

# Uncommon Adult Brain Herniations

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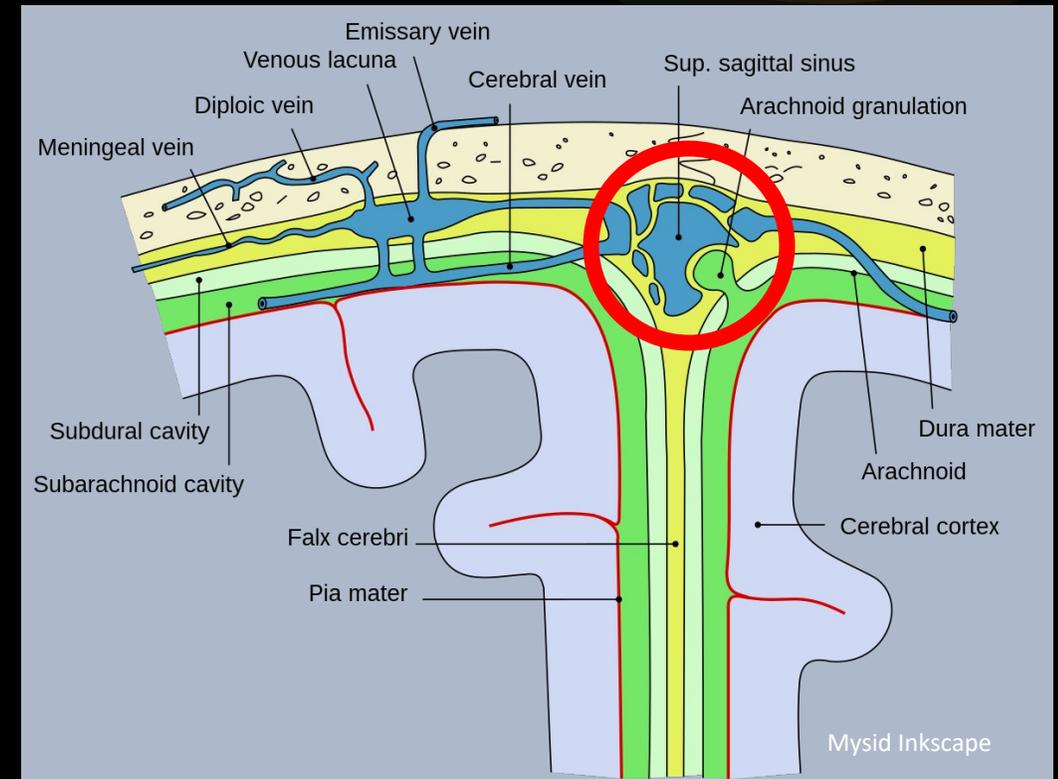
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# Summary/Purpose

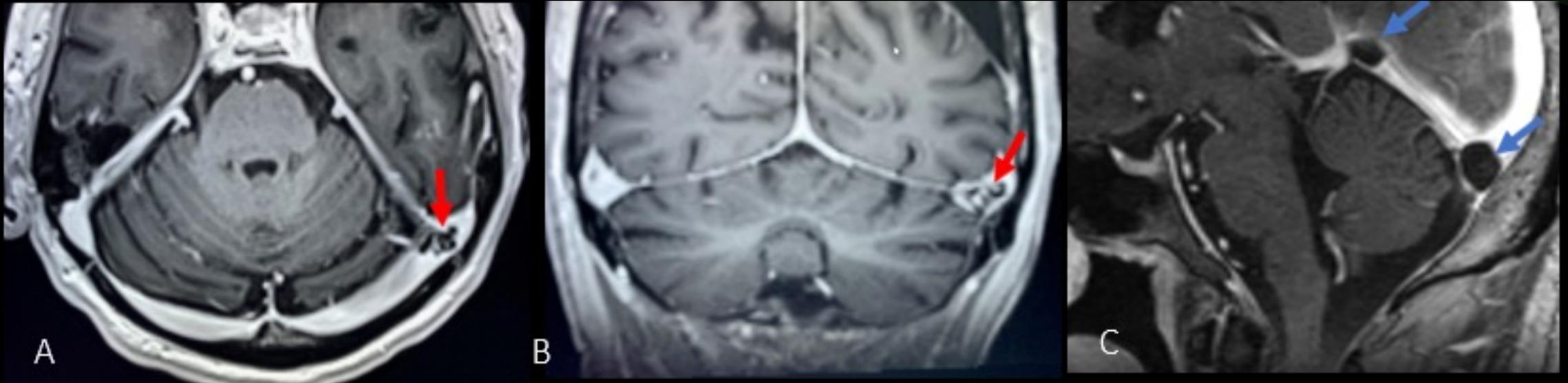
- Reporting has increased of brain parenchyma herniating through arachnoid granulations (BHAG) into the dural sinuses and diploic space.
- Herniation of brain parenchyma into these spaces is very uncommon.
- Clinical presentation may be quite variable and may include seizure, vertigo, pseudotumor cerebri, and pulsatile tinnitus depending on location.
- Given its rarity, it is important for radiologists and trainees to be familiar with the concept of BHAG into less common spaces.
- We review both the normal imaging appearance of arachnoid granulations and the various pathologies related to arachnoid granulations via a review of several BHAG cases into the dural sinuses and diploic space.

