



THE LAYERS OF THE LATERAL WALL OF THE CAVERNOUS SINUS

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Summary: We do not approve of the concept that the lateral wall of the cavernous sinus has only two layers, a superficial dural layer and a deep layer. We studied 80 fetuses by surgical microscope. Micropaque as a contrast was injected in the fetal arterial system. In the lateral wall of the fetal cavernous sinus we are able to recognize the following four layers: 1.The first or outside dural layer. 2.The second layer we named the layer of the trochlear nerve and its vessels. 3.The third layer is the layer of the oculomotor nerve and ophthalmic division of the trigeminal nerve and their vessels. 4.The fourth layer of the lateral wall of the cavernous sinus we called the deeper layer. Recognition of those layers in the lateral wall of the cavernous sinus is important in cavernous sinus surgery.

Key words: Cavernous sinus, the lateral wall of the cavernous sinus, four layers

Introduction

The cavernous sinuses make a double venous channel located on each side of the body of the sphenoid bone and pituitary gland. They extend from the superior orbital fissure to the petrous portion of the temporal bone. It is generally accepted that the cavernous sinus has the periosteal layer forming the floor and medial wall and dural layer forming the roof and the lateral wall. The internal carotid artery and its branches, sympathetic plexus and the abducent nerve are located in the cavity of the sinus. The third and fourth cranial nerves and the ophthalmic and maxillary division of the trigeminal nerve spread within the lateral wall of the sinus. Numerous pathologic processes may appear in the cavernous sinus, such as: aneurysms, carotid-cavernous fistulas or various kinds of tumors. The lateral wall of the cavernous sinus has special importance for surgical approach to the cavernous sinus cavity.

In most classical descriptions the third, the fourth cranial nerves and the ophthalmic and maxillary division of the trigeminal nerve are embedded in the lateral wall of the sinus. Rouviere (6) stated that the lateral wall is split into superficial and deep layers. Patouillard and Vanneville (4) described an inner deep layer of the lateral wall through which nerves III, IV and V_{1,2}

passed. Harris and Rhoton (1) and Rhoton et al. (5) recognized two "dural leaves" in the lateral wall of the sinus and nerves III, IV and V_{1,2} running between them. Umansky and Nathan (9) described that the lateral wall of the cavernous sinus consists of two layers, that is, a smooth superficial layer formed by the dura mater and a deep layer containing nerves III, IV and V₁. The two layers of the lateral wall are loosely attached to each other and could be easily separated. Parkinson (3) defined a triangular space between nerves III and IV above and V₁ and VI below through which he found a surgical approach in order to reach the internal carotid artery so its branches in the cavernous sinus.

We cannot agree with the concept that the lateral wall of the cavernous sinus has only two layers, a superficial dural layer and a deep layer and our aim is to demonstrate what we discovered concerning that field.

Materials and Methods

The lateral wall of the cavernous sinus was studied in 80 fetuses of 20–40 weeks of gestational age. Micropaque as a contrast was injected in fetal arterial system. Fetuses were kept from seven to ten days in 10% formaldehyde and after that we studied the lateral wall of the

cavernous sinus. We used the method of microdissection using the operating microscope. We started the microdissection at the level of the lateral end of the posterior border of the lesser wing of the sphenoid bone. Each layer could be separated from a deeper layer in order to allow reflexion of a layer laterally toward the floor of the middle cranial fossa.

Results

Our discoveries indicate that the lateral wall of the cavernous sinus has in all cases the following four layers, which we labelled as follows: The first or outside, or sometimes, the venous layer. The second layer or the layer of the trochlear nerve and its vessels. The third layer or the layer of the oculomotor nerve and ophthalmic division of the trigeminal nerve and their vessels. The fourth layer or the deeper layer (Fig.1).

and course within it, posterior to the superior petrosal sinus (Fig.2). That is the reason why we sometime call this layer the venous layer.

