HEAD AND NECK ASSIGNMENT 2

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DEPARTMENT: MEDICINE AND SURGERY

LEVEL: 300

Question 1

Write an essay on the cavernous sinus

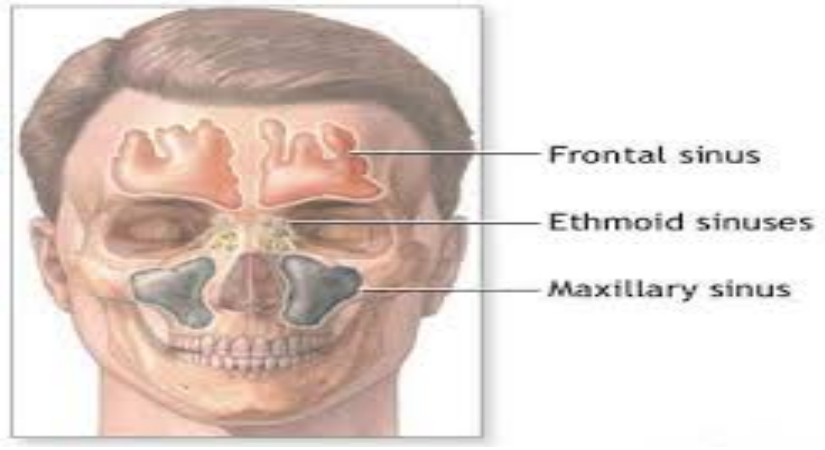
Introduction

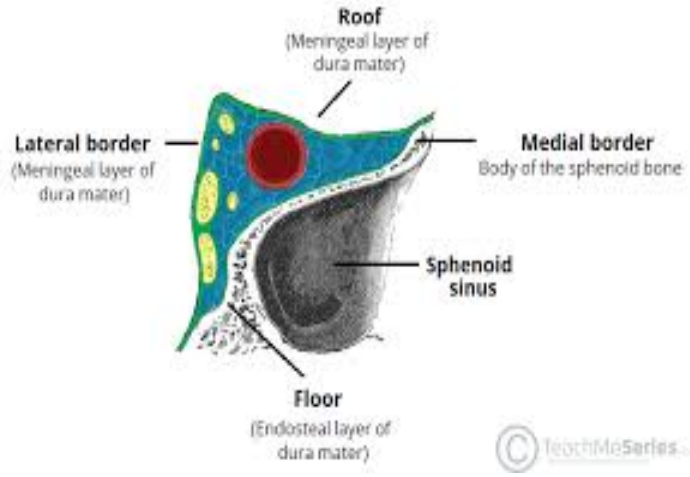
The cavernous sinus is part of the brain's dural venous sinus and contains multiple neuro-vasculatures.

It is situated bilaterally to the sella turcica and extends from the superior orbital fissure anteriorly to the petrous part of the temporal bone posteriorly, and is about 1 cm wide and 2 cm long.

The venous blood that flows to the cavernous sinus is from the superior and anterior ophthalmic veins, superficial middle cerebral vein, and sphenoparietal sinus.

The communication between the left and right cavernous sinuses is made by the intercavernous sinuses anterior and posterior to the infundibulum of the pituitary gland (Ipsalali et al., 2019; Ngnitewe et al., 2019; Graffeo et al., 2017)





Structure and function

The cavernous sinus works as a conduit.

Cranial nerves leaving the brainstem travel through the cavernous sinus before entering the orbit to innervate extraocular and intrinsic eye muscles.

Also, different venous tributaries drain into the cavernous sinus. The superior ophthalmic vein collects venous blood from the ethmoidal, vorticose, central retinal, and nasofrontal veins before draining into the anterior part of the cavernous sinus through the superior orbital fissure.

The inferior ophthalmic vein, on the other hand, receives blood from the lacrimal sac, eyelids, the inferior rectus and inferior oblique muscles, the vorticose vein, and from the anterior and medial wall of the orbit. It then runs posteriorly toward the lower part of the orbit and divides into two branches.

One of these branches joins the cavernous sinus, while the other one drains into the pterygoid plexus.

The superficial middle cerebral originates on the lateral surface of the hemisphere, runs in the lateral sulcus, and drains most of the temporal lobe into the cavernous sinus.

