Learning objectives

Learning Objectives:

1. To understand posterior fossa venous embryology and anatomy.

2. To describe various nomenclatures used according to its relation to adjacent brain structure.

3. To illustrate variations in venous drainage.

4. To discuss common and uncommon posterior fossa venous pathology.

Background

Veins of posterior fossa principally drain into three main confluence namely galenic (superior confluent), torcular (posterior confluent) and petrosal (anterior confluent). The venous draining pattern can be highly variable. They are closely related to the hindbrain surface hence named according to the structures it's overlying. We describe the venous embryology, anatomy and common and rare pathology such as developmental venous anomalies, arterio-venous malformations, arterio-venous fistulas, vein of galen malformations and venous thrombosis.

Imaging findings OR Procedure details

With recent advances in CT and MR techniques, most of the posterior fossa venous drainage is easily identifiable however catheter angiogram is still helpful to assess the venous draining pattern. In this pictorial review we demonstrate a step wise approach to identify posterior fossa veins and we also describe a variety of venous pathologies.

Posterior fossa veins anatomy.

- Posterior fossa veins drain into 3 main confluenets (1) -names derived from hindbrain structure to which it is closely applied-:

  - Galenic (superior confluent) mainly draining towards the Vein of Galen, including the mesencephalic and superior brainstem drainage, and cranial aspect of the cerebellum (Figure 1 &2)
• **Superior vermian vein**
• **Pre-central vein**
• **Lateromesencephalic vein**

- **Torcular** (posterior confluent) towards the torcular and lateral sinuses, draining the posteroinferior aspect of the cerebellum (Figure 3)
  
  • **Inferior vermian vein**
  • **Hemispheric veins (great horizontal fissure)**

- **Petrosal** (anterior confluent) draining the rest of the brainstem, cranial nerves, and anterior cerebellum. (Figure 4)
  
  • **Petrosal vein (draining into the superior petrosal sinus)**
  • **Anterior hemispheric vein (primary fissure)**
  • **Veins of the brainstem (variable)**

The inferior petrosal sinus sometimes receives also the vein of the lateral recess of the IV ventricle.

**Embryology**

The primitive mesencephalic and metencephalic pia-arachnoidal veins are the main drainage for the mesencephalon and metencephalon (future cerebellum) in the early foetus. Later in development venous drainage diverts to the three main confluents described below.

A perpendicular pattern of venous connections appears to be the main scheme for venous evolution to cover the drainage needs of the developing cerebellum and brainstem (2). (Figure 5)

**Superior Group**

• The primitive dorsal mesencephalic vein contributes via its anterior branches to the drainage of the mesencephalon and either gets incorporated into the basal vein of Rosenthal or adopts an independent course towards the vein of Galen.

• The veins that drain the superior region of the vermis & cerebellar hemispheres converge towards the straight sinus & vein of Galen in the superior vermian veins and pre-central vein, because in the relatively late stage when the cerebellum develops (up to 70 mm) the venous precursor of the vein of Galen has still a plexal arrangement.

**Posterior Group**

• Carried primarily by vessels derived from the dorsal mesencephalic vein.
• Secondary vermian venous drainage include the vein of the choroid plexus of the fourth ventricle
• A variable number of tentorial sinuses may be observed on each side, usually 1-2.

Anterior Group

• Superior petrosal sinus is the derivative of one of the five main encephalic veins of the embryo: the pia-arachnoidal metencephalic vein.
• Petrosal vein is intradural in foetal life, and is partially related to the lateral aspect of the choroid plexus. It also receives venous drainage from the neighbouring cranial nerves.
• The veins of the archicerebellum & veins that drain the lateral region of the choroid plexus of the 4th ventricle are first to appear.
• Brainstem venous development show multiple perpendicular anastomoses connecting anterior & superior confluents.

Common Pathology

Arterio Venous Malformation

• Abnormal direct arterio-venous connection without intervening capillaries (nidus)
• Usually seen in the supratentorial compartment, <15% infratentorial
• More likely to present with haemorrhage and/or progressive neurological deficits, in the posterior fossa
• Greater morbidity & mortality than supratentorial AVMs due to confines of the posterior fossa & proximity to crucial structures

Annual rupture rate of 11.6% in first 5 years after presentation and 6.7% overall (3)

Examples:

Case: PICA feeding right hemispheric and vermian AVM draining towards precentral vein (Arrow) and superior petrosal sinus (arrow heads). Note PICA aneurysm (arrow) (Figure 6, 7, 8)

Case: PICA feeding a posterior superior AVM draining into superior vermian vein. Note PICA aneurysm (Figure 9)

Case: AVM draining into inferior vermian vein and vein of lateral recess of fourth ventricle draining into inferior petrosal sinus. (figure 10)
Vein of Galen Malformation

True VoG malformation is not a posterior fossa malformation. It is related to persistence of embryonic prosencephalic vein of Markowski which is a supratentorial vein draining towards the superior sagittal plexus (later sinus). (figure 11, 12)

- Develops between 6 - 11 weeks of foetal life
- Fed by anterior cerebral, anterior & posterior choroidal, lenticulostriate and thalamic perforating arteries
- Results in high output heart failure, cerebral ischaemia, progressive paresis, mass effects, hydrocephalus, rarely causing haemorrhage

