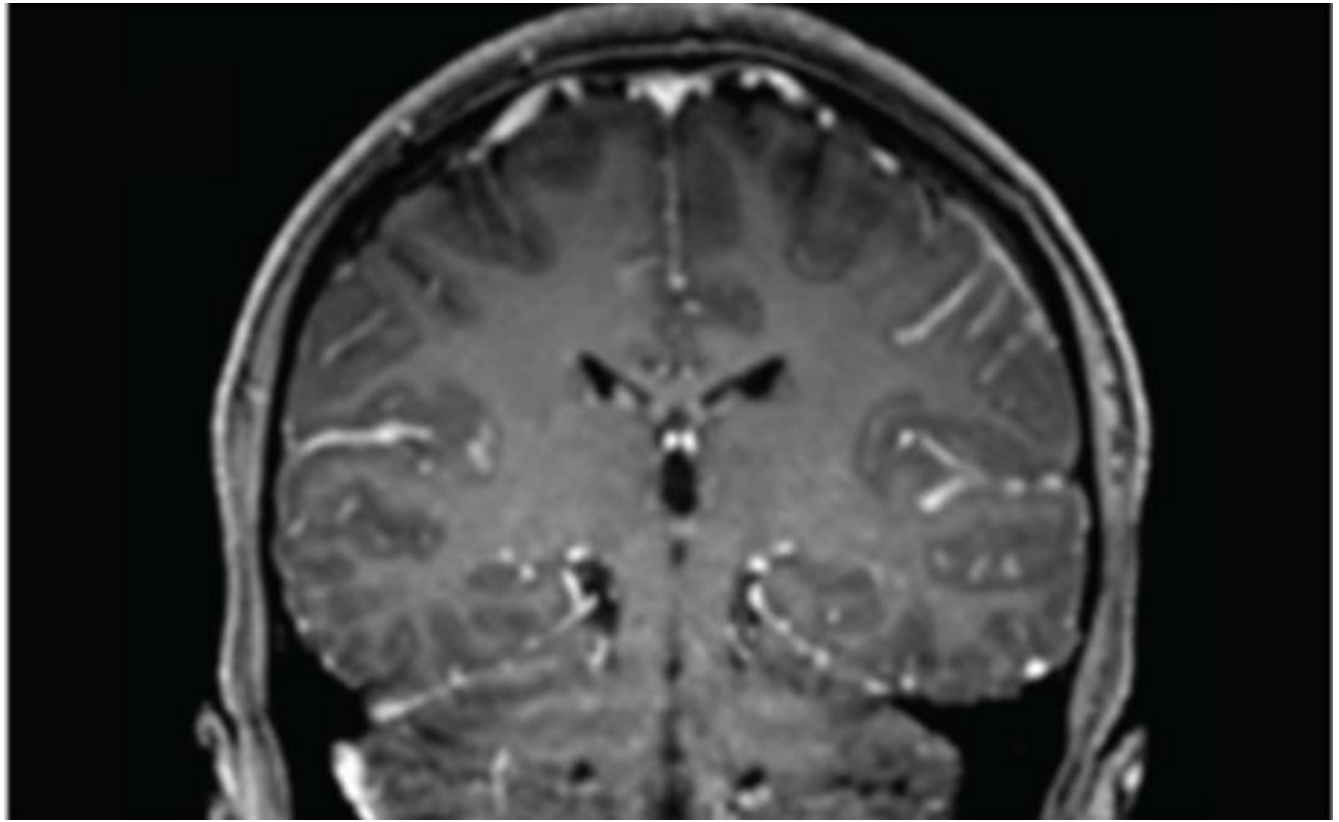
Axial T2 FLAIR with cortical FLAIR hyperintensity involving the right parietal cortex and T1-post-contrast image with associated leptomeningeal enhancement

Wang et al., Clinical Radiology, 2025

Aseptic Meningitis

- Characterized by headache, fever, encephalopathy, photophobia nuchal rigidity mimicking infectious meningitis[10]
- Radiographically characterized by leptomeningeal enhancement on T1-weighted post-contrast images[10]
- Approximately 50% of patients with MOG-associated meningitis evolve into typical core demyelinating events[10]
- While meningitis is not listed among the core phenotypes, recent evidence suggests that meningitis/meningoencephalitis may be added as a recognized phenotype in future criteria updates

Meningitis



T1-post contrast magnetic resonance imaging of MOGAD meningitis showing sulcal leptomeningeal enhancement

Aboseif et al., *JAMA Neurology*, 2025

MOGAD 2023 International Diagnostic Criteria

MOGAD Criteria (All of the below must be met):

1) 1 core clinical demyelinating event: Optic neuritis, myelitis, ADEM, cerebral monofocal/polyfocal deficits, brainstem/cerebellar syndrome, cerebral cortical encephalitis
2) Positive serum MOG Ab: cell based-assay with titer greater than or equal to 1:100
3) If low titer/no titer available **or** only CSF antibody positivity, then at least 1 supporting clinical or MRI feature and AQP4 seronegativity is required
4) Exclusion of a better alternative diagnosis

Banwell et al., *The Lancet* 2023

Supporting Clinical or MRI Features

Optic neuritis

- Bilateral simultaneous clinical involvement
- Longitudinal optic nerve involvement (>50% optic nerve length)
- Perineural optic sheath enhancement
- Optic disc edema

Banwell et al., The Lancet 2023

Supporting Clinical or MRI Features

Myelitis

- Longitudinally extensive (>3 spinal segments)
- Central cord lesion or H sign
- Conus lesion

Banwell et al., The Lancet 2023

Supporting Clinical or MRI Features

Brain/brainstem/cerebral syndrome

- Multiple ill-defined T2 hyperintense lesions in supratentorial and often infratentorial white matter
- Deep gray matter involvement
- Ill-defined T2 hyperintensity involving the pons, middle cerebellar peduncle, or medulla
- Cortical lesion with or without lesional and overlying meningeal enhancement

Banwell et al., *The Lancet* 2023

Diagnosis of MOGAD (requires fulfilment of A, B, and C)			
(A) Core clinical demyelinating event	Optic neuritis* Myelitis† ADEM‡ Cerebral monofocal or polyfocal deficits§ Brainstem or cerebellar deficits¶ Cerebral cortical encephalitis often with seizures‖		
(B) Positive MOG-IgG test	Cell-based assay: serum**	Clear positive††	No additional supporting features required
		Low positive‡‡	• AQP4-IgG seronegative AND • ≥1 supporting clinical or MRI feature
		Positive without reported titre	
		Negative but CSF positive§§	
Supporting clinical or MRI features	Optic neuritis		• Bilateral simultaneous clinical involvement • Longitudinal optic nerve involvement (> 50% length of the optic nerve) • Perineural optic sheath enhancement • Optic disc oedema
	Myelitis		• Longitudinally extensive myelitis • Central cord lesion or H-sign • Conus lesion
	Brain, brainstem, or cerebral syndrome		• Multiple ill-defined T2 hyperintense lesions in supratentorial and often infratentorial white matter • Deep grey matter involvement • Ill-defined T2-hyperintensity involving pons, middle cerebellar peduncle, or medulla • Cortical lesion with or without lesional and overlying meningeal enhancement
(C) Exclusion of better diagnoses including multiple sclerosis¶¶			

Banwell et al., *The Lancet* 2023

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