The meninges enclosing the CNS have generally been considered to consist of 3 different layers: the outermost layer (dura mater), the intermediate layer (arachnoid mater), and the innermost layer (pia mater). The dura mater forms the outer meninx and covers the spine and the brain. Taptas’ work on the cavernous sinus has significantly improved our knowledge of the descriptive anatomy of the dura; in particular, he was the first to show that the LSC is an extradural space that contains venous blood, fat, the carotid artery, and CN VI. Since then, the lateral, medial, and superior walls of the cavernous sinus have been thoroughly described. Parkinson integrated the anatomy of the LSC into an anatomical concept, the EDNAC, which extends from the coccyx to the orbit.

Laboratory investigation

Patrick François, M.D., Ph.D., Nadine Travers, M.D., Emmanuel Lescanne, M.D., Ph.D., Brigitte Arbeille, Ph.D., Michel Jan, M.D., and Stéphane Velut, M.D., Ph.D.

1Laboratoire d’anatomie and 2Département de Microscopie Electronique, Université François Rabelais de Tours; Service de 3Neurochirurgie et 4Oto-Rhino-Laryngologie, Centre Hospitalier Régional Universitaire de Tours, France

Object. The dura mater has 2 dural layers: the endosteal layer (outer layer), which is firmly attached to the bone, and the meningeal layer (inner layer), which directly covers the brain. These 2 dural layers join together in the middle temporal fossa or the convexity and separate into the orbital, lateral sellar compartment (LSC), or spinal epidural space to form the extradural neural axis compartment (EDNAC). The aim of this work was to anatomically verify the concept of the EDNAC by using electron microscopy.

Methods. The authors studied the cadaveric heads obtained from 13 adults. Ten of the specimens (or 20 perisellar areas) were injected with colored latex and fixed in formalin. They carefully removed each brain to allow a superior approach to the perisellar area. The 3 other specimens were studied by microscopic and ultrastructural methods to describe the EDNAC in the perisellar area. Special attention was paid to the dural layers surrounding the perisellar area. The authors studied the anatomy of the meningeal architecture of the LSC, the petroclival venous confluence, the orbit, and the trigeminal cave. After dissection, the authors took photographs of the dural layers with the aid of optical magnification. The 3 remaining heads, obtained from fresh cadavers, were prepared for electron microscopic study.

Results. The EDNAC is limited by the endosteal layer and the meningeal layer and contains fat and/or venous blood. The endosteal layer and meningeal layer were not identical on electron microscopy; this finding can be readily related to the histology of the meninges.

Conclusions. In this study, the authors demonstrated the existence of the EDNAC concept in the perisellar area by using dissected cadaveric heads and verified the reality of the concept of the meningeal layer with electron microscopy. These findings clearly demonstrated the existence of the EDNAC, a notion that has generally been accepted but never demonstrated microscopically. (DOI: 10.3171/2010.1.JNS081701)

Key Words • cavernous sinus • dura mater • meninges • anatomical study • skull base surgery

Abbreviations used in this paper: CN = cranial nerve; EDNAC = extradural neural axis compartment; EL = endosteal layer; LSC = lateral sellar compartment; ML = meningeal layer.
EL covers the sphenoid bone. The interperiosteal-dural space is located between the EL and the ML. The orbital segment of the interperiosteal-dural space is the rostral part of the EDNAC and lies between the EL (periorbita) and the ML (optic dural sheath). Consequently, the orbital compartment is an extradural space that contains fat (to facilitate movements), venous blood, muscles, and the CNs implicated in eye mobility. The spinal compartment of the interperiosteal-dural space extends between the periesteum (EL), which covers the vertebral bone, and the ML, which contains the spinal cord. These layers demarcate the epidural space containing fat and epidural veins. This space is the caudal part of the EDNAC.

The EDNAC is a generally accepted concept, especially by skull base neurosurgeons, but it has never been demonstrated microscopically. The aim of this work was to demonstrate the reality of this concept by focusing on the perisellar compartment using microanatomical cadaver dissections and to provide microscopic proof based on electron scan studies.

