

Acknowledgment

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List of abbreviations

- (AC) : Anticoagulation .
- (ADP) : Adenosine Diphosphate .
- (AED) : Antiepileptic drugs .
- (AHA) : American Heart Association .
- (ANCA) : Anti-neutrophil cytoplasmic antibodies.
- (anti DNA) : Anti-deoxyribonucleic acid antibodies.
- (AP) : Anterior-posterior .
- (APC) : Activated protein C .
- (aPTT) : Activated partial thromboplastin time .
- (AT) : Antithrombin .
- (AV) : Arteriovenous .
- (AV) : Atrial Vein .
- (AVFs) : Arteriovenous fistulas .
- (BV) : Basal Vein .
- (cAMP) : cyclic Adenosine Monophosphate .
- (CBC) : Complete blood count .
- (CCSVI) : Chronic cerebrospinal venous insufficiency .
- (CNS) : Central nervous system .
- (CSDAVFs) : cavernous sinus Development of arteriovenous fistulas .
- (CSF) : Cerebrospinal fluid .
- (CT) : Computed tomographic scans .
- (CTV) : Computed tomographic venography .
- (CVST) : Cerebral venous sinus thrombosis .

(CVT) : Cerebral venous thrombosis .

(CVT) : Cerebral venous thrombosis .

(DAVF) : Development of arteriovenous fistula .

(DIC) : Disseminated intravascular coagulation .

(EEG) : Electroencephalogram .

(EFNS) : European Federation of Neurological Societies .

(F I) : Clotting factor I (Fibrinogen) .

(FII) : Clotting factor II (Prothrombin) .

(FIX) : Clotting factor IX .

(FV): Clotting factor V .

(FVII) : Clotting factor VII .

(FVIII) : Clotting factor VIII .

(FX) : Clotting factor X .

(FXI) : Clotting factor XI .

(FXII) : Clotting factor XII .

(FXIII) : Clotting factor XIII .

(Hcy) : Homocysteine .

(HELLP) : Syndrome: (H) hemolysis, (EL) elevated liver enzymes, and (LP) low platelet count.

(HIT) : Heparin-induced thrombocytopenia .

(ICH) : Intracranial hemorrhage .

(ICP) : Intracranial pressure .

(ICSOL) : Intracranial Space Occupying Lesions .

(ICV) : Internal Cerebral Vein .

(INR) : International Normalized Ratio .

(ISCVT) : International Study on Cerebral Vein and Dural Sinus Thrombosis .

(ISS) : Inferior sagittal sinus .

(IV) : Intravenous .

(LMWH) : Low molecular weight heparin .

(LS) : Lateral sinus .

(MP) : Microparticles .

(MRA) : Magnetic resonance arteriography .

(MRI) : Magnetic resonance imaging .

(MRV) : Magnetic resonance venography .

(NCS DAVFs) : Noncavernous sinus Development of arteriovenous fistulas .

(PAI-1and PAI-2) : Plasminogen activator inhibitor 1 and 2 .

(PDPH) : Post– dural puncture headache .

(PT) : Prothrombin time .

(RBC) : Red blood cells .

(RCoA) : Ristocetin cofactor .

(rt-PA) : Recombinant human tissue plasminogen activator .

(SAH) : Subarachnoid hemorrhage .

(SC) : Subcutaneous .

(SS) : Straight Sinus .

(SSPCA) : Single-slice phase-contrast angiography .

(SSS) : Superior sagittal sinus .

(STV) : Striothalamic Vein .

(SV) : Subependymal Veins .

(TAFI) : Thrombin activatable fibrinolytic inhibitor .

(TAT) : Thrombin-antithrombin III-complex .

(TCCS) : Venous Transcranial Color-Coded Sonography .

(t-PA) : Tissue plasminogen activator .

(TS) : Transverse sinus .

(TTP) : Thrombotic Thrombocytopenic Purpura .

(UFH) : Unfractionated heparin .

(VA) : Venous Angle .

(VG) : Vein of Galen .

(VSP) : Vein of the Septum Pellucidum .

(VTE) : Venous thromboembolism .

(vWf) : von Willebrand factor .

