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**Medicine and Surgery**

**ANA 301: Gross Anatomy of Head and Neck**

**Write an essay on the cavernous sinus**

**Cavernous Sinus**

The [human brain](https://www.kenhub.com/en/library/anatomy/cerebral-cortex) is a highly vascular organ responsible for coordinating a myriad of processes throughout the body. Therefore, it is important that a pathway exists to return blood that enters [the cranium](https://www.kenhub.com/en/library/anatomy/the-skull) to systemic circulation. The cavernous sinuses are one of several drainage pathways for the brain that sits in the middle. In addition to receiving venous drainage from the brain, it also receives tributaries from parts of the [face](https://www.kenhub.com/en/library/anatomy/the-human-face).

The left and right cavernous sinuses communicate by through the anterior and posterior intercavernous sinuses. The cavernous sinus drains to the superior and inferior petrosal sinuses, which then join the sigmoid sinus.

**Structure**

The cavernous sinuses are 1 cm wide cavities that extend a distance of 2 cm from the most posterior aspect of the [orbit](https://www.kenhub.com/en/library/anatomy/bones-of-the-orbit) to the petrous part of the [temporal bone](https://www.kenhub.com/en/library/anatomy/the-temporal-bone). They are bilaterally paired collections of venous plexuses that sit on either side of the [sphenoid bone](https://www.kenhub.com/en/library/anatomy/the-sphenoid-bone). Although they are not truly trabeculated cavities like the corpora cavernosa of the penis, the numerous plexuses, however, give the cavities their characteristic sponge-like appearance.

The cavernous sinus is roofed by an inner layer of [dura mater](https://www.kenhub.com/en/library/anatomy/meninges-of-the-brain-and-spinal-cord) that continues with the diaphragma sellae that covers the superior part of the [pituitary gland](https://www.kenhub.com/en/library/anatomy/pituitary-gland). The roof of the sinus also has several other attachments. Anteriorly, it attaches to the anterior and middle clinoid processes, posteriorly it attaches to the tentorium (at its attachment to the posterior clinoid process). Part of the periosteum of the greater wing of the sphenoid bone forms the floor of the sinus. The body of the sphenoid acts as the medial wall of the sinus while the lateral wall is formed from the visceral part of the dura mater.

**Contents**

The cavernous sinus contains the internal carotid artery and several cranial nerves. Abducens nerve (CN VI) traverses the sinus lateral to the internal carotid artery. The remainder of the cranial nerves passes through the lateral wall of the carotid sinus, and from superior to inferior they are:

* Oculomotor nerve (CN III)
* Trochlear nerve (CN IV)
* Trigeminal nerve (CN V) - ophthalmic and maxillary divisions.

**Internal carotid artery**

In addition to the thin walled veins that traverse the cavernous sinus, a lone arterial vessel also uses the area as a conduit. The [internal carotid artery](https://www.kenhub.com/en/library/anatomy/internal-carotid-artery) (a branch of the common carotid artery) – along with its postganglionic sympathetic plexus from the superior cervical ganglion – gains access to the cavernous sinus posteriorly.

As the petrous part of the internal carotid artery leaves the carotid canal, it curves vertically and superiorly above foramen lacerum to enter the cavernous sinus. Here the artery is also referred to as the cavernous part.

Within the sinus, the internal carotid artery travels anteriorly, in a horizontal manner until it reaches the anterior limit of the sinus. Here it curves vertically and superiorly to exit the sinus through its roof and become the cerebral part of the internal carotid artery. It is noteworthy that the cavernous part of the internal carotid artery is the only arterial vessel that is completely surrounded by venous networks. This fact is of great clinical significance.

**Abducent nerve**

This motor nerve leave the pons and gains access through the posterior part of the sinus after passing of the apical potion of the petrous temporal bone. It has also been known to access the cavernous sinus by way of the petrosal sinus, adjacent to the clivus.

Within the cavernous sinus, it takes an inferolateral course, relative to the internal carotid artery. It exits the sinus by way of the superior orbital fissure to gain access to the orbit, where it innervates the [lateral rectus muscle](https://www.kenhub.com/en/library/anatomy/lateral-rectus-muscle) of the eyeball.

