Laterocavernous Sinus

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ABSTRACT

Here we describe an anatomic structure that takes the form of a venous channel (VC) within the two layers of the lateral wall of the cavernous sinus (CS). Colored gelatin was injected in both superficial middle cerebral veins (SMCV) of 29 human specimens. When a SMCV terminated into the CS, the latter was dissected giving particular attention to its lateral wall. The termination of the VC and its eventual communications with the CS and adjacent venous structures were studied. A VC in the lateral wall of the CS was found in 14 of 58 lateral walls (24.1 %). It was in continuation with the SMCV in 13 cases, with the uncal vein in one case. The VC drained into the superior petrosal sinus (71.4 %), the pterygoid plexus (21.4 %), or the posterior part of the CS (7.2 %). Two alternate drainage pathways for the SMCV were observed, toward the anterosuperior aspect of the CS (13.8 %) or through a paracavernous sinus located along the floor of the middle cranial fossa (32.8 %). These different pathways were not observed to occur concomittantly. SMCV were absent in 29.3 %. Despite its close topographic relation with the CS, the VC in the lateral wall can be considered as an anatomic entity with potential clinical relevance. We propose to call it the laterocavernous sinus. Anat Rec 254:7–12, 1999.

Key words: superficial middle cerebral vein; lateral wall of cavernous sinus; laterocavernous sinus; dissection; corrosion casts

The lateral wall of the cavernous sinus (CS) is classically described as a double-layered stucture enclosing the nerves III, IV, V1, and V2 (Gray's Anatomy, 1996). The presence of a venous structure in-between the two layers of the lateral wall, sometimes referred to as the superficial compartment of the CS, remains controversial. Some authors (Paturet, 1958) consider the medial (inner) layer of the lateral wall as a septum containing the nerves III, IV, V1, and V2, which separates the CS cavity into two compartments filled with venous blood: a medial or deep compartment containing the internal carotid artery (ICA) and the VIth nerve, and a lateral or superficial compartment. In their study of 70 CS, Umansky and Nathan (1982) never found such a superficial venous compartment, although they observed that the dural layers forming the lateral wall were readily separable. However, recent radio-anatomic investigations using dynamic computerized tomography (CT) (Bonneville et al., 1995) have revealed the presence of veins in the lateral wall of the CS that might correspond to such superficial compartement. These authors also observed early filling of this compartment during dynamic CT of the sellar region. Occasional references to venous structures enclosed in the lateral wall of the CS are also found in anatomic (Mercier et al., 1974) and surgical (Dolenc, 1992) literature.

This work describes an anatomic structure that takes the form of a venous channel enclosed within the dural layers of the lateral wall of the CS observed during an anatomical study of the termination of the superficial middle cerebral vein (SMCV) in the middle cranial fossa. In the majority of the cases, this VC represents the drainage pathway of the SMCV in the middle cranial fossa. In the available literature, no similar descriptions of the venous drainage along the lateral wall of the CS were found. It is believed that the knowledge of this VC might

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be relevant for the understanding and treatment of pathologies involving the CS and its lateral wall.

MATERIALS AND METHODS

This study was conducted on adult necropsic material (Department of Pathology, University of Geneva) consisting of 58 CS on 29 specimens (17 males, 12 females) with ages ranging from 23 to 95 years (mean: 72.3 years). In each case, the skull cap was opened and when present, the SMCV was injected with colored gelatin (Merck, Germany). Gelatin of a different color was used for each side. If several SMCVs were found, the larger vessel was injected. After brain removal, the skull base was inspected for the presence of gelatin. When a SMCV seemed to terminate into the CS, the latter was carefully dissected giving particular attention to its lateral wall. If a VC was found within the lateral wall, its termination and eventual communications with the CS were studied before opening of the latter.

