



# Venous Anatomy

*Last Updated: September 13, 2021*

## Intracranial Venous System

### Superficial Veins

- **Superficial cortical veins** are thin walled, valveless, and traverse the subarachnoid space within the cerebral sulci
  - **Superior**
    - 8 to 12 smaller cortical veins over hemispheres
    - Dominant *superior anastomotic vein of Trolard*
  - **Middle**
    - Variable superficial middle cerebral veins
    - Dominant *middle anastomotic vein of Labbé*
    - Inferior: middle cerebral veins, *basal vein of Rosenthal*
- **Medullary veins**
  - Small, linear venous branches originating in the subcortical white matter
  - Course toward ventricles, terminate in subependymal veins

### Deep Veins

- **Subependymal veins**
  - Along the margins of the ventricles
- **Septal veins**
  - Course posteriorly along septum pellucidum
  - Join with transverse sinus to form internal cerebral veins at interventricular foramen
- **Thalamostriate veins**
  - Receive caudate veins that course anteriorly between caudate

nucleus, thalamus

- Curve over caudate nuclei
- Terminate at interventricular foramen (of Monro) by uniting with septal veins to form **internal cerebral veins**
- **Internal cerebral veins**
  - Deep paired paramedian veins
  - Course posteriorly in cavum veli interpositi
  - Terminate in rostral quadrigeminal cistern by uniting with the **basal veins of Rosenthal** to form **vein of Galen**
  - Formed by thalamostriate and septal veins
- **Great cerebral vein of Galen**
  - Short, U-shaped midline vein formed from union of **internal cerebral veins, basal veins of Rosenthal**
  - Curves posteriorly and superiorly under corpus callosum splenium in quadrigeminal cistern
  - Unites with **inferior sagittal sinus** at falcotentorial apex to form **straight sinus**
- Brainstem/posterior fossa veins
  - **Superior (galenic)**
  - **Anterior (petrosal)**
  - **Posterior (tentorial)**

## Dural Venous Sinuses

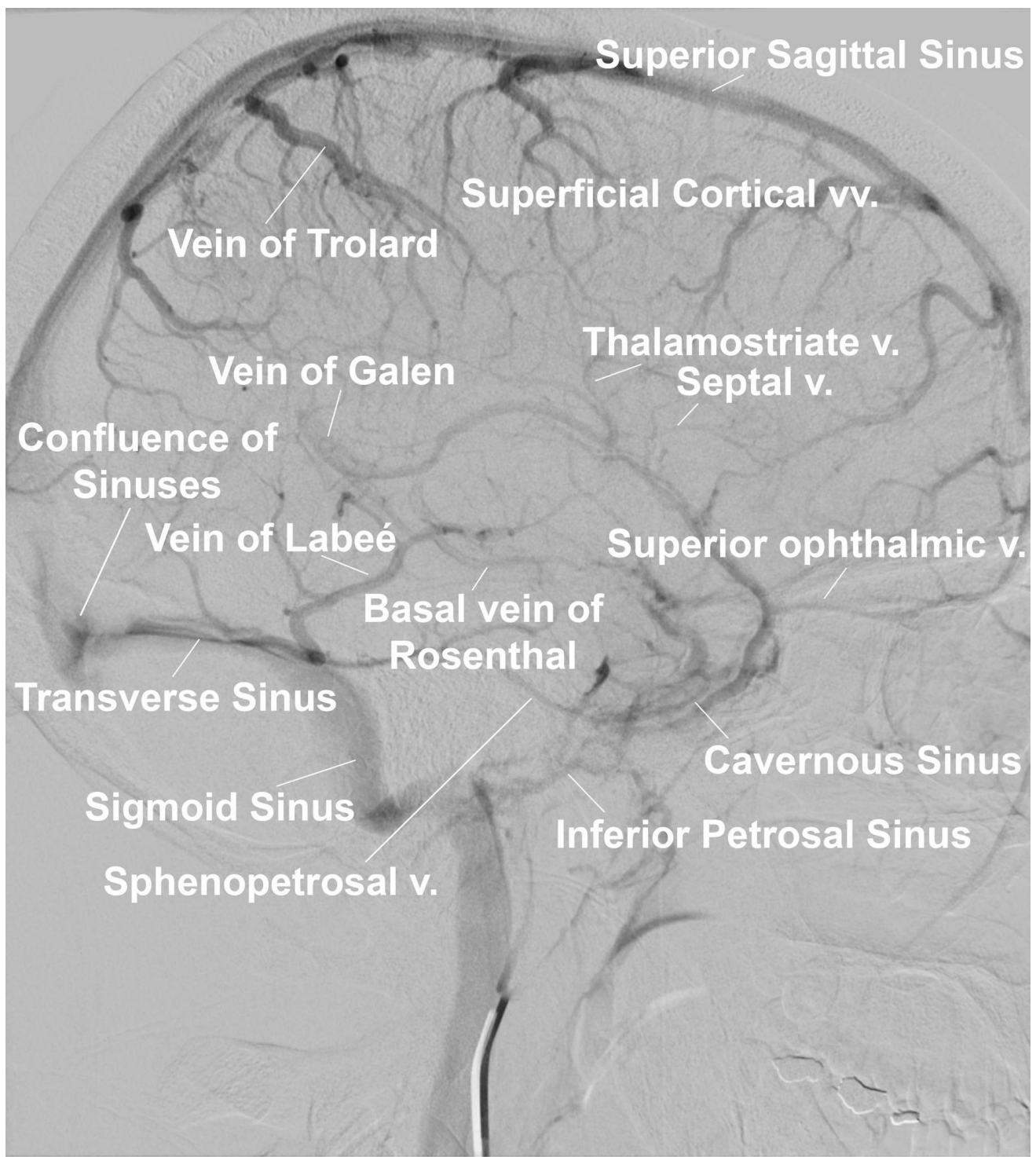
Endothelium-lined venous conduits encased within dural reflections

