

# Not in Vein? Imaging of Anatomical Variants of Dural Venous Sinus

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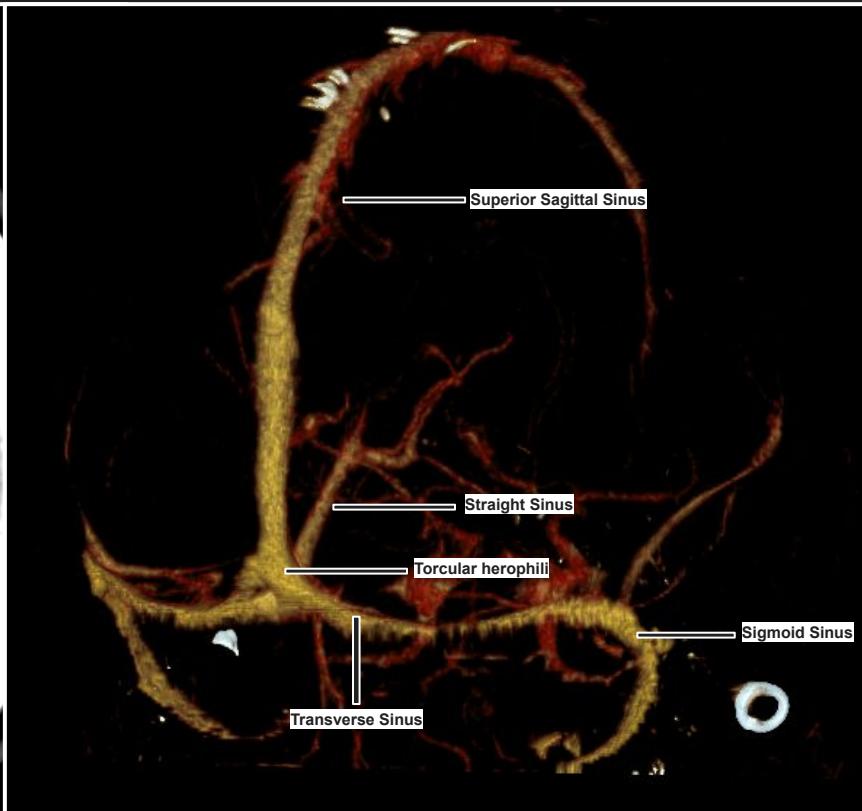
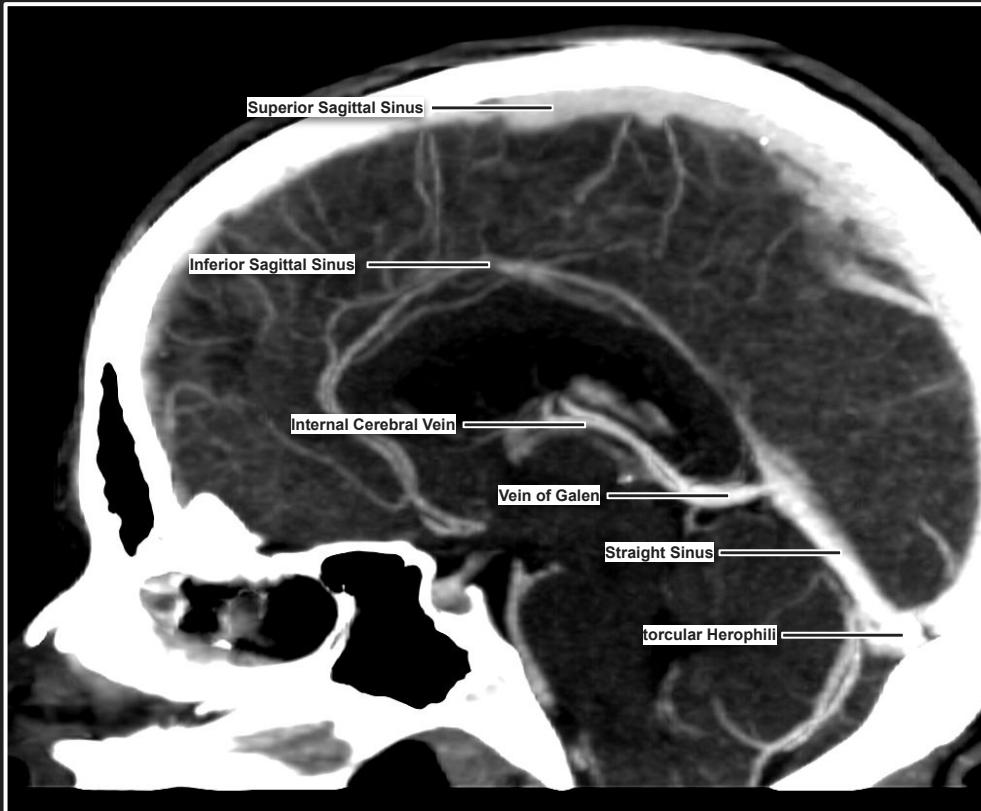


# Objectives

- Review normal intracranial dural venous sinus anatomy and relevant imaging techniques including CT and MR venography.
- Highlight cases of common dural venous sinus variants.
- Display more unusual anatomic variants and congenital venous sinus presentations.
- Discuss few relevant clinical implications for management of dural venous sinus variants.

# Normal Anatomy

- Dural venous sinuses
  - Endothelial lined channels between layers of dura mater.
  - Drain venous blood from the brain and cerebrospinal fluid from the subarachnoid space via arachnoid granulations.
- Cerebral veins can be classified as superficial (cortical) or deep.
  - Superficial system:
    - Drains the cortex and subcortical white matter.
    - Includes the cortical veins, sagittal sinuses, sphenoparietal, and superior petrosal veins.
  - Deep system:
    - Drains deep brain structures such as the thalamus, basal ganglia and deep white matter.
    - Includes transverse (lateral) sinuses, sigmoid sinuses, inferior sagittal sinus, straight sinus, inferior petrosal, and deep cerebral veins (great cerebral vein, subependymal and medullary veins).
- Deep Cerebral Veins
  - Medullary veins: originate below the cortical grey matter and traverse through the deep medullary white matter and subsequently draining into the subependymal veins and the deep venous system.
  - Subependymal veins: line the ependymal margins and drain into the internal cerebral veins.
  - Great cerebral vein: main collector of deep cerebral venous blood. Formed by union of both internal cerebral veins and joins inferior sagittal sinus to form straight sinus.
  - Additional paired sinuses include the superior and inferior petrosal and sphenoparietal sinuses.



27 year old female with headache. CT venogram sagittal and 3D volume-rendered reformat images.  
Please note presence of bilateral occipital sinuses (not labelled)

# Imaging Modalities for Dural Venous Sinus Variants

- CT Venography (CTV)
  - Uses contrast enhanced CT to visualize venous structures
  - Good for detecting hypoplasia, atresia, thrombosis, and bony anatomy around sinuses
  - Pros: Fast, widely available
  - Cons: Uses radiation and contrast dye
- MR Venography (MRV)
  - Uses magnetic resonance techniques (Time of flight, phase-contrast, contrast-enhanced)
  - Good for detecting flow patterns, duplicate and aberrant structures
  - Pros: No radiation, better for soft tissue contrast
  - Cons: Slower/time consuming, may miss slow flowing vessels especially without contrast

# Dural Venous Sinus Variants: Development

- During embryological development:
  - The dural venous system develops from a primary brain plexus.
  - This occurs via the union of the anterior cardinal vein and sprouts from the dorsal aorta.
  - By week 4 to 5, this leads to the formation of a primitive capillary network.
- Influential factors on development:
  - Local oxygenation and hemodynamics greatly affect the development of the intracranial venous system.
  - Cortical venous development is driven by metabolism and vascularization in late second and third trimesters.
  - Extracerebral vein development is influenced by development of the brain and skull.
- Dural venous sinus variants are highly variable, yet common. More typical variants include sinus atresia, hypoplasia, and duplication.

# Dural Venous Sinus Variants: Clinical Implications

- Typically variants are asymptomatic but can be clinically relevant in imaging interpretation and neurosurgical planning.
- Dural venous sinus variants may give rise to altered flow dynamics and contribute to increased intracranial pressure.
- Conversely, in the setting of increased intracranial pressure from other causes, variants may be recruited to increase venous drainage and reduce intracranial pressure.