Corrosion casts of the cranial venous system of two nonfixed human specimens (73F and 75M) were also used. In the first case, a postmortem digital substraction angiography (DSA) was performed prior to injection of the casting material, using standard angiographic equipment (Integris BN 3000, Philips, Netherlands). The corrosion cast was obtained by injecting the left SMCV and the right internal jugular vein with differently colored methylmetacrylate (Beracryl, Troller, Switzerland). The specimen was then immersed in a 15 % solution of potassium hydroxide (KOH) maintained at 40°C until complete elimination of the surrounding soft and bony tissues was achieved. The second corrosion cast was obtained by injection of the right internal jugular vein with methylmetacrylate. The rest of the procedure was as described for the first specimen. These two cases were not included in the statistical data.

RESULTS

A VC in the lateral wall of the CS was found in 14 out of the 58 lateral walls studied (24.1 %) (Fig. 1). In 13 cases, the VC was the continuation of the SMCV. Although in some cases the SMCV coursed under the lesser sphenoidal wing, it did not adopt dural characteristics. On one occasion a vein probably corresponding to the uncal vein gave rise to the VC in the absence of a SMCV (Fig. 2). The point of connection between the VC and its tributary was located at the anterior third of the lateral wall of the CS in all 14 cases. The VC drained into the superior petrosal sinus (SPS) in 10 cases (71.4 %) (Fig. 3), into the pterygoid plexus (PP) in three cases (21.4 %), and into the posterior part of the CS in one case (7.2 %). In two of the 14 cases small foramina (1–2 mm in diameter) were observed connecting the VC through the medial layer of the lateral wall to the CS. Colored gelatin was observed both in the VC and the ipsilateral CS on two other occasions, but no communication was found between the two structures.

Abbreviations List

CS	cavernous sinus
CT	computed tomography
DSA	digital subtraction angiography
PP	pterygoid plexus
SMCV	superficial middle cerebral vein
SPS	superior petrosal sinus
VC	venous channel

Two alternate drainage pathways for the SMCV were observed: (1) toward the antero-superior aspect of the CS (classical "textbook" termination) on eight occasions (13.8 %) and (2) through a paracavernous sinus on 19 occasions (32.8 %). A VC in the lateral wall and a paracavernous sinus were not observed to occur concomitantly. In 17 occasions (29.3 %) there was no SMCV.

DISCUSSION

In the present study, a VC was found enclosed in the lateral wall of the CS in 24.1% of the cases. The VC received blood from the SMCV in the majority of cases. It should be noted that when the SMCV coursed under the lesser sphenoidal wing, it did not adopt any dural characteristics and thus did not form the sphenoidal part of a sphenoparietal sinus. Although the VC drained itself principally into the SPS or PP, it was also seen to communicate with the CS on three occasions, either through a large opening in the posterior aspect of the lateral wall of the CS or through small "en passant" connections located in the medial layer of the lateral wall of the CS. Since no communication existed between the two structures in the majority of cases, the VC of the lateral wall can be considered as an independant venous pathway running parallel to the CS, representing one of the main variants in the drainage pattern of the SMCV.

Due to its slitlike configuration and its location between two dural layers, the VC in the lateral wall may escape detection during an anatomic dissection if no previous injection of its tributary(ies) has been performed. This might explain why Umansky and Nathan (1982) did not observe the VC in their study of the lateral wall of the CS. For the same reasons and because of their close topographic relationship, the VC of the lateral wall and the CS itself are probably difficult to differentiate during routine radiological vascular investigations (DSA, CT and magnetic resonance imaging). This probably explains the paucity of references mentionning a venous structure in the lateral wall of the CS in the relevant literature (Dolenc, Bonneville, and Cattin).

In our study, an alternate drainage pathway for the SMCV was frequently observed in the form of a paracavernous sinus (32.7%), while the "classical" termination of the SMCV into the CS was only found in a few number of cases (13.8%). When present, the paracavernous sinus always originated under the lesser wing of the sphenoid bone and ran posteriorly through the middle cranial fossa toward the PP, the transverse sinus, or the SPS. This anatomic pattern corresponds to the description of the paracavernous sinus made by Padget under the name of tentorial sinus (1948, 1954). According to our observations, the venous outflow of the SMCV toward the middle cranial fossa may thus assume three different aspects: (1) a *medial group* corresponding to the lateral compartment of the CS (the so-called "classical" termination of the SMCV); (2) an *intermediate group* represented by the VC in the lateral wall of the CS; (3) a *lateral group* taking the form of the paracavernous sinus. These different venous pathways were always related to the SMCV (except for the case possibly involving the uncal vein) and were never found to occur simultaneously in the same side of a specimen.