- Outer (periosteal) and inner (meningeal) dural layers
- Valveless, however can be complex
  - Fenestrated, septated, and/or multichanneled
- Contain arachnoid granulations and arachnoid villi
  - Extension of arachnoid through dural wall into lumen of venous sinus
  - Cerebrospinal fluid (CSF) resorption into venous circulation

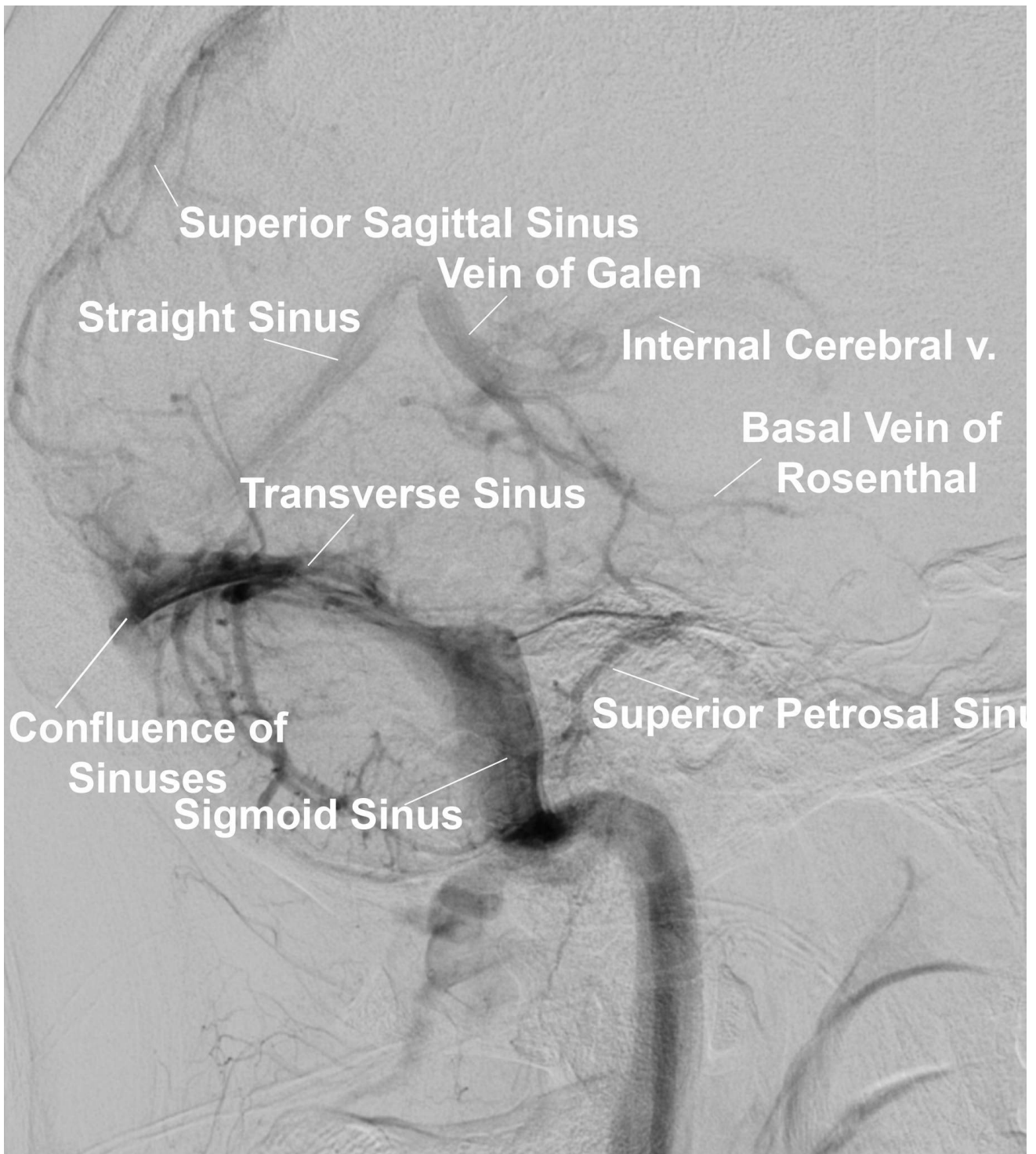
- CSF-equivalent filling defects in dural sinuses
- Can be large and irregular, pitfall for dural venous sinus thrombosis
- Receive venous blood from supratentorial superficial (cortical) veins and deep (subependymal) veins
- Variable parallel conduits with extracranial veins via ***diploic calvarial veins***
- **Superior sagittal sinus**
  - Curvilinear sinus and courses typically along the inner medial calvarium
  - Originates from the ascending frontal veins, anteriorly; courses posteriorly in midline at junction of the falx cerebri with the calvarium
  - Collects superficial cortical veins and increases in diameter as it courses posteriorly
  - Terminates in the **torcula**, at the falcotentorial apex, joining with **vein of Galen** to form **straight sinus**
- **Straight sinus**
  - Runs from falcotentorial apex posteroinferiorly to the sinus confluence
  - Receives tributaries from the falx cerebri, the tentorium, and cerebral hemispheres
- **Torcular Herophili (also: torcula, venous sinus confluence)**
  - Formed by the union of the **superior sagittal sinus**, **straight sinus**, and **transverse sinuses** with highly variable interconnections and often asymmetric, right commonly larger than left
  - Contained between the attachment of tentorial leaves to the calvarium
  - Can extend laterally to posterior border of petrous temporal bone and receive tributaries from the tentorium, cerebellum, and inferior temporal/occipital lobes