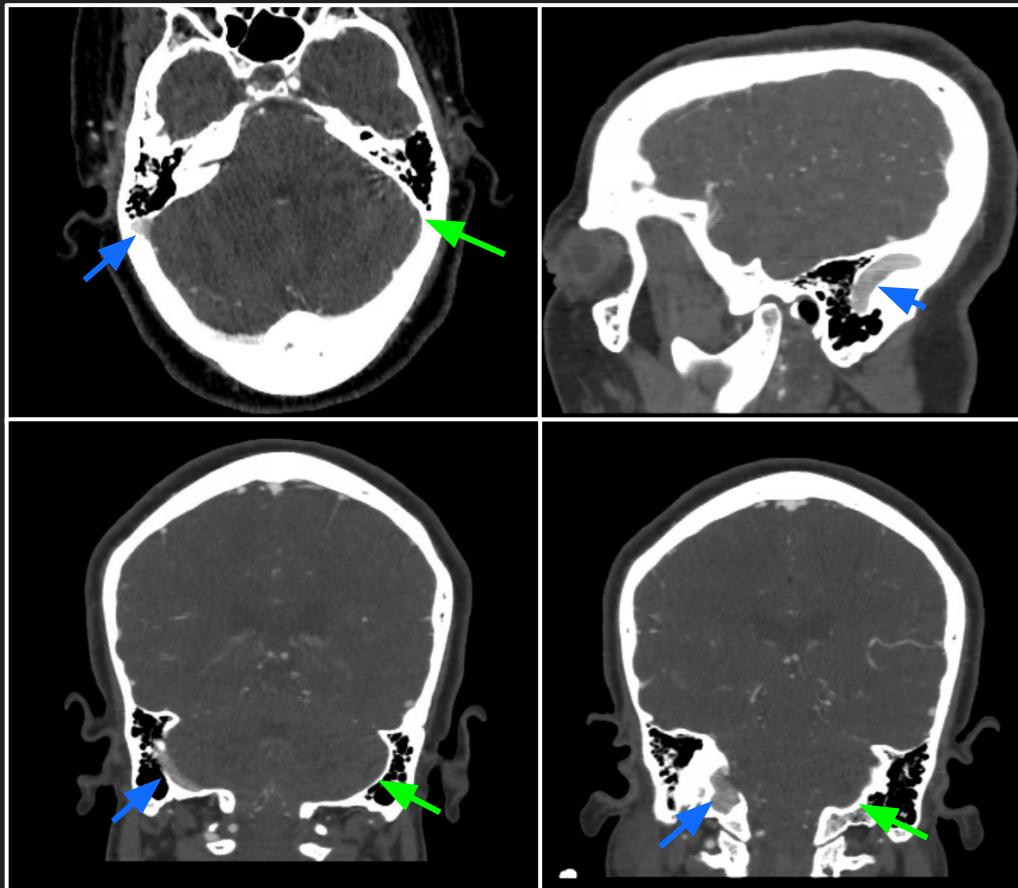
# Transverse and Sigmoid Sinus Aplasia/Hypoplasia

- Unilateral transverse sinus hypoplasia is a common incidental finding, with an incidence reported as high as 20–39%.
- Atresia refers to the complete absence or closure of a venous sinus, while hypoplasia describes an underdeveloped or narrowed sinus.
- The clinical significance of transverse sinus narrowing lies in its association with idiopathic intracranial hypertension (IIH).
- In a study by Ozkacmaz et al., morphological variants of the dural venous sinuses were evaluated, and the most common dual anatomical variation was found to be sigmoid sinus hypoplasia in conjunction with transverse sinus hypoplasia.
- Chronic thrombosis can mimic hypoplasia. One method to distinguish between the two is the “sigmoid notch sign.” A study by Can et al. demonstrated that asymmetry of the sigmoid notch is significantly more predictive of hypoplasia or atresia than transverse sinus thrombosis.
- Other less common atretic or hypoplastic sinus variants can involve the superior sagittal, inferior sagittal, and straight sinuses.

# Transverse, sigmoid, and internal jugular vein aplasia in an asymptomatic patient

63-year-old female with a history of cerebral aneurysms and no other acute symptoms.

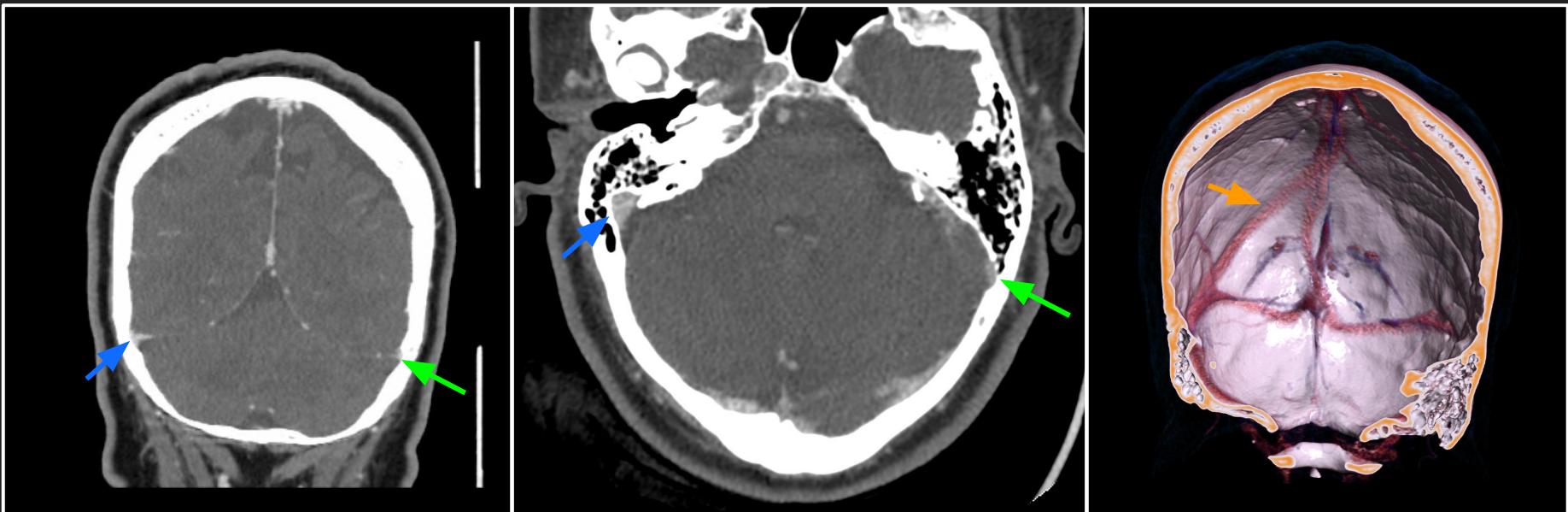
CT venogram images demonstrate aplasia of the left transverse sinus, sigmoid sinus, and internal jugular vein. Blue arrows highlight the normal anatomical structures, while green arrows indicate the abnormal side. This case demonstrates the "sigmoid notch sign" on axial CT venogram images, with a normal right sigmoid notch and an absent left sigmoid notch.



# Transverse and sigmoid sinus hypoplasia with anomalous branch of superior sagittal sinus in a symptomatic patient

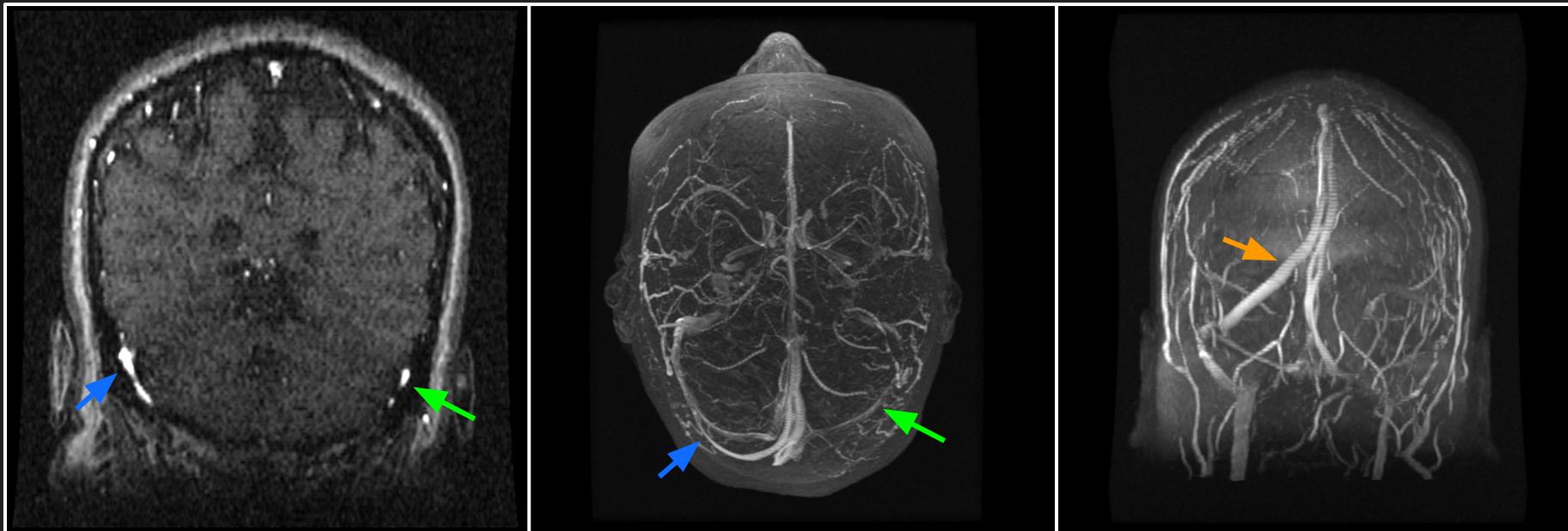
58-year-old female presenting with symptoms concerning for increased intracranial pressure, including papilledema.