Peripartum sagittal sinus thrombosis in ICU

Pregnancy and puerperium are most prevalent prothrombotic states leading to cerebral venous thrombosis.

Pregnancy induces several physiological changes in coagulation system, which persists at least during early puerperium, rendering it a prothrombotic state. Hypercoaguability worsens further after delivery as a result of volume depletion and trauma. During puerperium additional risk factors include infection and instrumental delivery or Caesarean section. *(Khealani ; et al ., 2006)*

Dural venous sinus thrombosis is an interesting but rare condition. It is characterised by its varied clinical presentations, wide spectrum of clinical signs with highly variable modes of onset, pathogenic variability and clinical course as well as prognosis. Because of its extremely diverse clinical presentations, it remains a diagnostic and therapeutic challenge. *(Lim ., 2007)*

Although dural venous sinus thrombosis is a rare but potentially fatal complication during peripartum period . The headache symptoms of this disorder often mimic those of post-dural puncture headache (PDPH). This often leads to misdiagnosis after regional anesthesia performed for vaginal delivery or cesarean delivery. The incidence of 10–20 per 100,000 is likely higher than reported. *(Lockhart ; et al ., 2011)*

Headache remains the commonest symptom encountered due to intracranial disease during the course of pregnancy and the puerperium. Thus, the development of acute headache should be taken seriously. There is considerable overlap of the clinical features of different disease entities affecting the central nervous system (CNS). There is a general tendency for delayed

diagnosis of uncommon but serious conditions during pregnancy because of a reluctance to perform imaging studies.

(Tate ; et al .,2011)

Dural venous sinus thrombosis most commonly occurs in the superior sagittal sinus (SSS). Isolated inferior sagittal sinus (ISS) thrombosis is an extremely rare event. Although dural venous sinus thrombosis and accompanying hemorrhagic infarcts are not uncommon in routine radiological practice, this clinical entity represents a diagnostic challenge due to the diversity of clinical presentation.

(Erbas ; et al .,2006)

Imaging procedures have led to easier recognition of venous sinus thrombosis, offering the opportunity for early therapeutic measures.

(Saposnik ; et al ., 2011)

Cerebral venous sinus thrombosis (CVST) occurred 10 to 13 times more often during puerperium than during pregnancy. Amongst all pregnant patients, CVT occurred more frequently in the second and third trimesters. It is very rare during the first trimester.

Likelihood of stroke to be of venous origin is greater in stroke associated with pregnancy compared to stroke unrelated to pregnancy.

(Martinelli ; et al ., 2010)

The association of Cerebral venous sinus thrombosis (CVST) with pregnancy and puerperium remains a recognized cause of maternal mortality and morbidity in developing countries , and represents the main cause of puerperium stroke .

(Tomar ; et al ., 2010)