The sphenoparietal sinus receives blood from some branches of the middle meningeal vein before draining into the cavernous sinus. Efferent hypophyseal veins also drain into the cavernous sinus.

After collecting venous blood from these different veins, the cavernous sinus drains to the superior and inferior petrosal sinuses, which then join the sigmoid sinus to form the internal jugular vein. The internal jugular vein exits the brain through the jugular foramen and connects with the subclavian vein to become the right or left brachiocephalic vein (Patel et al., 2016; Klinger et al., 2013; Park et al., 2015.

Embryology

Most of the cavernous sinus is formed before birth.

It first emerges as a collection of small venous canals consisting of only an endothelial layer.

Throughout gestation, these canals gradually expand to form larger structures.

After 13 weeks of gestation, the cavernous sinus appears as a faint cluster of small vessels, whereas after 27 weeks of gestation, the inferior venous pathways suddenly increase in size.

Blood supply

The common carotid artery bifurcates in the cervical region and gives rise to the external and internal carotid artery.

The internal carotid artery travels superiorly and enters the skull via the carotid canal. On entering the carotid canal, the internal carotid makes a 90 -degree turn and travels horizontally in the petrous part of the temporal bone - this is the petrous part of the internal carotid artery.

The petrous part of the internal carotid then enters the cavernous sinus via the foramen lacerum.

In the cavernous sinus, the internal carotid artery is also referred to as the cavernous part. The cavernous part travels horizontally and anteriorly until it reaches the anterior limit of the sinus, where it curves vertically, exits the sinus superiorly, and becomes the cerebral part of the internal carotid artery.

It is important to mention that the cavernous part of the internal carotid artery is the only artery in the body that is surrounded completely by venous blood.

Nerve supply

The nerves of the cavernous sinus are the oculomotor nerve (CN III), trochlear nerve (CN IV), ophthalmic nerve (V1), maxillary nerve (V2), abducens nerve (CN VI), and the sympathetic plexus around the internal carotid artery.

The CN III exits the midbrain ventrally at the interpeduncular fossa, pierces the dura, and enters the cavernous sinus, where it runs on the roof and lateral wall. After exiting the cavernous sinus, it goes through the superior

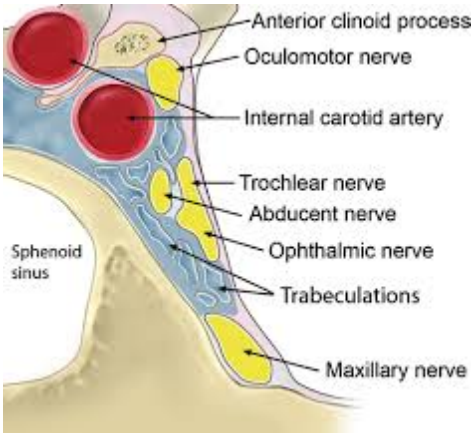
orbital fossa. Within the superior orbital fossa, it splits into the superior and inferior division.

The CN IV is the only nerve exiting the midbrain dorsally. It originates from the trochlear nerve nucleus; it crosses the midline and emerges inferior to the inferior colliculus, situated in the posterior part of the midbrain. It then travels anteriorly around the midbrain, pierces and enters the dura mater near the tentorium cerebelli, and continues its course in the lateral wall of the cavernous sinus. After exiting the cavernous sinus, it enters the orbit through the superior orbital fissure to innervate the superior oblique muscle.

The ophthalmic nerve (V1) and the maxillary nerve (V2) are divisions of the trigeminal nerve (CN V). The CN V exits the brainstem from the ventrolateral pons and enters the Meckel's cave, where the trigeminal ganglion lies. The V1 branches of the trigeminal ganglion pass through the inferior part of the cavernous sinus and after exiting the cavernous sinus, they enter the orbit via the superior orbital fissure. Also, the V2 branches of the trigeminal ganglion enter the cavernous sinus and exit the skull via the foramen rotundum.

The CN VI exits the brainstem ventrally at the pontomedullary junction, pierces the dura, and travels the longest intracranial distance of all the cranial nerves. After its long intracranial course, it enters the cavernous sinus, where it is surrounded by venous blood, like the internal carotid artery.