CT venogram and 3D volume-rendered reformatted images demonstrate severe narrowing of the distal left transverse sinus and decreased caliber of the left sigmoid sinus. The left sigmoid notch is attenuated compared to the contralateral side, suggesting a congenital etiology. Blue arrows indicate the normal anatomical side, and green arrows highlight the abnormal side. Orange arrow identifies a venous variant with anomalous branch draining the superior sagittal sinus to the right transverse sinus—potentially due to abnormal flow dynamics.



# Transverse and sigmoid sinus hypoplasia with anomalous branch of superior sagittal sinus in a symptomatic patient ctd.

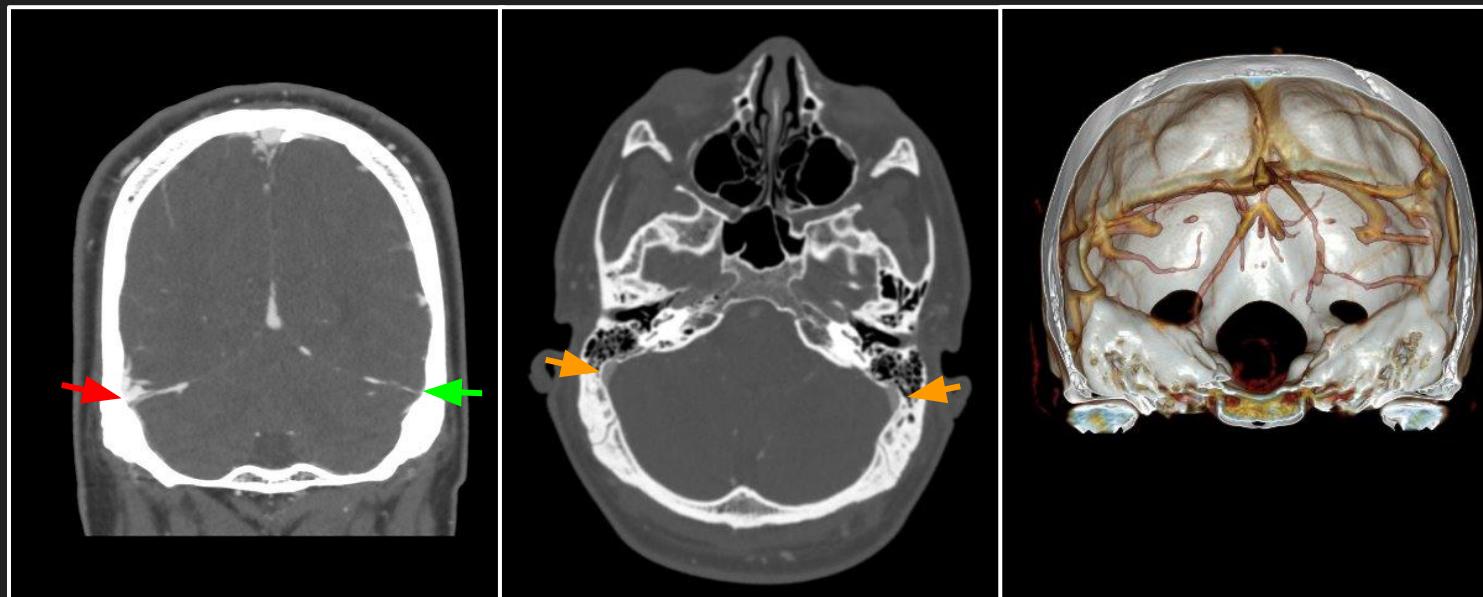
MR venogram of the same patient shows narrowing of the distal left transverse and sigmoid sinuses (green arrows) compared to the contralateral side (blue arrows), along with venous variant with anomalous branch draining the superior sagittal sinus to the right transverse sinus (orange arrow).



# Hypoplasia vs Stenosis: Transverse sinus stenosis in symptomatic patient

24-year-old male with papilledema.

CT venogram images demonstrate severe narrowing of the distal left transverse sinus (green arrow). Orange arrows highlight the normal appearance of both sigmoid sinuses and sigmoid notches. No additional dural venous sinus variants were identified. Given the presence of normal sigmoid sinuses, the findings likely represent transverse sinus stenosis, a feature commonly seen in idiopathic intracranial hypertension.



# Falcine Sinus

- Accessory venous sinus found in the falx cerebri which drains the deep cerebral venous system into the superior sagittal sinus.
- Normally involutes during embryological development.
- More commonly seen with vein of Galen malformation, arteriovenous malformations, or absence of the corpus callosum.
- May be completely or partially recanalized.
- Incidental finding, however may occasionally affect surgical planning (e.g. falx based masses)

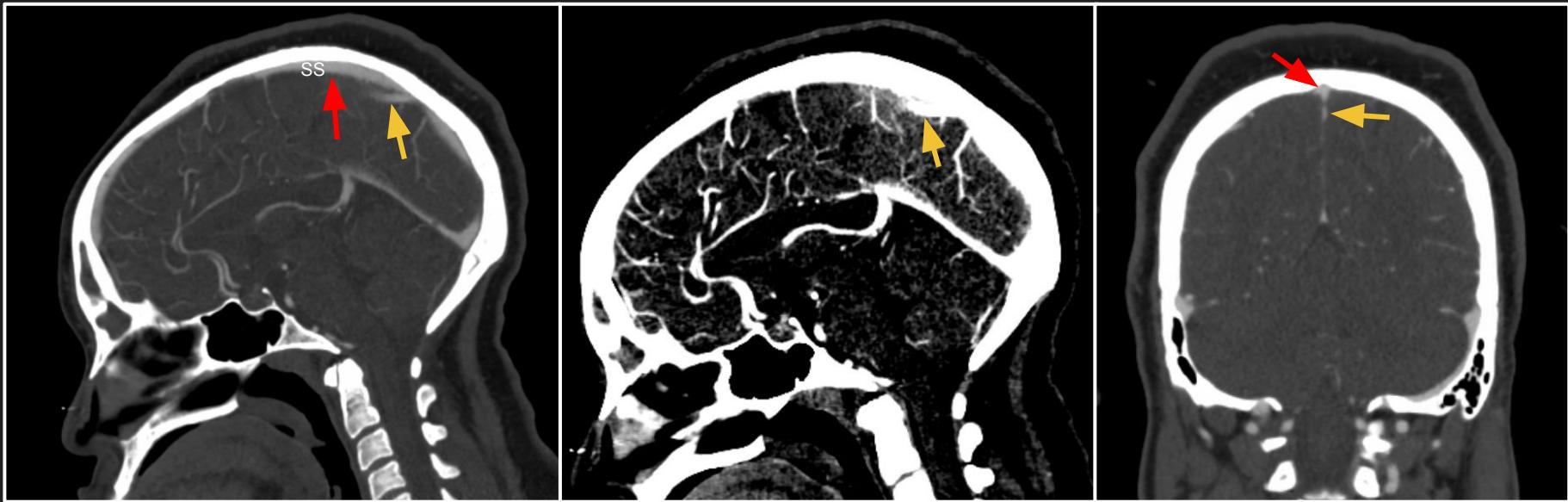
# Occipital Sinus

- The smallest of the dural venous sinuses, arising from fine plexiform venous channels of the primitive torcular plexus.
- Usually single and present in up to 65% of individuals based on cadaveric studies. Imaging studies report a lower incidence of 10–18% on MR venography.
- Communicates with the marginal sinus and posterior internal vertebral venous plexuses.
- Typically an incidental finding, but may occasionally affect surgical planning (e.g., posterior fossa masses or craniotomies).

