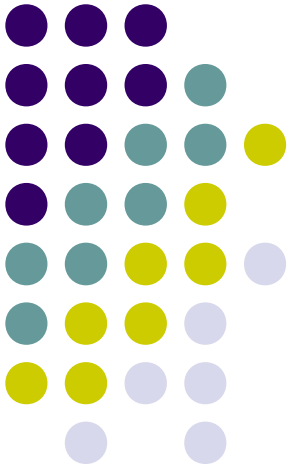
SKULL BASE

PART-1

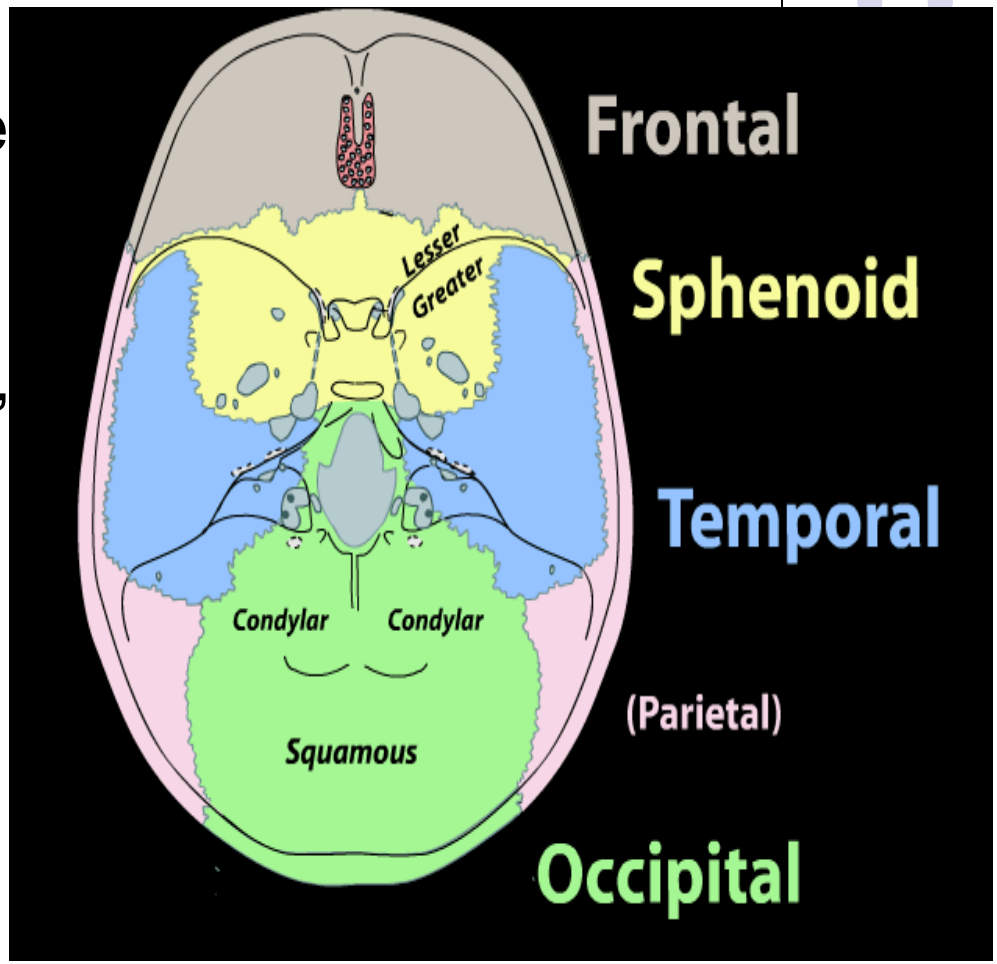
radiological anatomy and imaging



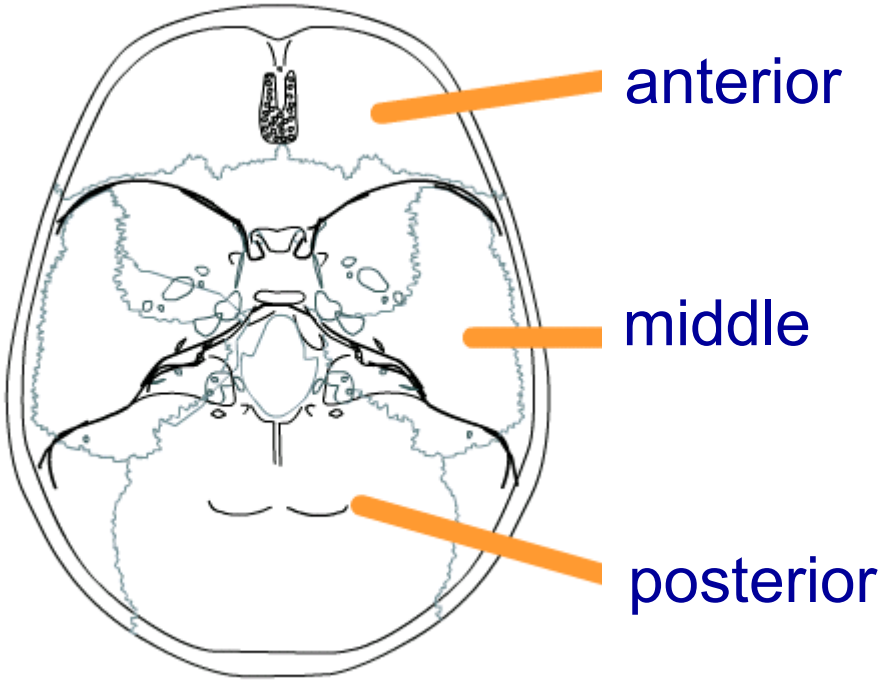
- The skull base, which forms the floor of the cranial cavity and separates the brain from other facial structures, is a complex anatomical region

Skull base

- The 5 bones that make up the skull base are the ethmoid, sphenoid, occipital, paired frontal, and paired temporal bones.

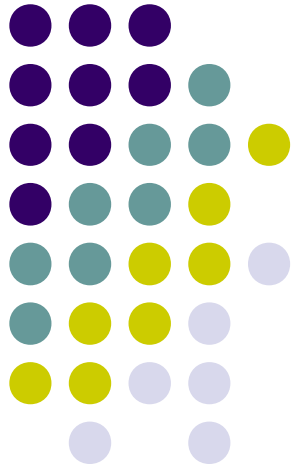


- The skull base can be subdivided into 3 regions, the anterior, middle, and posterior cranial fossae.



- The middle cranial fossa can be further subdivided into one central component and two lateral components by the petro-occipital fissure.