The sympathetic plexus around the internal carotid artery originates from the superior cervical ganglion, travels with the internal carotid artery, enters the skull through the carotid canal, and enters the cavernous sinus through the jugular foramen. Within the cavernous sinus, it gives sympathetic fibers to the CN III and V1.



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Clinical anatomy

Cavernous Sinus Syndrome

Cavernous sinus syndrome is a medical emergency and life-threatening disorder that presents with different symptoms depending on what structure is affected.

A severe lesion involving the entire sinus will present with total ophthalmoplegia, due to CN III, IV, and VI injury, accompanied with fixed and dilated pupils due to compression of the superficial parasympathetic fibers of the CN III.

Cavernous sinus syndrome can lead to Horner's syndrome. Horner's syndrome occurs when the sympathetic plexus around the internal carotid is damaged.

When CN V1 and CN V2 are involved, sensory loss in the face, scalp, maxilla, nasal cavity, sinuses, and palate occurs.

There are several causes of cavernous sinus syndrome, including metastatic tumor, meningioma, pituitary tumor, extension of nasopharyngeal tumors, granulomatous diseases, cavernous sinus thrombosis, and aneurysms of the cavernous part of the internal carotid artery.

In case of rupture of a cavernous aneurysm, a carotid-cavernous fistula is created, leading to a pulsating exophthalmos on physical examination.

Facial veins and implication to cavernous sinus infection

Blood from the medial angle of the eye, lips, and nose usually drain via the facial vein.

However, blood from these parts may also drain superiorly through the facial vein, to the superior ophthalmic, to the cavernous sinus. By doing so, it provides a pathway for infections from the face to spread to the cavernous sinus and from the sinus to the brain.

Another way for infections to spread from the face to the brain is via the inferior ophthalmic vein.

The inferior ophthalmic vein communicates with the pterygoid plexus of veins, and the pterygoid plexus communicates with the cavernous sinus via the emissary's vein.

Gravity dictates the blood flow from the cavernous sinus to the pterygoid plexus; however, in the case of inflammation or obstruction, the pressure gradient can be reversed. Because there are no valves in the brain's venous sinus, blood will flow from the pterygoid plexus to the cavernous sinus carrying bacteria with it.

Question 2

Discuss the walls of the nose

Introduction

The walls of the nose are formed by the nasal cavities.

The nasal cavity is a large air-filled space above and behind the nose in the middle of the face.

The nasal septum divides the cavity into two (2) cavities.

The role of the nasal cavity is to humidify and warm the inspired air.

Also, as the air passes through, the nasal cavity removes minute airborne particles and other debris before the air reaches the lower airways. It also traps pathogens.

Columnar epithelium lines the nasal cavity.

This type of epithelial lining also secretes mucus that coats the lining and helps with the mucociliary clearance of minute aerosolized particles that become trapped in the nasal mucosa.

The nasal cavity also functions to facilitate drainage for the secretions from the adjacent paranasal sinuses.

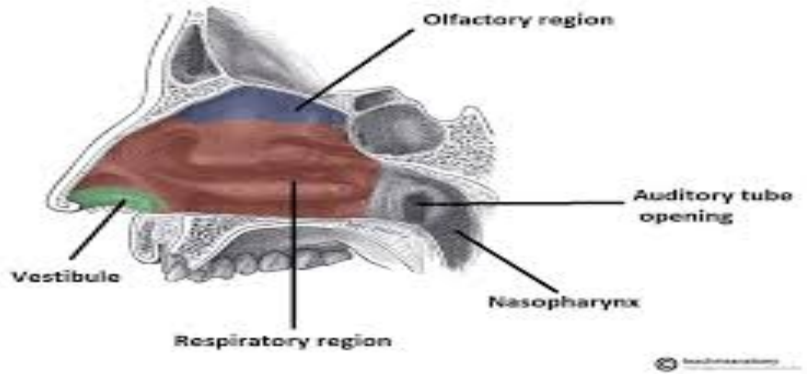
It also captures the odour bearing particles and transmits them to the olfactory recesses that are in the superior portion of the nasal cavity, just medial to the superior turbinates.

Air containing mucosal lined sinuses surround the nasal cavity, which include the frontal, paired maxillary, sphenoid, and ethmoid sinuses. These cavities directly communicate with the nasal cavity. The secretions from these sinuses drain into the nasal cavity via the thin-walled ostia.

