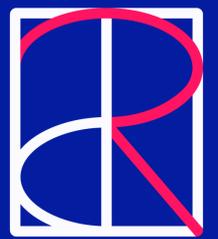


# THE ICONOGRAPHIC IMPACT IN MICRONEUROSURGERY: MASTERING THE INTRACRANIAL VENOUS SYSTEM



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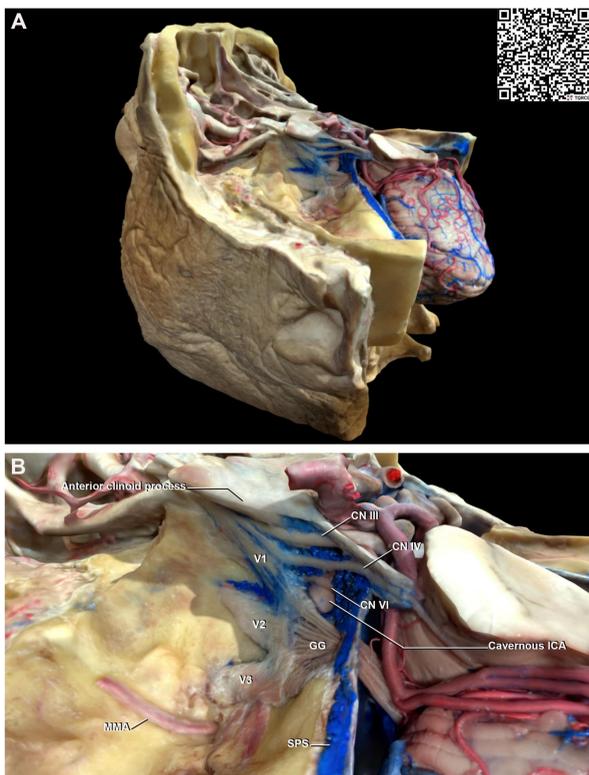
RHOTON PROGRAM

## BACKGROUND

The cerebral venous channels represent a major challenge in microneurosurgery, especially in the pineal region, where multiple veins drain into the great vein of Galen. Preserving the venous outflow is the most reliable strategy to prevent postoperative venous strokes or venous hypertension. Thus, a thorough understanding of the venous anatomy is crucial for minimizing risks and complications during surgery.

## MATERIAL AND METHODS

Four formalin-fixed, latex-injected anatomical specimens were dissected to analyze the relevant venous anatomy through a high-resolution photographic image. The deep cerebral veins and their surrounding neural structures were methodically dissected and documented, as well as the major superficial veins. A 3D anatomical model generated through the photogrammetry scanning technique was described (Fig. 1).

