Extradural neural axis compartment

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The lengthy, continuous, slender extradural neural axis compartment (EDNAC), which extends from the coccyx to the orbit, has been not so much discovered as recognized. Through this compartment run arteries, myelinated and unmyelinated nerves, and valveless veins. Adipose tissue is abundant in the orbital and spinal segments, possibly due to movement requirements, although it is very sparse in the skull base segment, the last segment to be recognized as a continuation of the EDNAC, which connects Breschet’s veins to the orbit. The lateral sellar compartment (in older terminology, the cavernous sinus) is an enlarged segment of this EDNAC along the skull base connecting the orbit with the extradural space through the superior orbital fissure and down the dorsum to Breschet’s veins of the basilar process of the occipital bone. Understanding the continuity of the EDNAC should help the student understand any segment, particularly the skull base.

As Batson noted, “Living anatomy is slowly editing and replacing the anatomy of the dead room.”

Key Words • extradural neural axis compartment • lateral sellar compartment • skull base • cavernous sinus • orbit • coccyx

Abbreviations used in this paper: EDNAC = extradural neural axis compartment; LSC = lateral sellar compartment.

My awareness that the LSC (in old terminology, the cavernous sinus) was only a segment of the EDNAC, which extends from the coccyx to the orbit, occurred many years ago during a conversation I had with Vinko Dolenc in August 1987 concerning the nature of the venous structure and connections of the LSC. The slender EDNAC is characterized by its content of valveless veins through which blood may run freely in either direction between the orbit and coccyx. This compartment is also characterized by its content of adipose tissue, which apparently varies according to the amount of movement required by particular anatomy; the adipose tissue is abundant in the spine and orbit and scanty along the skull base. In addition, there are nervous, arterial, and venous elements that enter and leave the compartment in its various segments. Visualization of the entire extradural column should assist in our understanding of the relationships of the segment located along the skull base.

Anatomy of the EDNAC

Spinal and orbital segments of the EDNAC are accurately depicted in standard texts, although it is not often realized that the orbital compartment is extradural, located between the dural sheath of the optic nerve and the periorbita. In addition to muscles, lacrimal gland, and globe, the orbit contains multiple branches of the superior and inferior orbital veins, which are valveless, multiple cranial and autonomic nerves, and branches of the ophthalmic artery, all of which are embedded in adipose tissue. The EDNAC has a direct connection through the superior orbital fissure to the LSC, which is also extradural, being located between the visceral and parietal layers of the dura laterally and superiorly and the periosseum of the sphenoid bone medially and inferiorly. Adipose tissue in the LSC is less abundant than that found elsewhere in the EDNAC, and the amount decreases with age. Epidural veins of the LSC are connected down through the clivus and the basilar process of the occiput with Breschet’s veins, which in turn are an upward extension of the spinal epidural veins of Batson (Fig. 1). From the posterior fossa the fifth and sixth cranial nerves enter this shallow extradural compartment on their way to the extradural LSC, whereas the third and fourth cranial nerves enter from the middle fossa, each dragging for varying distances a sleeve of meninges—a very robust sleeve in the case of the fifth nerve, that is, Meckel’s cave (Fig. 1). The LSC contains the internal carotid artery and its parasellar branches, cranial and autonomic nerves, and an extremely variable plexus of valveless veins that are dissimilar on opposite sides, even in the same individual.
individual (Fig. 2). If adjacent, the thin venous walls may appear to be a septum, whereas if extremely short they become a trabecula (Willis’ cord) in appearance. An examination of microscopic sections shows that, continuing down the basilar process of the occiput, the two dural and the periosteal layers are virtually fused, and our casts show correspondingly shallow venous channels (Fig. 2). It is difficult to understand how the venous channels depicted by Breschet were so voluminous. Batson’s veins run longitudinally and horizontally, avoiding the spaces opposite discs, which are all too easily entered during epidural injections, in a relatively thick sleeve of adipose tissue through which run segmentally nerves, arteries, and veins. The realization that this compartment provides a link to similar compartments in the orbit and spine also came somewhat later.