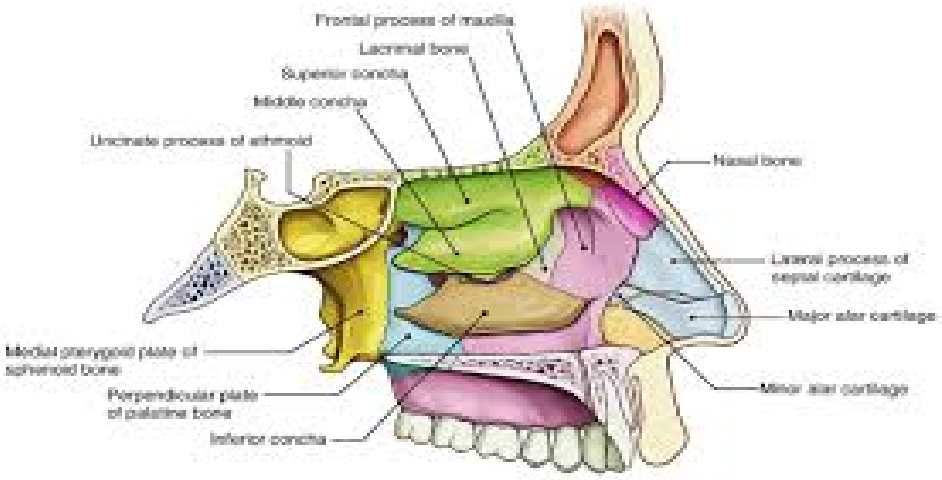
The wall lining of the sinuses also secretes mucus. The cilia on the surface sweep the mucus in a carpet like fashion and move them towards the nasal ostia.

The hard palate lines the floor of the nasal cavity.

The lateral walls are spiral shaped mucosal folds that overlie the turbinates and sinus ducts draining into the ostia. The spiral shape of the turbinates is designed to increase the surface area for the inspired air.



Segments



Respiratory region

The respiratory region functions to humidify, warm, filter, protect, and eliminate debris.

Covered in respiratory epithelium and mucous cells, this is the most substantial part of the nasal cavity.

As air traverses through the nasal cavity, it warms to body temperature and

reaches near one hundred percent humidity.

The neurovascular supply of this region aids this. It regulates the nasal airflow by controlling the blood volume in the erectile tissue on the inferior turbinate and anterior septum.

Under normal conditions, this tissue is continuously stimulated by sympathetic signals via the superior cervical ganglia to keep the nasal cavity uncongested.

Particles that get past the nasal vestibule then become trapped in the mucosa of the nasal cavity. When this occurs, the mucociliary system helps get rid of these particles.

The ciliated pseudostratified columnar epithelium sweeps particles at a rate of one centimeter per minute into the nasopharynx for further expulsion.

The mucus of the nasal cavity forms a protective barrier to inhaled pathogens. The components of the mucus that actively protect the host are immunoglobulin A, lysozymes, and lactoferrin (Oneal et al., 1999; Patel, 2017; Lafci & Andaloro, 2018).

Olfactory segment

Olfaction requires orthonasal or retronasal airflow to transport odor-bearing particles up to the olfactory epithelium located at the apex of the nasal cavity.

As odorants become trapped in the mucus, it binds to odorant binding proteins that concentrate and help solubilize the particles. The particles are then attached to olfactory receptors on cilia that transmit specific signals up through the cribriform plate to synapse with neurons of the olfactory bulb, which then sends signals through the olfactory nerve (CNI) into the secondary neurons for higher processing before entering the brain.

A unique feature of the olfactory receptors is that a single receptor cell can detect only one odorant type and cannot regenerate (Oneal et al., 1999; Patel, 2017; Lafci & Andaloro, 2018).

Nasal vestibule

The nasal vestibule is the first area encountered as you move posteriorly through the anterior nares, also known as the nostrils or external nasal valve.

The first half of the vestibule has a covering of keratinized stratified squamous epithelium that contains coarse hairs called vibrissae.

These hairs filter inhaled particles. The covering of the second half of the vestibule is in respiratory epithelium, pseudostratified ciliated columnar epithelium (Oneal et al., 1999; Patel, 2017; Lafci & Andaloro, 2018).