# Partial falcine sinus

35 year old postpartum female with severe thunderclap headache, found to have subarachnoid hemorrhage.

Sagittal CT angiogram image demonstrates a short venous structure along the midline falx (orange arrows), which may represent a truncated falcine sinus. Red arrows/SS = superior sagittal sinus.

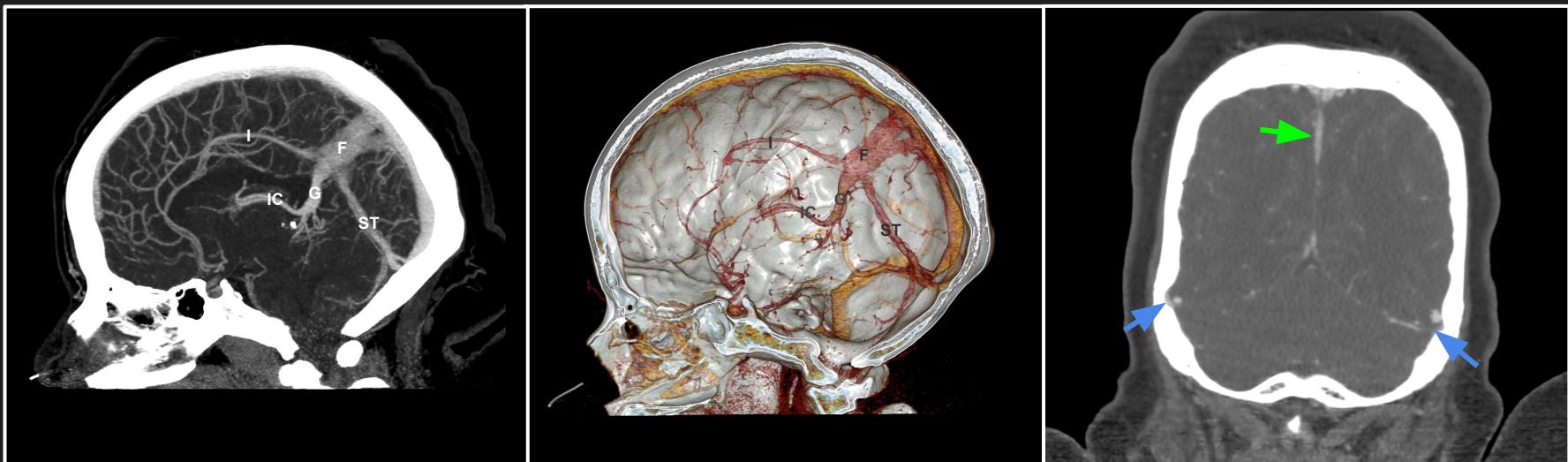


# Persistent falcine sinus

19-year-old female with idiopathic intracranial hypertension, presenting with chronic headaches and papilledema.

Sagittal CT venography and 3D volume-rendered reformatted images demonstrate bilateral recanalized falcine sinuses. A coronal CT venography image of the same patient shows bilateral distal transverse sinus stenosis (blue arrows) along with a recanalized falcine sinus (green arrow). S = Superior Sagittal Sinus, I = Inferior Sagittal Sinus, G = Vein of Galen, ST = Straight Sinus, IC = Internal Cerebral Veins, F = Falcine Sinuses.

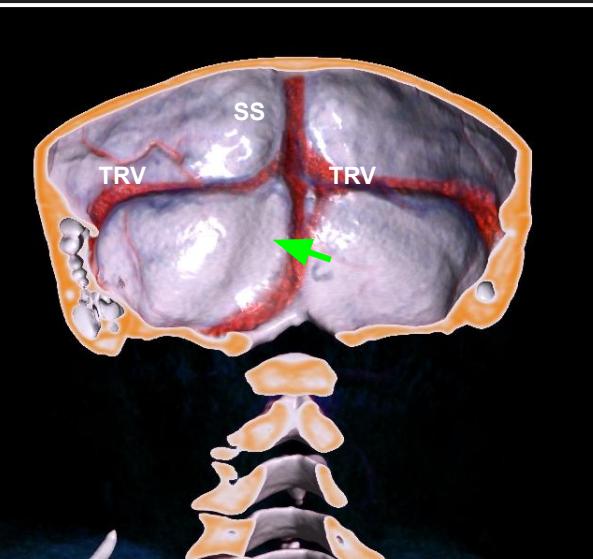
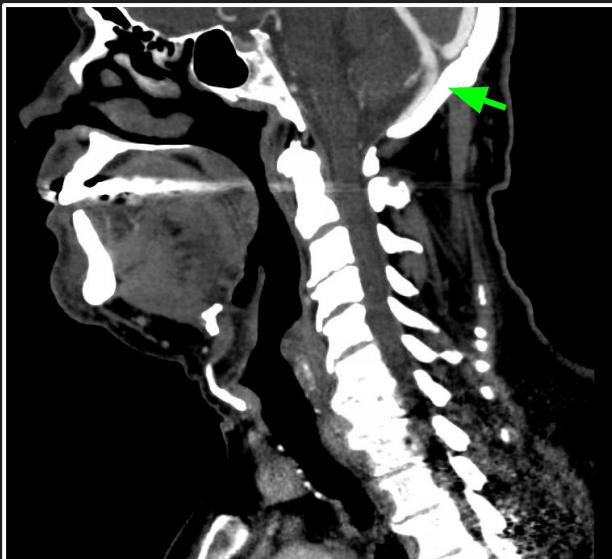
Patients with idiopathic intracranial hypertension may demonstrate recruitment of accessory venous pathways due to stenotic outflow through the transverse sinuses. We postulate that the recanalized falcine sinus could represent compensatory recruitment of an accessory sinus pathway secondary to elevated intracranial pressure. The patient was treated with lumbar puncture and transverse sinus stenting, with resulting decreased intracranial pressure and symptomatic improvement.



# Occipital sinus supplied by straight sinus

67-year-old with a history of glottic squamous cell carcinoma status post surgical excision.

Contrast-enhanced re-staging CT of the neck with 3D volume-rendered reformatted images incidentally demonstrates a venous structure originating from the straight sinus and traversing the posterior fossa, compatible with an occipital sinus (green arrows). Both transverse sinuses originate from the superior sagittal sinus and are nearly isolated from the straight and occipital sinuses. Abbreviations: SS = Superior Sagittal Sinus, TRV = Transverse Sinus



# Hypoplastic left internal jugular vein with alternative drainage from sigmoid sinus to occipital vein.

63 year old female with multiple right sided rib fractures.

CT angiogram was obtained to assess for blunt vascular injury. Images demonstrate a hypoplastic left sigmoid sinus with large emissary veins communicating with prominent occipital veins (orange arrows). The left internal jugular vein is hypoplastic (green arrow) compared to the contralateral side (blue arrow), likely due to collateralization via the occipital veins and redirected venous outflow.



# Prominent drainage from sigmoid sinus to occipital vein via condylar canal.

87-year-old female presenting with numbness and dizziness, concerning for stroke.