The second layer we named the layer of the trochlear nerve and its vessels. This layer is formed by the connective tissue, which is thinner and less compact and less complete than the first layer. Posteriorly, at the level of the semilunar ganglion the second layer becomes very thin and acts under constriction of the anterior wall of Meckel's diverticulum. Laterally to the ophthalmic division of the trigeminal nerve the second layer is also very thin and is continued in the other parts of the middle cranial fossa, under the first layer. Immediately at level of the lateral wall of the cavernous sinus the second layer is more compact and complete in comparison with the other parts. In the proximal part of this layer course the trochlear nerve and its accompanying arterial vessels (Fig.3). The arterial vessels of this layer

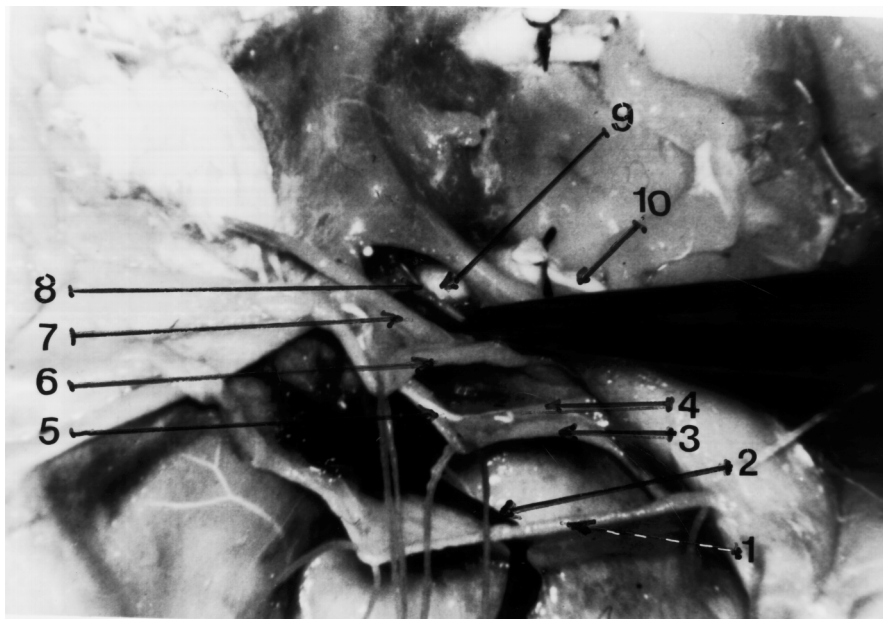


Fig.1. The layers of the lateral wall of the cavernous sinus. Superolateral view.

1.The first layer. 2.The superficial sylvian vein. 3.The second layer. 4.The trochlear nerve. 5.The arterial vessel of the trochlear nerve. 6.The third layer. 7.The oculomotor nerve. 8.The fourth layer. 9.The intracavernous portion of the internal carotid artery. 10.The ophthalmic artery.

The first or outside layer is a smooth superficial layer formed by the dura mater. This layer is thicker and more complete than the other layers. Its surface is the largest one in comparison with the other three layers of the lateral wall of the cavernous sinus. The dural layer of the lateral wall of the cavernous sinus is continued by the dura mater of the other parts of the middle cranial fossa. The superficial sylvian vein sometimes penetrates the lateral side of this layer in front part

course just near to the trochlear nerve and are of different origin. It may be either a branch of the meningohypophyseal trunk, a branch of the lateral trunk of the intracavernous portion of the internal carotid artery, a branch of the middle meningeal artery or a branch of the lacrimal artery. Sometimes there is a combination of two vessels which accompany the trochlear nerve. When the arterial vessels of this layer is a branch of the meningohypophyseal trunk its name is the tentorial

artery. If there exists either a branch of the lateral trunk, a branch of the middle meningeal artery, a

nerve and their vessels. Immediately at the level of the lateral wall of the cavernous sinus this layer is