- Lateral: lateral crus of the lower lateral cartilage (LLC) and fibrofatty alar tissue
- Medial: medial crus of the LLC and septal cartilage
- Posterior: limen naris

The roof of the nasal cavity

The mucosa of the roof of the nasal cavity contains perforations that communicate with the cribriform plate. Within these perforations are the olfactory axons (Oneal et al., 1999).

- Anterior: nasal spine of the frontal bone and nasal bone
- Posterior: cribriform plate of the ethmoid and the body of the sphenoid

The floor of the nasal cavity

The floor of the nasal cavity is broader than that of the roof (Oneal et al., 1999).

- Anterior: the palatine process of the maxilla
- Posterior: horizontal plate of the palatine bone

Incisive Canal

This canal is located in the floor of the nasal cavity, posterior to the central incisor, and lateral to the nasal septum.

This structure transmits the nasopalatine nerve into the oral cavity and the greater palatine artery into the nasal cavity (Oneal et al., 1999).

Nasal Septum

The nasal septum partitions the nasal cavity into two equal but separate compartments.

Cartilage and bone comprise the nasal septum.

It is covered by squamous epithelium, which differs from the lateral walls of the nasal cavity.

A portion of the anterior septum is covered in erectile tissue. It also contributes to lateral projections called the upper lateral cartilages, which makes up the middle third of the nose.

The bony segment of the septum is pneumatized, and when it over expands, it has the potential to obstruct airflow.

Below are the components of the septum (Oneal et al., 1999).

Quadrangular (septal) cartilage: This is the most anterior portion of the septum. It contains the Kiesselbach plexus (Converse, 1955).

Attachments:

- Superior: nasal bone
- Inferior: anterior nasal spine of the maxilla
- Posterior-Superior: perpendicular plate of the ethmoid
- Posterior-Inferior: vomer and maxillary crest

Perpendicular Plate of the Ethmoid: This is a vertical projection from the cribriform plate of the ethmoid inferiorly to the septal cartilage (AlJulaih & Lasrado, 2019).

Vomer: Located inferior and slightly posterior to the perpendicular plate of the ethmoid. It is attached inferiorly to the nasal crest of the maxilla and palatine bone (AlJulaih & Lasrado, 2019).

Nasal Crest of the Maxilla and Palatine Bone: Together these bones form the inferior support for the septal cartilage (AlJulaih & Lasrado, 2019)

Anterior Nasal Spine of the Maxilla: This is a bony projection formed by the paired maxillary bones. It located anterior to the piriform aperture and are palpable at the superior portion of the philtrum of the upper lip (AlJulaih & Lasrado, 2019).

Lateral Wall of the Nasal Cavity

The nasal cavity's lateral wall has three medially projecting inferiorly curved

bones called conchae. The middle and superior conchae are part of the ethmoid bone, whereas the inferior concha is a separate bone altogether. There is a normal variant called the supreme conchae. These conchae, when covered by mucosa, are termed turbinates. The turbinates augment the surface area of the nasal cavity to aid in its functions of humidifying, warming, and humidifying the air. The turbinates create four channels. Three of these channels are termed meatuses, and the fourth is the sphenoethmoidal recess (Oneal et al., 1999; Capello & Dublin, 2018; AlJulaih & Lasrado, 2019; Galarza-Paez & Downs, 2018).

Bones of the lateral wall:

- Ethmoid bone
- Perpendicular plate of the palatine bone
- The medial plate of the pterygoid process of the sphenoid bone
- Medial surface of the lacrimal and maxillary bones
- Inferior concha

Sphenoethmoidal Recess: Located superior to the superior turbinate and inferior to the nasal cavity roof, which is the drainage site of the sphenoid sinus (Oneal et al., 1999; Capello & Dublin, 2018; AlJulaih & Lasrado, 2019; Galarza-Paez & Downs, 2018).

Meatuses

- Superior Meatus: located inferior to the superior turbinate and superior to the middle turbinate; this is the drainage site of the posterior ethmoid sinus.
- Middle Meatus: located inferior to the middle turbinate and superior to the inferior turbinate - there are several structures within this meatus. This is the drainage site of the frontal, anterior ethmoid, and maxillary sinuses.
- Inferior Meatus: Located inferior to the inferior turbinate and superior to the floor of the nasal cavity. The nasolacrimal duct drains tears from the lacrimal sac at the medial aspect of the eye into the anterior portion of this meatus via Hasner's valve (Oneal et al., 1999; Capello & Dublin, 2018; AlJulaih & Lasrado, 2019; Galarza-Paez & Downs, 2018).