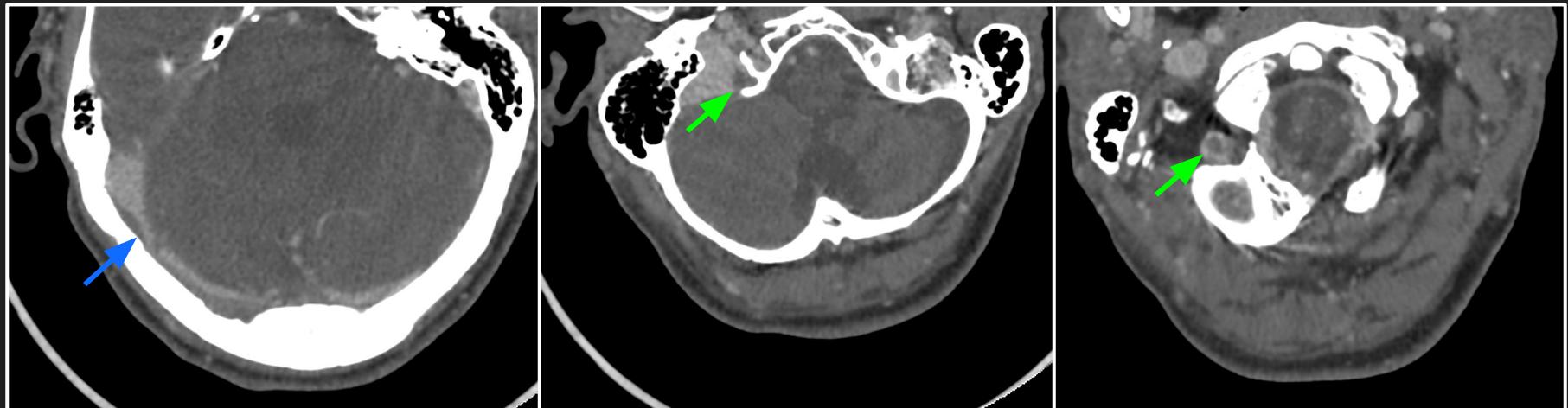
CT angiogram images demonstrate prominent drainage from the sigmoid sinus (orange arrow) through the left condylar canal (green arrow) into the occipital vein (red arrow).



# Thrombus extending from sigmoid sinus through condylar canal into posterior condylar vein.

55 year old presenting with traumatic brain injury with findings of multiple contusions and subdural hematoma.

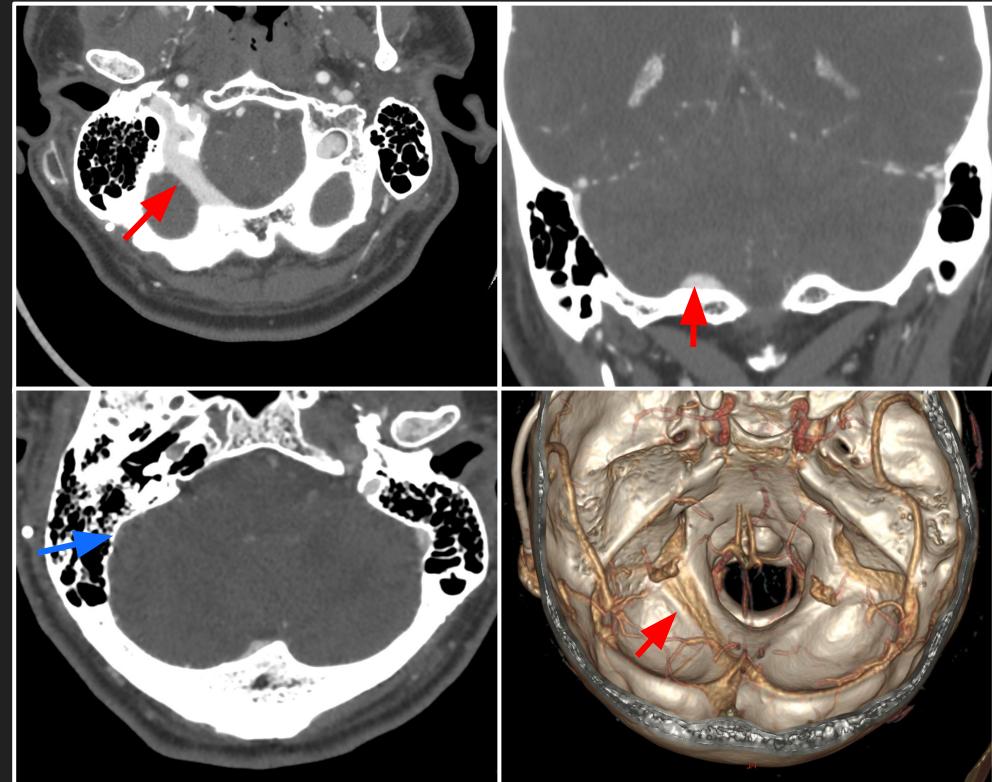
CT venogram images demonstrate thrombus within the sigmoid sinus (blue arrow). Thrombus extends into the condylar canal and posterior condylar vein (green arrows).



# Anomalous drainage from torcular to sigmoid sinus in the absence of transverse sinus

35 year old male with postural orthostatic hypotension and arachnoid cyst with new bradycardia and hypotension.

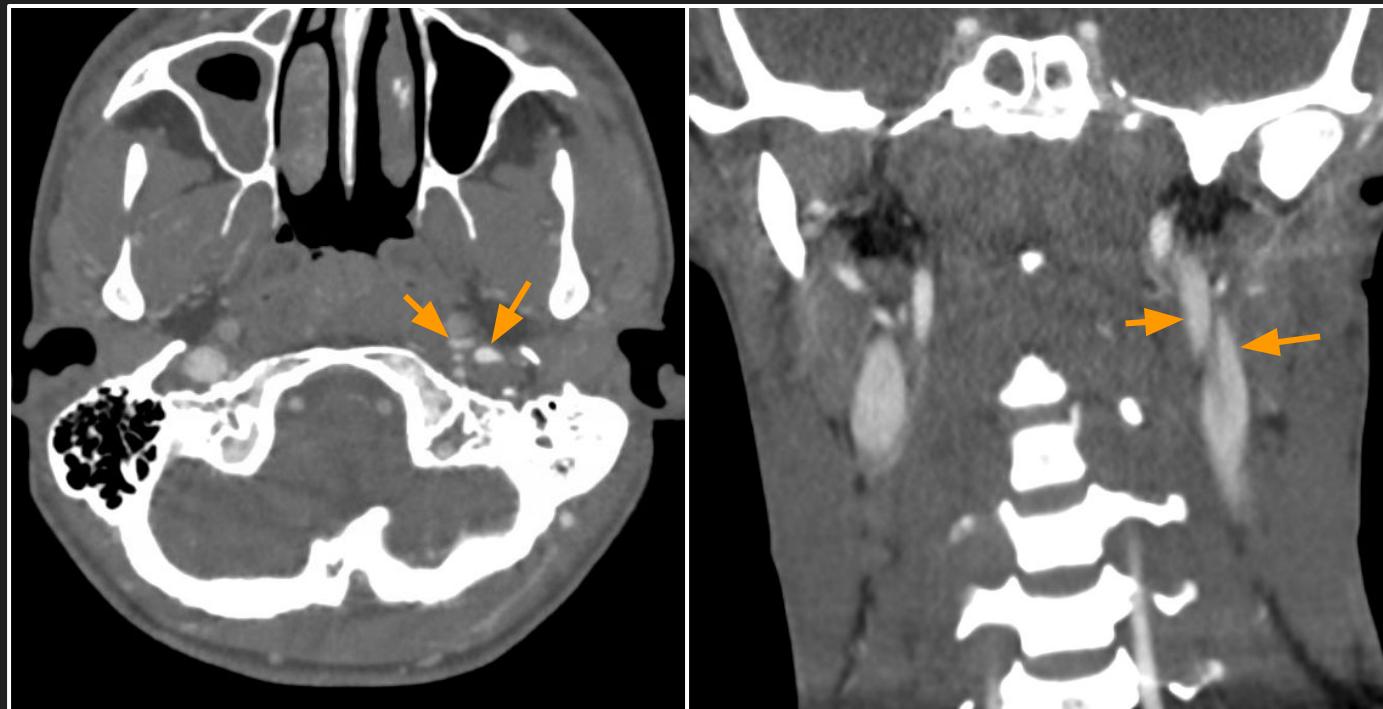
CT venogram and 3D volume-rendered reformatted images demonstrate an aberrant venous structure coursing along the right occipital bone and posterior fossa, draining into the right sigmoid sinus (red arrows). The blue arrow highlights the absence of a right sigmoid notch, indicating a hypoplastic right sigmoid sinus.



# Internal jugular vein fenestration

16-year-old male presenting with a skull base fracture involving the left occipital bone and condyle.