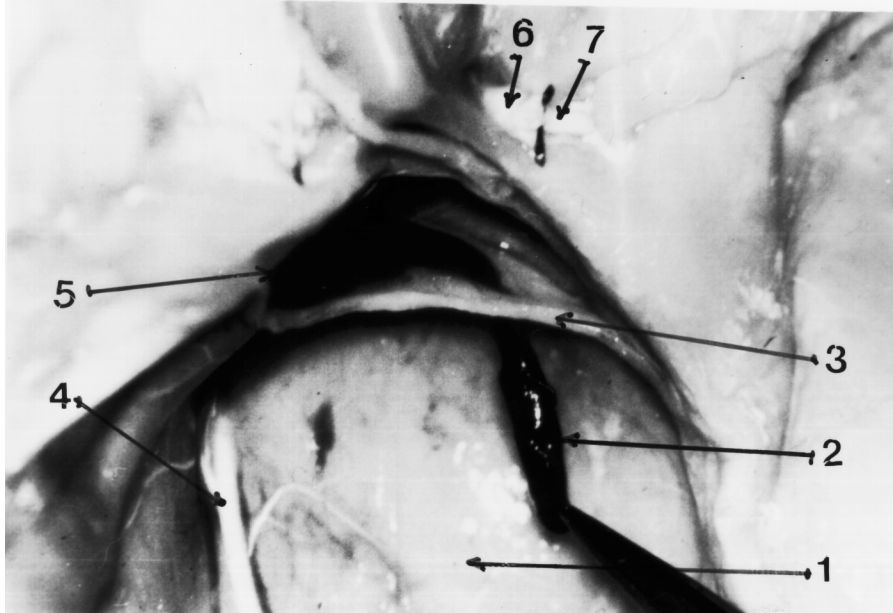


Fig.2. The first layer of the lateral wall of the cavernous sinus. Superior view.
 1.The middle cranial fossa. 2.The superficial sylvian vein. 3.The first layer. 4.The middle meningeal artery. 5.The superior petrosal sinus. 6.The internal carotid artery. 7.The ophthalmic artery.

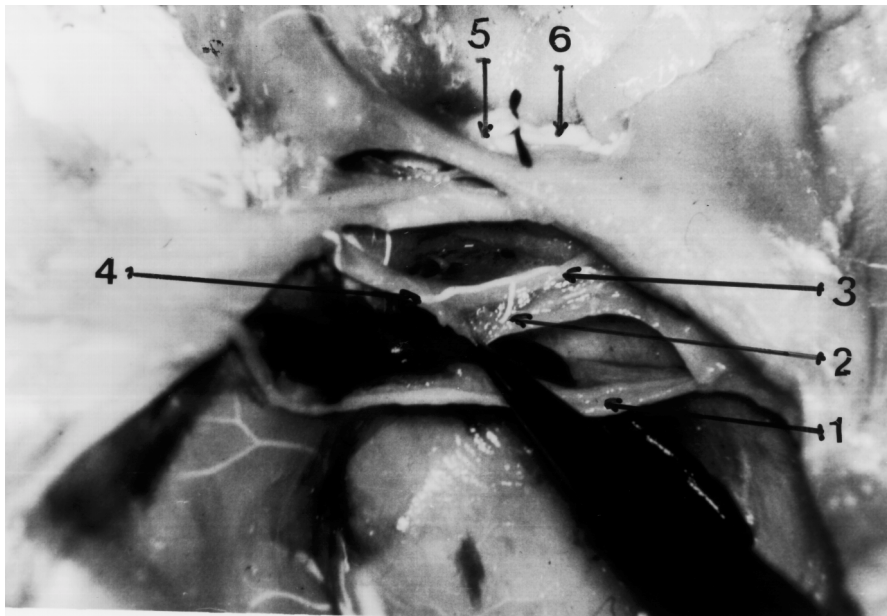


Fig.3. The second layer of the lateral wall of the cavernous sinus. Superior view.
 1.The first layer. 2.The second layer. 3.The trochlear nerve. 4.The accompanist arterial vessel of the trochlear nerve. 5.the internal carotid artery. 6.The ophthalmic artery.

branch of the lacrimal artery, it could be called the artery of the free margin of the tentorium or the accessory tentorial artery.

The third layer of the lateral wall of the cavernous sinus is the layer of the oculomotor nerve and ophthalmic division of the trigeminal

in form of a triangle. In part of the superior margin of this layer passes the oculomotor nerve and in part of the inferior margin of this layer passes the ophthalmic division of the trigeminal nerve (Fig.4). A modification of Parkinson's triangle or a kind of the triangular window of Umansky and

Nathan can be observed on the lateral side of this layer, between the III and V₁ nerves (Fig.4). Posteriorly, at the level of the semilunar ganglion the third layer divides into very thin layers from which one acts under construction of the anterior wall of Meckel's diverticulum and the other one under construction of the posterior wall of Meckel's

diverticulum. Laterally to the ophthalmic division of the trigeminal nerve the third layer is continued as periosteum of the other parts of the middle cranial fossa, under the second layer. The arterial vessels of this layer may be a branch of the lateral trunk, a branch of the meningo-hypophyseal trunk of the intracavernous portion of the internal carotid artery.