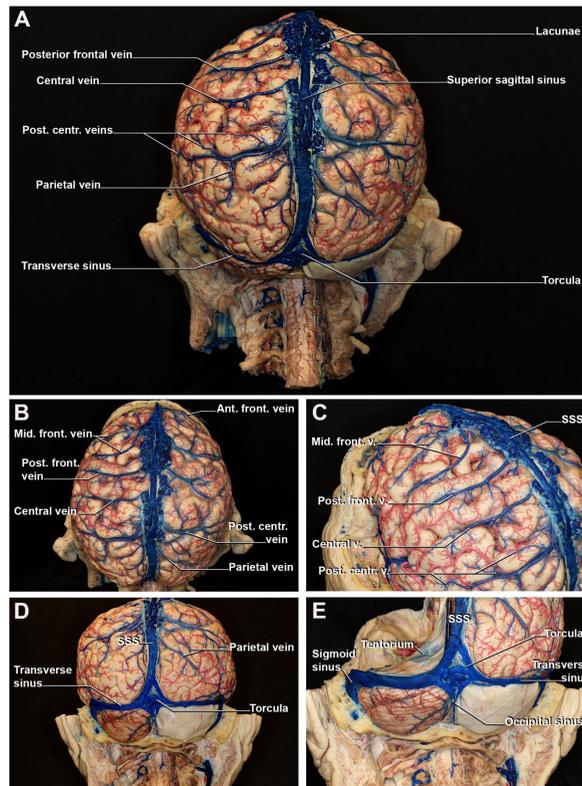


**Figure 1 – A.** Overview of the 3D interactive anatomical model available by scanning the QR code. The lateral wall of the CS is a double layer dura composed of the meningeal and periosteal layers. This double layer dura covers the floor of the middle fossa laterally, joins the superior wall of the CS medially, converging with the dura that covers the concavity of the greater sphenoid wing anteriorly as well as the dura that covers the tentorium posteriorly. The lateral wall is limited superiorly by the anterior petroclinoid ligament, inferiorly by the superior border of maxillary nerve, anteriorly by the superior orbital fissure, and posteriorly by an imaginary line at the level of dorsum sellae. **B.** Close-up view of the lateral wall of the cavernous sinus. The supraorbital and infratrochlear triangles of the CS are revealed once the meningeal layer is removed. Within the periosteal layer resides CN III, IV and V1. Abbreviations: CS, cavernous sinus; CN, cranial nerve; GG, Gasserian ganglion; ICA, internal carotid artery; MMA, middle meningeal artery; SPS, superior petrosal sinus; V1, ophthalmic division of the trigeminal nerve; V2, maxillary division of the trigeminal nerve; V3, mandibular division of the trigeminal nerve.

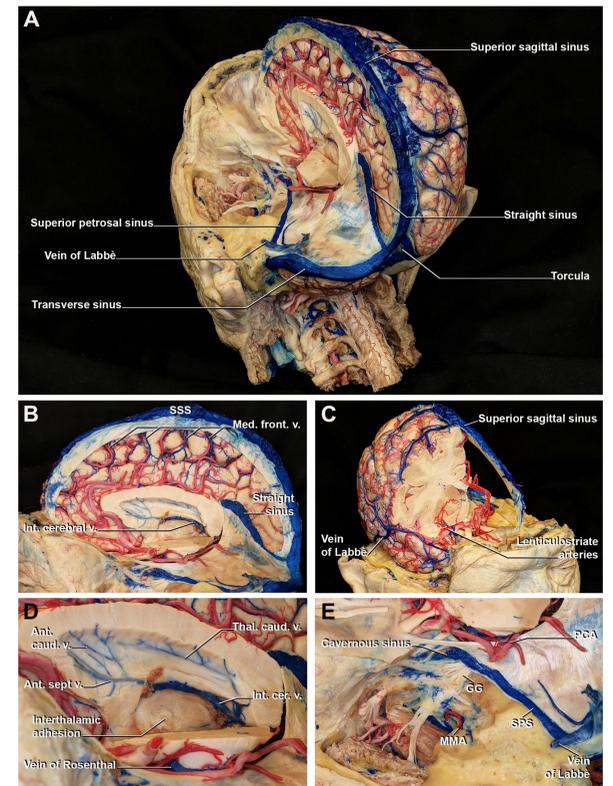
## RESULTS

The evaluated cerebral veins were displayed in a superficial to deep fashion. The SSS drains into the transverse sinus at the internal occipital protuberance through a plexiform confluent venous complex, known as the torcular herophili, which connects the superior sagittal, transverse, straight, and occipital sinuses (Fig. 2). The straight sinus begins behind the corpus callosum at the junction of the inferior sagittal sinus and the great vein of Galen (Fig. 3). In approaching the pineal region, several veins may obstruct the surgical route (Fig. 4). These include the superior vermian, draining into the posteroinferior aspect of the vein of Galen, as well as the tectal and pineal veins, draining into its anterosuperior aspect. The basal vein of Rosenthal represents the major anterolateral vein. The location of these veins and their drainage territories were carefully documented. The 3D anatomical model was dissected to highlight the anatomy of the cavernous sinus and its major tributaries.