Methods

We studied cadaveric heads from 13 adults (or 26 perisellar areas) by performing microdissection and electron microscopy. For the microanatomical study, we injected the blood vessels in 10 cadaveric heads with dyed neoprene latex, using red for the internal carotid and vertebral arteries and blue for the jugular veins. The specimens were fixed with a 10% formalin solution. Among these 10 cadaveric heads, 2 were injected as described above and subsequently bleached with a 20% hydrogen peroxide solution. After several weeks, this procedure produced softening of the bone without modifying the fixed, soft tissues, thus allowing the bone to be cut with an ordinary scalpel, thereby permitting coronal dissections. Careful removal of the skull vault and brain of the skull base allowed us to use a superior approach to the parasellar area. Dissections were performed with the aid of optic magnification (250–300- and 400-mm focal distances). The dural layers were progressively dissected to clearly identify the dura mater within the parasellar area.

We used 3 fresh (< 24 hours) cadaveric heads for the scanning electron microscopy study. We removed the dural bag around the pituitary gland, the dural sheath of the optic nerve, the lateral wall of the LSC, the dura mater covering the clivus, and the periorbita with the help of optic magnification. The samples obtained were correctly oriented and fixed in 1% glutaraldehyde, 4% paraformaldehyde in 0.1 M phosphate buffer (pH 7.4), postfixed in 2% osmium tetroxide, dehydrated in a graded ethanol series, critical point-dried using carbon dioxide and coated with gold sputtering, as previously described. The samples were subsequently bleached with a 20% hydrogen peroxide solution to facilitate movements, venous blood, muscles, and the CNs implicated in eye mobility. The spinal compartment of the interperiosteal-dural space extends between the periesteum (EL), which covers the vertebral bone, and the ML, which contains the spinal cord. These layers demarcate the epidural space containing fat and epidural veins. This space is the caudal part of the EDNAC.

The EDNAC is a generally accepted concept, especially by skull base neurosurgeons, but it has never been demonstrated microscopically. The aim of this work was to demonstrate the reality of this concept by focusing on the perisellar compartment using microanatomical cadaver dissections and to provide microscopic proof based on electron scan studies.

Sources of Supplies and Equipment

The surgical microscope (model OPMI 9FC) we used was manufactured by Zeiss. The Nikon camera (FE) and Kodak film (Ektachrom 160T) were purchased from Nikon and Eastman Kodak, respectively. We used a GEMINI 982 LEO Scanning Electron Microscope for scanning electron microscopy. The Hasselblad camera and lenses were purchased from Victor Hasselblad AB. The RSX100 120 roll-film was manufactured by Agfa-Gevaert S.A. The neoprene latex (#671) injected into the vessels of the cadaveric heads was manufactured by E.I. Du Pont de Nemours-Dow Elastomers.

Results

The LSC

The LSC formed the middle part of the EDNAC. The lateral wall of the LSC was formed by the apposition of 2 meningeal layers: the outer layer, which was a continuation of the ML covering the middle cranial fossa, and the inner layer, which was formed by dural sheaths surrounding the CNs and coursed along the lateral wall of the LSC to reach the orbit. The dural sheath of the oculomotor nerve was clearly evident on the coronal section passing through the LSC (Fig. 1A). The trochlear dural sheath and the ophthalmic dural sheath, demarcating the Parkinson triangle, were found below the dural sheath of CN III. The medial wall of the LSC was formed by the dural bag surrounding the pituitary gland. Laterally, the pituitary gland can be described as a tonguelike extension above the horizontal segment of the carotid artery. The ML, which covered the sphenoidal planum, extended caudally to form the diaphragm sellae and the pituitary dural bag (Fig. 1C).