**Oculomotor nerve**

The other nerves travelling through the cavernous sinus do so between the endothelial lining and the dura mater of its lateral wall. The most superior of the four nerves in the lateral wall is the [oculomotor nerve (CN III)](https://www.kenhub.com/en/library/anatomy/the-oculomotor-nerve). At the posterior aspect of the roof of the cavernous sinus, the free and attached edges of tentorium cerebelli forms a space through which CN III enters the lateral wall of the sinus. It takes an anterior, inferomedial course (relative to the other nerves in the lateral wall) towards the anterior extremity of the sinus.

Here it bifurcates into its superior and inferior rami that pass through the superior orbital fissure. Along with sympathetic fibers from the internal carotid plexus, CN III provides motor supply to [inferior oblique](https://www.kenhub.com/en/library/anatomy/inferior-oblique-muscle), [levator palpebrae superioris](https://www.kenhub.com/en/library/anatomy/levator-palpebrae-superioris-muscle), and the inferior, medial and superior recti muscles.

**Trochlear nerve**

The smallest of the cranial nerves, the [trochlear nerve (CN IV)](https://www.kenhub.com/en/library/anatomy/the-trochlear-nerve-and-the-abducent-nerve), enters the posterior aspect of the cavernous sinus after leaving the posterior part of the [brainstem](https://www.kenhub.com/en/library/anatomy/the-brainstem) and decussating with the same nerve from the opposite side. It continues anteriorly in the lateral wall of the cavernous sinus, inferior to CN III and passes through the superior orbital fissure at the anterior aspect of the sinus. Once in the orbit, CN IV has the responsibility of innervating the [muscles of the eyeball](https://www.kenhub.com/en/library/anatomy/muscles-of-the-orbit) that are responsible for inferolateral motions.