# Arachnoid Granulations: Normal Structure and Function

- The arachnoid penetrates the dura mater to communicate with the dural venous sinuses, primarily the superior sagittal sinus.
- Arachnoid granulations facilitate circulation of cerebrospinal fluid (CSF) into the brain's venous outflow.
- Normally quite small, larger granulations can be a normal variant with some large granulations being able to erode the inner table of the calvarium
- Although arachnoid granulations are a normal and necessary part of the intracranial anatomy, they may serve as openings in the dura which allow brain parenchyma to herniate



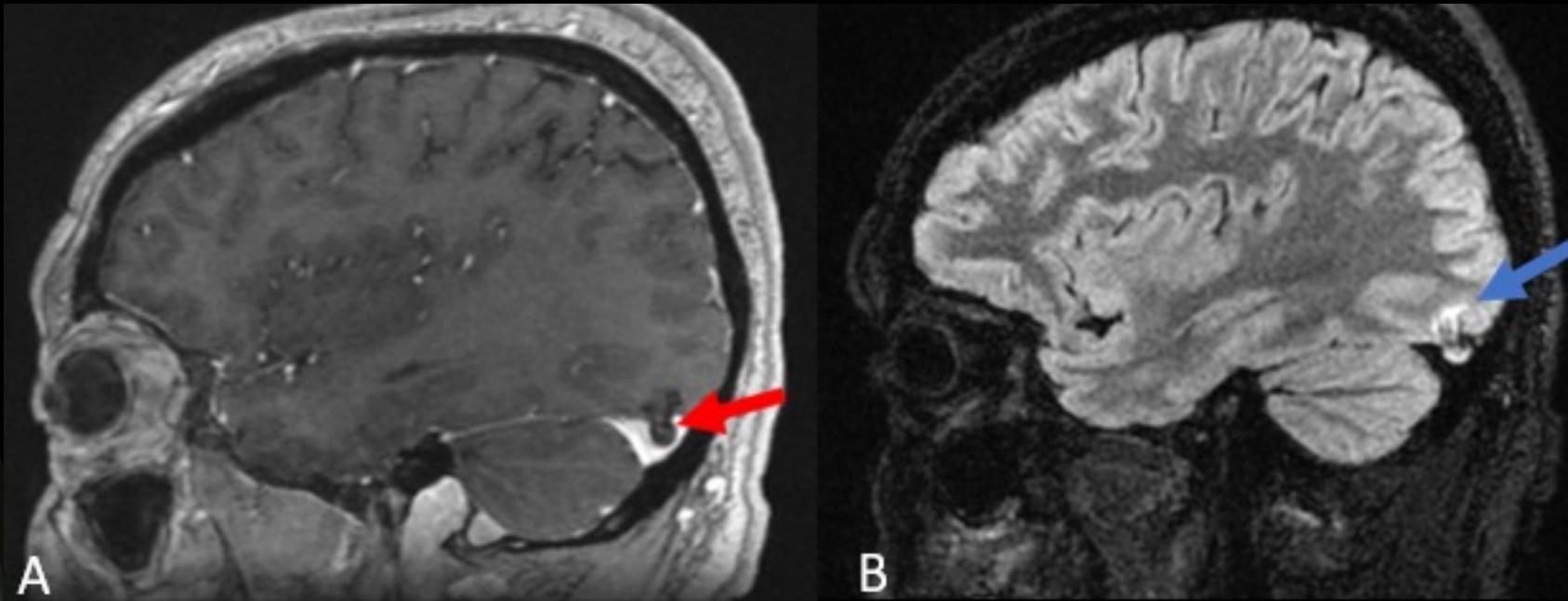
# Arachnoid Granulations: Normal Imaging Appearance