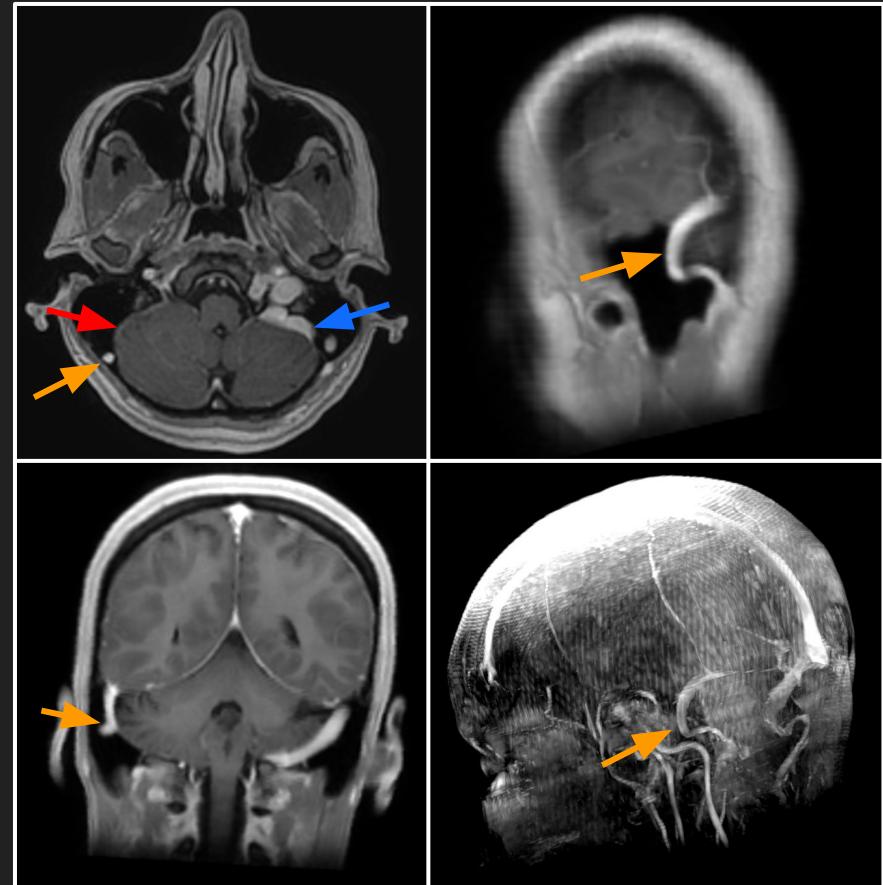
CT venogram images incidentally demonstrate duplication or fenestration of the proximal left internal jugular vein.



# Right transverse sinus drainage to vertebral venous plexus via retromastoid emissary vein

34 year old female presenting with dizziness and syncope.

Pre- and post-contrast MRI of the brain was obtained. Fast T1 3D Gradient-Echo (GRE) Brain Volume (BRAVO) sequence images demonstrate an aplastic right sigmoid sinus (red arrow); the blue arrow highlights the normal left sigmoid sinus. Orange arrows indicate anomalous drainage of the right transverse sinus via a retromastoid emissary vein into the vertebral venous plexus.



# Conclusion on Dural Venous Sinus Variants

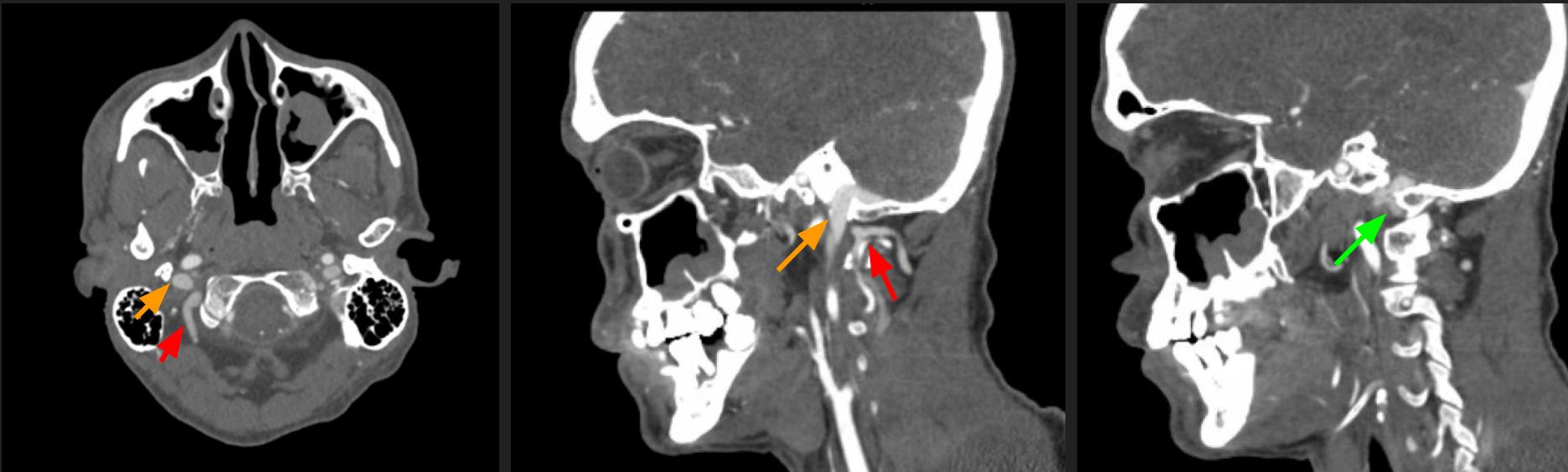
- The anatomy of the dural venous sinuses is highly variable, largely influenced by oxygenation patterns during embryologic development.
- Common anatomical variants include hypoplasia or atresia—particularly of the transverse and sigmoid sinuses—and the persistence or recanalization of embryonic sinuses such as the falcine and occipital sinuses.
- Hypoplasia of the left transverse sinus is the most frequently observed anatomical variant, with reported prevalence ranging from 21% to 39% in various populations.
- These variants are typically incidental findings but hold clinical significance in surgical planning and diagnostic interpretation.
- Awareness of these variations is crucial to avoid misdiagnosis, such as mistaking them for dural venous sinus thrombosis. Therefore, it is essential to trace these anatomical variants back to their connecting vessels during imaging assessments.

# References So Far

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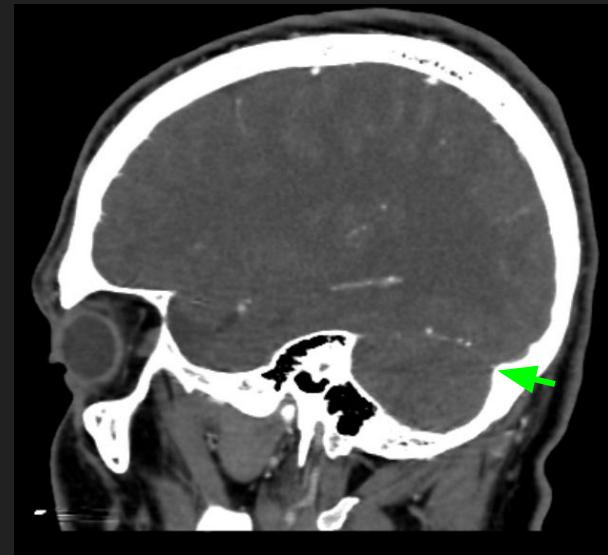
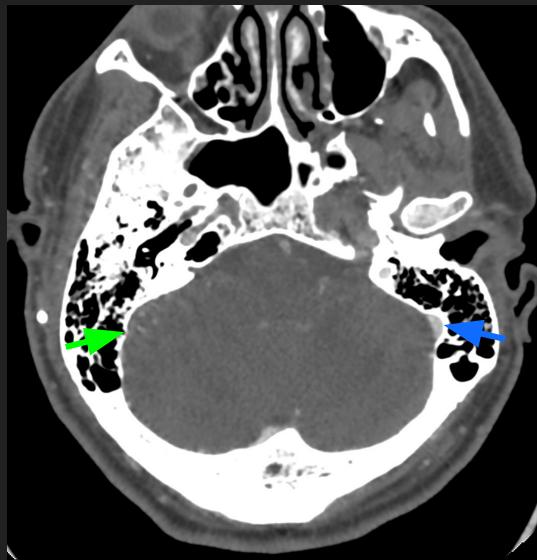
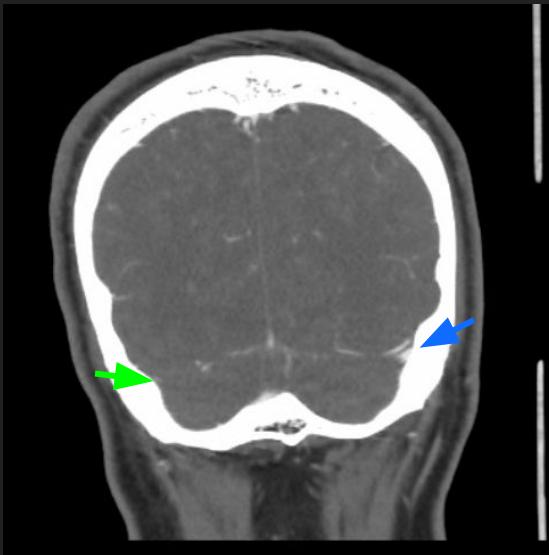
# Anastomosis between vertebral vein and internal jugular vein