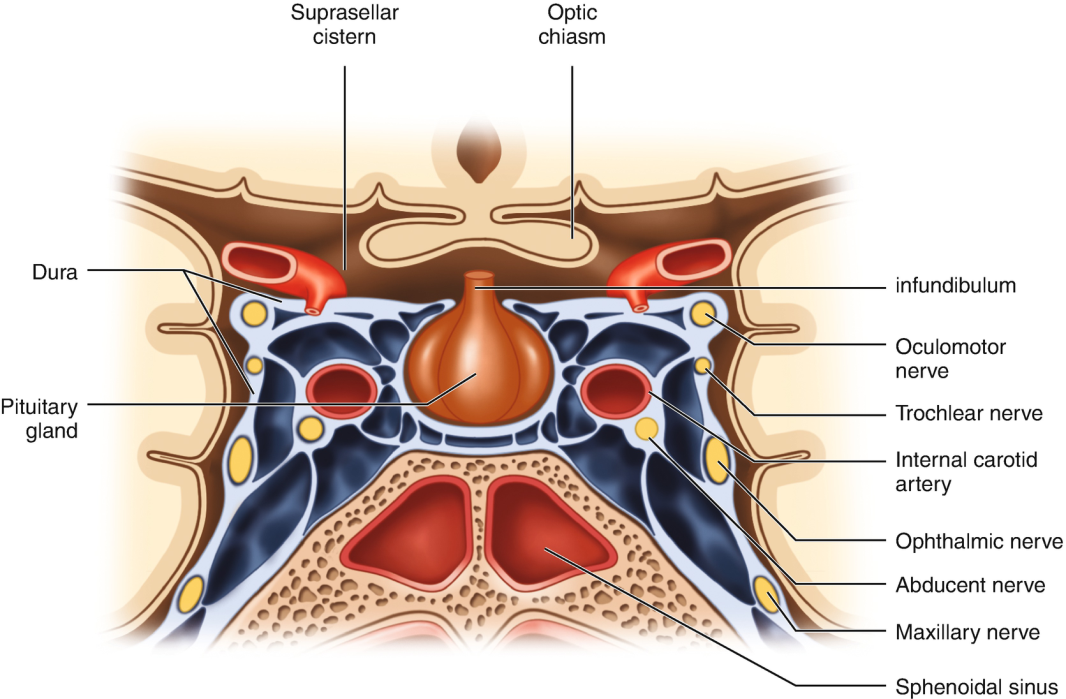
**Trigeminal nerve**

Finally, two of the three branches of the [trigeminal nerve (CN V)](https://www.kenhub.com/en/library/anatomy/the-trigeminal-nerve) pass through the cavernous sinus. Prior to entering the cavernous sinus, the proximal portion of the nerve lies in Meckel’s cave, where it forms the trigeminal ganglion. After leaving the cave, the [mandibular division (CN V3)](https://www.kenhub.com/en/library/anatomy/the-mandibular-branch-of-the-trigeminal-nerve) courses inferiorly to pass through foramen ovale (without entering the cavernous sinus).

The other two branches, the [ophthalmic](https://www.kenhub.com/en/library/anatomy/the-ophthalmic-branch-of-the-trigeminal-nerve) and the [maxillary](https://www.kenhub.com/en/library/anatomy/the-maxillary-branch-of-the-trigeminal-nerve) (CN V1 and CN V2, respectively), travel through the lateral wall of the sinus. Both take courses inferior to CN III and CN IV, however, CN V2 is the most inferior of them all. Both CN V branches in the sinus travels horizontally. CN V2 leaves the sinus via foramen rotundum, while the three branches of CN V1 exit the cranial fossa via the superior orbital fissure. CN V1 and CN V2 are purely sensory and supply specific regions of the face.

**Relations**

There are numerous structures surrounding the cavernous sinus that are noteworthy. Medially, the sinus is adjacent to the lateral walls of the pituitary fossa with the pituitary gland, the sphenoid bone and its air sinus. The cerebral part of the internal carotid artery courses superiorly. Laterally, the medial aspect of the temporal lobe of each hemisphere lies adjacent to the sinus. And posteriosuperiorly, the uncus of the [temporal lobe](https://www.kenhub.com/en/library/anatomy/topography-of-the-cerebral-hemispheres) has a relation to the sinus.



**Communications**

The cavernous sinus is an unconventional venous system in the sense that it does not have a unidirectional flow of blood. Owing to the fact that there are no valves in the sinus and its connected veins, the direction of blood flow is dependent on venous pressure. The veins that communicate with the cavernous sinus are:

* Superior ophthalmic vein
* Inferior ophthalmic vein
* Superficial middle cerebral vein
* Middle meningeal vein
* Hypophyseal veins
* **Superior ophthalmic vein**

The cavernous sinus generally has five venous tributaries. The superior ophthalmic vein receives blood from the ethmoidal, nasofrontal, vorticose (drains the ocular choroid), and central retinal veins. It drains into the anterior part of the sinus via the superior orbital fissure.

* **Inferior ophthalmic vein**

The inferior ophthalmic vein collects blood from the eyelids, lacrimal sac, and some vorticose contributions, as well as the anterior floor and medial wall of the orbit. In addition to draining to the cavernous sinus, it also drains to the pterygoid plexus.

* **Superficial middle cerebral vein**

At the point where the internal carotid artery emerges, the superficial middle cerebral vein pierces the roof of the sinus. Here, it drains blood from the cortices that are adjacent to it as it courses through the lateral sulcus.

* **Middle meningeal vein**

Finally, branches of the middle meningeal vein may join the sphenoparietal sinus on its way to the cavernous sinus. Before piercing the roof of the sinus, it travels along the edge of the lesser wing of the sphenoid between the layers of dura mater.

* **Hypophyseal veins**

Additionally, efferent hypophyseal veins of both the adenohypophysis and neurohypophysis drain to the cavernous sinus.

**Intercavernous sinuses and drainage**

The left and right cavernous sinuses communicate by way of the anterior and posterior intercavernous sinuses. These vessels travel anteriorly and posteriorly (respectively) around the infundibulum of the pituitary gland, deep to the diaphragma sellae, between the layers of dura mater.