After opening the pituitary dural bag and partially removing the pituitary gland (Fig. 1E), the anterior and posterior coronary sinuses were exposed between the LSCs. These transsellar connections between the LSCs may exist at any point from the anterior to the posterior wall of the sella and are named on the basis of their relationship to the pituitary gland. The floor of the LSC was formed by the EL, which covered the sphenoid sinus (Fig. 1A). The posterior portion of the roof of the LSC was formed by a layer of ML between the lateral wall of the LSC and the diaphragma sellae. The oculosellar dural sheath was formed by an evagination of the dura mater at this level (Fig. 1A). The anterior roof of the LSC was more complex; to study it, the anterior clinoid process had to be drilled to expose the anterior clinoid space (Fig. 1D), which is a virtual space filled with the clinoid process in undisturbed crania. The carotid oculomotor membrane was located between the oculomotor dural sheath and the carotid artery. The proximal and distal dural rings demarcated the clinoid segment of the carotid artery and were formed by a reinforcement of the carotid oculomotor membrane around the carotid artery (Fig. 1D). The carotid artery branched into its cavernous segments below the proximal dural ring (lower ring).

As previously described by Inoue et al., the intra cavernous carotid artery was divided into 5 segments. The posterior vertical segment was the proximal part of the artery, the second part was the posterior bend, the third part was the horizontal segment (Fig. 1C), and the fourth part was the anterior bend, which was continued by the anterior vertical fifth segment. The carotid artery penetrated the subarachnoid space above the distal dural ring (upper ring). The optic strut was a bridge of bone that...
The interperiosteo-dural concept applied to the perisellar area

separated the optic canal from the superior orbital fissure and extended between the optic and oculomotor nerves (Fig. 1B). The anterior clinoid space was covered by the ML. This continuous horizontal layer spreading between the 2 anterior petroclinoid folds (dural folds that connect the petrous apex with the anterior clinoid process) formed the roof of the LSC laterally, and on the midline formed the diaphragma sellae, which was pierced by the diaphragmatic foramen containing the pituitary stalk.

The Orbit

The orbital compartment was the rostral part of the EDNAC. This extradural space lay between the dural sheath of the optic nerve and the periorbita. Arteries, veins, muscles, and nerves were embedded in abundant adipose tissue. The oculomotor, trochlear, and ophthalmic nerves converged at the superior orbital fissure. Beneath the periorbita, the fat had to be removed to expose the trochlear nerve, which passed above the levator muscle to reach the superior oblique muscle. The frontal nerve arose from the ophthamlic nerve and entered the orbit by passing through the lateral part of the superior orbital fissure, lateral to the anular tendon before dividing into the supratrochlear and supraorbital nerves. The lachrymal