Limen Naris: The limen naris is a mucosal ridge that signifies the posterior boundary of the nasal vestibule and the anterior boundary of the nasal cavity proper (Oneal et al., 1999; Capello & Dublin, 2018; AlJulaih & Lasrado,

2019; Galarza-Paez & Downs, 2018).

Agger Nasi Cells: These cells are the most anterior portion of the anterior ethmoid air cells. They are located anterior and superior to the basal lamella, most anterior attachment to the lateral wall, of the middle turbinate to create the anterior aspect of the frontal recess (Oneal et al., 1999; Capello & Dublin, 2018; AlJulaih & Lasrado, 2019; Galarza-Paez & Downs, 2018).

Frontal Recess: Located between the posterior wall of the agger nasi cells and the middle turbinate ((Oneal et al., 1999; Capello & Dublin, 2018; AlJulaih & Lasrado, 2019; Galarza-Paez & Downs, 2018).

Uncinate Process of the Ethmoid: This is a thin crescent-shaped bone that is part of the ethmoid bone. It is attached to the lacrimal bone anteriorly, the inferior turbinate inferiorly and superiorly to the lamina papyracea. This structure protects the sinuses of the infundibulum from inhaled foreign particles (Oneal et al., 1999; Capello & Dublin, 2018; AlJulaih & Lasrado, 2019; Galarza-Paez & Downs, 2018).

Lamina Papyracea: This thin bone is the separation between the orbit and the ethmoid air cells (Oneal et al., 1999; Capello & Dublin, 2018; AlJulaih & Lasrado, 2019; Galarza-Paez & Downs, 2018).

Ethmoid Infundibulum: This is a pyramidal shaped channel located at the anterior portion of the semilunar hiatus that drains the maxillary, anterior ethmoid, and frontal sinuses.

Semilunar Hiatus: Located between the uncinate process anteriorly and the ethmoid bulla posteriorly, this is a space that empties the ethmoid infundibulum.

Ethmoid Bulla: Located just anterior to the semilunar hiatus and superior to the ethmoid infundibulum, which is where the middle ethmoidal air cells open into the nasal cavity.

Ostiomeatal Complex (OMC): This is an area located lateral to the middle turbinate that houses the ostia of the lateral wall sinuses; frontal, maxillary, and anterior/middle ethmoid sinuses.

Sphenopalatine Foramen: This foramen connects the nasal cavity to the pterygopalatine fossa and is posterior to the middle turbinate in the posterior portion of the superior meatus. The significant content of this foramen is:

- Sphenopalatine artery of the maxillary artery
- Nasopalatine branch of the maxillary nerve of the trigeminal nerve

(CNV2)

- Posterior superior lateral nasal nerves of CNV2

Choanae

The choanae are also known as posterior nasal apertures. It is the posterior boundary of the nasal cavity proper. It opens into the nasopharynx.

- Superior: the body of the sphenoid bone
- Inferior: horizontal plate of the palatine bone
- Lateral: the medial pterygoid process of the sphenoid bone
- Medial: vomer

Internal Nasal Valve (INV)

The INV is the narrowest portion of the nasal cavity and constitutes the area of highest resistance to airflow, which causes an increase in the acceleration of airflow. Without proper support, this increased airflow causes a decrease in intraluminal pressure, which ultimately causes the INV to collapse; this is Bernoulli's principle of flow. The average cross-sectional area of the INV in adults is around 0.73 square centimeters. At the apex of the valve the ULC and, the nasal septum come together at an angle of 10 to 15 degrees (Haight & Cole, 1983).

- Superior: upper lateral cartilage (ULC/caudal edge)
- Inferior: nasal floor or hard palate
- Lateral: the anterior portion of the inferior turbinate
- Medial: nasal septum

Arterial Supply

The nasal cavity has an abundant supply of vasculature to aid in functions of warming and humidifying inhaled air.

It allows the mucosa to enlarge and shrink, under the influence of sympathetic innervation.

The arterial supply to the nose and nasal cavity originates from the internal and external carotid arteries (Widdicombe, 1997).