The cavernous sinus in turn drains to the superior and inferior petrosal sinuses. Both sinuses join the sigmoid sinus, which then becomes the internal jugular vein. The internal jugular vein meets with the subclavian vein to become the left (or right) [brachiocephalic vein](https://www.kenhub.com/en/library/anatomy/brachiocephalic-veins).

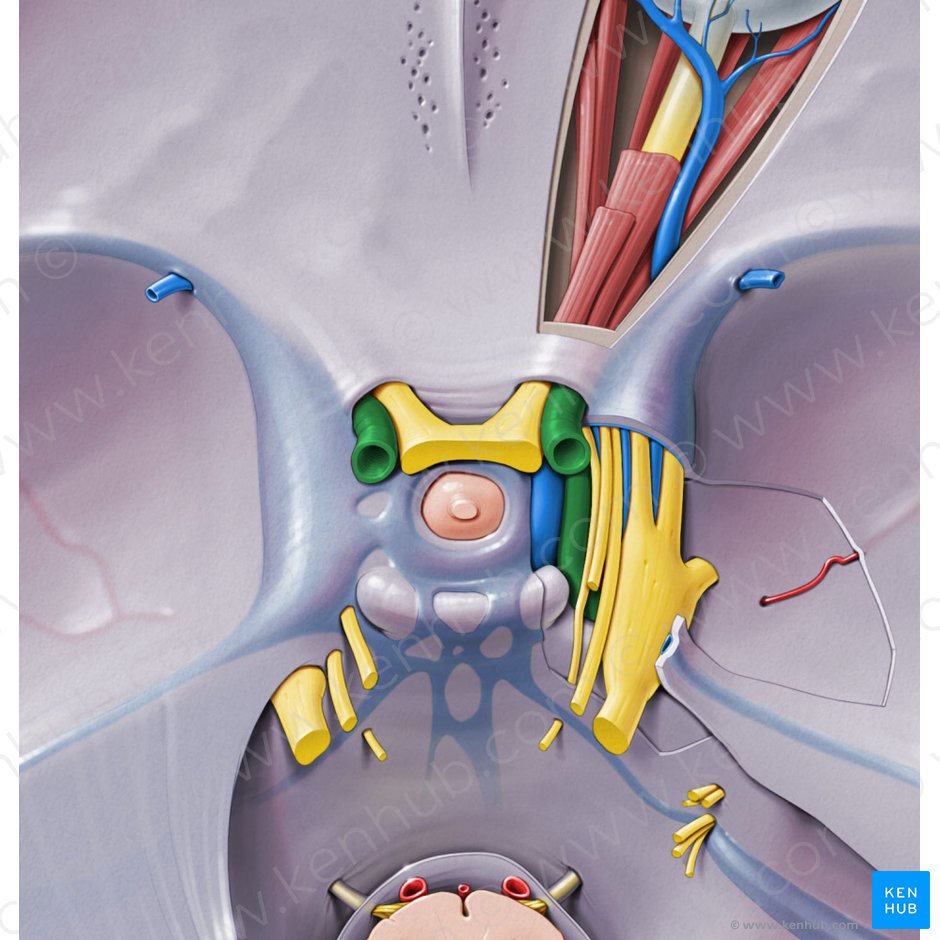
**Clinical significance**

* **Carotid-cavernous fistula**

Head trauma resulting in rupture of the cavernous part of the internal carotid artery can produce what is known as a carotid-cavernous fistula. A pulsating exophthalmos can result as the venous pressure in the sinus would increase and reverse the flow of blood in the ophthalmic veins.

* **Cavernous sinus thrombosis**

The sinus also has communicating branches from the sin of the face. Particularly in the ‘danger area’ (at the nasolabial crease and at the crease between the ala of the nose and the cheek), an infection can spread to the cavernous sinus, which can result in a cavernous sinus thrombosis. This condition can result in internal strabismus (crossed [eyes](https://www.kenhub.com/en/library/anatomy/eye-anatomy)) if the CN VI is damaged, doubled vision while looking downward if CN IV was damaged, or ophthalmoplegia (paralysis or weakness in muscles of movement of the eye).



