

RESPIRATORY SYSTEM

ANATOMY



Title: Sheet 2

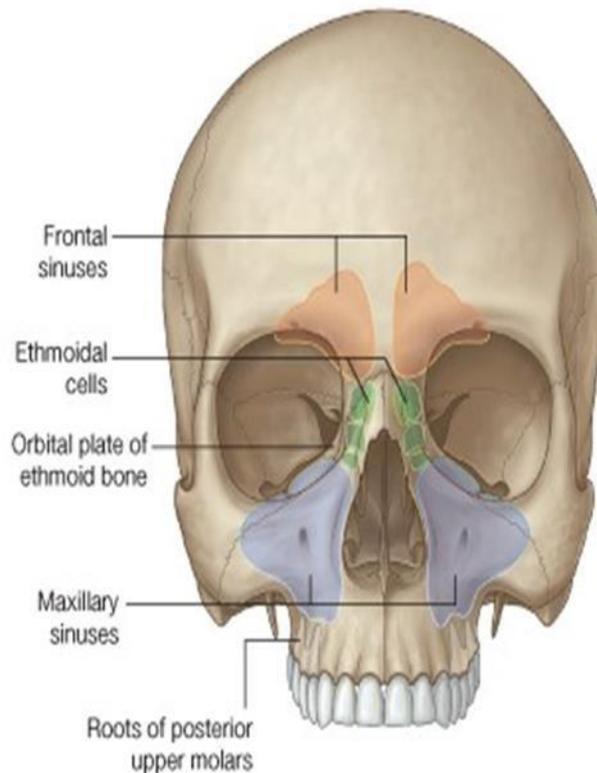
Writer: Nasser M. Abdelqader + Obada Froukh

Science: Nasser M. Abdelqader + Obada Froukh

Final: Dana Alnasra

Doctor:

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The paranasal sinuses are spaces inside some of the skull bones. They're all lined with respiratory mucosa which is **pseudostratified ciliated columnar epithelium**, but the mucosa here is thin.

- All sinuses open by ducts into the lateral wall of the nose.
- The innervation is branches from the **Trigeminal nerve** (the Trigeminal gives rise to three branches: ophthalmic, maxillary and mandibular).
- In the paranasal sinuses we're interested in the first two branches, the mandibular nerve doesn't innervate these sinuses.
- There are 6 ethmoidal sinuses, 2 sphenoidal sinuses, 2 maxillary sinuses, and 2 frontal sinuses.

Functions:

- 1- resonance of the voice.
- 2- decreased weight of the skull.

3- Protection (by moisturizing and modifying of the temperature and reduction of intracranial pressure).

Paranasal sinuses:

1- The **Frontal** air sinus is present in frontal bone and it is triangular in shape. (rudimentary at birth, but grows as the skull grow).

Drainage: frontonasal duct into infundibulum (a space in the middle hiatus)

Innervation: it is innervated by the supraorbital nerve, a branch of the ophthalmic nerve that passes through supraorbital foramen.

2- The **Ethmoidal** air sinuses/cells are three pairs of sinuses; anterior, middle and posterior (3 on the right and 3 on the left). Lying in the anterior cranial fossa.

each sinus represents one cell that has its own duct. The middle sinus is in the bulla ethmoidalis and opens into it. The anterior sinus opens in the anterior part of hiatus semilunaris and the posterior sinus opens in the superior meatus.

Nerve supply: Innervated by the anterior and posterior ethmoidal branches of nasociliary nerve, a branch of ophthalmic nerve

Ophthalmic nerve → nasociliary nerve → anterior and posterior ethmoidal nerves

3- The **Maxillary** sinus in maxilla. It is the largest sinus. It has bad drainage (because the duct is located high up) and opens in hiatus semilunaris posteriorly. It has apex and base. The apex is directed laterally, and the base is in the wall of nasal cavity.

It is innervated by the infraorbital and alveolar branches of the maxillary nerve.

Molars and premolars are directly inferior to the maxillary sinus.