ANTERIOR SKULL BASE

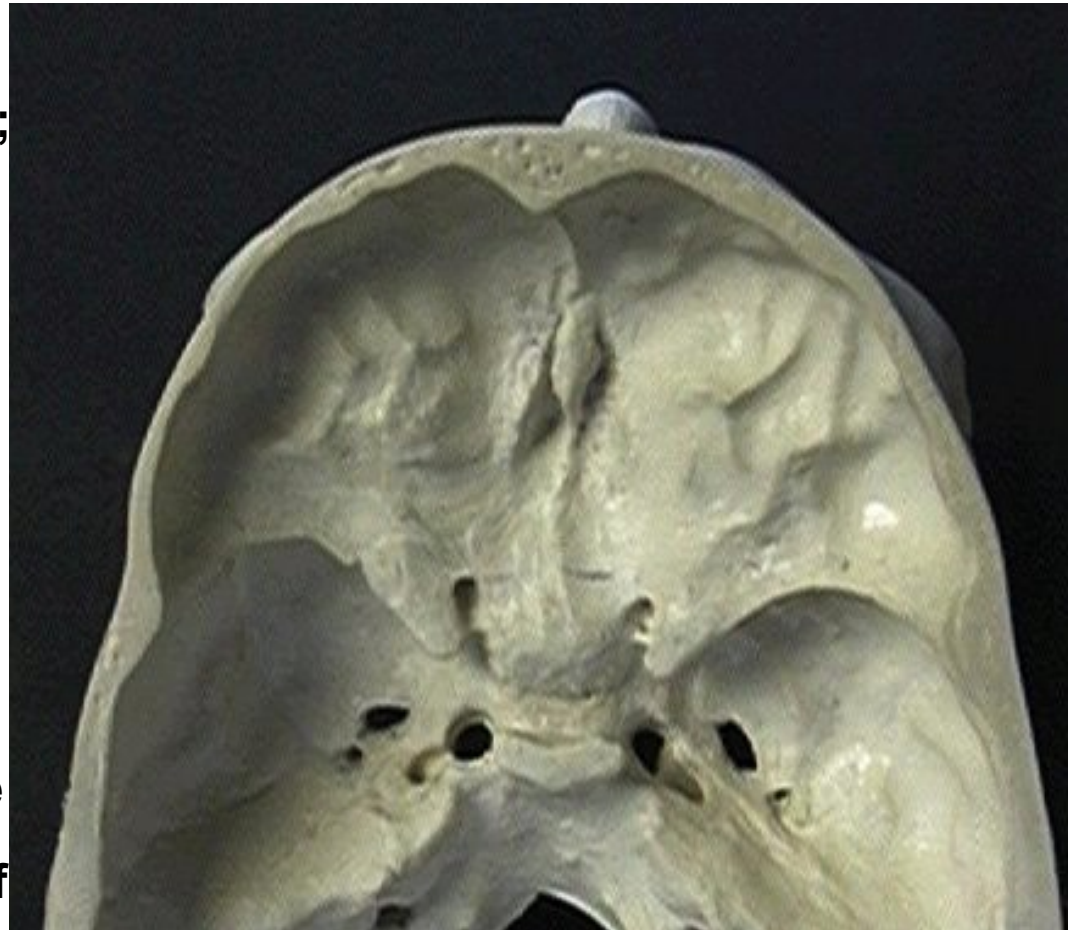


ANTERIOR SKULL BASE

- The anterior limit of the anterior skull base is the posterior wall of the frontal sinus. The posterior limit is marked by the anterior clinoid processes and the planum sphenoidale, which forms the roof of the sigmoid sinus. The lateral boundaries are formed by the frontal bone.

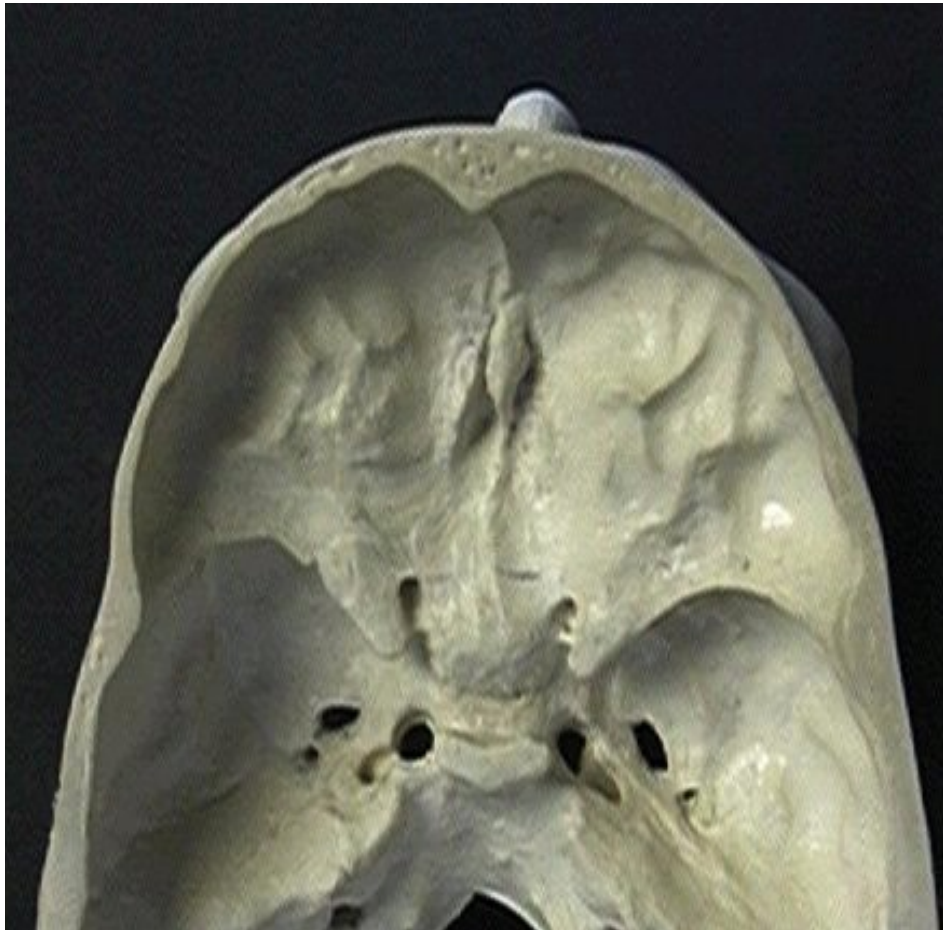
ANTERIOR SKULL BASE

- The greater portion of the anterior floor is convex and grooved by the frontal lobe gyri; this portion of the skull base is made up of the orbital portion of the frontal bone.
- The central part of the floor is formed by the ethmoid bone and is the deepest area of the anterior cranial fossa. In the center of this region is the cribriform plate, through which the olfactory tracts pass.
- The cribriform plate may be more than 1cm lower than the roof of the ethmoid cavity (fovea ethmoidalis) and is made of extremely thin bone as compared to the thicker bone of the lateral fovea ethmoidalis.