**Discuss the walls of the nose**

The nasal cavity has a roof, floor, medial wall and lateral wall.

**The roof**: is curved and narrow, except at its posterior end and it is divided into 3 parts. They are named from the bones forming each part.

* frontonasal
* ethmoidal
* sphenoidal .

**The floor**: is wider than the roof and is formed by the palatine processes of the maxilla and the horizontal plates of the palatine bone.

**The medial wall**: formed by the nasal septum

**The lateral walls**: are irregular owing to three bony plates, the nasal conchae, which project inferiorly, somewhat like louvers

**The Medial Wall/ Nasal Septum**

It divides the chamber of the nose into two nasal cavities. It has a bony part and a soft mobile cartilaginous part. The components of the nasal septum are:

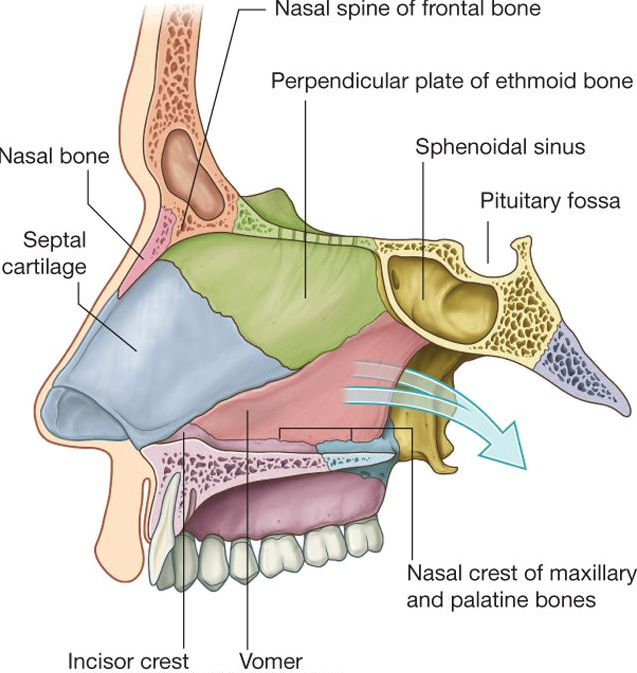
* perpendicular plate of the ethmoid bone
* Vomer bone
* septal cartilage
* nasal crest of the maxillary bone
* nasal crest of palatine bone

The perpendicular plate of ethmoid, vomer, nasal crests of maxillary and palatine bones form the bony part of nasal septum while the septal cartilage forms the cartilagenous part

**The thin perpendicular plate of the ethmoid bone**: forming the superior part of the nasal septum descends from the cribriform plate and is continued superior to this plate as the crista galli which is seen in the anterior cranial fossa.

**The vomer**: a thin flat bone, forms the posteroinferior part of the nasal septum, with some contribution from the nasal crests of the maxillary and palatine bones.

The septal cartilage has a tongue-and-groove articulation with the edges of the bony septum.



**Lateral wall**

We can find 3 types of nasal conchae in the nasal cavity. Those are:

* Inferior nasal concha. It is the longest and broadest of the conchae and is formed by an independent bone (of the same name, inferior concha). The concha is covered by a mucous membrane that contains large vascular spaces and is one of the three that work to both humidify and clear the air that passes into the nasopharynx.
* Superior and middle nasal conchae arise from the perpendicular plate of the ethmoid bone. The middle nasal concha is found in between the superior and [inferior nasal concha](https://www.kenhub.com/en/library/anatomy/inferior-nasal-concha) and plays a role in humidifying and clearing inspired air of micro-particles such as dirt. The superior nasal concha is a bony shelf located above the middle nasal concha and below the sphenoethmoidal recess. Similar to the middle nasal concha the superior concha is itself part of the ethmoid bone.

