Cavernous nodules in the dural sinuses

An anatomical, angiographic, and morphological investigation

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In x-ray examination of the confluence of the great vein of Galen and the straight sinus in 94 autopsy cases, a polypoid or lip-like contrast defect was observed at the lower border of this confluence in 10 cases. The contrast defect was caused by a structure containing collagen fibers forming a trabecular system, a plexus of sinusoidal channels, and nerve fibers. The defect has also been observed clinically in the venous phase of cerebral angiograms. The possible effect of the structure on the blood flow in the great vein of Galen and the straight sinus is discussed.

KEY WORDS  dural sinuses  great vein of Galen  carotid angiography  cavernous nodule

This study developed from an investigation of the tentorial notch and the positional relationship between the apex of the tentorium cerebelli and the confluence between the great vein of Galen, the inferior sagittal and the straight sinuses. In some a polypoid or valve-like structure was observed bulging into the lumen of the venous channels above the confluence between the great vein of Galen and the straight sinus.

A study of the literature revealed little information on the nature of these structures. Le Gros Clark described a large arachnoid granulation attached directly to the dural floor of the straight sinus, where it is joined by the vein of Galen. This structure, which was named the suprapineal arachnoidal body, contained a stroma of unusually dense pial tissue, forming a reticulum of well-defined trabeculae, and the meshes of the latter contained a rich plexus of sinusoidal blood vessels and several large interconnecting blood sinuses. The whole structure bore a very close microscopic resemblance to erectile tissue, although it contained no muscle or elastic fibers. Furthermore the whole structure was traversed by a slender nerve, which could be traced from the tip of the pineal gland into the dural floor of the straight sinus. Clark put forward the hypothesis that the structure may play an important part in regulating the venous flow through the great vein of Galen.
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Commenting on Clark's hypothesis, Gladstone and Wakeley vigorously rejected this hypothesis but did not offer any alternative.

Báló examined the dura mater of 100 individuals and found that the posterior half of the superior sagittal sinus was surrounded by tissue made up of cavernous spaces which resembled those of the corpora cavernosa of the penis. This spongy or cavernous tissue, which caused thickening of the wall of the sinus, extended for 1 to 2 cm along the wall of the sinus, alternating with regions which had little or no cavernous tissue. A similar structure, but with less cavernous tissue, was found to surround the straight sinus. At the confluence of sinuses, the thickening of the sinus wall often occurred as pad-like elevations, which bulged into the lumen of the sinus. The cavernous tissues were situated between the collagenous fibers of the sinus wall. They were not lined by elastic laminae, nor by smooth-muscle fibers. There were no smooth-muscle fibers in the septa between the cavities. The nerve fibers were not described. Elastic fibers were found below the endothelial layer of the dural sinuses in the form of an internal elastic lamella. Small arteries seemed to communicate with the cavernous spaces, which drained into the sinuses. The spaces might be empty or filled with red blood cells. Báló considers that the cavernous tissue in the sinuses is of importance in the regulation of the cerebral circulation.

Johanson made an anatomic and angiographic study of the central veins and deep dural sinuses of the brain in 75 autopsy cases. A suprapineal body, or a structure resembling it, was not present in this material.

Browder, et al., have made incidental findings of polypoid tumors in the superior sagittal and transverse sinuses. Two tumors located in the caudal part of the superior sagittal sinuses were of sufficient size to produce some dilatation of the sinus at the level of the mass. Histological sections of the tumors demonstrated irregular bands of thick collagen fibers separated by spaces comprising thinner bands of collagen fibers. A few arachnoidal cell clusters were present and additional sparse fibroblasts and endothelium-coated spaces could be seen. In 23 cases, small nodules with the same histological picture were found in the transverse sinus. All the nodules were of firm consistency and strikingly different from the Pacchionian granulations commonly found in the cerebral dural sinuses. The authors concluded that this kind of lesion is probably not rare, that consideration should be given to the possible presence of such a lesion in examining angiographic films, and finally that all cerebral sinuses should be opened and thoroughly inspected at autopsy.

Material and Methods

In routine autopsies of 94 patients aged 26 to 94 years, roentgen examinations of the head were performed in the lateral projection, after injection of 5 ml of a 50% suspension of Micropaque in water into the straight sinus, and the proximal parts of the inferior sagittal sinus and the great vein of Galen. The deep venous channels were cleared with water before injection of the contrast medium in order to avoid artifacts caused by clots and blood.

In six of the 94 cases, a rounded contrast defect of a different size in each patient was observed in the region of the confluence between the great vein of Galen and the straight sinus (Fig. 1 left). In four other cases, a more or less pronounced valve-like formation was observed in the same region (Fig. 1 right).

After the x-ray examination, the posterior wall of the straight sinus and the postero-inferior parts of the inferior sagittal sinus were opened, and the formation that caused the contrast defect could be inspected. The polypoid (often multilobulated) or lip-like formation was dissected free, together with the surrounding parts of the inferior sagittal and straight sinuses and of the great vein of Galen. For comparison, seven specimens were dissected from cases in which the roentgen examination had demonstrated no contrast defect in the actual region.