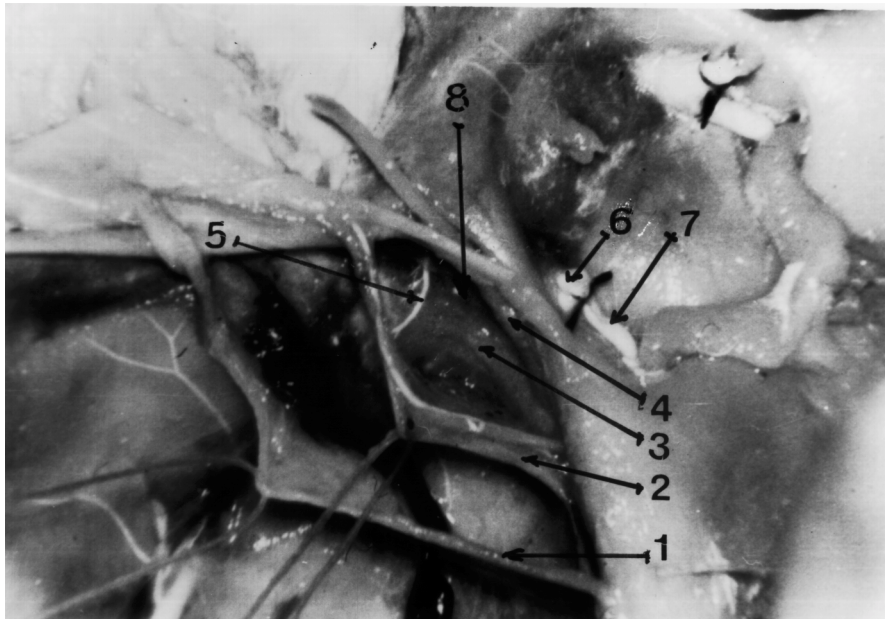


Fig.4. The third layer of the lateral wall of the cavernous sinus. Superolateral view.

1.The first layer. 2.The second layer. 3.The ophthalmic division of the trigeminal nerve. 4.The oculomotor nerve. 5.The arterial vessel of the third layer. 6.The internal carotid artery. 7.The ophthalmic artery. 8.A modification of the Parkinson's triangle or a kind of the triangular window of the Umansky and Nathan.

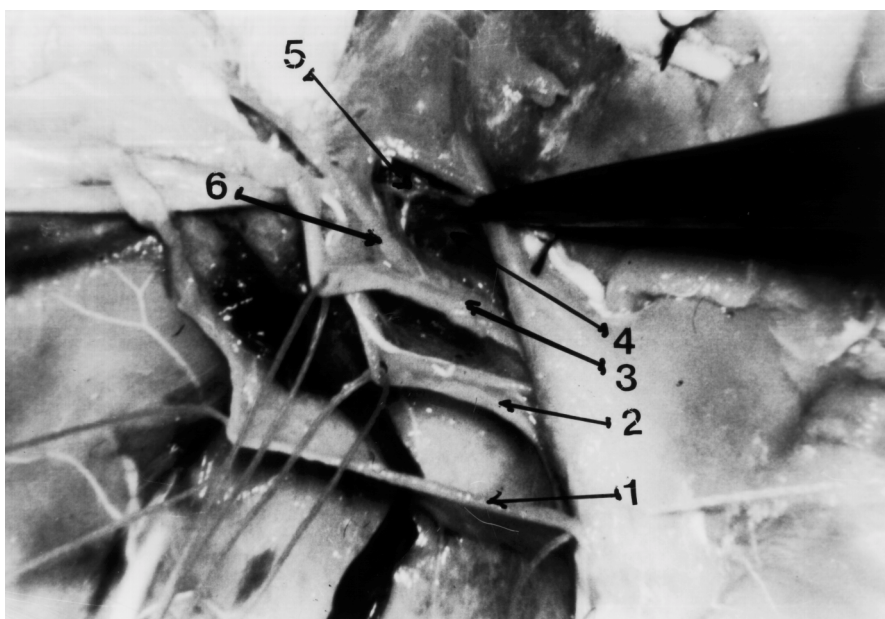


Fig.5. The fourth layer of the lateral wall of the cavernous sinus. Superolateral view.