38 year old male presenting with multiple rib fractures. CT angiography images demonstrate an abnormal anastomosis (green arrow) between the right vertebral vein (red arrow) with the right internal jugular vein (orange arrow)



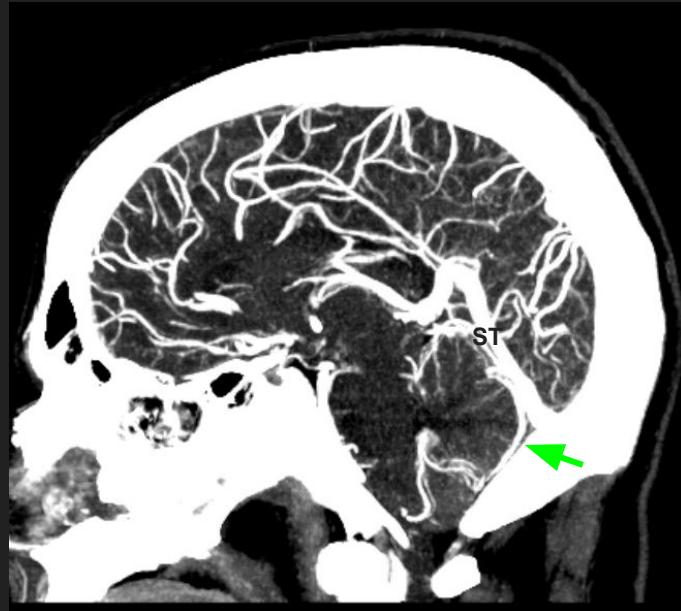
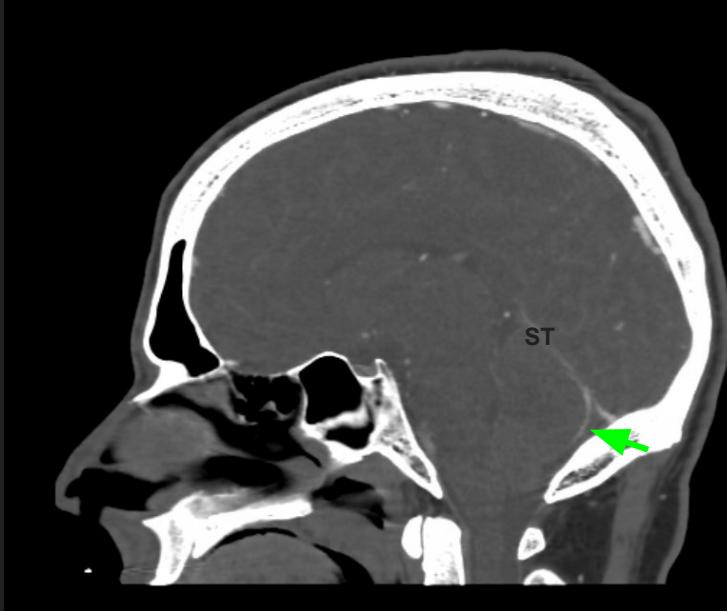
# Transverse and sigmoid sinus hypoplasia

35 year old female with signs of increased intracranial pressure. Coronal and sagittal CT venogram images demonstrates a narrowed and nearly effaced right transverse sinus. The left transverse sinus is normal in caliber with a larger sigmoid notch. Blue arrows demonstrate the normal anatomical side and green arrows highlight the abnormal side. Note the absence of a sigmoid notch on the right side.



# Occipital Sinus

35 year old male with postural orthostatic hypotension and arachnoid cyst with new bradycardia and hypotension. CT venogram sagittal and sagittal MIP images show a midline vascular structure along the posterior fossa (green arrows), compatible with an occipital sinus. (ST = straight sinus)





19 year old female with chronic headaches and papilledema. Sagittal CT venography (A) and 3D images (B) demonstrates a recanalized falcine sinus (A). An example of normal venous sinus anatomy is shown as comparison (C) and (D).

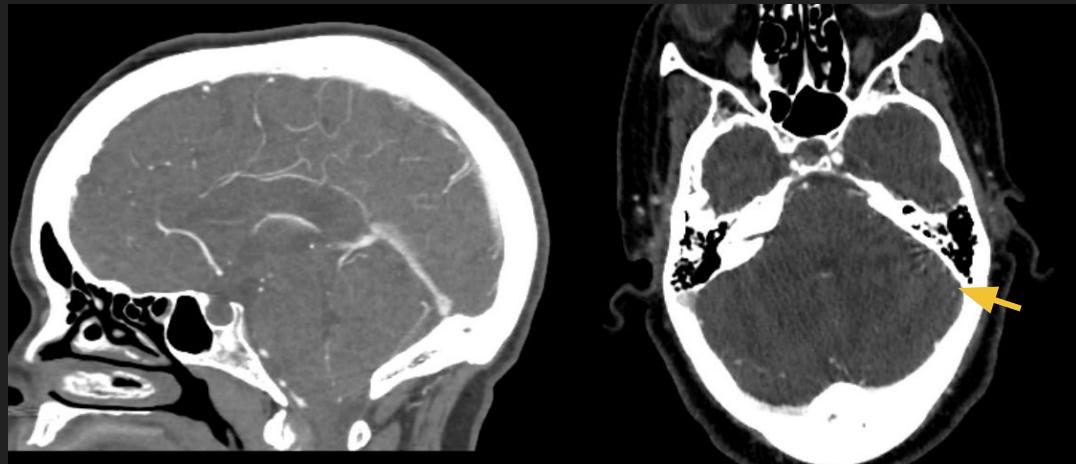
Same



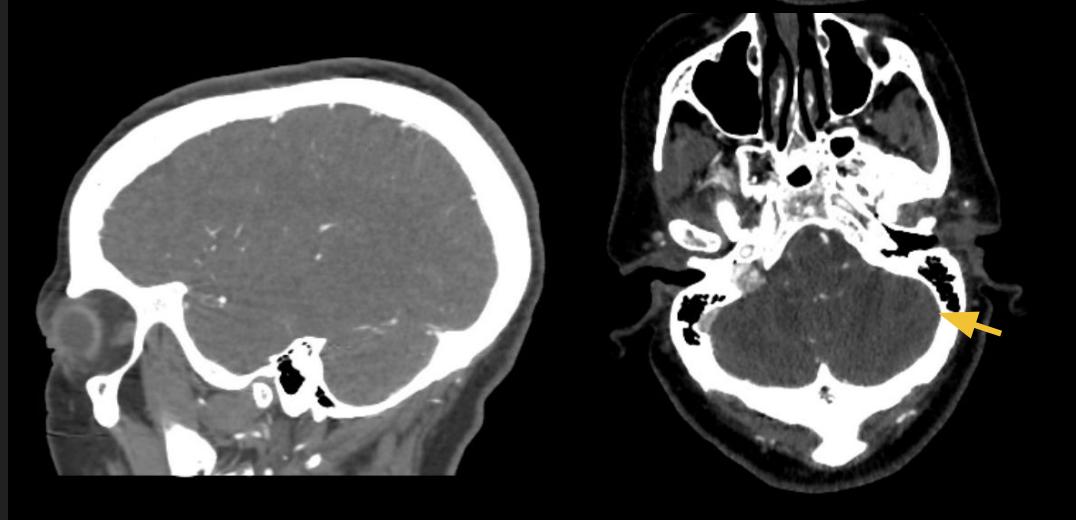
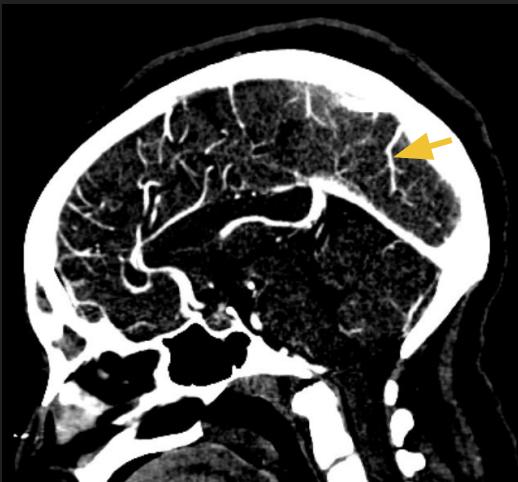
## Occipital Sinus



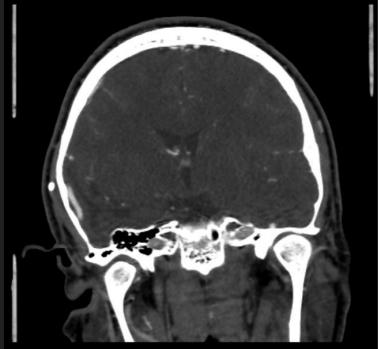
60 year old female undergoing evaluation of left ICA terminus aneurysm. Absent Left Transverse Sinus, Sigmoid Sinus, and Internal Jugular Vein



## Partial Falcine Sinus



Prominent veins of labbe traversing the petrous pyramid and supplying the distal sigmoid sinuses.