A: Axial T2, B: Coronal T2 – Normal lobulated arachnoid granulations extending into the transverse sinus (**red arrows**);  
C: Sagittal T1 – Two Spherical arachnoid granulations, one in the straight sinus, one in the torcula (**blue arrows**).

# Case 1: Occipital Herniation into Transverse Sinus

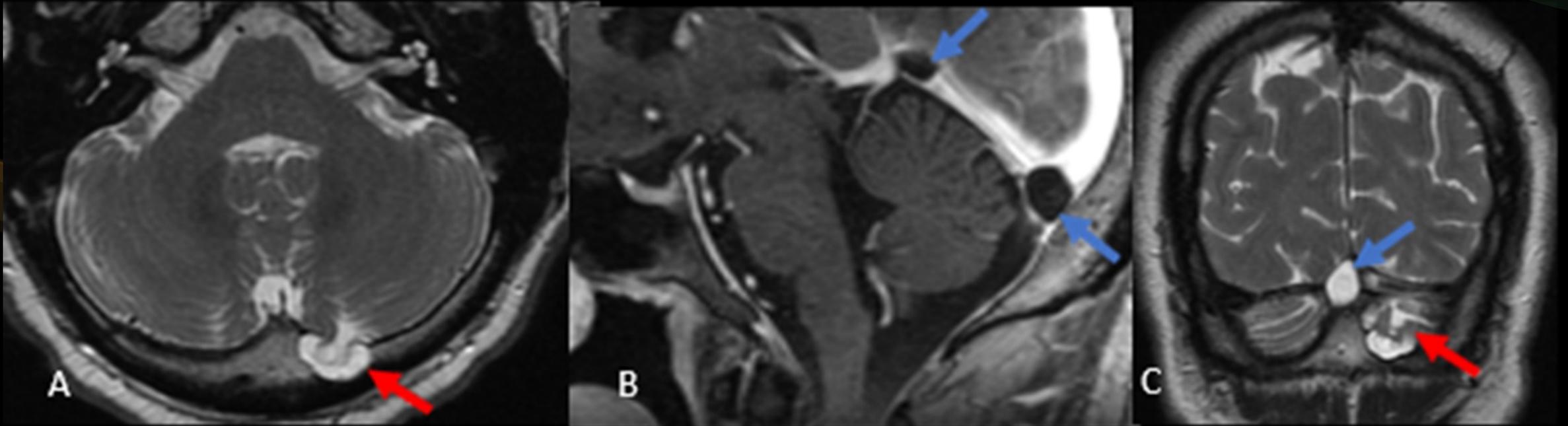
- 30-year-old male with a history of multiple head traumas presented with seizures.
- Found to have an occipital lobe herniation within an arachnoid granulation extending into the transverse sinus.
- Neurologic evaluation and EEG were consistent with occipital lobe seizures.



Sagittal A: T1 post contrast and B: Flair T2 – Reveals small herniation of occipital lobe into the transverse sinus (red arrow). Please note abnormal T2 FLAIR signal in the parenchyma adjacent to the herniation (blue arrow).