1.The first layer. 2.The second layer. 3.The third layer. 4.The fourth layer. 5.The arterial vessel of the fourth layer. 6.The oculomotor nerve.

The deeper layer is the name we gave to the fourth layer of the lateral wall of the cavernous sinus. It directly contacts the cavity of the cavernous sinus (Fig.1, and Fig.5). The deeper layer is formed by uniformly single and soft connective tissue which covers the cavity of the sinus. This layer is not present without the lateral wall of the cavity of the sinus. A clear cleavage plane between the third and fourth layers could be recognized there (Fig.5). Along the superior margin of this layer we recognized an arterial vessel. It may be a branch of the meningohypophyseal trunk or a branch of the lateral trunk of the intracavernous portion of the internal carotid artery.

Discussion

Our description of the layers of the lateral wall of the cavernous sinus is completely different from the descriptions of other authors. Many authors (1,2,4,5,8,9) described only two layers, a superficial and a deep layer in the lateral wall of the cavernous sinus. But, according to Taptas⁷, Hovelacque in 1927 was the first author who described that the lateral wall appeared multilayered. Many authors (1,5,9) described the outer layer as a smooth superficial layer formed by the dura mater, and we are in agreement with that statement. But, nobody emphasized that the first layer may contain a venous vessel as the superficial sylvian vein and its position in this layer.

Our description and demonstration of the second layer seems to be quite different from the description of other authors (1,5,8,9). We are the first who stress that this layer is a layer of the trochlear nerve and its vessels. We cannot agree with the claim that the third and fourth cranial nerves bring a fairly long sleeve adherent to the lateral wall. Our preparation of the second layer demonstrated that this layer lies just below whole surface of the first layer and this layer contains the

trochlear nerve and its accompanying vessels. Also, the second layer may be prepared easily when we started the microdissection at the level of the lateral end of the posterior border of the lesser wing of the sphenoid bone, where it is thicker. But, if we started the microdissection from the lateral end of the middle cranial fossa, we can not discover this second layer because in this place the second layer is very thin and very hard adhered to the inner surface of the first layer. In the course of the cavernous sinus surgery we may elevate the part of the second layer together with the trochlear nerve and its vessels and a clear cleavage plane between the second and third layer could be recognized, if we started the microdissection at the level of the lateral end of the posterior border of the lesser wing of the sphenoid bone. On the lateral side of the third layer it can be seen a kind of the triangular window of Umansky and Nathan or a modification of Parkinson's triangle between the III and V₁ nerves. This triangle is important in cavernous sinus surgery and it may be clearly seen in our Fig.4. After microdissection the part of the third layer the inner side of this layer and the lateral side of the fourth layer could be seen. This may be seen in our Fig.5.

It is important to stress that the fourth or deeper layer is present only at the level of the lateral wall of the cavity of the cavernous sinus, by contrast to the other three layers of the lateral wall of the cavernous sinus, which are continued to all parts of the middle cranial fossa, one under other.

Conclusion

We think that this new concept of the layers of the lateral wall of the cavernous sinus will give a better basis for the cavernous sinus surgery to neurosurgeons.

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SLOJEVI U SPOLJAŠNJEM ZIDU KAVERNOZNOG SINUSA

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Kratak sadržaj: Mi se nismo složili sa konceptom da spoljašnji zid kavernoznog sinusa ima samo dva sloja, jedan površni duralni sloj i jedan duboki sloj. Ispitali smo 80 fetusa uz pomoć hirurškog mikroskopa. Micropaque kao kontrastno sredstvo bio je ubrizgan u fetalni arterijski sistem. U spoljašnjem zidu fetalnog kavernoznog sinusa bili smo sposobni da prepoznamo sledeća četiri sloja: 1.Prvi ili spoljašnji duralni sloj. 2.Drugi sloj koga smo imenovali slojem trohlearnog živca i njegovih krvnih sudova. 3.Treći sloj je sloj okulomotornog živca i oftalmične grane trigeminalnog živca i njihovih krvnih sudova. 4.Četvrti sloj spoljašnjeg zida kavernoznog sinusa nazvali smo najdubljim slojem. Prepoznavanje ovih slojeva u spoljašnjem zidu kavernoznog sinusa važno je pri hirurškim zahvatima u predelu kavernoznog sinusa.

Ključne reči: Kavernozni sinus, spoljašnji zid kavernoznog sinusa, četiri sloja

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