After all specimens had been inspected and photographed through the dissection microscope (Fig. 2), they were embedded in paraffin and cut into 5 μ slices, which were stained by the Van Gieson, Ehrlich's
Fig. 1. Lateral view of the confluence between the great vein of Galen (black crossed arrows), the inferior sagittal (triple crossed arrows), and the straight sinuses (double crossed arrows), filled with contrast medium. Left: At the lower contour there is a bullous formation (single white arrow) protruding into the lumen of the vein and of the straight sinus. Right: The confluence has a valve-like appearance (single white arrow). The thin, longitudinal contrast defect in the bulge in the upper part of the straight sinus was caused by a septum in the lumen of the sinus. The free edge of the tentorium cerebelli and the inferior margin of the falx cerebri are indicated by a metal thread; the point where the right and left edges of the tentorium cerebelli meet is indicated by a pinhead.

Fig. 2. Left: Specimen demonstrating a multilobulated bullous formation (single arrow) at the confluence of the great vein of Galen (crossed arrow) and the straight sinus (double crossed arrow). The posterior wall of the straight sinus has been opened and the specimen is viewed from behind. Dissection microscope, \( \times 4 \). Right: Same area viewed from behind showing a valvular configuration (single arrows) of the protruding tissue, as well as a small adhesion ('Y' arrow). Dissection microscope, \( \times 4 \).
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hematoxylin, elastin and Bodian protargol techniques.

Results

Macroscopic Findings

A polypoid formation with a lobulated, hard surface, harder than that of a Pacchioni granulation, protruded into the lumen of the straight sinus. In the cases with a more valve-like formation in the x-ray film, there was a relatively soft, lip-like structure rising from the confluence between the great vein of Galen and the straight sinus.

Microscopic Findings

The polypoid formation was usually associated with arachnoidal tissue but was sometimes also found to be incorporated within the wall of the sinus. It contained irregular collagen fibers of varying thickness, forming the reticulum of a well-defined trabecular system; there was also a plexus of sinusoidal channels, which in some places were dilated to form larger sinusoids. The channels were coated with spindle-shaped cells and their lumens sometimes contained erythrocytes (Fig. 3 left). No muscular or elastic tissues were observed. The specimen also contained a nerve, which was divided into thin bundles; one to five fibers ran close under the spindle-shaped cells (Fig. 3 right). The formation thus resembled erectile tissue with the muscular and elastic components lacking.

The lip-shaped formations showed a similar histological structure. Moreover, all the specimens from cases in which the roentgen film had revealed no contrast defect showed a comparable tissue at the confluence between the great vein of Galen and the straight sinus.

Discussion

Roentgen examinations of the dural sinuses and deep cerebral veins in autopsy cases have been performed to investigate their structure.4,6,8,9 Johanson6 did not find any structure resembling the suprapineal arachnoidal body; other authors do not mention the possible existence of this body or similar formations in the dural sinuses. The presence of a nodule of cavernous tissue at the confluence between the great vein of Galen and the straight sinus explains why the normally pointed contour of the confluence (Fig. 4 upper left) is sometimes rounded on a lateral carotid or vertebral angiogram in the venous phase (Fig. 4 lower left and right).

![Fig. 3. Left: Photomicrograph of cavernous tissue with channels and sinusoids, some of them containing red blood corpuscles. The luminal surface is coated with spindle-shaped cells; other parts of the tissue are structured by collagen-rich fibers. H & E, × 550. Right: Photomicrograph of cavernous tissue. Directly under the spindle-shaped cells, outlining the channels and the sinusoids, there is a rich diffuse distribution of nerve cells. Bodian protargol stain technique, × 550.](image-url)
Morphologically, the structure observed by us seems to be similar to the suprapineal arachnoidal body described by Le Gros Clark; it differs from that described by Baló and Browder, et al., in that what they described did not contain nerve fibers. Our studies indicate that, in the region of the confluence of the great vein of Galen, the inferior sagittal and the straight sinuses, practically all individuals have a tissue containing collagen fibers and a plexus of sinusoidal channels coated with spindle-shaped cells and sometimes containing red blood cells. The tissue, in which no muscular or elastic components are seen, contains nerve fibers. It varies from person to person and may protrude more or less into the lumen of the venous channel above the angle between the great vein of Galen and the straight sinus and may have the shape of a polypoid or lip-like formation. The picture of this formation thus differs a great deal from that of Pacchionian bodies, which are softer, contain elastic tissue and are not lined with vascular endothelium; moreover, their lumina are filled with, and communicate with, the spinal fluid.

The exact mechanism of this structure's function is not easy to understand, as no muscular or elastic tissue components were found. One must therefore speculate, with Le Gros Clark and Baló, that the rich nervous tissue in this structure regulates the vessels and has a secondary effect on the blood flow. One may ask too whether it also has some receptor function concerned, for example, with pressure, chemical-regulation or gas-tension measurement. We agree with Browder, et al., that the possible presence of an intrasinusoidal expansive lesion should be borne in mind in examining angiographic films and at autopsy. This lesion may be represented by a cavernous nodule or a polypoid tumor.
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References


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