Extraction of one of the upper molars will form a fistula between maxillary sinus and oral cavity, and if there is sinusitis, there would be discharge of the sinus content into the oral cavity which is bad.

Relations of the maxillary sinus:

above: orbit.

Below: upper molars and premolars.

Laterally: infratemporal fossa.

Medially: lower part of nasal cavity.

4-The **sphenoidal** sinuses in the body of the sphenoid bone.

The duct opens into the sphenoidal recess.

It is innervated by the posterior ethmoidal nerve of the ophthalmic nerve AND the orbital branches of the maxillary nerve.

Relations of the sphenoidal sinus:

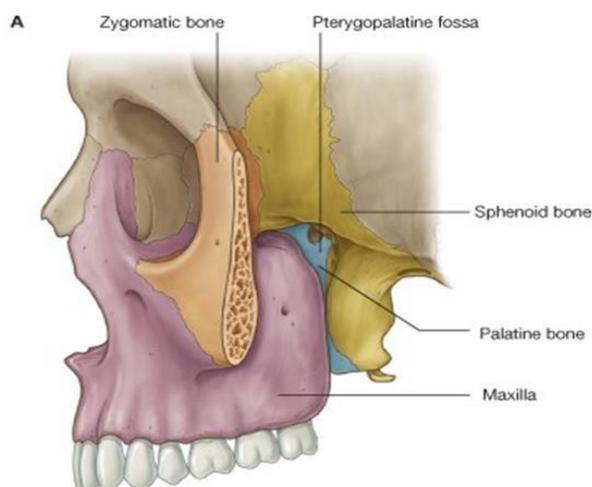
Above: the pituitary gland in the Sella turcica and the optic chiasma.

Note: If there is an invasive tumor in the pituitary gland, it causes changes in the underlying bone and compresses the sphenoidal sinus. (these changes can be observed in X-ray).

Laterally: the cavernous sinuses

Below and Infront: the nasal cavity.

The pterygopalatine fossa (sphenopalatine fossa):



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It is very important since all nerves and blood supply of the nose, nasopharynx and the orbit come from the pterygopalatine fossa.

It has a shape of an Inverted teardrop and it lies Between the bones on the lateral side of the skull.

The **walls** of the pterygopalatine fossa:

The **anterior** wall: is formed by the posterior surface of the maxilla.

The **medial** wall: is formed by the lateral surface of the palatine bone (there is a foramen in the palatine bone called Sphenopalatine foramen where sphenopalatine vessels and nerves pass).

The **posterior** wall: pterygoid plate (part of sphenoid bone).

The **roof**: is formed by greater wing of sphenoid bone.

The **Lateral** wall: formed by infratemporal fossa

Note: The posterior wall and roof are formed by parts of **the sphenoid bone**.

There are two important foramina in sphenoid bone:

- 1- The Foramen Rotundum (for maxillary nerve).
- 2- The Pterygoid canal: comes from the middle cranial fossa as a groove then goes to the roof of foramen lacerum and makes a groove in its cartilage (remember that foramen lacerum is covered by cartilage) to reach pterygopalatine fossa. The nerve of pterygoid canal passes through it and it is composed of two types of fibers; greater petrosal nerve (parasympathetic part) and deep petrosal nerve (the sympathetic part). The difference between the two parts is that the parasympathetic is preganglionic and synapses in the pterygopalatine ganglia (part of facial nerve) while the deep petrosal (sympathetic) is postganglionic and passes through the ganglia without synapsing.

These two foramina connect the middle cranial fossa with pterygopalatine fossa.

Remember that the trigeminal nerve is in the middle cranial fossa and gives us three branches; ophthalmic, maxillary (pure sensory nerve that enters the pterygopalatine fossa through foramen rotundum) and the mandibular nerves.