- **Transverse-sigmoid sinuses**
  - **Sigmoid sinus** is the anteroinferior continuation of the **transverse sinus**
  - Sigmoid sinuses terminate by becoming the internal jugular veins at the skull base
- **Cavernous sinuses**
  - Complex trabeculated venous compartment along the sides of the sella turcica, extending from the superior orbital fissure anteriorly to the clivus and petrous apex posteriorly. Important tributaries to the **cavernous sinuses** include the **ophthalmic veins** and **sphenoparietal sinus**. Each cavernous sinus communicates inferiorly with the **pterygoid venous plexus**, medially with the **intercavernous sinus** to the contralateral **cavernous sinus**, and posteriorly with the **superior and inferior petrosal sinus**, and **clival venous plexus**.
  - Important contents
    - C4 segment of the internal carotid artery
    - Cranial nerve VI
      - Enters the dura mater through Dorello canal
      - Traverses along the inferolateral aspect of the cavernous internal carotid artery
    - Cranial nerves III, IV, V1, and V2
      - Travel within lateral dural wall
- **Superior petrosal sinus**
  - The **superior petrosal sinus** courses along the petrous ridge from the **cavernous sinus** to the sigmoid sinus
- **Inferior petrosal sinus**
  - The **inferior petrosal sinus** courses along the petro-occipital fissure from the **clival venous plexus** to the **jugular bulb** at the skull base
- **Sphenoparietal sinus**
  - The **sphenoparietal sinus** courses along the margin of the lesser sphenoid wing from the Sylvian fissure to **cavernous sinus** or **inferior petrosal sinus**

- **Occipital sinus**
  - Usually the smallest dural sinus, the **occipital sinus** arises from the foramen magnum, courses along the midline posterior fossa and terminates at the **torcula**
- **Clival venous plexus**
  - The **clival venous plexus** is located along the clivus from dorsum sellae to foramen magnum
- **Notable normal variants**
  - Variations are the rule, not the exception
  - **Superior sagittal sinus**
    - Absent anterior **superior sagittal sinus** (may begin posteriorly near coronal suture)
    - Parasagittal course, drainage to transverse sinus directly
  - **Transverse-sigmoid sinuses**
    - Absence or hypoplasia of part or all of one **transverse sinus**