**Associated structures**

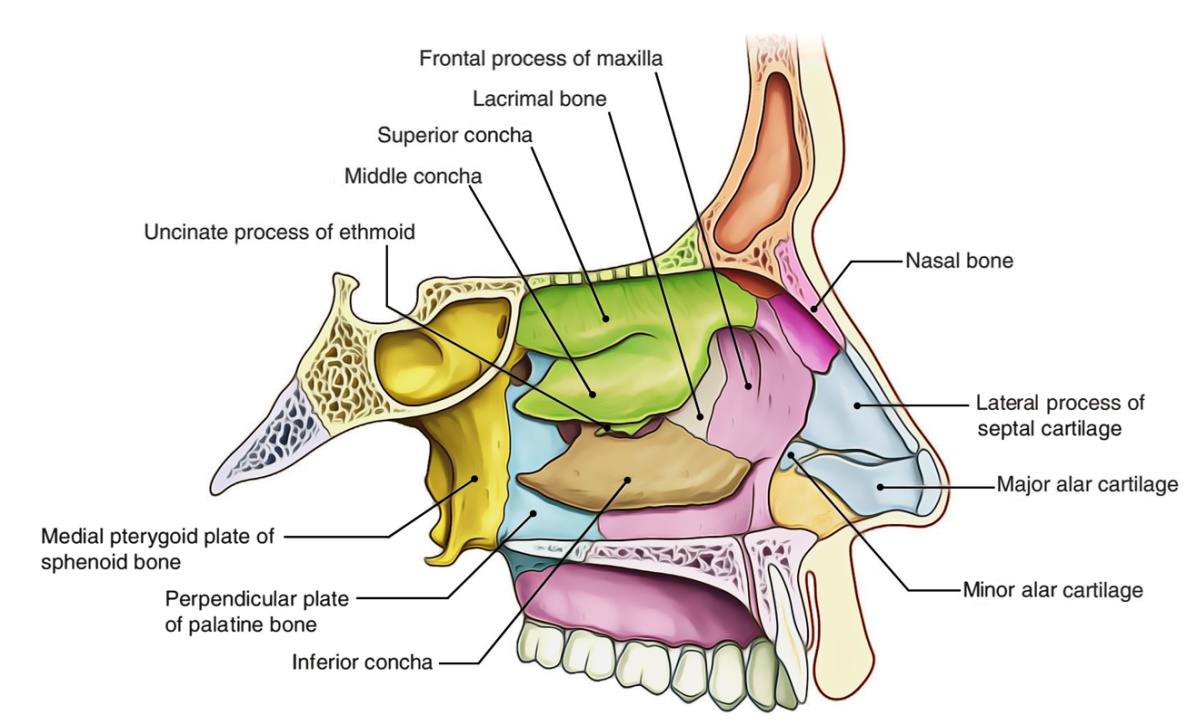
* Sphenopalatine foramen (Foramen sphenopalatinum): The sphenopalatine foramen is found in the posterior most region of the nasal cavity, at the back of the middle meatus. The foramen is formed by the processes on the superior border of the [palatine bone](https://www.kenhub.com/en/library/anatomy/the-palatine-bone), and the under surface of the sphenoidal body, which form a foramen. It connects the nasal cavity to the pterygopalatine fossa, and thus transmits the sphenopalatine artery and vein as well as the superior nasal and nasopalatine nerves.
* The medial plate of the pterygoid process is an inferior projection of the [sphenoid bone](https://www.kenhub.com/en/library/anatomy/the-sphenoid-bone). The plate forms a laterally pointing hook like process at its most inferior point, known as the pterygoid hamulus. The tensor veli palatine muscle glides around this structure. The lateral surface of the medial plate forms the medial border of the pterygoid fossa, and the medial surface forms the lateral boundary of the choana of the adjacent nasal cavity.
* **Limen nasi**

The limen nasi is approximately 10mm in length and is defined as the boundary between the nasal cavity proper and the vestibule. It is relatively wide and superficial anteriorly but gradually narrows as it extends posteriorly towards the anterior region of the middle concha. It lies upon the upper edge of the lateral crus of the greater alar cartilage and detached pieces of cartilage may take part in its formation.