Gateways between pterygopalatine fossa and the surrounding areas (very important clinically):

Seven foramina and fissures provide apertures through which structures enter and leave the pterygopalatine fossa

1. **Foramen rotundum** and **pterygoid canal** communicate with the middle cranial fossa. (explained above).
2. **Palatovaginal canal** opens into the posterior wall and leads to the nasopharynx to give blood and nerve supply.
3. **Palatine canal:** small canal leads to the roof of the oral cavity (hard palate) and opens inferiorly through greater and lesser palatine foramina. palatine artery and nerve pass through it. Palatine nerve divides into two branches: greater and lesser palatine nerves. Greater palatine nerve passes through the greater palatine foramina (located on the hard palate) to reach the hard palate and then to the nose by passing through incisive foramina. The lesser palatine nerve passes through the lesser palatine foramina to reach the soft palate.
4. **Sphenopalatine** foramen on the medial wall and opens into the lateral wall of the nasal cavity. Gives blood supply and innervation to the nose.
5. **Pterygomaxillary** fissure between lateral aspect of the pterygopalatine fossa and the infratemporal fossa. The maxillary artery (branch from the external carotid) starts from the parotid gland then enter the pterygopalatine fossa through this fissure (pterygomaxillary fissure). The direction of the artery is opposite to the direction of the branch of maxillary nerve (middle cranial fossa > pterygopalatine fossa>infratemporal fossa)
6. **Inferior orbital fissure** between the superior aspect of the fossa into the floor of the orbital cavity. For maxillary nerve and vessels, they pass from the pterygopalatine fossa into orbital cavity and then in the floor of the orbit then groove then canal and then exit through infraorbital foramen. Some books name them (maxillary N and V) the infraorbital nerve and vessels after the entry of the orbit and others called them infraorbital N and V when they exit the foramen. (The nomenclature is not important but what you have to know is that when they exit from infraorbital foramen they're called infraorbital N and V).

The contents of pterygopalatine fossa (sphenopalatine fossa):

1 .The maxillary nerve: the second branch of trigeminal nerve, it is a **pure sensory** nerve for upper teeth and the skin of facial and temporal bones and reaches the pterygopalatine fossa from the middle cranial fossa through foramen rotundum.

2 .Terminal part of the maxillary artery (maxillary artery is one of the terminal branches of external carotid artery in the parotid gland, then it goes medially to the infratemporal fossa. (lateral pterygoid muscle divides maxillary artery into three parts. Third part is the terminal branch of maxillary artery located in the pterygopalatine fossa. There it will give **sphenopalatine** artery (long & short), **palatine** artery (greater & lesser), **orbital branches and branches to the nasopharynx.**

The first is before the muscle, the second is behind or anterior to muscle and the third is in the pterygopalatine fossa.

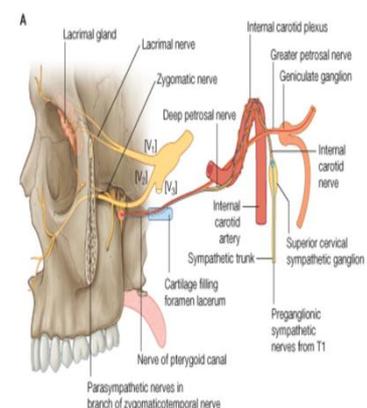
3 .Nerve of the pterygoid canal: it contains sympathetic and parasympathetic fibers.

4 .The pterygopalatine ganglion (**parasympathetic ganglia** in which parasympathetic fibers make synapses) gives fibers (parasympathetic and the associated sympathetic (without synapse) to the glands in the nose, nasopharynx, orbit and the oral cavity.

5 .Veins and lymphatics also pass through the pterygopalatine fossa.

The Pterygopalatine ganglia: In the head and neck we have 4 parasympathetic ganglia: otic ganglia, submandibular ganglia, ciliary ganglia in the eye and pterygopalatine ganglia (largest). The sympathetic is already post ganglionic so it passes without synapsing and both end up in the glands.