## Case 2: Cerebellar Herniation into the Diploic Space

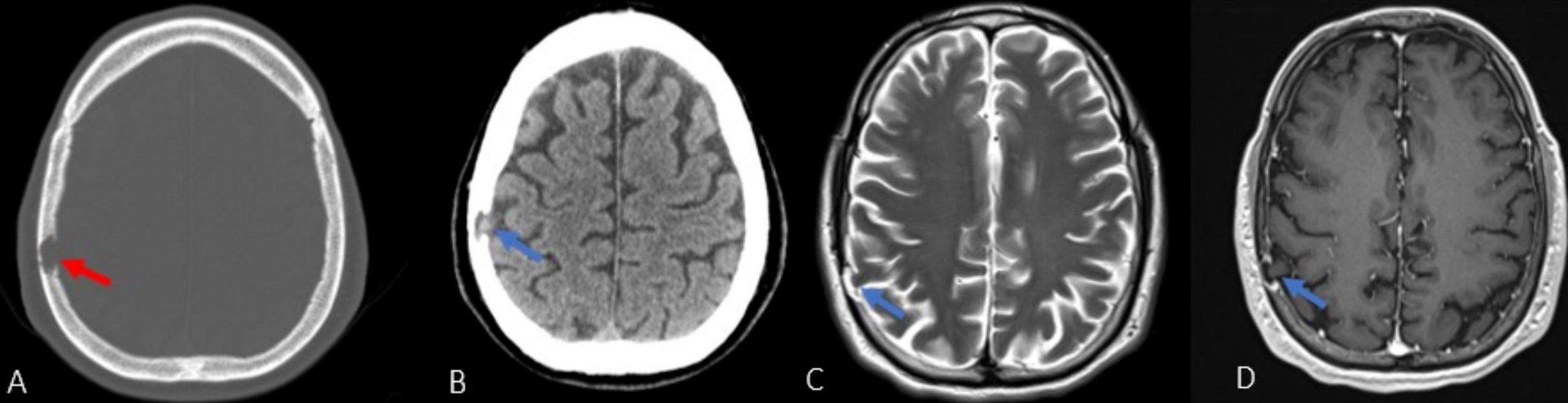
- 49-year-old male with a history of chronic bilateral tinnitus, bilateral carotid artery stenosis, and TIA presented with tinnitus and vertigo.
- Found to have a cerebellar herniation within arachnoid granulation extending into the diploic space.



- A: Axial T2, B: Sagittal T1 post contrast, C: Coronal T2 – Reveals small herniation of arachnoid and brain parenchyma from the left medial cerebellar hemisphere into the diploic space of the left occipital bone (red arrows). Please note 2 incidental arachnoid granulations, one in the straight sinus, one in the torcula (blue arrows).