* The inferior nasal meatus lies beneath the inferior nasal concha and the lateral nasal wall. It is broader in front than behind and extends the entire length of the lateral wall of the nose and the anterior third contains the termination of the nasolacrimal or ‘tear’duct. This opening is covered by a mucosal valve known as Hassner’s valve. The middle nasal meatus is located above the inferior and below the middle nasal concha. It is also part of the ethmoidal complex as it drains the maxillary, frontal and anterior ethmoidal sinuses. The superior meatus is located below the superior nasal concha and drains the posterior ethmoidal air cells.
* **Sphenoethmoidal recess (Recessus sphenoethmoidalis)**

The sphenoethmoidal recess is a small cleft like pocket located above the superior nasal concha and drains the sphenoid sinus. The sphenoethmoidal recess is a space found superior to the superior turbinate bone and drains the sphenoidal sinus as well as some of the ethmoidal sinuses. The frontal sinuses are situated between the brow ridges and lie between the two layers of the [frontal bone](https://www.kenhub.com/en/library/anatomy/the-frontal-bone). They are unlikely to be symmetrical and are not usually involved in sinusitis.

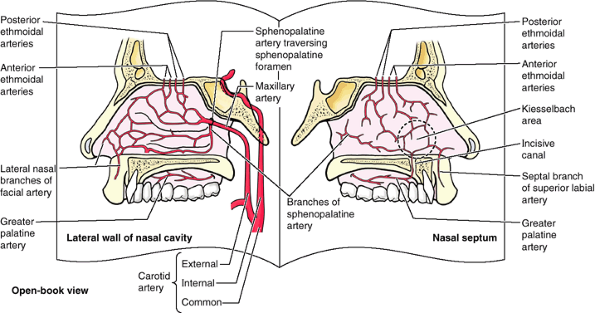
* The sphenoidal sinus is contained within the body of the sphenoid bone itself. There is a great deal of variation in the shape and size of this sinus between individuals. The sinus drains into the sphenoethmoidal recess which is located superior to the choana. The main expansion of their size occurs during puberty and they perform a similar function to the other sinuses.
* The nasal vestibule is the visible part of the internal nasal cavity from an external view. The vestibule is maintained by the greater and lesser alar cartilages and contains small hairs which trap dirt and small particles during inspiration. The vestibules are lined by stratified squamous [epithelium](https://www.kenhub.com/en/library/anatomy/overview-and-types-of-epithelial-tissue), and are separate from the [nasal cavity](https://www.kenhub.com/en/library/anatomy/nasal-cavity) proper, which is lined with respiratory epithelium.



**The arterial supply**

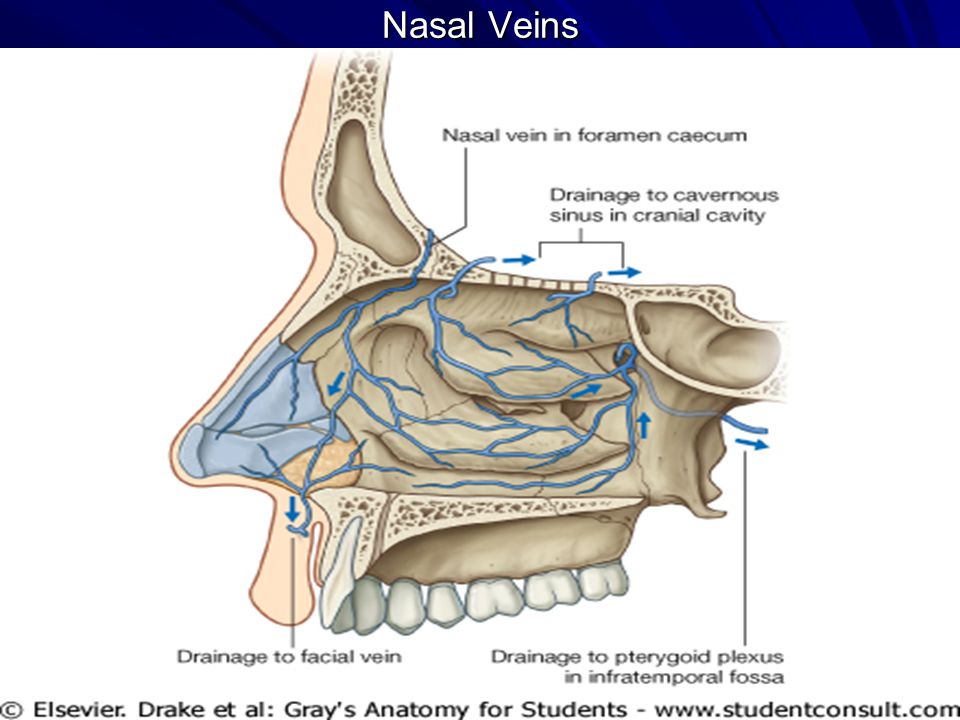
The arterial supply of the **medial** and **lateral walls** of the nasal cavity is from five sources:

