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CARVANOUS SINUS

The cavernous sinuses (sinus cavernosus) are so named because they present a reticulated structure, due to their being traversed by numerous interlacing filaments.They are of irregular form, larger behind than in front, and are placed one on either side of the body of the sphenoid bone, extending from the superior orbital fissure to the apex of the petrous portion of the temporal bone. Each opens behind into the petrosal sinuses.

On the medial wall of each sinus is the internal carotid artery, accompanied by filaments of the carotid plexus; near the artery is the abducent nerve; on the lateral wall are the oculomotor and trochlear nerves, and the ophthalmic and maxillary divisions of the trigeminal nerve. These structures are separated from the blood flowing along the sinus by the lining membrane of the sinus.

The cavernous sinus receives the superior ophthalmic vein through the superior orbital fissure, some of the cerebral veins, and also the small sphenoparietal sinus, which courses along the under surface of the small wing of the sphenoid.It communicates with the transverse sinus by means of the superior petrosal sinus; with the internal jugular vein through the inferior petrosal sinus and a plexus of veins on the internal carotid artery; with the pterygoid venous plexus through the foramen Vesalii, foramen ovale, and foramen lacerum, and with the angular vein through the ophthalmic vein.

The two sinuses also communicate with each other by means of the anterior and posterior intercavernous sinuses.

Anatomy of the Cavernous Sinus

**Relations**

Anterior: superior orbital fissure

Posterior: apex of the petrous temporal bone

Superior: internal carotid artery, optic tract and optic chiasma

Lateral: uncus of the temporal lobe

Medial: the body of the sphenoid and sella turcica

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The internal carotid artery (ICA) enters the posterior inferior aspect of the cavernous sinus forming the cavernous part of the artery. Then it travels horizontally anteriorly within the sinus. Once it reaches the anterior wall of the sinus, it traverses vertically upwards towards the roof of the sinus and exits to form the cerebral part. It gives rise to two branches within the sinus: the meningohypophyseal branch and the inferolateral branch. It is clinically significant that this part of the internal carotid artery is the only artery which is surrounded by a network of veins.

Sympathetic nerves around the carotid plexus: these nerves arise from the superior cervical ganglion and surround the cavernous part of the ICA.

The abducent nerve (CN VI) traverses the sinus inferolateral to the ICA and exits by entering the superior orbital fissure anteriorly. It innervates the lateral rectus muscle once it reaches the orbit.

The oculomotor nerve (CN III) is the most superior nerve in the lateral wall of the sinus. As it reaches the anterior wall of the sinus, it divides into superior and inferior branches, which pass through the superior orbital fissure. CN III and the sympathetic plexus around the ICA innervate the levator palpebrae superioris, the inferior oblique, and superior, medial and inferior recti muscles of the orbit.

The trochlear nerve (CN IV) lies in the lateral wall of the sinus, below CN III. It leaves through the anterior wall of the sinus and enters the superior orbital fissure. It supplies the superior oblique muscle in the orbit.

The ophthalmic nerve and maxillary nerve are branches of the trigeminal nerve (CN V). They lie below CN IV in the lateral wall of the cavernous sinus. The ophthalmic branch exits via the superior orbital fissure, while the maxillary nerve exits the sinus via the foramen rotundum.

Fat: in obese patients, and in patients taking corticosteroids, fatty deposits may occasionally be seen within the cavernous sinus.

**Tributaries or incoming veins:**

Superficial middle cerebral vein

Inferior cerebral vein from the temporal lobe

Intercavernous sinus, which connects the cavernous sinuses on either side

Inferior and superior ophthalmic veins (which drain the facial veins) from the orbit

Sphenoparietal sinus from the meninges

Central retinal vein, which may drain into the superior ophthalmic vein.

Tributary of the middle meningeal vein, which may drain into the pterygoid plexus or sphenoparietal or cavernous sinus.

**The cavernous sinus drains via:**

Venous plexus around the ICA to the basilar venous plexus

Superior petrosal sinus to the sigmoid sinus

Inferior petrosal sinus to the internal jugular veins

Emissary veins passing through various foramina in the skull base, e.g., foramen ovale, foramen lacerum, and sphenoidal foramen

Since the superior ophthalmic veins and the other complex of veins do not have valves, the blood flow is bidirectional depending on the pressure gradients. The cavernous sinus receives blood via this bidirectional route and hence infections from the mid-face, nose, paranasal sinuses, orbits, tonsils, and even the middle ear can spread to it easily.

**Clinical Relevance of the Cavernous Sinus**

**Cavernous sinus thrombosis (CST)**

This condition was first described in 1831 by Bright. It is a late complication of infection in the dangerous (central) area of the face (e.g., furuncle on the nose, dental caries, etc.) or paranasal sinuses and a medical emergency requiring urgent management with a high incidence of morbidity and mortality.