Here we have geniculate ganglia of facial nerve. It's exclusive for parasympathetic so it gives us greater petrosal nerve (preganglionic), it passes through pterygoid canal. While sympathetic fibers come from superior cervical



sympathetic ganglia and pass around internal carotid artery then give us deep petrosal nerve. The two fibers (greater and deep petrosal) when they are in the pterygoid canal collectively called nerve of pterygoid canal. They reach the ganglia, and as we said only the parasympathetic synapses and sympathetic just pass through. After that, they distribute with branches of maxillary nerve.

Ganglia give branches to the palate, nasal cavity, nasopharynx and orbit. Other fibers pass superiorly through the ganglionic branches of the maxillary nerve to enter the main trunk of the maxillary nerve and then distributed with the zygomatic, posterior superior alveolar, and infra-orbital nerves.

These ganglionic branches are:

- 1) sympathetic: to the blood vessels.
- 2) parasympathetic to the glands in the submucosa in the nasal cavity, oral cavity and nasopharynx (secretomotor to the glands).

Maxillary nerve gives sensory fibers and two branches to the ganglia (twigs) So, if there is an inflammation in the ganglia the sensation is carried by maxillary nerve.

Pterygopalatine ganglion branches:

- ✓ Pharyngeal branch through palatovaginal canal to the mucosa and glands in the nasopharynx.
- ✓ Palatine nerve (greater and lesser): it descends through the palatine canal to the oral cavity to give:

1. **Lesser palatine** (Middle, Post, palatine) to the soft palate.

2. **Greater palatine** (Ant. palatine) to hard palate and then through the incisive foramen to the nose.

- ✓ Nasal nerves: nasopalatine nerve (long) mainly to the septum, and short to the nasal wall.

- ✓ Orbital branches: to the orbit through the inferior orbital fissure to supply the periosteum (orbital wall), lacrimal gland, sphenoidal and ethmoidal air sinuses.

Nasal nerves

- Seven in number
- Pass medially through the sphenopalatine foramen to enter the nasal cavity
- **Short sphenopalatine** (Post.Sup. Lateral nasal) supply the mucosa of the Post,Sup. quadrant of the nasal cavity.
- The **Nasopalatine nerve (long Sphenopalatine)** is the largest of the nasal nerves
- Passes anteriorly grooving down the nasal septum
- Through the incisive canal and fossa in the hard palate
- Supply mucosa, gingiva, and glands adjacent to the incisor teeth.
- Join the greater palatine nerve.

- ✓ Zygomatic branch: zygomaticofacial and zygomaticotemporal (**it also carries parasympathetic fibers to lacrimal gland**)

Maxillary nerve:

Purely sensory. It originates from the trigeminal ganglion in the cranial cavity and exits the middle cranial fossa and enters the pterygopalatine fossa through the foramen rotundum. After reaching the pterygopalatine fossa, **it passes to the infratemporal fossa by pterygomaxillary fissure to give posterior superior alveolar nerve** (sensory to the last three molars and the surrounding gingiva and maxillary air sinuses) opposite to the direction of maxillary artery (which passes from the infratemporal fossa to pterygopalatine fossa through pterygomaxillary fissure). And then, maxillary nerve enters the inferior orbital fissure (groove → canal) and then continues as infraorbital nerve (the terminal end of maxillary nerve).

Maxillary nerve branches:

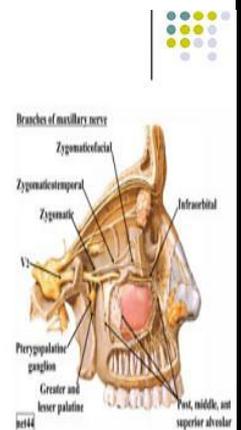
1. Meningeal (before it enters the Fossa)
2. Two ganglionic branches pass through the pterygopalatine ganglion (Postganglionic parasympathetic fibers and sensory).

3. Zygomatic nerve.

4. Posterior superior alveolar nerve (last three molars): Passes laterally out of the fossa through the pterygomaxillary fissure then enters the posterior surface of the maxilla approximately midway between the last molar tooth and the inferior orbital fissure. It Supplies the molar teeth and adjacent buccal gingivae and contributes to the supply of the maxillary sinus.

