Anatomy of the falcine venous plexus

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Object. The superior and inferior sagittal sinuses have been well studied. Interestingly, other venous structures within the falx cerebri have received scant attention in the medical literature. The present study was performed to elucidate the presence and anatomy of these midline structures.

Methods. The authors examined 27 adult latex- or ink-injected cadaveric specimens to observe the morphological features of the sinuses within the falx cerebri (excluding the inferior and superior sagittal sinuses).

Results. All specimens were found to have an extensive network of small tributaries within the falx cerebri that were primarily concentrated in its posterior one third. In this posterior segment, these structures were usually more pronounced in the inferior two thirds. The portion of the falx cerebri not containing significant falcine venous sinus was termed a “safe area.” These vascular channels ranged in size from 0.5 mm to 1.1 cm (mean 0.6 mm); 100% of these vessels communicated with the inferior sagittal sinus. Classification of the structures was then performed based on communication of the falcine venous sinus with the superior sagittal sinus. Type I falcine sinuses had no communication with the superior sagittal sinus, Type II falcine sinuses had limited communication with the superior sagittal sinus, and Type III falcine sinuses had significant communication with the superior sagittal sinus. Seventeen (63%) of 27 specimens communicated with the superior sagittal sinus (Types II and III). Further subdivision revealed 10 Type I, seven Type II, and 10 Type III falcine venous plexuses.

Conclusions. There are other venous sinuses in the falx cerebri in addition to the superior and inferior sagittal sinuses. Neurosurgical procedures that necessitate incising or puncturing the falx cerebri can be done more safely via a described safe area. Given that the majority of specimens in the authors’ study were found to have a plexiform venous morphology within the falx cerebri, they propose that these channels be referred to as the falcine venous plexus and not sinus. The falcine venous plexus should be taken into consideration by the neurosurgeon.

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Key Words • cadaver • cranium • falx cerebri • vein • venous anatomy

The falx cerebri is an intracranial midline partition composed of the meningeal layer of the dura mater. This structure has a superior attached portion and an inferior free part housing the superior and inferior sagittal sinuses, respectively. Anecdotally, we have observed venous hemorrhage from the falx cerebri during endoscopic fenestration procedures that were not near the superior or inferior sagittal sinuses. The extant medical literature has scant statements regarding other potential veins within the falx cerebri. Crosby et al.¹ have stated that the inferior sagittal sinus “begins in about the middle of the border of the falx with the convergence of the falcial plexus of veins.” The superior sagittal sinus may communicate with the inferior sagittal sinus through a venous channel in the falx cerebri.⁴ Rhoton⁵ has stated that this connection may rarely be so large that the superior sagittal sinus drains primarily into the inferior sagittal and straight sinuses. This latter configuration, not to be confused with a falcine venousplexus, most likely represents a persistent falcial sinus to be discussed later. Lastly, Kaplan et al.⁴ have stated that freely anastomosing small plexiform channels may be present throughout the falx cerebri. In the present study we sought to further elucidate the anatomy of such falcine veins and to provide landmarks for the neurosurgeon who may need to incise or puncture this midline structure.

Materials and Methods

We performed dissection in 25 formalin-fixed adult cadavers and two fresh specimens (age range at time of death 60–88 years, mean 81 years). Fifteen specimens were male and 12 were female. No specimen was found to have gross evidence of an intracranial pathological entity such as tumor or aneurysm. All specimens underwent isolation and irrigation of the left and right internal jugular veins. Blue or red latex was then manually injected into the internal jugular veins. Following a cure time of 24 hours, the calvaria was removed with an oscillating bone saw. The dura mater was incised, and the superior sagittal and straight sinuses were identified. Ten specimens did not have adequate latex perfusion into the small ves-
sels within the falx cerebri; thus direct injection of black ink or colored latex was performed via the straight and superior sagittal sinuses. All measurements were made using microcalipers and under an operating microscope (Zeiss). Classification of the structures was then performed based on the extent of communication between identified falcine veins and the superior sagittal sinus.

Results

All specimens were found to have falcine veins of varying sizes (Fig. 1). However, no specimen was found to have a persistent falcine sinus. These vascular channels ranged in size from 0.5 mm to 1.1 cm (mean 0.6 mm). Of these vessels, 100% communicated with the inferior sagittal sinus and were classified as follows: Type I falcine veins had no communication with the superior sagittal sinus (Fig. 2A), Type II falcine veins had limited communication with the superior sagittal sinus (Fig. 2B and C), and Type III falcine veins had significant communication with the superior sagittal sinus (Fig. 2D). No draining veins were found in communication with these identified veins in the falx cerebri. Seventeen (63%) of 27 specimens had communication with the superior sagittal sinus (Types II and III). Further subdivision revealed 10 Type I (37%), seven Type II (26%), and 10 Type III (37%) falcine venous plexuses. Generally, most falcine veins in the falx cerebri were found in its posterior one third and within this posterior one third, in the inferior two thirds.

Discussion

We identified a falcine venous plexus in all specimens. An important distinction should be made between the rare persistent fetal falcine sinus and the falcine venous plexus. The falcine sinus is a normal in utero venous structure located in the falx cerebri that normally involutes before birth. This sinus develops from mesenchyme in the mesencephalic flexure, which is the same area that gives rise to the straight sinus. When the straight sinus is absent or rudimentary, the falcine sinus may be recanalized. It is extremely rare to find a persistent falcine sinus without associated anomalies. Associated anomalies include bifid cranium, vein of Galen malformation, agenesis of the corpus callosum, Apert syndrome, osteogenesis imperfecta, Chiari malformation Type II, occipital encephalocoele, absent tentorium cerebelli, and bilateral giant parietal foramina.

Streeter defined the sagittal plexus in the 20-mm embryo stage as a mesh of anastomotic loops from which the superior sagittal and straight sinuses develop. Similarly, the inferior sagittal sinus is thought to develop from the ventral aspect of the sagittal plexus after the disappearance of the smaller channels of this plexus. However, in its posterior one third, more than one channel of the sagittal plexus may contribute to the development of the superior sagittal sinus. Residual vessels of previous stages dwindle and disappear with the progression of normal development. The superior sagittal sinus in the 50-mm embryo stage is plexiform in its caudal part. We would therefore hypothesize that the falcine venous plexus is also derived from the sagittal plexus.

In the present study we found that all falcine venous plexuses communicated with the inferior sagittal sinus, whereas only 63% communicated with the superior sagittal sinus. This sinus within the falx may receive a bridging vein (MG Yaşargil, personal communication, 2006). We also identified a relatively “safe area” where the falcine venous plexus was not as concentrated. This area was in most specimens (Types I and II) in the anterior two thirds of the falx cerebri between the superior and inferior sagittal sinuses. Surgical ramifications of these findings center mainly around approaches for lesions near the falx. Transtentorial approaches as well as posterior transcrallosal routes both...
come in close contact with the posterior one third of the falx. Large meningiomas may involve this region, and caution must be taken in dissection around or removal of this specific area. Occasionally, “windows” of falx are opened to allow access to the opposite hemisphere, assist in complete tumor removal, or rotate as a flap around a bleeding superior sagittal sinus. Therefore, the potential for bleeding from the venous plexus of the falx should be considered.

Conclusions

Knowledge of the venous plexuses within the falx cerebri is necessary for the surgeon who performs intracranial operations. As the majority of specimens in our study were found to have a plexiform venous morphology within the falx cerebri, we propose that these channels should be referred to as the falcine venous plexus and not sinus. Based on our findings, puncture or incision into the posteroinferior falx cerebri will violate the falcine venous plexus. These data may prove useful to the neurosurgeon.

References


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