According to Padget, the paracavernous sinus constitutes the adult remnant of the embryological drainage pathway of the SMCV (her tentorial sinus). Secondary anastomoses between the tentorial sinus and the CS,

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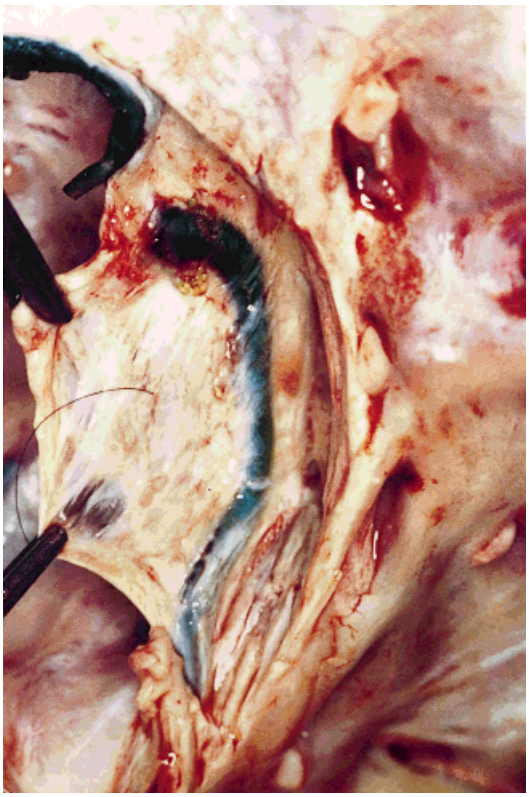
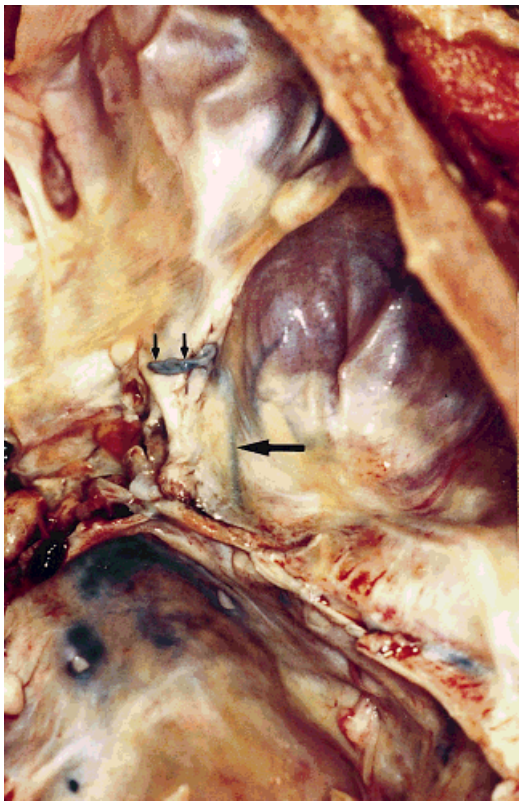


b.