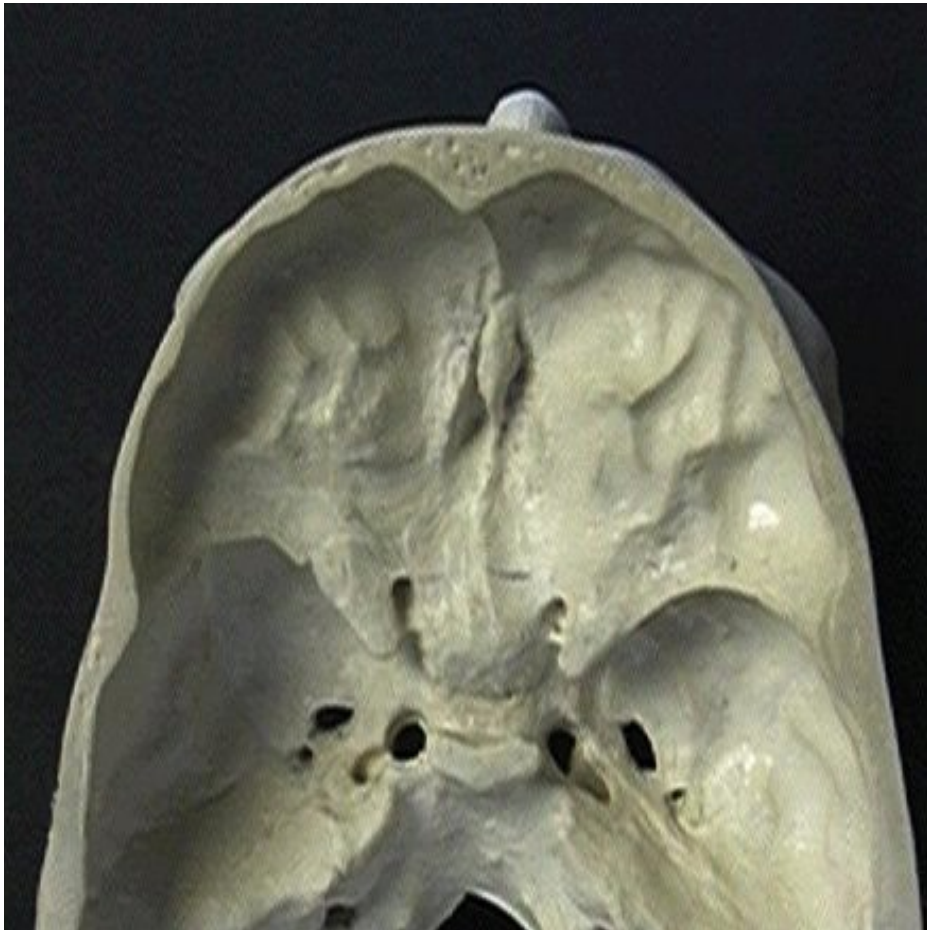
ANTERIOR SKULL BASE

- The foramen cecum sits between the frontal crest and the prominent crista galli, and is a site of communication between the draining veins of the nasal cavity and the superior sagittal sinus.
- The crista galli, which projects up centrally between the cerebral hemispheres, serves as the site of attachment for the falx cerebri.