**Figure 1: Lateral digital subtraction angiogram (DSA) of the intracranial venous structures.**



**Figure 2: Detailed lateral-view DSA of the posterior intracranial venous structures.**

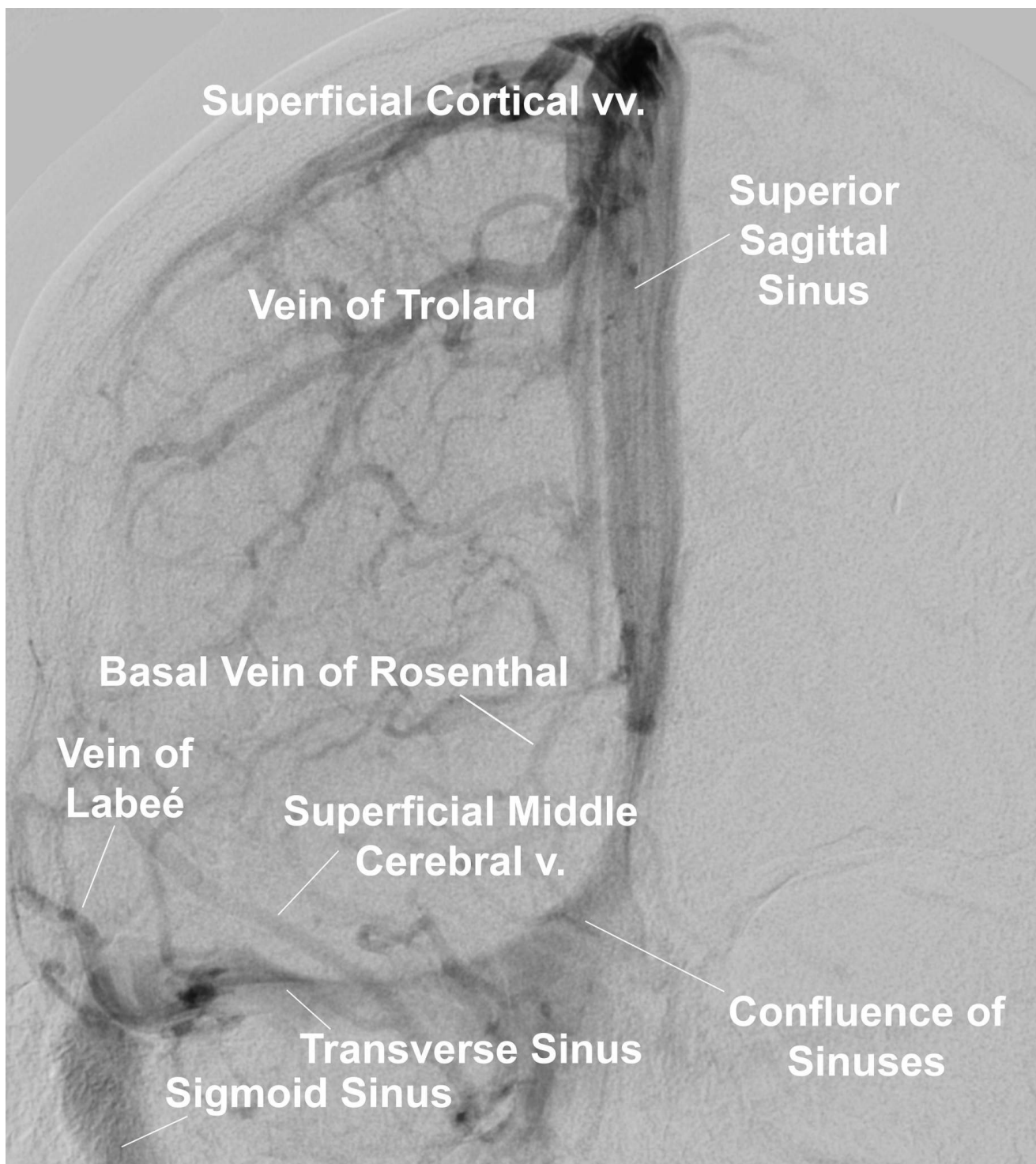


Figure 3: Frontal-view DSA of the left intracranial venous structures.