* Anterior ethmoidal artery (from the ophthalmic artery)
* Posterior ethmoidal artery (from the ophthalmic artery)
* Sphenopalatine artery (from the maxillary artery)
* Greater palatine artery (from the maxillary artery)
* Septal branch of the superior labial artery (from the facial artery)
* The anterior part of the nasal septum is the site **(Kiesselbach area)** of an anastomotic arterial plexus involving all five arteries supplying the septum



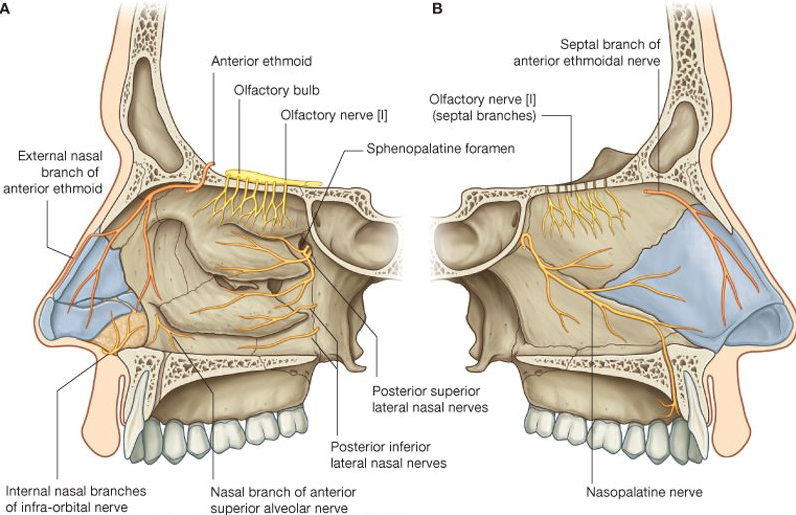
**Venous drainage**

A rich submucosal venous plexus deep to the nasal mucosa drains into the sphenopalatine, facial, and ophthalmic veins.



**Innervation**

* olfactory nerve
* branches of the ophthalmic [V1] which include the anterior and posterior ethmoidal nerves
* maxillary [V2] nerves which include;
* posterior superior lateral nasal nerves
* posterior superior medial nasal nerves
* nasopalatine nerve
* posterior inferior nasal nerves



**Clinical Correclate**

**Sinusitis**

Sinusitis is an inflammation of the different sinuses found in the head. That type of inflammation may result in different symptoms including:

* plugged nose;
* nasal mucus;
* pain in the facial region.

The [frontal bone](https://www.kenhub.com/en/library/anatomy/the-frontal-bone) overlies the frontal lobe of the brain and lies anteriorly forming the brow, forehead and one third of the anterior scalp. The bone contains the frontal sinus, which in sinusitis and nasal infections can become filled with fluid.

**Epistaxis**

Epistaxis (nosebleed) is relatively common because of the rich blood supply to the nasal mucosa. In most cases, the cause is trauma and the bleeding is from an area in the anterior third of the nose (Kiesselbach area). Epistaxis is also associated with infections and hypertension. Spurting of blood from the nose results from rupture of arteries. Mild epistaxis may also result from nose picking, which tears veins in the vestibule of the nose.

**Rhinitis**

The nasal mucosa becomes swollen and inflamed (rhinitis) during severe upper respiratory infections and allergic reactions (e.g., hayfever). Swelling of the mucosa occurs readily because of its vascularity.