

Cerebral Venous System Anatomy

Muhammad Azeem Uddin, Tanveer Ul Haq, Muhammad Zafar Rafique

Department of Radiology, Aga Khan University Hospital, Karachi.

Abstract

Cerebral venous system can be divided into a superficial and a deep system. The superficial system comprises of sagittal sinuses and cortical veins and these drain superficial surfaces of both cerebral hemispheres. The deep system comprises of lateral sinus, straight sinus and sigmoid sinus along with draining deeper cortical veins.

Both these systems mostly drain themselves into internal jugular veins. The veins draining the brain do not follow the same course as the arteries that supply it. Generally, venous blood drains to the nearest venous sinus, except in the case of that draining from the deepest structures, which drain to deep veins. These drain, in turn, to the venous sinuses. The superficial cerebral veins

can be subdivided into three groups. These are inter-linked with anastomotic veins of Trolard and Labbe. However, the superficial cerebral veins are very variable. They drain to the nearest dural sinus. Thus the superolateral surface of the hemisphere drains to the superior sagittal sinus while the posteroinferior aspect drains to the transverse sinus. The veins of the posterior fossa are variable in course and angiographic diagnosis of their occlusion is extremely difficult. Blood from the deep white matter of the cerebral hemisphere and from the basal ganglia is drained by internal cerebral and basal veins, which join to form the great vein of Galen that drains into the straight sinus. With the exception of wide variations of basal vein, the deep system is rather constant compared to the superficial venous system. Hence their thrombosis is easy to recognize.

Introduction

Cerebral venous system can be divided into two basic components.¹⁻³

A) A Superficial System;

The superficial system comprises of sagittal sinuses and cortical veins and these drain superficial surfaces of both cerebral hemispheres.

B) A Deep System;

The deep system comprises of lateral sinus, straight sinus and sigmoid sinus along with draining deeper cortical veins.

Both these systems mostly drain themselves into internal jugular veins.⁴

A) Superficial cerebral venous system

The superficial cerebral veins (Figure 1 and 2) can be divided into three collecting systems.⁵

First, a mediodorsal group draining into superior sagittal sinus (SSS) and the straight sinus (SS); Second, a lateroventral group draining into the lateral sinus; and Third, an anterior group draining into the cavernous sinus.

These veins are linked by the great anastomotic vein of Trolard, which connects the SSS to the middle cerebral veins. These are themselves connected to the lateral sinus (LS) by the vein of Labbe.

The veins of the posterior fossa may again be divided into three groups:

- 1) Superior group draining into the Galenic system,
- 2) Anterior group draining into Petrosal sinus and
- 3) Posterior group draining into the torcular Herophili and neighbouring transverse sinuses.⁶

The veins of the posterior fossa are variable in course and angiographic diagnosis of their occlusion is extremely difficult.

The Superior Sagittal Sinus (SSS) (Figure 3) starts at the foramen cecum and runs backwards towards the internal occipital protuberance, where it joins with the straight sinus and lateral sinus to form the torcular Herophili. Its anterior part is narrow or sometimes absent, replaced by two superior cerebral veins that join behind the coronal suture.⁷ This fact should be borne in mind while evaluating for cerebral venous thrombosis (CVT). The SSS drain major part of the cerebral hemispheres.

The cavernous sinuses drain blood from the orbits, the inferior parts of the frontal and parietal lobe and from the superior and inferior petrosal sinuses. Blood from them flow into the internal jugular veins.