Zygomatic nerve

- Originates directly from the maxillary nerve in the pterygopalatine fossa
- Enter the orbit through the inferior orbital fissure
- Divides into zygomaticotemporal and zygomaticofacial branches
- **Zygomaticotemporal branch** enter the temporal fossa and passes superficially to supply skin over the temple
- Carries postganglionic parasympathetic and sympathetic fibers and form a special autonomic nerve to join the lacrimal nerve
- The **Zygomaticofacial branch** opens on the anterolateral surface of the zygomatic bone, and supply the adjacent skin.



5. Infra-orbital nerve. (gives palpebral, labial and nasal nerves).

Upper jaw contains incisors, canine, premolars and molars.

Molars: posterior superior alveolar nerve

Premolars: middle superior alveolar nerve

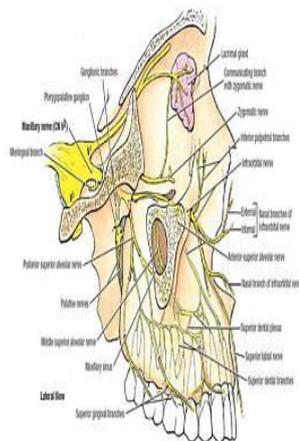
Incisors and canine: anterior superior alveolar nerve.

Infra-orbital nerve

- Anterior continuation of the maxillary nerve
- Leaves the pterygopalatine fossa through the inferior orbital fissure
- First in the **infra-orbital groove** in the floor of the orbit and then continues forward in the **infra-orbital canal**.
- While in the infra-orbital groove and canal, the infra-orbital nerve gives origin to **middle** and **anterior superior alveolar nerves**:
- They Join the **superior alveolar plexus** to supply the upper teeth
- Middle superior alveolar nerve also supplies the maxillary sinus
- Anterior superior alveolar nerve also gives origin to a small nasal branch

Infra-orbital nerve

- The infra-orbital nerve exits the infra-orbital canal through the **infra-orbital foramen**
- Divides into nasal, palpebral, and superior labial branches
- Nasal branches supply skin over the lateral aspect of the external nose and part of the nasal septum;
- Palpebral branches supply skin of the lower eyelid;
- Superior labial branches supply skin over the cheek and upper lip, and the related oral mucosa.



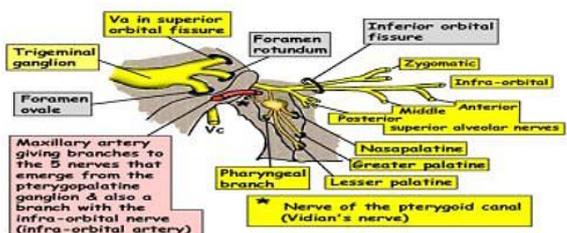
Maxillary Nerve and Pterygopalatine ganglion

PTERYGOPALATINE FOSSA 1

Right side of skull cut away to show trigeminal ganglion lying in Meckel's cave and the maxillary division entering the pterygopalatine fossa through foramen rotundum. The nerve of the pterygoid canal is seen entering the pterygopalatine ganglion and connecting to Vb so that sensory fibres can be distributed with the parasympathetic fibres from the ganglion and so that parasympathetics can pass on Vb to be distributed to sinuses and lacrimal gland.

The contents of the pterygopalatine fossa are:

- Terminal branches of the maxillary artery
- Maxillary nerve (Vb) to upper teeth, floor of orbit, face/skin
- Pterygopalatine ganglion for distribution of parasympathetics to nose and palate



Maxillary artery:

Terminal branch of external carotid artery in the parotid gland (adjacent to the neck of mandible). It originates in the parotid then passes through infratemporal fossa then enters the pterygopalatine fossa through pterygomaxillary fissure.

it is divided into three parts by lateral pterygoid muscle:

1st part:

Before lateral pterygoid muscle and gives five branches (each one enters either a foramen or fissure). For example, **inferior alveolar artery** branch descends along the mandible through mandibular foramen and supplies lower jaw (teeth). others upper branches descend upward to middle cranial fossa:

middle meningeal (through foramen spinosum) and **accessory middle meningeal** (through foramen ovale) arteries. The last two branches are **deep auricular** and **anterior tympanic arteries** to the ear.