Fig. 1. Superior view of a middle cranial fossa (left side) as seen after brain removal. The superficial middle cerebral vein (SMCV) has been injected with green gelatin. **(a)** SMCV (small arrow) running under the lesser wing of the sphenoid bone and entering the dura of the lateral wall of the cavernous sinus (CS) at the level of the anterior clinoid process (asterisk). The venous channel (VC) (large arrow) of the lateral wall of the CS is seen running posteriorly toward the superior petrosal sinus (SPS). **(b)** The two dural layers of the lateral wall are separated. The VC is attached to the lateral dural layer. Note that the CS has not been opened yet. **(c)** Opening of the CS revealing its content. The medial layer is held between the tweezers. Note the absence of gelatin inside the CS excluding the existence of a communication between the SMCV or VC and the CS.

transferring some or all of the SMCV outflow toward the CS, usually occur after birth and depend on the position of the tentorial sinus in the middle cranial fossa, i.e., the more medial it is situated, the more likely it will form anastomoses with the CS (Padget, 1956). The VC in the lateral wall of the CS may be considered as an intermediate location of this remnant. The three SMCV's outflow patterns observed in this study might thus be related to an embryologically identical venous structure (Padget's tentorial sinus) whose variable location in the adult middle cranial fossa would depend on its secondary migration and anastomosis. According to Padget (1956), the CS does not drain any cortical blood during prenatal life. We think that the parasellar venous pathways in the adult may still be considered as two parallel and functionally independent systems, schematically: (1) a medial system formed by the superior ophthalmic vein, the medial compartment of the CS, and the inferior petrosal sinus; (2) a lateral system consisting of one of the three aforementioned SMCV

c.



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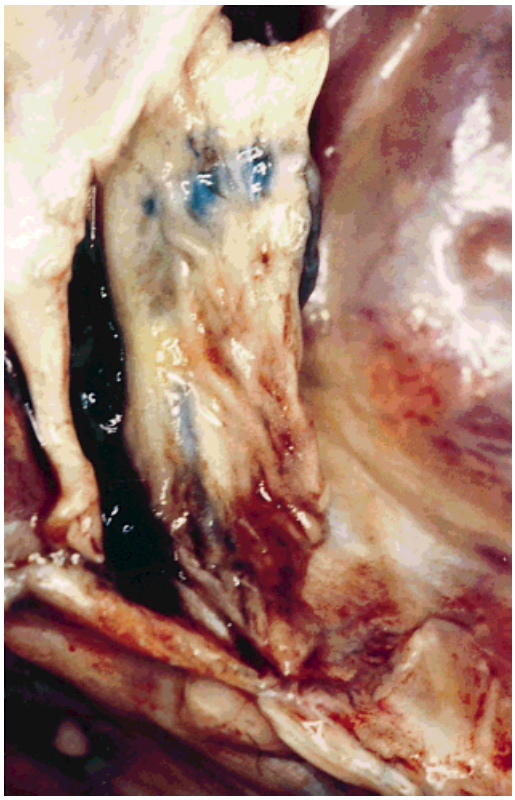
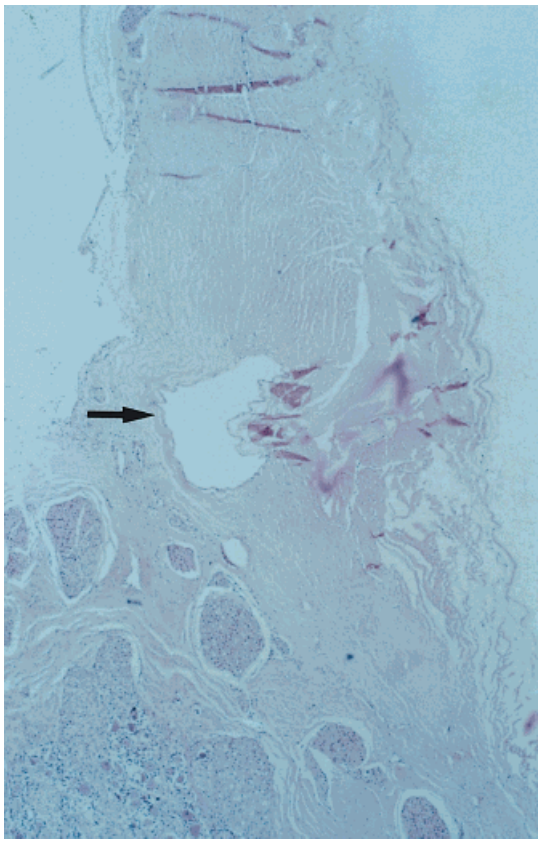


b.