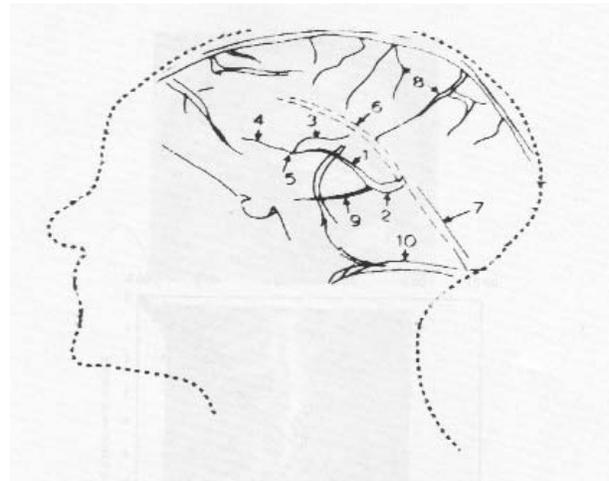


Figure 1. Diagram to illustrate A). Internal cerebral vein; B). Vein of Galen; C). Striothalamic Vein; D). Septal vein; E). Venous angle; F). Inferior sagittal sinus; G). Straight Sinus; H). Superficial Cortical Veins; I). Basal Vein; J). Lateral Sinus.

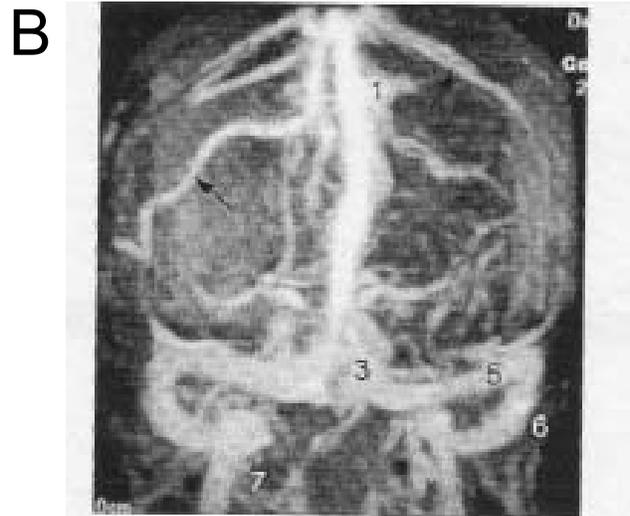


Figure 2A & 2B. Normal cerebral MR Venogram. 3D TOF images obtained after intravenous injection of gadolinium in sagittal (a) & coronal (b) planes. There is visualization of dural venous sinuses and superficial & deep cerebral veins. 1=Superior sagittal sinus, 2= Straight sinus, 3=Torcular Herophili, 4=Vein of Galen, 5=Lateral sinus, 6=Sigmoid sinus, 7=Internal Jugular vein, 8=Internal cerebral vein, 9=Basal vein of Rosenthal and the arrows points to superficial cerebral veins.

The straight sinus is formed by the union of inferior sagittal sinus and the great vein of Galen. The inferior sagittal sinus runs in the free edge of falx cerebri⁸ and unites with the vein of Galen to form the straight sinus. It runs backwards in the center of the tentorium cerebelli at the attachment of the falx cerebri, emptying into the torcular Herophili at the internal occipital protuberance.

The lateral sinuses extend from torcular Herophili to jugular bulbs and consist of a transverse and sigmoid portion. They receive blood from the cerebellum, the brain stem and posterior parts of the hemisphere. They are also joined by some diploic veins and small veins from the middle ear. There are numerous LS anatomic variations that may be misinterpreted as sinus occlusion.⁹

B) Deep cerebral venous system

The deep cerebral veins are more important than superficial veins from the angiographic point of view.¹⁰ Three veins unite just behind the interventricular foramen of Monro to form the internal cerebral vein (Figure 4). These include choroid vein, septal vein and thalamostriate vein. The Choroid vein runs from the choroid plexus of the lateral ventricle. The Septal vein runs from the region of the septum pellucidum in the anterior horn of the lateral ventricle and the thalamostriate vein runs anteriorly in the floor of the lateral ventricle in the thalamostriate groove between the thalamus and lentiform nucleus. The point of union of these veins is called the venous angle.

The internal cerebral veins of each side run posteriorly in the roof of the third ventricle and unite beneath the splenium of the corpus callosum to form the great cerebral vein. The internal cerebral veins, which lie within 2 mm of the midline, are the most important deep veins since they can be used to diagnose midline shifts.¹¹

The great cerebral vein of Galen is a short (1-2 cm long), thick vein that passes posterosuperiorly behind the splenium of corpus callosum in the quadrigeminal cistern. It receives the basal veins and the posterior fossa veins and drains to the anterior end of the straight sinus where this unites with the inferior sagittal sinus.