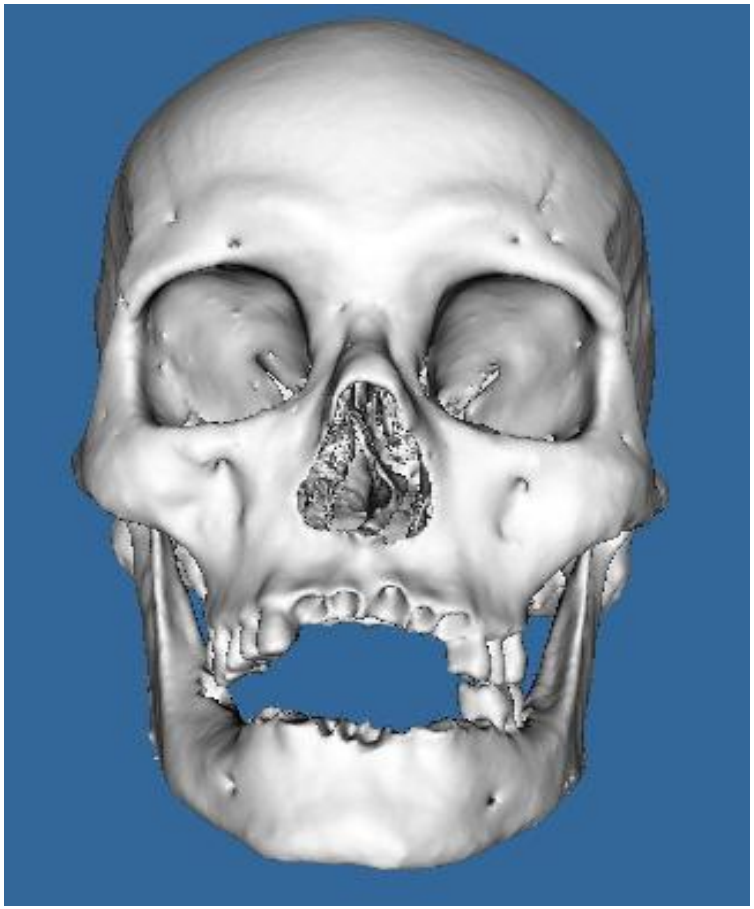
ANTERIOR SKULL BASE

- The optic chiasm or chiasmatic sulcus sits slightly posteriorly in the midline. The posterolateral segment is formed by the anterior clinoid processes, which also help form the roof of the optic canal. Medially, the lesser wing of the sphenoid forms the anterior clinoid process, an important landmark for the optic nerve and supracavernous internal carotid artery



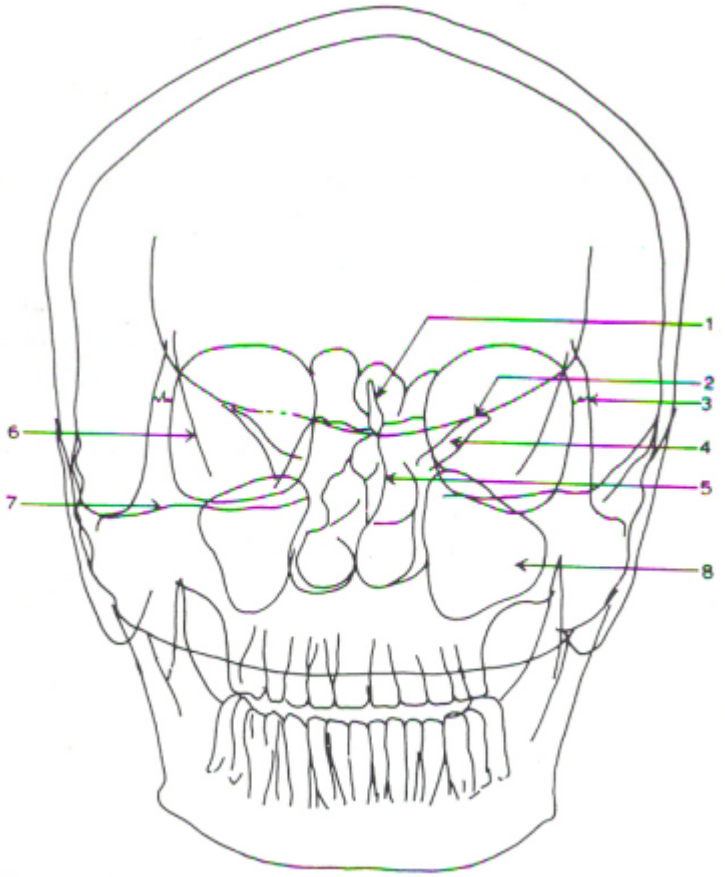
Inferior Relationships – Extracranial Aspects

- The most important anatomical structures below the anterior cranial fossa are the orbits and the paranasal sinuses.
- The bony orbit is often a route for intracranial and extracranial spread of infection and tumors due to its direct proximity to the anterior fossa.