Anatomy of cerebral venous system

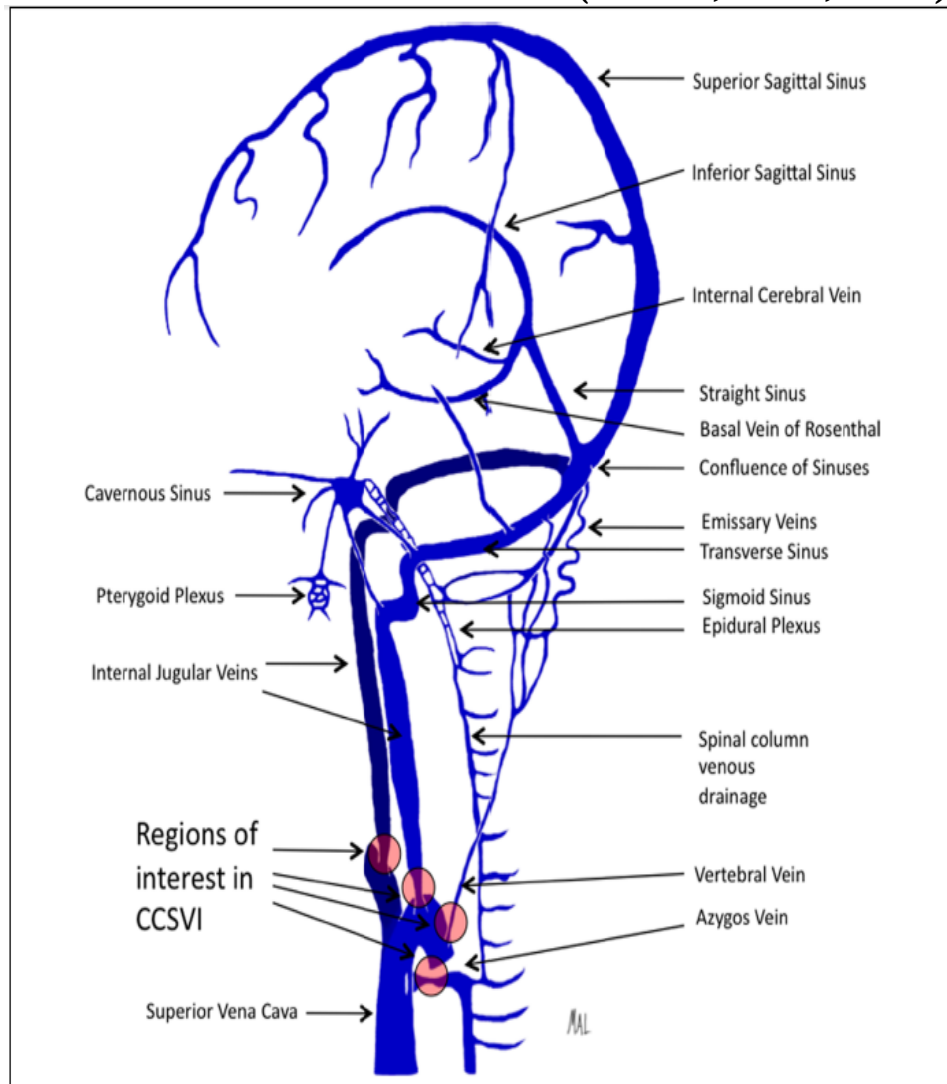
Understanding cerebral venous system is important to describe the pathophysiology and treatment of cerebral venous sinus thrombosis. Especially when surgery is planned, one has to be able to recognize the major veins and sinuses and to describe their direction of flow.

The cranial dural sinuses are endothelial lined channels without valves located between the outer and inner layers of the dura (lie in the subarachnoid space). They collect blood from the superficial and deep veins, meninges and calvarium. They pierce the arachnoid mater and the meningeal layer of the dura and drain into the cranial venous sinuses. Dural sinuses connect with the extracranial venous system via emissary veins which pass directly through the skull vault and basal foramina and these serve as an important pathway for collateral venous flow in cerebral venous sinus thrombosis (CVST) (*Figure 1.1*). Dural sinuses also communicate with meningeal and diploic veins. (*Lazzaro ., et al ., 2011*)

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 interlinked with anastomotic veins of Trolard and Labbe. However, the superficial cerebral veins are very variable. 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.

(Uddin ., et al ., 2006)



(Figure 1.1) Illustration depicting the predominant veins and sinuses involved in the craniocervical venous outflow. Venous narrowing is depicted at locations of interest in chronic cerebrospinal venous insufficiency (CCSVI).
(Lazzaro ., et al ., 2011)