With the advent of broad-spectrum antimicrobial drugs, the incidence of CST has decreased markedly. The infection may cause thrombosis within the facial veins and when the clot breaks off and travels to the cavernous sinus, it can cause CST. Also, due to the close relationship of the cavernous sinus to the paranasal sinuses, the orbit, the complex of veins, cranial nerves, internal carotid artery and meninges, and the absence of valves in the veins draining to and from the cavernous sinus, infection from draining tissues can result in cavernous sinus thrombosis.This is characterized by edema of the eyelids, conjunctiva, and paralysis of the cranial nerves intimately related to the cavernous sinuses.The common organisms involved in CST include Staph aureus, Strep pneumococcus, gram-negative bacteria, anaerobes as well as fungi like Rhizopus and Aspergillus.Diagnosis of CST is done clinically and confirmed with either CT scan or MRI with MR venogram, which is the study of choice.Treatment consists of empirical broad-spectrum antibiotics with corticosteroids to reduce edema. Surgery may be required to drain/clean infected material from the paranasal sinuses. Delay in diagnosis and treatment is associated with high morbidity and mortality. Patients who survive may have a visual impairment or cranial nerve deficits.

**Cavernous sinus syndrome (CSS)**

The pituitary gland is located in a fossa between the two cavernous sinuses. As Pituitary tumors grow, they can expand towards and later compress the cavernous sinus. This can lead to cavernous sinus syndrome, which is characterized by ophthalmoplegia (paralysis of CN III, IV, VI), loss of sensation in the region of the ophthalmic and maxillary nerves as well as Horner’s syndrome due to compression of the sympathetic plexus around the internal carotid artery.

CSS can also be caused by tumors extending from the nasopharynx, pituitary or metastasis or even following CST.

**Carotico-cavernous fistula (CCF)**

CCF is formed due to an unnatural direct communication between the cavernous sinus and the ICA traversing through it. This direct fistula is formed due to either trauma or rupture of an aneurysm.

Arterial dissection, collagen vascular diseases like Ehler Danlos and fibromuscular dysplasia could also be causes of CCF.

Patients may present, among other symptoms, with pulsatile proptosis, orbital congestion, chemosis, corneal exposure, diplopia, paralysis of CN III, IV, VI, and retinopathy.

CT angiography is the test of choice.Usually, these fistulae resolve spontaneously. Persistent symptomatic fistulae require treatment, which consists of steroids in the acute phase to reduce edema, followed by definitive surgery.Endovascular approaches with obliteration of the fistula and restoration of arterial and venous flow lead to resolution of the fistula.

**Triangular space near the cavernous sinus**

Parkinson, in 1965, described a triangular space between the ophthalmic and trochlear nerves, to approach lesions around the cavernous part of the ICA. With the advent of radiosurgery and endovascular surgery, this direct approach through the triangular space is rarely required.

If endovascular surgery or occlusion of carotico-cavernous fistula fails, then direct surgery through this triangular space may be necessary. Also, in the case of certain tumors like meningiomas, schwannomas, pituitary adenomas, and chondromas, neurosurgeons may have to gain access to the tumors through this triangle.

Walls of the nose

The nasal cavity is divided into two lateral compartments separated down the middle by the nasal septum. The nasal cavity communicates anteriorly through the nostrils and posteriorly with the nasopharynx through openings called choanae. The nasal cavities and septum are lined with a mucous membrane and are richly vascularized by branches of the maxillary, facial, and ophthalmic arteries. The nasal cavity receives innervation via branches of the olfactory [cranial nerve (CN) I], ophthalmic (CN V-1), and maxillary nerves (CN V-2).

Boundaries of the Nasal Cavity

The nasal cavity is bordered by the following structures (Figure 23-1A–C):

Roof. Formed by the nasal, frontal, sphenoid, and ethmoid bones (cribriform foramina, which transmits CN I for smell).

Floor. Formed by the maxilla and the palatine bones. The incisive foramen transmits branches of the sphenopalatine artery and the nasopalatine nerve for general sensation from the nasal cavity and palate.

Medial wall (nasal septum). Formed by the perpendicular plate of the ethmoid bone, the vomer bone, and the septal cartilage.

Lateral wall. Formed by the superior, middle and inferior nasal conchae. In addition, the maxillary, sphenoid, and palatine bones contribute to the lateral wall. The lateral wall contains the following openings:

Sphenoethmoidal recess. The space between the superior nasal concha and the sphenoid bone, with openings from the sphenoid sinus.

Superior meatus. The space inferior to the superior nasal concha, with openings from the posterior ethmoidal air cells.

Middle meatus. The space inferior to the middle nasal concha, with openings for the frontal sinus via the nasofrontal duct, the middle ethmoidal air cells on the ethmoidal bulla, and the anterior ethmoidal air cells and maxillary sinus in the hiatus semilunaris.

Inferior meatus. The space inferior to the inferior nasal concha, with an opening for the nasolacrimal duct, which drains tears from the eye into the nasal cavity.

Sphenopalatine foramen. An opening posterior to the middle nasal concha receives the nasopalatine nerve and the sphenopalatine artery from the pterygopalatine fossa into the nasal cavity.