## Jugular Bulbs

- Variable size
- Variable configuration
  - High-riding
  - Jugular diverticulum
  - Dehiscent jugular bulb



## Anomalies

- **Vein of Galen malformation**
  - **Primitive median prosencephalic vein** persists as outlet for diencephalic, choroidal venous drainage
  - Associated with abnormal arteriovenous shunt
  - Associated persistent embryonic **falcine sinus**
- High position of the **torcula** (Lambdoid-torcular inversion) with Dandy-Walker spectrum

## Drainage Patterns

*The cerebral venous system is highly variable, but it can be conceptualized as having 3 dominant patterns of superficial, deep supratentorial, and deep infratentorial drainage pathways.*

### Superficial Drainage

*The superficial drainage of the brain is radial or centrifugal from the Sylvian fissures by way of cortical and dominant anastomotic venous branches*

- Laterally, by the **superficial vein of Labbé**, which drains into the transverse sinus
- Superiorly, by the superior cerebral veins and **superficial vein of Trolard**, which empties into the superior sagittal sinus
- Internally, by the **superficial middle cerebral vein**, which drains from the Sylvian fissure into the cavernous sinus
  - The vein of Labbé may arise from the posterior extent of the superficial middle cerebral vein

### Deep Supratentorial Drainage

*The deep venous drainage of the supratentorial cerebrum converges on the internal cerebral veins and the vein of Galen*

- **Medullary veins** radiate inferiorly from the superficial white matter to drain to the **subependymal and thalamostriate veins**

- **Deep veins of central and nuclear regions** (choroidal, caudate, terminal, lateral, atrial, and ventricular veins) drain to the medial subependymal septal vein and the lateral subependymal thalamostriate veins, which unite with the **internal cerebral veins**
- The **internal cerebral veins** commonly arise at the foramen of Monro and run on either side of the roof of the third ventricle
- The **internal cerebral veins** unite to form the **vein of Galen**
- The vein of Galen drains to the straight sinus

## Deep Infratentorial Drainage

*The anatomy of the posterior fossa venous drainage is complex*

- Superior vermian, posterior pericallosal, mesencephalic, and internal occipital veins drain into the **vein of Galen**, which also receives drainage from the **basal vein of Rosenthal**, which in turn receives venous supply from the insular lateral mesencephalic veins (and deep middle cerebral and anterior cerebral veins of the cerebrum)
- The **vein of Galen** and **inferior sagittal sinus** drain to the **straight sinus**, which in turn drains into the **torcula** along with the superior sagittal sinus
- The **torcula** drains into the **paired transverse sinuses**, which also receive drainage from the **superior petrosal sinuses**, diploic veins, and lateral cerebellar veins; the transverse sinuses course laterally in the leaves of the tentorium and continue as the sigmoid sinuses, which also drain the **occipital sinuses**
- The **sigmoid sinus** terminates as the **internal jugular vein**
- The inferior vermian veins and superior hemispheric veins drain into the **straight sinus**
- Each transverse sinus receives blood from the inferior and superior cerebellar hemispheric venous system
- The deep middle cerebral vein courses deep in the Sylvian fissure, and it meets with the anterior cerebral vein to form the **basal vein of**

**Rosenthal** arising along the brain stem; the **basal vein of Rosenthal** receives blood from the anterior pontomesencephalic vein in front of the brain stem, the lateral mesencephalic veins, and the precentral cerebellar vein

- Anterior venous drainage converges on the **cavernous sinuses**; these venous channels receive blood from superior and inferior ophthalmic veins, the **sphenoparietal sinus**, and the superficial middle cerebral vein. The **cavernous sinus** communicates via
  1. An extensive network across midline to the opposite cavernous sinus via the **intercavernous sinus**
  2. Posteriorly via the **superior petrosal sinus** to the **transverse sinuses** just before the latter dive inferior to the **sigmoid sinus**
  3. Inferiorly into the **inferior petrosal sinuses**, which subsequently drain directly to the **jugular bulbs**; the **inferior petrosal sinus** also drains the internal auditory canal venous system

## Venous Vascular Territories

- Highly variable compared to arterial territories
- Cortical venous drainage is ideally radial, centrifugal from the Sylvian regions
- Cerebral cortex and subcortical white matter drained by cortical veins to superior sagittal sinus
- Posterior and inferior temporal lobes, temporoparietal region drained by **vein of Labbé** to **transverse sinus**
- Anterior temporal lobe, insular cortex, parenchyma around Sylvian fissure drained by **sphenoparietal sinus** to **cavernous sinus**
- Central and deep white matter, basal ganglia drained by **medullary** and **subependymal veins** to **internal cerebral veins**, **vein of Galen**, **straight sinus**
- Medial temporal lobe drainage via **basal vein of Rosenthal** to **vein of Galen**

- Sylvian

Contributors: Daniel Murph, MD, Andrew DeNardo, MD, John Scott, MD, and Daniel Sahlein, MD

DOI: <https://doi.org/10.18791/nsatlas.v2.03.03.03>