The basal vein of Rosenthal begins at the anterior perforated substance by the union of anterior cerebral vein, middle cerebral vein and the striate vein.¹² The basal vein on each side passes around the midbrain to join the great cerebral vein.

In summary, blood from the deep white matter of the cerebral hemisphere and from the basal ganglia, is drained by internal cerebral veins.¹³ and basal veins of Rosenthal, which join to form the great vein of Galen that drains into the straight sinus (Figure 2). With the exception of wide variations of basal vein, the deep system is rather constant

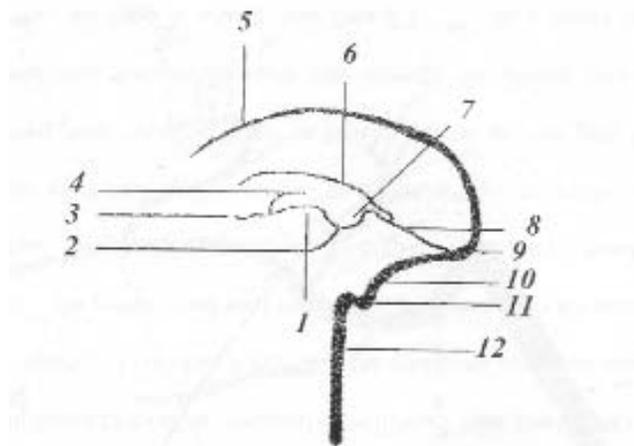


Figure 3. Diagram showing the relationship of deep cerebral veins and venous sinuses. 1). Internal Cerebral Vein. 2). Basal Vein of Rosenthal. 3). Septal Vein. 4). Thalamostriate Vein. 5). Superior Sagittal Sinus. 6). Inferior Sagittal Sinus. 7). Vein of Galen 8). Straight Sinus. 9). Torcular Herophili. 10). Transverse Sinus. 11). Sigmoid Sinus 12). Internal Jugular Vein.

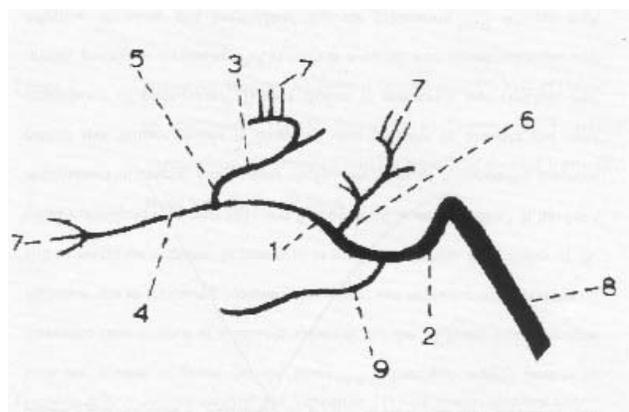


Figure 4. Diagram showing tributaries of deep cerebral veins. ICV). Internal Cerebral Vein; VG). Vein of Galen; STV). Striothalamic Vein; VSP). Vein of the Septum Pellucidum; VA). Venous Angle; AV). Atrial Vein; SV). Subependymal Veins; SS). Straight Sinus; BV). Basal Vein..

compared to the superficial venous system.¹⁴ Hence their thrombosis is easy to recognize.

Role of Specific Anatomic Features of Cerebral Venous System in Pathophysiology of Cerebral Venous Thrombosis

The cerebral veins and sinuses neither have valves nor tunica muscularis. Because they lack valves, blood flow is possible in different directions. Moreover, the cortical veins are linked by numerous anastomoses, allowing the development of a collateral circulation and probably explaining the good prognosis of some cerebral venous thromboses.

Lack of tunica muscularis permits veins to remain dilated. This is important in understanding the huge capacity to compensate even an extended occlusion.