ANTERIOR SKULL BASE

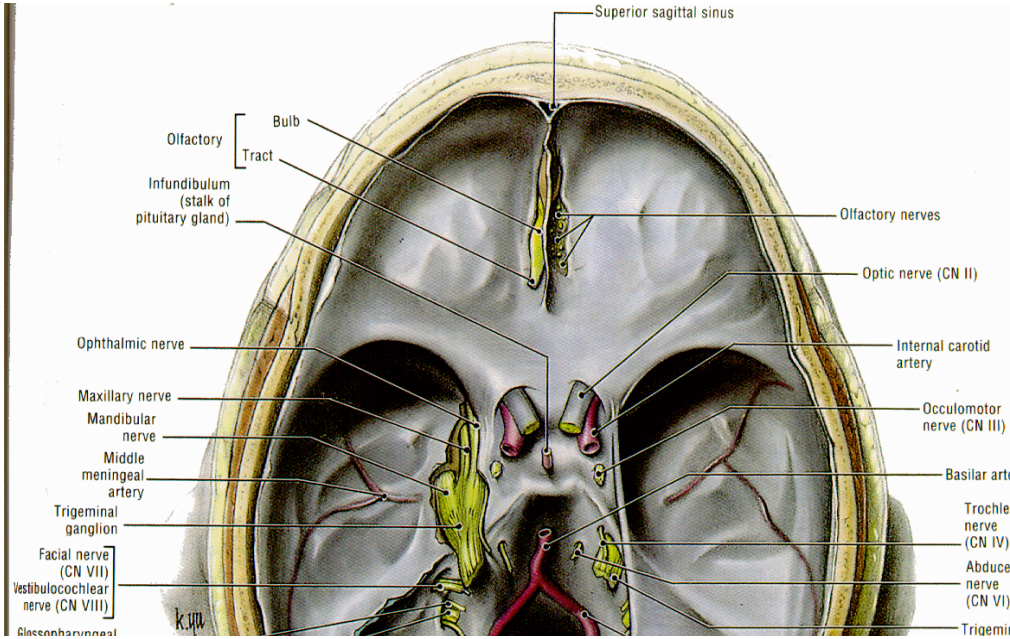
- The ethmoid sinuses can be found inferior to the anterior cranial fossa and medial to the orbits. The frontal sinuses arise as evaginations of ethmoid air cells into the frontal bone and have a thick anterior and thinner posterior wall.



