Atresia of the rostral superior sagittal sinus: substitute parasagittal venous channels

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Failure of development of a rostral superior sagittal sinus results in concomitant embryonal establishment of substitute dural and cerebral venous pathways. The longer the segment of atresia of this sinus, the more extensive the compensatory venous channels. These developmental variants assume clinical importance in the interpretation of cerebral angiograms.

Key Words · atresia of superior sagittal sinus · anomalous cerebral veins · anomalous dural channels

In a continuing study of the cerebral dural sinuses, eight of 382 specimens showed unusual patterns of venous channels in the dorsal frontal dura mater. In seven of the eight specimens there were associated atresias of the rostral superior sagittal sinus of variable extent. In the remaining specimen the rostral part of the sinus had been sacrificed at autopsy. The findings have clinical implication in the interpretation of certain cerebral angiographic films. It therefore appears important that neurosurgeons should be aware of these "anomalies," especially those surgeons who must rely on their own interpretation of abnormalities demonstrated by cerebral angiography or sinography.

Material and Method

Fresh intracranial dura was obtained at autopsy. The size, origin, and course of the dural sinuses and their tributaries were determined and the results recorded by diagram. The fibrous core from the foramen caecum, which came away with the dura when it was removed, served to orient the examiner regarding the rostral extent of the superior sagittal sinus or of the atretic segment of this sinus. Vinylite casts of the superior sagittal sinus and its tributaries made in 78 of the 382 specimens helped immeasurably in determining the manner in which venous tributaries from the frontal lobes joined the sinus. The superior sagittal sinus in 10 additional specimens was injected with a radiopaque medium and roentgenograms made; while it was helpful, this type of demonstration of the cerebral venous channels was not as informative as that derived from the vinylite casts.

Observations

The major compensatory venous channels found in each of the eight specimens were intradural (Fig. 1). Cortical veins joined the channels as they coursed caudad.
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In the seven specimens in which measurement could be made, the atretic segment of the superior sagittal sinus, ranged from 1\(\frac{1}{8}\) to 9 cm in length. Histological examinations of the atretic or atrophic zones of the sinus disclosed minute irregularly-shaped endothelial-lined channels in the collagenous matrix (Fig. 2); none of these was large enough to be regarded as a significant venous pathway. The variable venous patterns found are displayed by diagram; consequently a narrative description of each seems superfluous.

Discussion

Early in the course of this study, a specimen was encountered with atresia of the rostral superior sagittal sinus associated with substitute intradural venous channels (Fig. 3 A) that coursed caudad from the frontal poles of the brain in the parasagittal regions, received tributaries from the cerebral cortex, and converged terminally to establish the lumen of the superior sagittal sinus. Other specimens showed variable patterns (Fig. 3 B-H) in embryonic development of the superior sagittal sinus and the cortical veins of the frontal lobes of the brain. No two of these variants were alike, but each reflected complete failure of development of some of the lumen of the rostral superior sagittal sinus.

One specimen (Fig. 3 F) showed unusual venous development on the left side only, whereas the remaining seven had bilateral variants. These departures from the average should be readily recognized when disclosed on angiographic studies provided the examiner is familiar with their occurrence and the venous patterns displayed by them. In a patient with venous development comparable to those illustrated in Fig. 3 A, E, F, G, a lateral film of a cerebral venogram may have the appearance of a depressed anterior segment of the superior sagittal sinus. The manner in which cortical veins join the substitute channel should give the clue that one is dealing with a parasagittal variant and not a displaced superior sagittal sinus.

In another study of 201 cerebral dural sinuses, there were 12 specimens with atresia of the rostral superior sagittal sinus. The atresia in these extended caudad for 3\(\frac{1}{2}\) to 4 cm from the foramen caecum. In this group the veins coursed irregularly over the cortex and then converged caudomedially to establish the lumen of the sinus (Fig. 4). There were no intradural channels in this group. There should be no difficulty in recognizing angiographically the significance of this type of venous pattern. It always indicates a substantial segment of atresia of the rostral superior sagittal sinus.

During the past year we have had two patients who on angiographic examination were considered to have parasagittal substitute intradural venous channels. In one of

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Fig. 1. Cross section of an intradural compensatory venous channel coursing in the meningeal side of the dura mater. H & E, X 3.5.

Fig. 2. Cross section of an atretic segment of the rostral superior sagittal sinus. These irregularly-shaped endothelial-lined channels are found in all atretic sinuses. H & E, X 120.
Fig. 3. Variable patterns of intradural compensatory venous channels. The diagrams show the larger venous pathways and their principal tributaries.

these a competent neurosurgeon entertained the thought that the superior sagittal sinus was probably separated from the skull by an epidural hematoma (Fig. 5). At operation a thin layer of subdural blood was found, but no epidural accumulation was present. The patient died, and at autopsy the venous pattern of the frontal region was as shown in Fig. 3 G. The second patient had an angiographic study following a moderately severe craniocerebral injury. A right frontal parasagittal channel coursing in an antero-posterior direction was demonstrated. This was interpreted as an intradural venous...
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Fig. 3 (continued). The variable patterns of intradural compensatory venous channels. The diagrams show the larger venous pathways and their principal tributaries. Diagram G was drawn from the autopsy specimen of the patient whose lateral phlebographic film is shown in Fig. 5.

Morris remarked that he had observed in a few cases that the anterior end of the superior sagittal sinus was "unfilled" on angiographic examination. No mention was made regarding associated changes in venous patterns of the frontal regions. Askenasy, et al., reported a case of chronic thrombosis of the superior longitudinal sinus which in all likelihood presented failure of

\[ \text{Diagram E} \]

\[ \text{Diagram F} \]

\[ \text{Diagram G} \]

\[ \text{Diagram H} \]
this sinus to develop. Jain and Pollak\(^2\) reported a similar example with an illustration comparable to that of Askenasy's and also to our Fig. 5.

Krayenbühl and Yasargil\(^4\) in their monograph included eight illustrations (pp. 94-95) concerning "variations of the ascending frontal vein and superior longitudinal sinus in the anterior third," and an illustration (p. 107) showing the "absence of the superior longitudinal sinus in the anterior third with abnormal fronto-parietal vein." Krayenbühl\(^3\) in another publication presented a comparable example with this legend: "Absence of the anterior third of the superior longitudinal sinus in a child. Normal variation. The frontal ascending veins are well visualized." He remarked: "It must be emphasized that absence of the anterior third of the superior longitudinal sinus is not, in itself, pathological. Hypoplasia or aplasia in this part is well known, especially in children." It is evident that Krayenbühl and Yasargil are familiar with the developmental variations found in the rostral superior sagittal sinus and the tributaries of this segment of the sinus. Our observations indicate that some of the large venous channels they termed "frontal ascending veins" course in the meningeal dura. In our examples in which the venous variants were cortically located, the veins had fan-shaped patterns. It is obvious that these are different from those intradurally situated (Fig. 4). A few of the former may be somewhat similar angiographically to patterns produced by intradural channels as shown in Fig. 3 B,C,D,H. Patterns comparable to those depicted in Fig. 3 A,E,F,G are always produced by intradural channels.

The accumulated evidence indicates that these venous variants are established \textit{in utero} and remain unchanged throughout life. Neurosurgeons and neuroradiologists should become familiar with them since they are found in 6% to 7% of the population. They are normal for that individual and should be readily recognized on angiographic examination and easily differentiated from pathological lesions displacing the venous system of the frontal intracranial cavity.

References

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