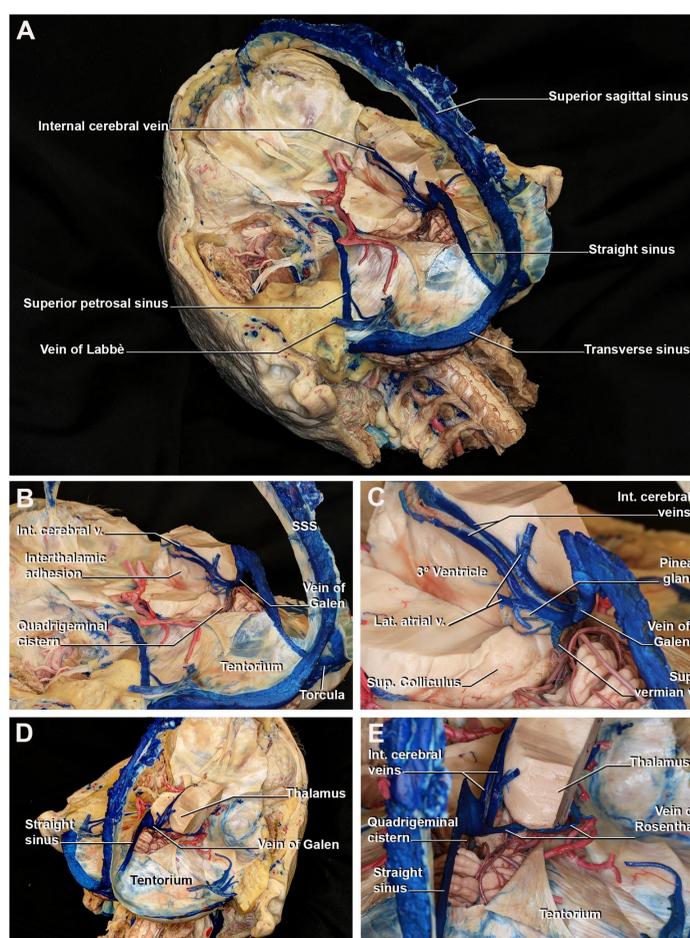
## RESULTS (CONTINUED)



**Figure 2 – A.** The SSS is located in the midline, beginning behind the frontal sinuses and increasing in size as it continues posteriorly in a shallow groove on the inner table of the skull. Enlarged venous spaces, known as lacunae, are present in the dura mater surrounding the SSS. These lacunae are most prominent and consistent in the parietal and posterior frontal regions, with smaller ones in the occipital and anterior frontal regions. They receive drainage primarily from the meningeal veins, which run along the meningeal arteries in the dura mater. **B. and C.** Veins originating from the frontal pole are directed posteriorly when they join the sinus, while those from the posterior part of the frontal lobe flow anteriorly, and those from the intermediate frontal areas join at a right angle. The terminal ends of the parietal and occipital superficial veins are directed forward, in an opposed direction to the SSS flow. **D. and E.** The SSS drains into the transverse sinus at the internal occipital protuberance through a plexiform confluent venous complex, which connects the superior sagittal, transverse, straight, and occipital sinuses. Abbreviations: SSS, superior sagittal sinus.



**Figure 3 – A.** Posterior lateral overview. The left hemisphere has been removed to methodically show the SSS, transverse, SPS, and straight sinuses. **B.** The straight sinus begins behind the corpus callosum at the junction of the inferior sagittal sinus and the great vein of Galen. It extends downward and posteriorly within the junction of the tentorium and falx. **B & C.** Lateral views of the SSS. **D.** Close-up view of the internal cerebral vein. The paired internal cerebral veins originate just behind the foramen of Monro and travel posteriorly within the velum interpositum. **E.** The SPS runs within the attachment of the tentorium to the petrous ridge. It drains into the posterior aspect of the cavernous sinus, while its lateral end joins the junction of the transverse and sigmoid sinuses. Abbreviations: GG, gasserian ganglion; MMA, middle meningeal artery; SSS, superior sagittal sinus; SPS, superior petrosal sinus



**Figure 4 – A.** Overview of the deep venous system (left side). The deep venous system collects into channels that course through the walls of the ventricles and basal cisterns and converge on internal cerebral veins, basal veins of Rosenthal, and the great vein of Galen. **B.** The internal cerebral and basal veins join in the quadrigeminal cistern to form the great vein of Galen. The posterior cerebral arteries enter the quadrigeminal cistern's upper part, and the superior cerebellar arteries enter the lower part. **C.** The basal, internal cerebral, lateral atrial, and superior vermian veins converge on the great vein of Galen. **D.** Overview of the deep venous system (right side). **E.** The basal vein of Rosenthal passes posteriorly above the posterior cerebral artery to join the internal cerebral vein in the quadrigeminal cistern. Abbreviations: SSS, superior sagittal sinus.

## CONCLUSIONS

This study provides a comprehensive and detailed description of the superficial and deep venous anatomy utilizing latex-injected cadaveric specimens with iconographic photogrammetry material. The presented images and descriptions offer valuable insights for planning and executing surgical approaches, especially to the pineal region, with the ultimate goal of minimizing potential risks and complications.