Fig. 2. Superior view of a middle cranial fossa (right side). This case shows an uncal vein draining into the VC, which was injected with blue gelatin. There was no SMCV on this side. The left SMCV was injected with black gelatin. **(a)** The uncal vein (small arrow) joins the dura of the lateral wall at the level of the anterior clinoid process. The VC (large arrow) courses posteriorly toward the SPS. **(b)** The medial and lateral layers of the lateral wall could not be separated. The VC is seen by transparency in the lateral wall of the CS once the CS has been opened. Note the presence of black gelatin inside the CS coming from the contralateral injection. **(c)** Histological preparation of the lateral wall of the CS showing the VC (large arrow) with the fifth nerve ganglion on the bottom left (magnification 10X). **(d)** Detail of the VC. The endothelium lining the VC is appreciated (magnification 40×).



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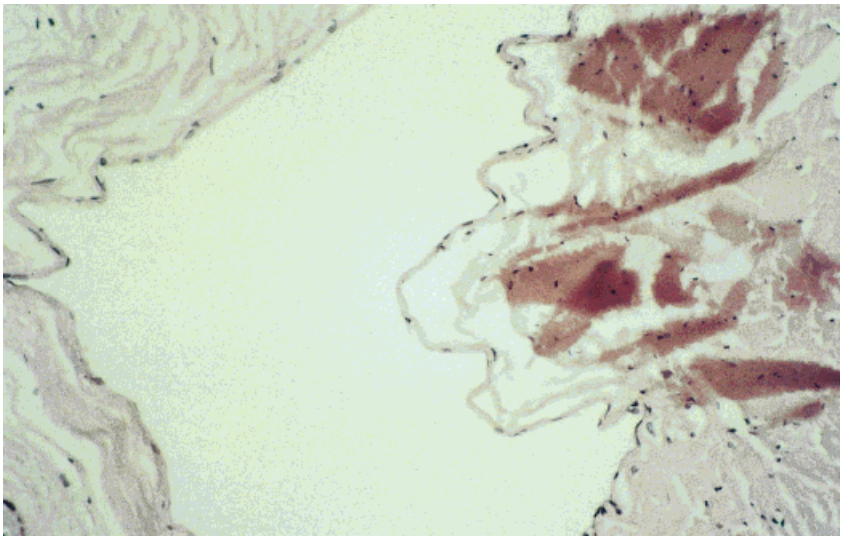