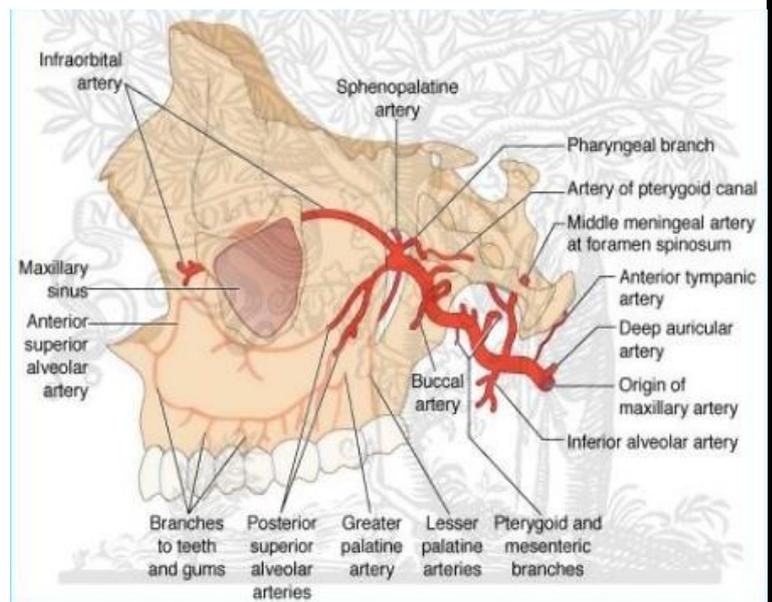
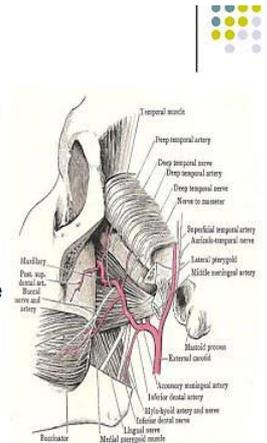
2nd part: Related to the lateral pterygoid muscle (anterior or posterior) and gives supply to the muscles of mastication (masseter, temporalis, medial pterygoid and lateral pterygoid) that's why it's called muscular artery. (Course with branches of the mandibular nerve).

3rd part:

In the pterygopalatine fossa anterior to the ganglion. Gives origin to branches that accompany branches of the maxillary nerve [V2] and the pterygopalatine ganglion. These branches supply much of the nasal cavity, the roof of the oral cavity, and all upper teeth. In addition, they contribute to the blood supply of the sinuses, oropharynx, and floor of the orbit, so, it gives orbital, palatine, sphenopalatine and nasal.

First part

- The first part of the maxillary artery is the part between the neck of mandible (Lat.) and the sphenomandibular ligament (Med.)
- Also related to the auriculo-temporal nerve (above) and the maxillary vein (below).
- Gives origin to two major branches (the middle meningeal and inferior alveolar arteries)
- Smaller branches (deep auricular, anterior tympanic, and accessory meningeal);



3rd part branches:

1. The posterior superior alveolar (in the infratemporal fossa): to the upper molars.

2. Infra-orbital (in the orbit): gives branches: middle sup alveolar artery and ant sup alveolar artery (incisors and canine).

3. Greater and lesser palatine: to the oral cavity

4. **Pharyngeal branch**: Travels posteriorly and leaves the pterygopalatine fossa through the palatovaginal canal with the pharyngeal nerve. It Supplies the posterior aspect of the roof of the **Nasal cavity**, the sphenoidal sinus, and the pharyngotympanic tube.