Fig. 1. A: Coronal section passing through the LSC. The medial wall of the LSC (hypophysial dural bag) is exposed. The dural sheaths of CNs III, IV, and V1 are exposed in the lateral wall of the LSC. The LSC contains fat, venous blood, the carotid artery, and CN VI. The ML of the lateral wall of the LSC is exposed (black arrowheads). The EL, which forms the floor of the LSC, is individualized (white arrowheads). B: Superior view of the perisellar area. The orbital roof has been drilled, and the periorbita has been opened to expose the orbital apex. The anterior clinoid process has been drilled; CNs II and III were dissected and delimited a dural spread (the carotid-oculomotor membrane that lies between the carotid artery and the CN III dural sheath). The ML of the middle fossa has been incised to expose the lateral wall of the LSC. The CNs III, IV, and V1 exit the skull and reach the orbit passing through the superior orbital fissure. C: Superior view of the right LSC. The ML, which formed the superior and lateral wall of the LSC, has been removed. The floor of the LSC is formed by the EL, which covers the sphenoid bone. The lateral portion of the pituitary gland has been resected to expose the dural bag around the hypophysis. The CN VI lies in the petroclival venous confluence and reached the LSC and the superior orbital fissure. D: Lateral view of the right LSC. The anterior clinoid space is exposed. The outer layer of the lateral wall of the LSC has been incised (asterisk). The carotid-oculomotor membrane forms the proximal and distal dural rings around the clinoid segment of the carotid artery. E: Superior view of the right LSC. The superior wall of the LSC has been removed. A partial hypophysectomy was performed to expose the anterior and posterior coronary sinuses between the EL and the ML. F: Posterio view of the right petroclival venous confluence. The CN VI reaches the LSC by passing between the EL and the ML of the clivus, beneath the petrophenoidal ligament of Grüber. Ant. = anterior; Clin. = clinoidal; Diaph. = diaphragm; Dist. = distal; Lig. = ligament; N. = nerve; Pit. = pituitary; Post. = posterior; Prox. = proximal; Seg. = segment.
nerve coursed along with the lachrymal artery beneath the periorbita and above the lateral rectus muscle and reached the lachrymal gland laterally (Fig. 1B). The optic dural sheath enclosed the optic nerve in the optic canal and was formed by a layer of the ML at the level of the optic canal. The falciform ligament appeared to be a dural fold extending from the anterior clinoid process to the tuberculum sellae, which formed the cranial part of the optic dural sheath. The anular tendon lay in front of the superior orbital fissure and the optic canal. The four recti muscles arose from the anular tendon, while the levator muscle arose from the lesser wing of the sphenoid; the superior oblique muscle ran from the body of the sphenoid dorsally to the optic canal. The optic dural sheath formed the central part of the orbit and reached the globe to form the sclera.

The Petroclival Venous Confluence

The petroclival venous confluence covered the clivus and contained the interdural venous confluence. There were fibrous trabeculations between the EL and the ML limiting this space; these trabeculations created small holes in the blue latex filling the venous space (Fig. 1F). This space was limited laterally by the LSC and was crossed by the abducent nerve, which was located in the Dorello canal.12 The abducent nerve pierced the upper part of the clivus, crossed the petroclival venous confluence, then passed beneath the petrosphenoidal ligament of Grüber to reach the LSC and the superior orbital fissure (Fig. 1C). The petrosphenoidal ligament of Grüber appeared to be a fibrous bundle extending from the apex of the petrous bone to the posterior clinoid process (Fig. 1F). In agreement with the work by Destrieux et al.,8 the dural sheath of CN VI was formed by the ML; it accompanied the nerve to the LSC. The petroclival venous confluence was located between the EL and the ML of the clivus. It drained the cavernous sinus, the superior petrosal sinus, the basal sinus of the clivus, and emptied into the inferior petrosal sinus and the jugular bulb. The petroclinoid venous confluence formed the middle part of the EDNAC between the LSC and the spinal compartment.

The Trigeminal Cave

The trigeminal cave contained the sensory and motor roots of the trigeminal nerve, the gasserian ganglion, and the arachnoid cistern. The trigeminal cave is a dural pocket beneath the dura mater of the middle cerebral fossa; within it, the posterior and motor roots of the trigeminal nerve fit like a hand in a glove (Fig. 2C). The floor of the trigeminal cave was formed by the apposition of the EL and the ML. The roof was formed by a doubling of the EL of the middle cerebral fossa (Fig. 2A and C). The ML of the middle cerebral fossa curved onto the anterior petroclinoid fold (free edge of the tentorium) to form the inner layer of the roof of the trigeminal cave (Fig. 2C). The superior petrosal sinus, which emptied into the LSC by passing above the trigeminal nerve (Fig. 2B and C), was located between these 2 layers. The motor root arose rostral to the sensory root and passed through the Meckel cave on the medial side of the posterior sensory root and ganglion. At the anterior convex margin of the gasserian ganglion, the ML of the trigeminal cave became the epineural sheath of each division of the trigeminal nerve. The ophthalmic nerve and its dural sheath reached the lateral wall of the LSC and the orbit below the oculomotor and trochlear nerves. The maxillary nerve and its dural sheath exited the skull through the foramen rotundum. The mandibular nerve reached the foramen ovale to join with the infratemporal fossa. The cleavage plane between the ML on the dorsal part of the trigeminal cave continued rostrally at the level of the epineural sheaths of the trigeminal nerve divisions and served as the anatomical basis for the interdural exposure of the contents of the Meckel cave.1,39
The interperiosteal-dural concept applied to the perisellar area