My awareness of the adipose tissue in the LSC came during the search for the collateral arteries of the parasellar carotid territory using fresh cadavers. This finding occurred almost simultaneously with the publication of Bol’Shakov’s study. When the fat is carefully, gently, and patiently brushed aside, it rolls up into globules and separate, discrete, extremely thin-walled veins are seen (Figs. 3 and 4). For a long time, the LSC was a surgical no-man’s-land. The true nature of its venous component remained unknown until, during surgery for a longstanding carotid–cavernous fistula with arterialized veins, I realized that the venous anatomy consisted of distinct, separate venous channels and not a venous cavern. I and others had suspected that this was the case beforehand. Some earlier anatomists, notably Pernkopf and Fener, had schematically drawn a plexus of veins, but nevertheless labeled them a singular cavernous sinus. Although it was noticed that two layers of dura (containing small intrinsic arteries and veins) had to be traversed to reach these veins, the extradural nature of the compartment was not recognized for several years—another embarrassment. Angiograms, unless obtained stereoscopically, rarely demonstrated more than the superimposed images of these small veins of the plexus in the LSC, giving the appearance of a single blob of contrast material, furthering the concept of a venous cavern. (Also misleading are many cast artifacts, in which the thin-walled veins appear to have disrupted, leaving puddles of cast material.) If compared with any of the true sinuses in the same model, the difference is immediately evident. In this respect, microscopic slides are most reliable. Using more advanced scanning techniques, multiple venous channels in the LSC were observed. In spite of this detailed observation in which it was noted that there is more than one venous channel in these beautiful works, the authors continue to use the singular term “cavernous sinus” for both the compartment and the veins contained within it.

The use of the term “cavernous sinus” remains the greatest single obstacle to understanding the anatomy of this area. The veins are neither cavernous nor a true dural sinus; they are multiple (not singular), extradural, and associated with arteries, nerves, and adipose tissue. The term is used interchangeably for the compartment and coverings, “tumors of the cavernous sinus,” and the venous contents, “thrombosis of the cavernous sinus.”
same double usage does not occur when discussing the continuations at either end, the orbit, and the spinal canal. This erroneous term, distracting in both its applications, has misled students, anatomists, and surgeons for more than 200 years.

Tapta23 pleaded that “a new terminology must be adopted distinguishing the space itself from the contents and the covering in the same way Meckel’s cave is distinguished from the gasserian ganglion it contains” (italics added). I suggest using the term “lateral sellar compartment” to refer to the space, and its contents should be labeled for what they are—the parasellar veins and so forth.

As the region assumes more clinical importance, we must have nomenclature that distinguishes the compartments from their contents. Many years of using incorrect terminology is no reason for continuing the error.

Conclusions

There is a lengthy, slender EDNAC containing multiple valveless veins, arteries, nerves, and adipose tissue, no segment of which resembles the true dural sinuses. Appreciation that the extradural veins and scanty adipose tissue of the skull base are part of the continuum of the EDNAC should aid in understanding the anatomy of the skull base and particularly that of the LSC, which is only an enlarged segment of the EDNAC.

Fig. 3. Enlarged photograph showing globules of fat (white and black arrows) being gently brushed aside from veins and nerves in the right LSC. Original magnification × 5.

Fig. 4. Enlarged photograph demonstrating that after patiently, gently, and completely brushing fat aside, the extremely thin walled veins are clearly visible in the LSC. C = carotid artery appearing out of focus beneath the veins. Original magnification × 5. (Parkinson D: Lateral sellar compartment O.T. (cavernous sinus): history, anatomy, terminology. Anat Rec 251:486–490, 1998. Reprinted with permission from Wiley-Liss, Inc., a subsidiary of John Wiley & Sons, Inc.).

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References


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