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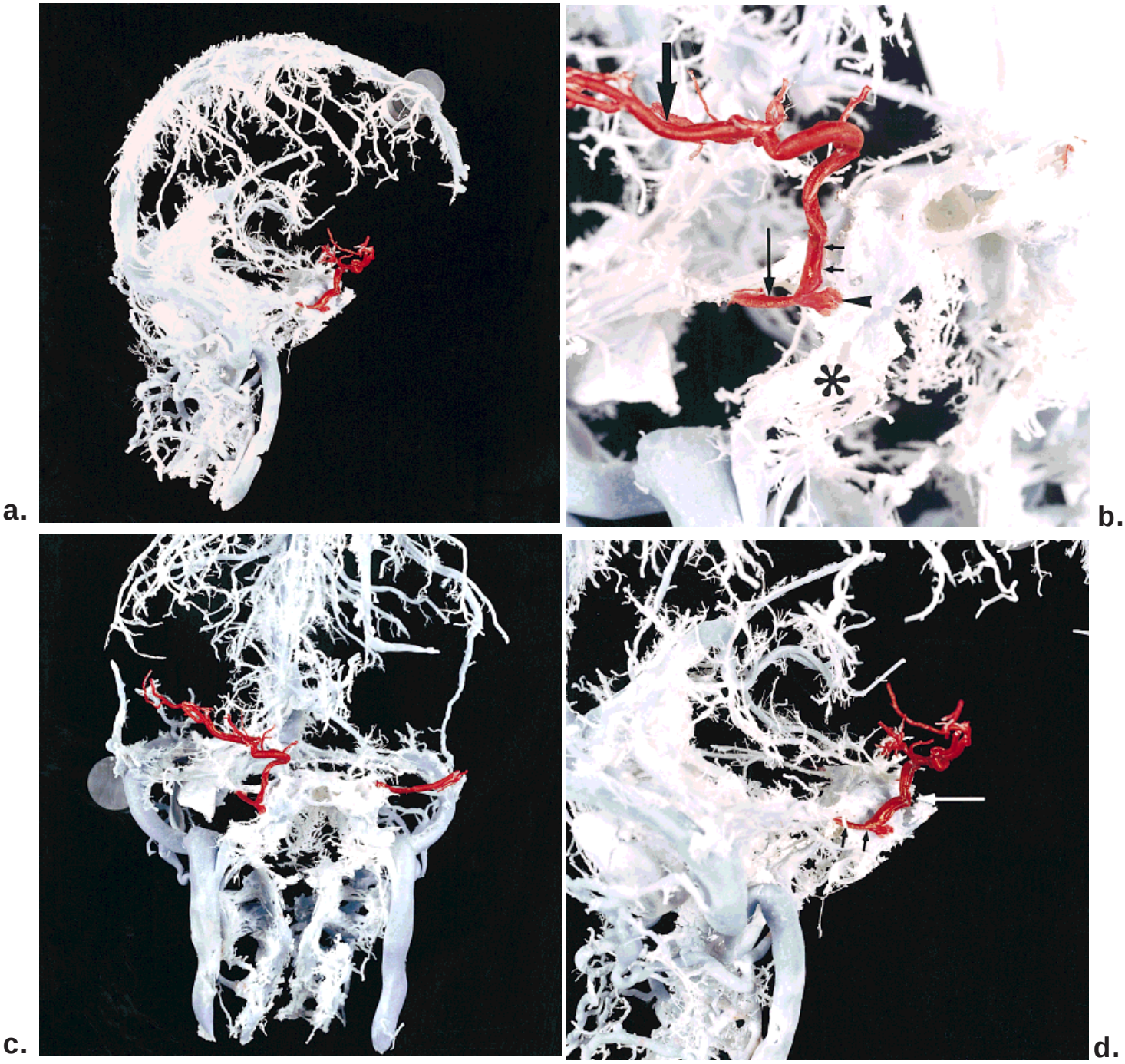

Fig. 3. Corrosion cast of the cerebral venous system. **(a)** Right lateral view showing the SMCV, VC and the medial third of the SPS in red. **(b)** Close–up of the same view. The white arrow shows the transition between SMCV and VC (corresponding to the entry point of the SMCV into the lateral wall). Note the posterior drainage of VC into SPS (double arrow). **(c)** Right anterior oblique view of the cast. **(d)** Close–up of the same view showing the SMCV (large arrow), the VC (small arrow) and the SPS (double arrow). Note concomitant drainage towards the pterygoid plexus (asterisk) by an emissary vein (arrowhead).

drainage patterns, linking the SMCV to the SPS, the transverse sinus or the PP.

Finally it should be noted that VC's in the lateral wall of the CS may present important clinical implications when involved in the venous drainage of vascular lesions. For example, a dural arteriovenous fistula located on a VC of the lateral wall of the CS cannot be accessed for embolization therapy through an usual endovascular approach, i.e., through the ophthalmic vein or inferior petrosal sinus. In such cases, knowledge of the existence of a VC in the lateral wall of the CS will allow to consider alternative therapeutic strategies and avoid predictible failure of the

endovascular procedure (Gailloud et al., 1996). In such cases, direct surgical approach may be warranted, the lack of communication in between the VC and the CS allowing for selective occlusion of the VC without the need to access the CS. Despite its close topographic relation with the CS, we think that the VC in the lateral wall of the CS should be considered as an anatomic entity both embryologically and functionally independent from the CS. Considering its important clinical implications and its lack of a proper denomination, we propose to name this venous structure the *laterocavernous sinus*.

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