B

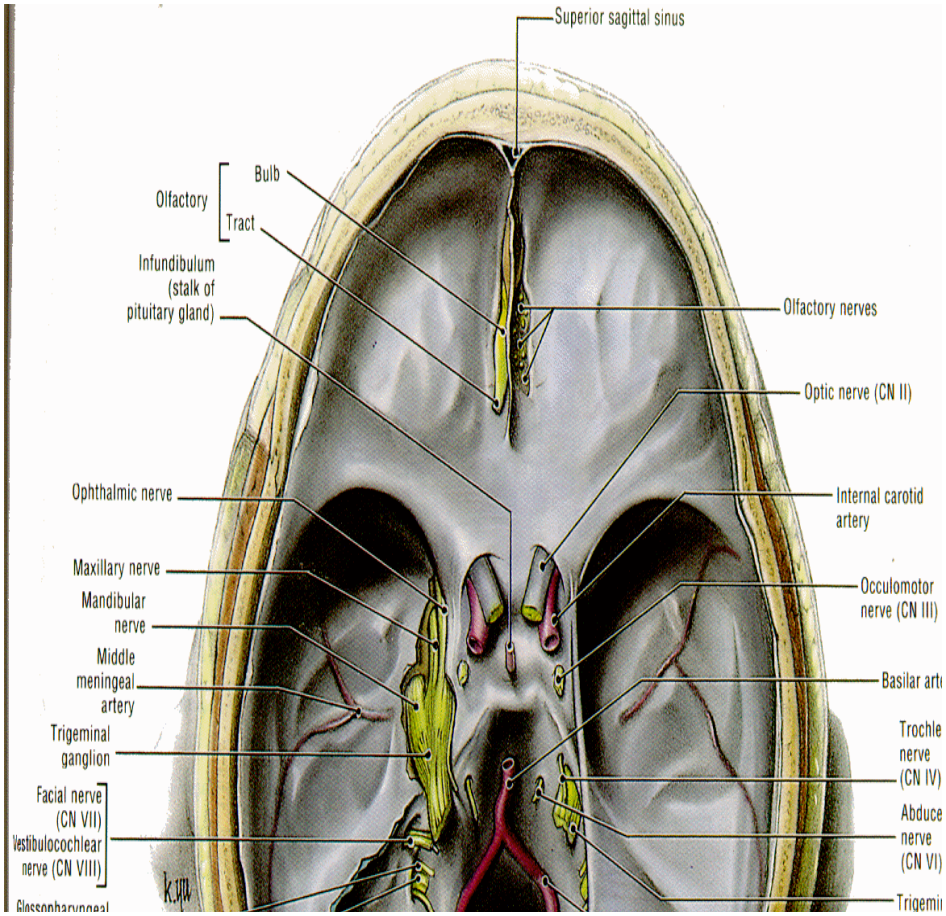
ANTERIOR SKULL BASE - contents

- The dura mater attaches anteriorly at the frontal crest and crista galli to form the falx cerebri, which transmits the superior and inferior sagittal sinuses.
- The foramen cecum, found anterior to the crista galli, usually ends blindly, although it may transmit a vein from the nasal mucosa to the superior sagittal sinus. Its patency may lead to the formation of developmental anomalies such as nasal dermoid cysts, nasal gliomas, encephaloceles, and meningoencephaloceles.

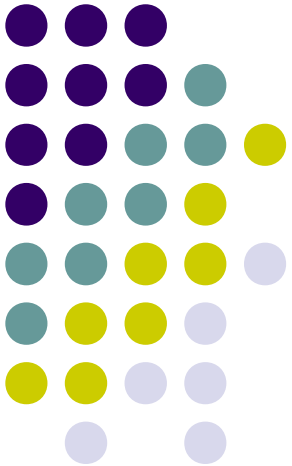


ANTERIOR SKULL BASE -contents

- The frontal lobes occupy the anterior fossa and sit superior to the orbits and sinonasal tract. The major structures in this area are the olfactory bulb and tract. The olfactory bulb lies along the medial edge of the frontal orbital plate and connects with the olfactory tract, which courses above the cribriform plate and planum sphenoidale.