# Case 3: Right Parietal Herniation into the Diploic Space Mimicking an Osseous Lesion

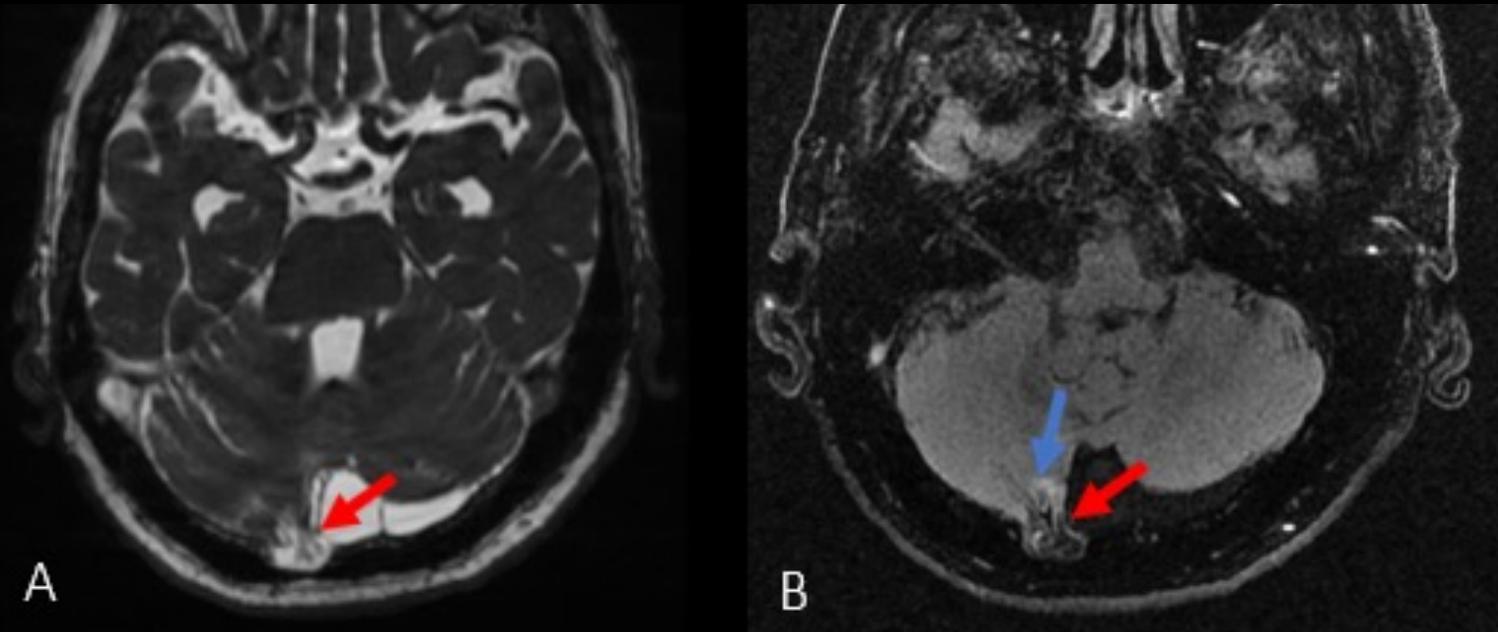
- 70-year-old male with a history of right sided skull fracture as a child presented after a 15 mm erosive lesion was incidentally found within the right parietal bone on outside xray
- Found to have a right parietal herniation within arachnoid granulation into the diploic space



- A: Axial CT bone windows, B: Axial CT noncontrast, C: Axial T2, D: Axial T1 post contrast – Reveals small herniation of arachnoid and right parietal lobe into the right parietal diploic space (blue arrows). Please note this mimics an erosive lesion on CT bone windows (red arrow).

# Case 4: Right Cerebellar Herniation into the Diploic Space

- 77-year-old male with history of left ear diving injury presented with left sided hearing asymmetry and word recognition difficulty for multiple several years
- Found to have a right cerebellar herniation within arachnoid granulation into the diploic space.



- A: Axial T2, B: Axial FLAIR T2 - Revealing small herniation of posterior right cerebellum into the right occipital diploic space (**red arrow**). Please note abnormal FLAIR signal adjacent to herniated brain (**blue arrow**).

# Discussion/Conclusions

- Although arachnoid granulations extending into the dural sinuses and diploic space are a relatively common finding on MRI, brain parenchyma herniating through arachnoid granulations (BHAG) is rare in these locations.
- This case series serves to educate radiologists and trainees about how adult brain matter can herniate through rare locations such as the dural sinuses and diploic space.
- Arachnoid granulations generally present in adults and are not as common in children. Adult BHAG are not well described in the literature, but they are mostly seen in the occipital squamosa and the transverse sinuses.
- Factors for developing BHAG may include congenital structural weakness and trauma. Of note, two of our cases had a history of head trauma.
- Associated neurologic symptoms may include seizures, headaches, tinnitus, and increased intracranial pressure.
- Two of our cases demonstrated abnormal signal adjacent to herniated brain, with one of these cases corresponding to clinical seizure with EEG abnormality localizing to the occipital lobe where the herniation existed. Further investigation into the relationship between seizure symptoms and brain signal abnormalities may be investigated.
- Improved spatial resolution afforded by high-field scanners with thinner sections, such very thin 1mm T1 and heavily T2 weighted 3D sequences may lead to increased detection of BHAG.
- Some of these herniations are quite small and may be easily missed or confused for normal arachnoid granulations, highlighting the importance of high-resolution imaging.

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