Electron Microscopy Studies

The Petroclival Sinus. The EL and ML of the dura contained an extensive amount of extracellular collagen. The EL was firmly attached to the clivus. The ML was separated from the EL by venous blood, which formed the petroclival venous confluence. On the transverse section, the EL and ML were similar and had a regularly aligned collagen fiber orientation. The ML was thicker than the EL, and the collagen bundles of both layers were arranged in a well-ordered network (Fig. 3B). The petroclival venous confluence is the portion of the EDNAC situated between the LSC and the spinal compartment. It contains venous blood from the LSC and the superior petrosal sinus and empties into the jugular bulb. The abducent nerve pierces the ML, which forms its dural sheath, and reaches the LSC between the EL and the ML.

The Pituitary Dural Bag. The ML covering the planum wrapped it caudally to form the pituitary dural bag. The diaphragm was in fact an extension between the ML of the anterior cranial fossa and the pituitary dural bag (Fig. 4A). The pituitary dural bag containing the pituitary gland was attached to the inferior aspect of the diaphragma sellae and was created by an evagination of the ML into the sella, which extended to the diaphragmatic foramen. The pituitary gland was covered by the pituitary capsule (Fig. 4B), which attached to the pituitary dural bag. The pituitary capsule is a thin, semitransparent membrane that adheres closely to the gland. On transverse section, the ML of the planum and the pituitary dural bag had the same thickness (Fig. 4D and E) and were formed by a network of collagen bundles.

The EL and ML. We removed most of the dural layers constituting the EDNAC in the perisellar compartment and closely studied them. The inner layer of the dura that covered the clivus (Fig. 5D), the periorbita (Fig. 5E), and the floor the LSC (Fig. 5F) corresponded to the EL, whereas the outer layer of the clivus (Fig. 5A), the optic dural sheath of the optic nerve (Fig. 5B), and the lateral wall of the LSC (Fig. 5C) corresponded to the ML. The EL and ML of the dura mater were composed of densely arranged extracellular collagen oriented in various directions. The ML was covered by extracellular, filamentous, amorphous, electron-dense material. We never observed this aspect in the EL. We did not observe any cells or cell membranes on these layers like those seen in the dural border cells. We consistently found this same significant result in each sample.

Discussion

The interperiosteal-dural concept, which has been called the EDNAC since Parkinson’s description, is an anatomical complex that extends from the coccyx to the orbit. It contains valveless veins and adipose tissue, which facilitate eye movements, and spinal dura, which is especially abundant in the spine and orbit. The orbital compartment lies between the periorbita and the optic dural sheath. The LSC was located between the EL that covered the sphenoid bone, and the ML that formed its upper and lateral wall and the pituitary dural bag. The caudal portion of the EDNAC extended from the EL covering the spine to the ML, which contained the spinal cord. According to Arnautović, et al., there are a number of anatomical similarities between the suboccipital region and the LSC, in particular venous cushioning and the anatomical properties of the vertebral and carotid arteries in this compartment with their loops, branches, dural rings, and dural architecture. Over the past 40 years, the meningeal structure of the LSC has been well described using microsurgical dissection in cadavers. However, only a few descriptions focus on the meningeal architecture of the LSC.