MIDDLE SKULL BASE



Boundaries – Intracranial Aspects

- The greater wing of the sphenoid helps form the anterior limit of the middle skull base.
- The posterior limit is the clivus.
- The lateral limit is formed by the greater wing of the sphenoid as it extends laterally and upwards from the sphenoid body to meet the squamous portion of the temporal bone and the anteroinferior portion of the parietal bone.

Boundaries – Intracranial Aspects

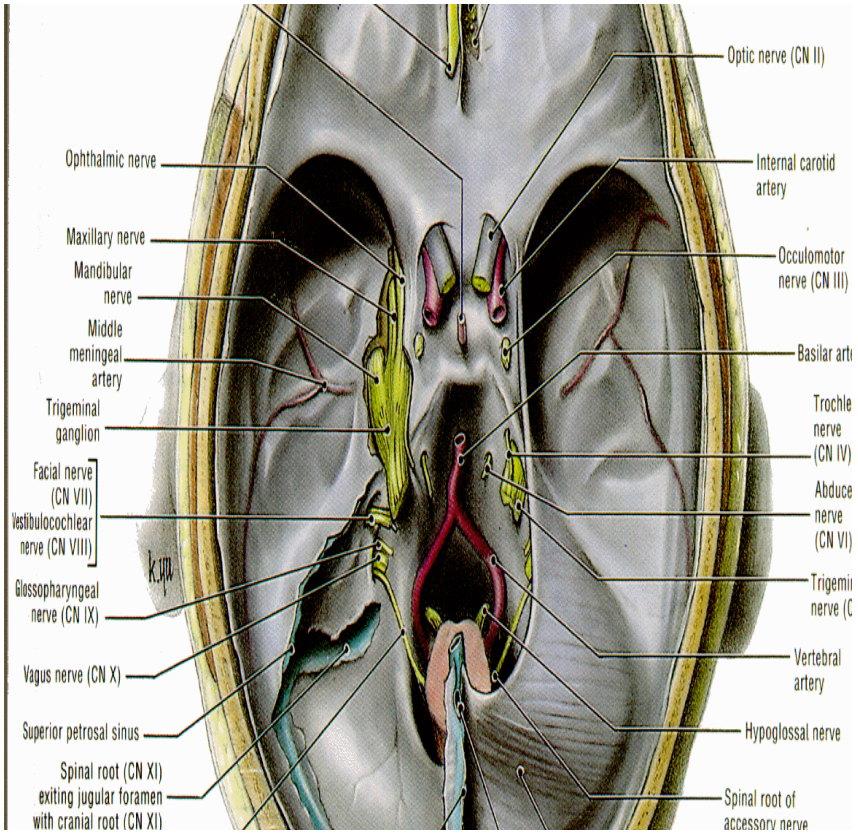
- Anteriorly, the floor of the fossa is formed by the greater wing of the sphenoid. Posteriorly, the floor of the middle cranial fossa is formed by the anterior aspect of the petrous temporal bone.
- The body of the sphenoid makes up the central portion of the middle fossa and houses the sella turcica.