Dural AV Fistula (figure 13 &14)

- Dural lesions with abnormal direct connections between arteries & venous sinuses / leptomeningeal veins
- Can occur anywhere within intracranial dura, normally close to the venous sinuses
- Represent 10-15% of intracranial vascular anomalies
- Aetiology generally proposed to be acquired, with venous sinus thrombosis a common thread
- Morbidity/mortality 1.8-20% per annum
- Symptoms vary with location from mild & non-specific (eg tinnitus) to severe (haemorrhage)

Vascular Tumours

Glomus Tumour:

(Figure 15 & 16)

- F>M
- sixth decade
- Insidious onset
- Slowly growing, Hypervascular tumour within jugular foramen
- Locally invasive
- Metastasis: uncommon
- Presentation: conductive deafness, vertigo, headache, cranial nerve involvement

Case: Angiogram showing glomus jugulare tumor draing into jugular vein, cavernous sinuses and both inferior petrosal sinuses.
Haemangioblastomas

- Von Hippel Lindau Syndrome
- Autosomal dominant
- Associated with clear cell renal carcinoma, cystadenomas, pheochromocytomas
- HGBLs in VHL are multiple, involves cerebellum in 35-40%
- Angiogram shows intensely vascular mass

Case: Angiogram showing intensely enhancing mass within the cerebellum draining through the inferior vermian vein (arrow) Figure 17 & 18

Venous Sinus Thrombosis

- Very infrequent to affect only posterior fossa veins
- Uncommon cause of stroke (postulated 1 case for every 62.5 cases of arterial stroke)
- Incidence increasing as less severe cases are being diagnosed
- Untreated mortality 13 - 48% with 25 - 30% experiencing full recovery
- Predisposing factors include hypercoagulable state, dehydration, pregnancy, infection, trauma and tumour
- Symptoms include headache, altered consciousness, seizure, neurological deficit and visual disturbance.

Images for this section:
**Fig. 1:** Lateral view vertebral artery angiogram showing 1. Pre central vein 2. Superior vermian vein
**Fig. 2:** lateral vertebral artery angiogram showing precentral vein (arrow)
Fig. 3: AP view vertebral angiogram showing anterior and posterior confluence 1. Tentorial sinus 2. Superior petrosal sinus 3. Hemispheric vein 4. Inferior vermian vein
Arrow head: Petrosal vein
Fig. 4: Lateral Vertebral artery angiogram showing Anterior Confluent Small single Arrow: Anterior pontomesencephalic vein Single Arrow head: Anterior medullary vein Double arrow head: Lateral pontomesencephalic vein Three arrow head: Transverse pontine vein Long arrow: Petrous vein Two long arrow: Superior petrosal sinus
Fig. 5: 50 mm CR length embryo showing the venous plexus, precursor of the vein of Galen within the primitive dural mesh between the falx and the primordium of the tentorium. 1: Cerebral hemispheres 2: Dural mesh 3: Venous plexus
Fig. 6: Lateral view: vertebral artery angiogram showing PICA aneurysm (arrow head)
**Fig. 7:** Lateral view: Vertebral artery angiogram showing PICA feeding right hemispheric and vermian AVM draining towards precentral vein (Arrow) and superior petrosal sinus (arrow heads).
Fig. 8: AP View: PICA feeding right hemispheric and vermian AVM draining towards precentral vein (Arrow)
Fig. 9: Lateral View: PICA feeding a posterior superior AVM draining into superior vermian vein. Note PICA aneurysm.
**Fig. 10:** Lateral view vertebral angigram showing AVM draining into 1. Inferior vermian vein 2. Vein of lateral recess of fourth ventricle draining into inferior petrosal sinus.
**Fig. 11:** Complex Vein of Galen and Spinal AVM 1. medullary vein 2. lateral pontomesencephalic vein 3. Joining vein of Galen
Fig. 12: Complex Vein of Galen and Spinal AVM 1. medullary vein 2. lateral pontomesencephalic vein 3. Joining vein of Galen
Fig. 13: Lateral view vertebral angiogram showing fistula point at tentorial sinus
**Fig. 14:** Lateral View vertebral angiogram showing Arrow: Hemispheric vein Long arrow: anterior confluent small arrow heads: Dilated cerebellar veins
Fig. 15: AP view angiogram showing glomus jugulare tumour draining into jugular vein, cavernous sinuses and inferior petrosal sinuses. Coronary sinus joining both cavernous sinuses (arrow)
Fig. 16: lateral view angiogram AP view angiogram showing glomus jugulare tumour draining into jugular vein, cavernous sinuses and inferior petrosal sinuses. Coronary sinus joining both cavernous sinuses (arrow)
**Fig. 17:** AP View Angiogram showing intensely enhancing mass within the cerebellum draining through vermian vein (arrow)
**Fig. 18:** Lateral view Angiogram showing intensely enhancing mass within the cerebellum draining through vermian vein (arrow)
Conclusion

The posterior fossa venous drainage is highly variable but constant pattern can be recognised. The knowledge and understanding the posterior fossa venous drainage is important for planning neurosurgical and endovascular management.

Personal Information

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References

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