Venous sinuses are located between two rigid layers

of duramater.¹⁵ This prevents their compression, when intracranial pressure rises.

Superficial cortical veins drain into SSS against the blood flow in the sinus, thus causing turbulence in the blood stream that is further aggravated by the presence of fibrous septa at the inferior angle of the sinus. This fact explains greater prevalence of SSS thrombosis.

In addition to draining most of the cerebral hemisphere, the superior sagittal sinus also receives blood from diploic, meningeal and emissary veins. Same is the case with other dural venous sinuses. This explains the frequent occurrence of CVT as a complication of infective pathologies in the catchments areas e.g. cavernous sinus thrombosis in facial infections, lateral sinus thrombosis in chronic otitis media and sagittal sinus thrombosis in scalp infections.¹⁶

The dural sinuses especially the SSS contain most of the arachnoid villi and granulations, in which absorption of CSF takes place. So dural sinus thrombosis blocks villi and leads to intracranial hypertension and papilloedema.

References

1. Sutton D., Stevens J.: Vascular Imaging in Neuroradiology in Textbook of radiology and Imaging, volume 2 by Churchill Livingstone New York 2003, pp1682-87.
 2. Ryan S.P., Mc Nicholas M.M.J., Central Nervous system in Anatomy for diagnostic Imaging by W.B. Saunders Company Ltd. London. 1998, pp 77-80.
 3. Kido DK, Baker RA, Rumbaugh Calvin L. Normal Cerebral Vascular Anatomy. In: Abrams Angiography, Vascular and Interventional Radiology by Abrams HL, Third Edition. Little, Brown and Company, Boston. USA. 1983 pp 257-68.
 4. Meder JF, Chiras J, Roland J, Guinet P, Bracard S, Bary F. Venous territories of the brain. J Neuroradiol 1994; 21:118 - 33.
 5. Einhaupl KM, Masuhr F. Cerebral Venous and Sinus thrombosis - an update Eur J Neurol 1994; 1: 109 - 26.
 6. Huang, Y.P., and Wolf, B.S. Angiographic features of fourth ventricle tumors with special reference to the posterior inferior cerebellar artery. Am J Radiol. 1969; 107:543.
 7. Hacker H: Normal Supratentorial veins and dural sinuses. In: Newton TH, Potts DG, eds: Radiology of Skull and Brain. Angiography. Book 3. St Louis: Mosby; 1974;2:1851-77.
 8. Weissleder R., Wittenberg J. Neurological Imaging in Primer of Diagnostic Imaging, Third Edition. Philadelphia: Mosby 2003 : p 492.
 9. Krayenbuhl HA, Yasargil MG. Cerebral Angiography (2nd ed.). London: Butterworth 1968.
 10. Dora F and Zileli T: Common Variations of the lateral and occipital sinuses at the confluence sinuum. Neuroradiology 1980; 20 : 23 - 7.
 11. Taveras J.M.: Angiography in Neuroradiology Third Edition. Baltimore: Williams & Wilkins. 1996 pp 998.
 12. Wolf, B.S., Newman, C.M. and Schlesinger, B. The diagnostic value of the deep cerebral veins in cerebral angiography. Am J Radiol. 1962;87:322.
 13. Wolf B S, Huang Y P, Newman C.M. The superficial Sylvian venous drainage system. Am J Radiol. 1963; 89:398.
 14. Wolf B S, Huang YP. The subependymal veins of the lateral ventricles. Am J Roentgenol Radium Ther Nucl Med. 1964; 91:406-26.
 15. Parkash C, Bansal BC. Cerebral venous thrombosis. J Indian Acad Clin Med. 2000; 5: 55 - 61.
 16. Kalbag RM, Woolf AL. Etiology of cerebral venous thrombosis in cerebral venous thrombosis publ. Ed Kalbagh RM, Wolf AL. Volume1. Oxford University Press London, 1967; pp 238.
 17. Wasay M, Azeemuddin M. Neuroimaging of Cerebral Venous thrombosis. J Neuroimaging 2005;15:118-28.
-