To the best of our knowledge, the EDNAC has never been clearly demonstrated using an electron scan study. The EL and ML are not identical. Notably, the EL is characterized by a large amount of collagen bundles, while the ML is formed by a network of collagen fibers covered by an amorphous material (Fig. 5). To better understand this
lagen fibers covered by amorphous material (arrowheads). Panels D–F had extracellular collagen without this rough aspect. The ML of the clivus (x 5000; A), optic dural sheath (x 5000; B), lateral wall of the LSC (x 10000; C), EL of the clivus (x 2000; D), periorbita (x 5000, E), and floor of the LSC (x 5000; F).

morphology, we have to focus on the histological structure of the meninges. The dura mater consists of 2 portions: an outer, endostea layer forming the periosteum of the inner table of the skull, and an inner, fibrous or meningeal layer.14,15 The cranial fibrous dura mater consists of a lamination of fibroblasts oriented parallel to the skull with layers of collagen fibers between them. Microfibrils and elastic fibers may also be present but in significantly smaller amounts than collagen.29 The dura immediately adjacent to the EL of the skull comprises plump osteoblasts and osteoclasts, rich in calcium, which coat the adjacent collagen fibers (Fig. 3A). The ML is formed by the apposition of the meningeal dura and the dural border cells. This aspect was first described by Nabeshima et al.23 The transition between the dural border cells and the meningeal dura is characterized by the appearance of loosely distributed collagen fibrils and a large amount of fuzzy extracellular material in the greatly dilated extracellular space. The dural border cells have no extracellular collagen, few cell junctions, and an enlarged extracellular space filled with an amorphous material that is described as being granular and fuzzy.14,22

The junction between the dural border cells and the meningeal dura is characterized by a decrease in this amorphous material and an increase in collagen fibers. In addition, the dural border cells are firmly attached to the arachnoid barrier layer, which can be distinguished from the underlying arachnoid by the compact arrangement of its cells and by the basement lamina separating its inner surface from the collagen of the arachnoid (Fig. 6). The layer of dural border cells is attached to the arachnoid barrier layer by a few cell junctions. The dural border cells are the weakest plane in the meninges.15 Finally, we failed to identify any subdural space at the interface between the arachnoid and dura, as has been previously described.22

The review by Haines et al.,14 which was based on Frederickson’s work,13 summarized our knowledge of the dura-arachnoid junction. Accordingly, the authors mentioned that the line of least resistance passes through the dural border cells and that the subdural space does not occur spontaneously but is the direct result of tissue damage. The dura and arachnoid are attached to one another and anchored in opposite directions. The EL is attached to the skull and the arachnoid is anchored to the brain. The removal of the ML along the weakest plane, referred to above, exposes the dural border cells and the amorphous materials contained in the extracellular compartment. This cleavage plane does not exist spontaneously; it may be the consequence of an opening in the dura, since the strain placed on the meninges when the dura is elevated can be relieved by a tear that occurs along the cleavage plane in the dural border cells. Furthermore, this phenomenon occurs in subdural hematomas since there is no natural space between the dura and the arachnoid. Venous blood coming from a tear in the wall of traversing veins dissects the dural border cell layer to form subdural hematoma.29 This may explain our findings concerning the superficial aspect of the EL and ML and corroborates present knowledge on the distribution of the EL and the ML in the EDNAC.