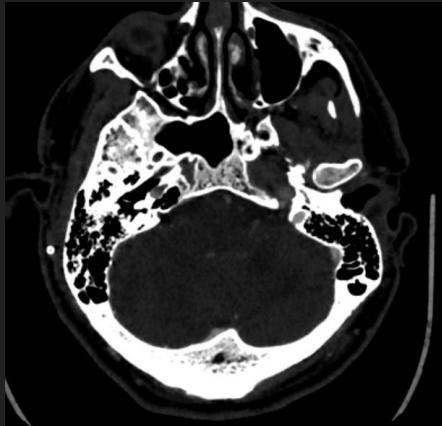
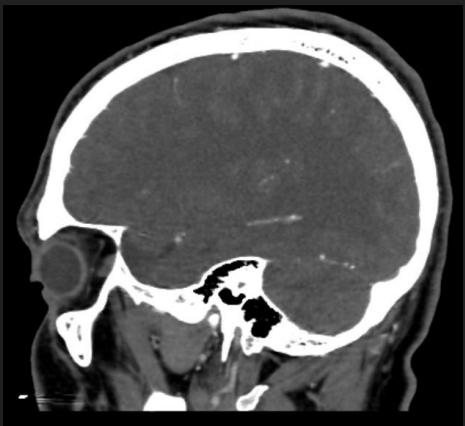
Hypoplastic right transverse



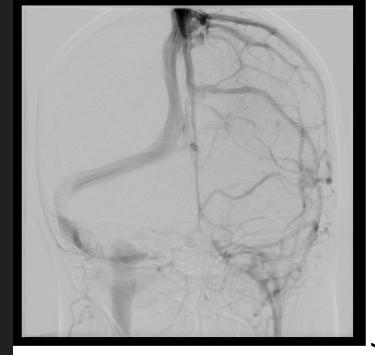
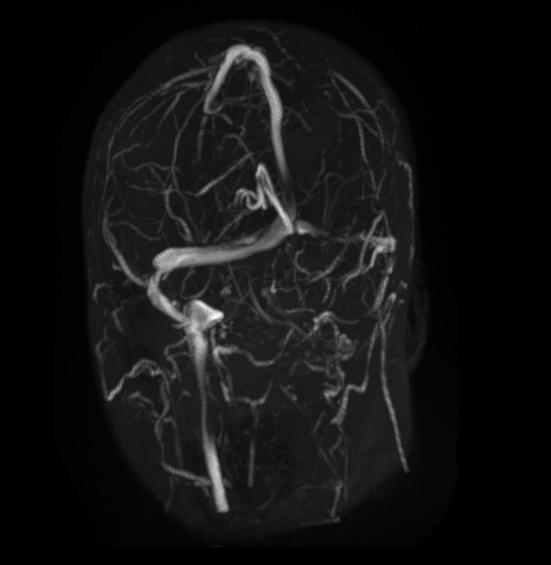
Diminutive Left transverse sinus



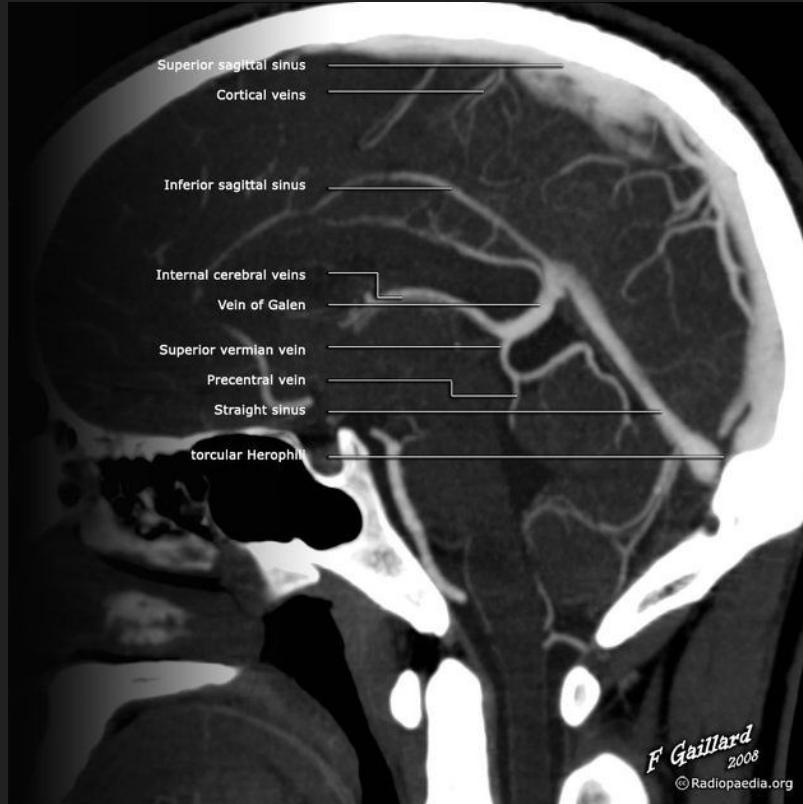
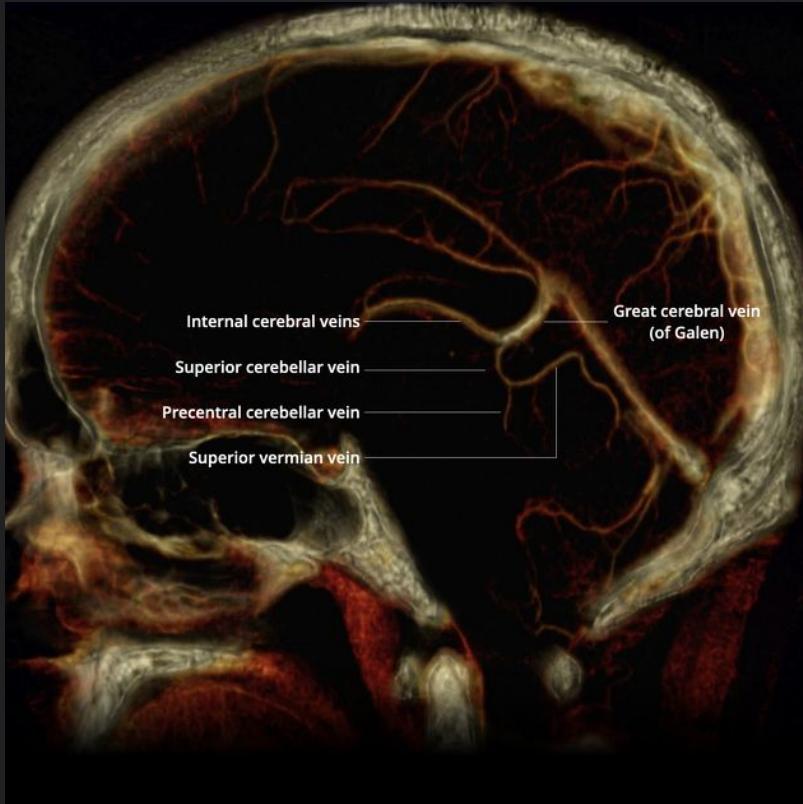
Flattened Sigmoid Notches



18 year old female with intracranial hypertension. Hypoplastic left TV sinus, right TV stenosis, prominent tentorial veins.  
(had left TV stent placed here in Jan 2024)



# Dural Venous Sinus Anatomy



Gaillard F, Cerebral veins (diagram). Case study, Radiopaedia.org (Accessed on 01 Apr 2025)  
<https://doi.org/10.53347/rID-36159>