Internal Carotid Artery (ICA)

The primary branch off of the ICA that supplies the nasal cavity is the ophthalmic artery.

Coming off of the ophthalmic artery are the anterior and posterior ethmoid arteries, as well as the dorsal nasal artery.

The anterior ethmoid artery supplies the lateral nasal wall and the nasal septum. The posterior ethmoid artery supplies the superior turbinate and the nasal septum. The dorsal nasal artery supplies the dorsal aspect of the external nose (Oneal et al., 1999; Patel, 2017).

External Carotid Artery (ECA)

The ECA gives rise to the maxillary artery and the facial artery. These two significant arteries then branch into smaller vessels.

Maxillary Artery

The maxillary artery branches into the descending palatine artery that then travels through the pterygopalatine fossa down the palatine canal and then branches into the greater and lesser palatine arteries.

The greater palatine artery then enters the greater palatine foramen on the posterior aspect of the palate before traversing the palate anteriorly to enter the nasal cavity via the incisive canal.

It supplies the septum and the floor of the nasal cavity.

The sphenopalatine artery is a branch of the maxillary artery. It branches off of the maxillary artery near the pterygopalatine fossa where it then enters the lateral wall of the nasal cavity through the sphenopalatine foramen, located just posterior to the medial turbinate.

The sphenopalatine artery then branches into the posterior lateral nasal branches and the posterior septal branch. The posterior lateral branches supply the middle and inferior turbinates, while the posterior septal branch supplies the posterior septum (Oneal et al., 1999; Patel, 2017; MacArthur FJ, McGarry, 2017).

Facial Artery

The facial artery gives rise to the superior labial artery, the lateral nasal artery, and the angular artery.

The superior labial artery gives off an alar branch and a septal branch that supply the same structures as their name.

The lateral nasal artery supplies the alar cartilage on the external nose and also supplies the nasal vestibule. The angular artery supplies the external nasal tip, dorsum, and lateral wall (Oneal et al., 1999; Patel, 2017; MacArthur FJ, McGarry, 2017).

Kiesselbach's Plexus (Little's Area)

Kiesselbach's plexus is a vascular anastomosis between the anterior ethmoid artery, superior labial artery, greater palatine artery, and the terminal branch of the posterior septal branch of the sphenopalatine artery.

This vascular plexus is located in the anterior nasal septum and is the most common site of epistaxis (Krulewitz & Fix, 2019).

Woodruff's Plexus

Woodruff's plexus is a vascular anastomosis between the sphenopalatine artery and the ascending pharyngeal artery. Located on the lateral wall of the nasal cavity in the area posterior to the middle and inferior turbinates (Chiu et al., 2008).

Venous Drainage

The names of the veins that drain the nose and nasal cavity follow that of the arteries with which they pair.

The maxillary branches drain either into the cavernous sinus or the pterygoid plexus located in the infratemporal fossa.

The veins of the anterior nasal cavity drain into the facial vein. Of note, infections located between the oral commissure and nasal bridge, have the potential to become intracranial infections. These must be treated promptly to prevent the extension of infection.

Lymphatics

The anterior nasal cavity drains anteriorly to the face that then makes its way to the submandibular lymph nodes in level IB. The lymphatics of the posterior nasal cavity and paranasal sinuses drain into the upper cervical lymph nodes and retropharyngeal lymph nodes (Creighton et al., 2016; Pan et al., 2009).

Clinical anatomy

Juvenile Nasopharyngeal Angiofibroma (JNA):

JNA is the most common vascular mass found in the nasal cavity.

It is typically seen in adolescent males with recurrent epistaxis and even nasal obstruction.

The site it is encountered most often is the roof of the nasal cavity near the sphenopalatine foramen. This tumor is locally aggressive but it does not metastasize.

Choanal Atresia

Choanal atresia occurs due to the presence of the bucconasal membrane or neural crest cell migration into the posterior nasal cavity.

During development, the bucconasal membrane usually obliterates around the sixth week of gestation.

If neural crest cell migration is the origin of the atresia, it can form a bony, bony-membranous, or membranous obstruction, the most common being the mixed bony-membranous.

Choanal atresia can be a unilateral or bilateral obstruction.

Unilateral atresia is typically associated with a right-sided defect, and bilateral atresia is associated with CHARGE syndrome.

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