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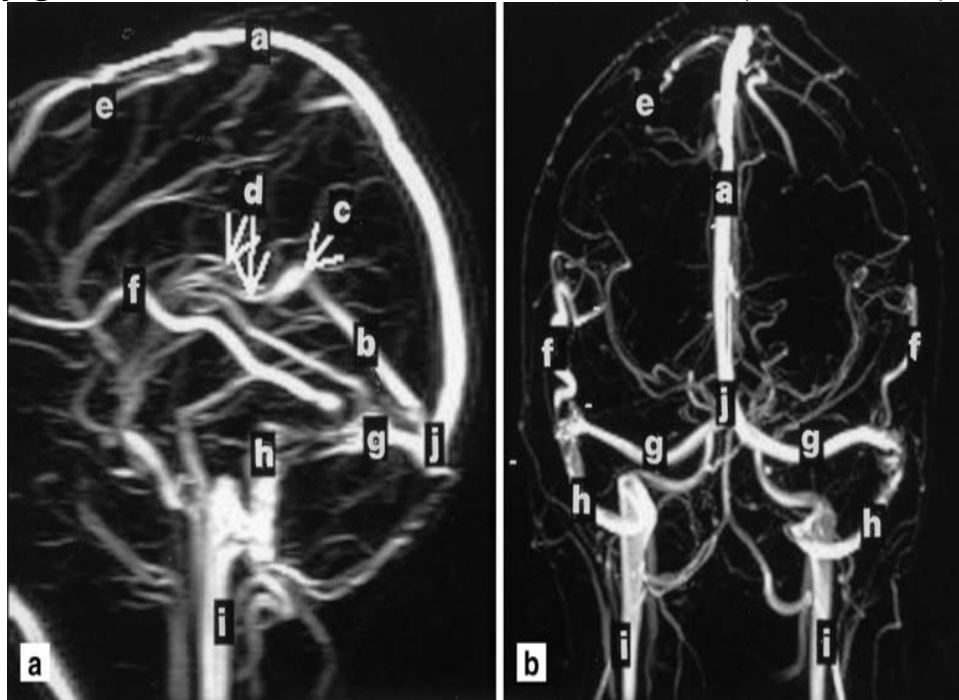
Cerebral venous system can be divided into two basic components (*Figure 1.2*) :

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. (*Das ., 2009*)



(Figure 1.2) Anatomy of venous sinuses demonstrated by 3D phase-contrast reformatted MR venograms [a. Lateral and b. frontal views] **a)** superior sagittal sinus, **b)**straight sinus,**c)** vein of Galen,**d)** internal cerebral veins, **e)** cortical vein,**f)** vein of Labbe, **g)** transverse sinus, **h)** sigmoid sinus, **i)** jugular vein, **j)**torcula. (*Renowden ., 2013*)

A) Superficial cerebral venous system :

The superficial cerebral veins can be divided into three collecting systems :

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.

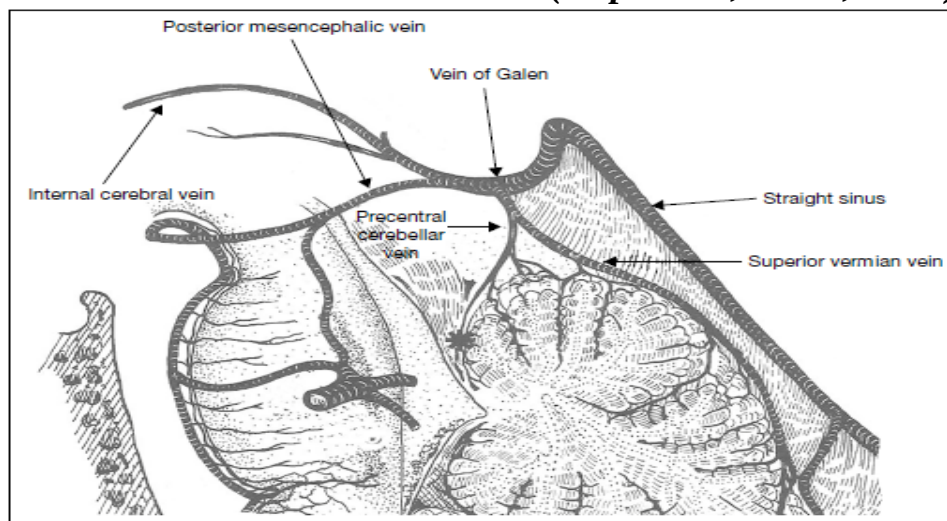
These veins are linked by the great anastomotic vein of Trolard, which connects the SSS to the middle cerebral veins. These are themselves connected to the lateral sinus (LS) by the vein of Labbe.

The veins of the posterior fossa may again be divided into three groups (*Figure 1.3*) :

- 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.

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

(*Saposnik ., et al ., 2011*)



(**Figure 1.3**) Posterior fossa veins and their drainage system.

(*Laganà ., et al ., 2011*)