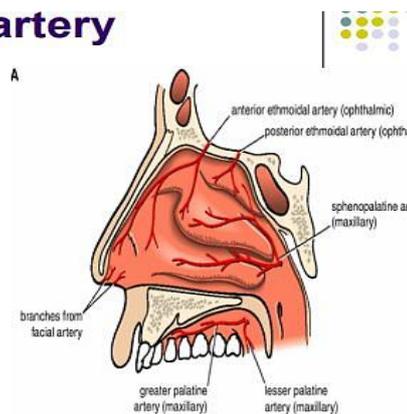
5. Sphenopalatine arteries (long & short).

POST SUP ALVEOLAR Artery

- Originates from the maxillary artery as it passes through the pterygomaxillary fissure
- Meets the posterior superior alveolar nerve,
- Accompanies it through the alveolar foramen on the infratemporal surface of the maxilla
- Supplies the molar and premolar teeth, adjacent gingiva, and the maxillary sinus.

Sphenopalatine artery

- The terminal branch of the maxillary artery
- Leaves the pterygopalatine fossa medially through the sphenopalatine foramen
- Accompanies the nasal nerves, giving off:
 1. Posterior lateral nasal arteries, which supply the lateral wall of the nasal cavity and contribute to supply of the paranasal sinuses;
 2. Posterior septal branches, which supply the nasal septum-the largest of these branches passes anteriorly down the septum to anastomose with the end of the greater palatine artery.



Infra-orbital artery

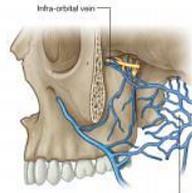
- Passes forward with the infra-orbital nerve and leaves the pterygopalatine fossa through the inferior orbital fissure
- With the infra-orbital nerve, it lies in the infra-orbital groove and infra-orbital canal
- Emerges through the infra-orbital foramen to supply parts of the face.
- In the orbital canal gives :
 1. Branches that contribute to the blood supply of structures near the floor of the orbit-the inferior rectus and inferior oblique muscles, and the lacrimal sac;
 2. **Anterior superior alveolar arteries**, which supply the incisor and canine teeth and the maxillary sinus.

6. The artery of the pterygoid canal: Passes posteriorly into the pterygoid canal and supplies surrounding tissues. Passing inferiorly through the cartilage filling the foramen lacerum and terminates in the mucosa of the nasopharynx.

The maxillary artery ends by infraorbital artery and enters to the infraorbital foramen with the nerve.

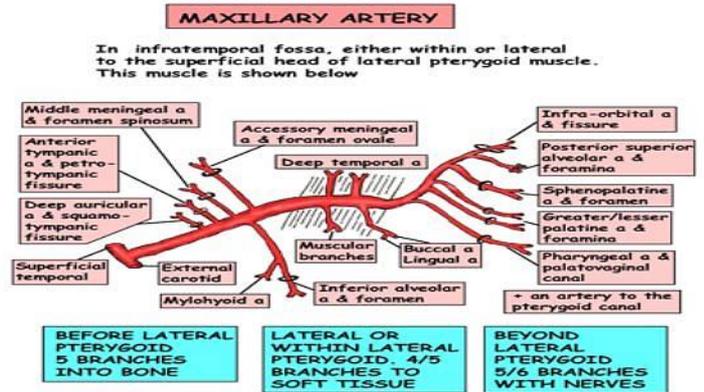
Veins

- Drain areas supplied by branches of the terminal part of the maxillary artery
- Generally travel with these branches back into the pterygopalatine fossa.
- The veins coalesce in the fossa and then pass laterally through the pterygomaxillary fissure to join the pterygoid plexus of veins in the infratemporal fossa
- The infra-orbital vein, drains the inferior aspect of the orbit,
- May pass directly into the infratemporal fossa, so bypassing the pterygopalatine fossa



Pterygoid plexus in infratemporal fossa
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Maxillary artery



Venous drainage:

Facial vein drains pterygoid and Ant. part of the face (especially from infraorbital vein).

Lateral pterygoid plexus drains the posterior aspect, this plexus drained by the maxillary vein that joins the superficial temporal vein in the parotid gland to make the retromandibular vein.

Good Luck