The existence of the EDNAC is a generally accepted concept, although certain details concerning the medial wall of the LSC remain controversial.9,19 The medial wall of the LSC corresponds to the lateral part of the pituitary fossa and forms the only border between the pituitary fossa and the contents of the LSC. This border may constitute a barrier to tumor spread into or out of the LSC. In contrast to the 2 layers of ML that we observed in the lateral and superior walls of the LSC, our microsurgical anatomical study demonstrated that the medial wall is formed by a single dural layer, which is a continuation
of the upper layer of the diaphragma sellae (Fig. 1A, C, and E). These findings were confirmed by the results of our electron scan study (Fig. 4A and C). On sagittal section (Fig. 4C), the ML covering the anterior cranial fossa curved at the level of the diaphragm to form the pituitary dural bag. On transverse section, the pituitary dural bag was identical to the ML of the anterior cranial fossa (Fig. 4D and E) and had the same density of collagen bundles. Furthermore, the pituitary dural bag is strengthened by a collagenous layer, the pituitary capsule (Fig. 4B). The pituitary capsule is a thin, translucent layer of connective tissue covering the surface of the pituitary gland, although it is different from the dural layer lining the sella turcica. The pituitary capsule may derive from the pia mater or from the mesenchymal cells located around the developing anhepophysis. The pituitary dural bag isolates the hypophysis from all surrounding structures, particularly the LSC. According to Destrieux et al., the pituitary dural bag extends laterally above the carotid artery in 29% of cases and can mimic tumor invasion into the cavernous sinus when an adenoma occurs in the lateral expansion of the pituitary dural bag. The preoperative diagnosis of LSC invasion by pituitary adenomas has been the subject of several studies since LSC invasion is the most common limiting factor in the resection of these tumors. Despite their benign histological nature, these adenomas can become quite aggressive and even invasive. The pituitary dural bag is quite thin in comparison with the superior and lateral walls of the LSC. Yokoyama et al. described small histological defects in the medial wall of the LSC through which adenomas may extend laterally. The presence of these defects may explain the discrepancy between the benign histological nature of pituitary adenomas and their frequent extension into the LSC. These results are in agreement with the work by Kawase et al. on the meningeal architecture of the LSC. The LSC is protected against tumor invasion from the exterior by both meningeal layers of the lateral wall. Tumors located in LSC may extend elsewhere through meningeal weak points located in the medial wall of the LSC, the meningeal pockets of CNs III and V, or the cavernous apex.

The medial wall of the LSC is a thin structure that is not visible on MR imaging; it is therefore not helpful for diagnosing invasion with MR imaging. Nevertheless, using high-field, high-resolution (3 T) MR imaging, Wolfsberger et al. have reportedly been able to observe the medial wall of the LSC in the form of a hypointense line on T1-weighted contrast-enhanced MR images. This allowed them to diagnose LSC invasion by pituitary adenomas in 84% of 3 T MR images compared with 59% using standard MR images. The medial wall of the LSC appears as a discrete line compared with the lateral wall of the LSC. This may be explained by the fact that the sellar portion of the medial wall is formed by a single layer of dura doubled by a pituitary capsule which covers the pituitary gland.

Conclusions

We present the anatomical meningeal features of the parasellar compartment in detail. Good knowledge of the surgical anatomical features of this region is important for the surgical management of paraclinoid aneurysms and neoplasms. The EDNAC concept is an accepted notion in the medical community. The EL and the ML have different superficial aspects that can be explained by the histological relationships between dural border cells and arachnoid barrier cells.

The medial wall of the LSC is very important for surgeons because it limits the pituitary dural bag laterally and the LSC medially. This medial wall is formed by 2 connective layers: a dural layer forming the pituitary dural bag and a connective layer forming the pituitary capsule.

Disclosure

This study was supported by the Association du Don du Corps, Université François Rabelais de Tours, Laboratoire d’Anatomie. Conception and design: P François. Acquisition of data: P François, B Arbeille. Analysis and interpretation of data: P François. Critically revising the article: N Travers, E Lescanne, M Jan. Reviewed final version of the manuscript and approved it for submission: S Velut.

Acknowledgments

The authors are indebted to Donald Schwartz, M.D., for Tours for his help in proofreading this paper. They also thank Gerald Deluermoz, Jean Paul Da Silva (Université François Rabelais de Tours, Laboratoire d’Anatomie), Daniel Bourry (Université François Rabelais de Tours, Service d’Iconographie), and Claude Lebos (Université François Rabelais de Tours, Département de Microscope Electronique) for their technical help. The neoprene latex (#671) was a gift from Laboratoires Säfic-Alcan, Puteaux, France.

References


Manuscript submitted January 6, 2009. Accepted January 4, 2010. Please include this information when citing this paper: published online February 12, 2010; DOI: 10.3171/2010.1.JNS081701. Address correspondence to: Stéphane Velut, M.D., Ph.D. email: velut@med.univ-tours.fr.