Boundaries – Intracranial Aspects

- The floor and the lateral walls are grooved for the middle meningeal artery, which courses anterolaterally from the foramen spinosum and divides into the frontal and parietal branches; the former ascends across to the pterion, where it courses posteriorly.
- The pterion is made up of thin bone can be easily fractured during traumatic injury. This can result in injury to the anterior branches of the middle meningeal artery, with eventual formation of an epidural hematoma.

Boundaries – Intracranial Aspects

- **The posteromedial limit of the middle cranial fossa is formed by the petrous portion of the temporal bone. The petrous ridge is longitudinally grooved by the superior petrosal sinus. The anteromedial petrous tip houses the trigeminal or gasserian ganglion in a region known as Meckel cave. This area is superior to the point at which the internal carotid artery enters the cavernous sinus just above the foramen lacerum.**

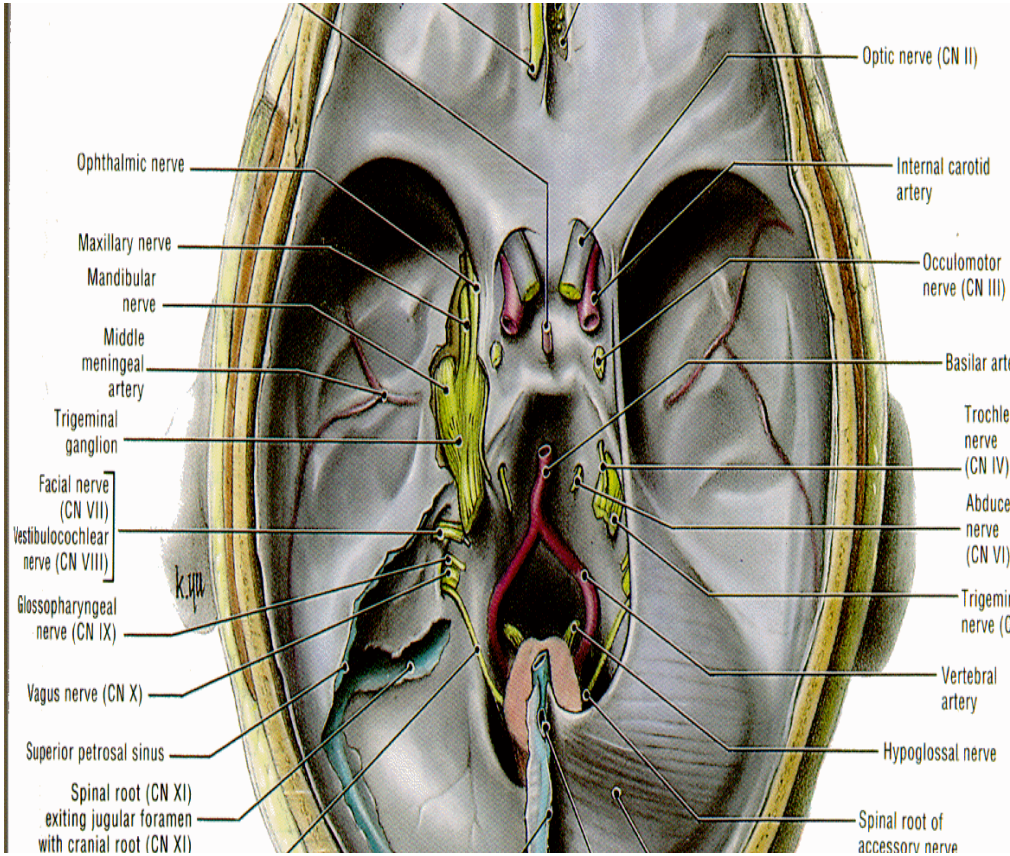


Intracranial Aspects

- The arcuate eminence is the superior extent of the superior semicircular canal, and can be appreciated on the superior aspect of the mid-petrous ridge.Lateral to the arcuate eminence, the middle ear and mastoid are covered by the thin tegmen tympani and tegmen mastoideum respectively.
- The tegmen is a thin plate of bone that separates the middle lobe dura from the middle ear and mastoid cavity. The bone of the middle fossa floor may be dehiscent over the geniculate ganglion of the facial nerve.

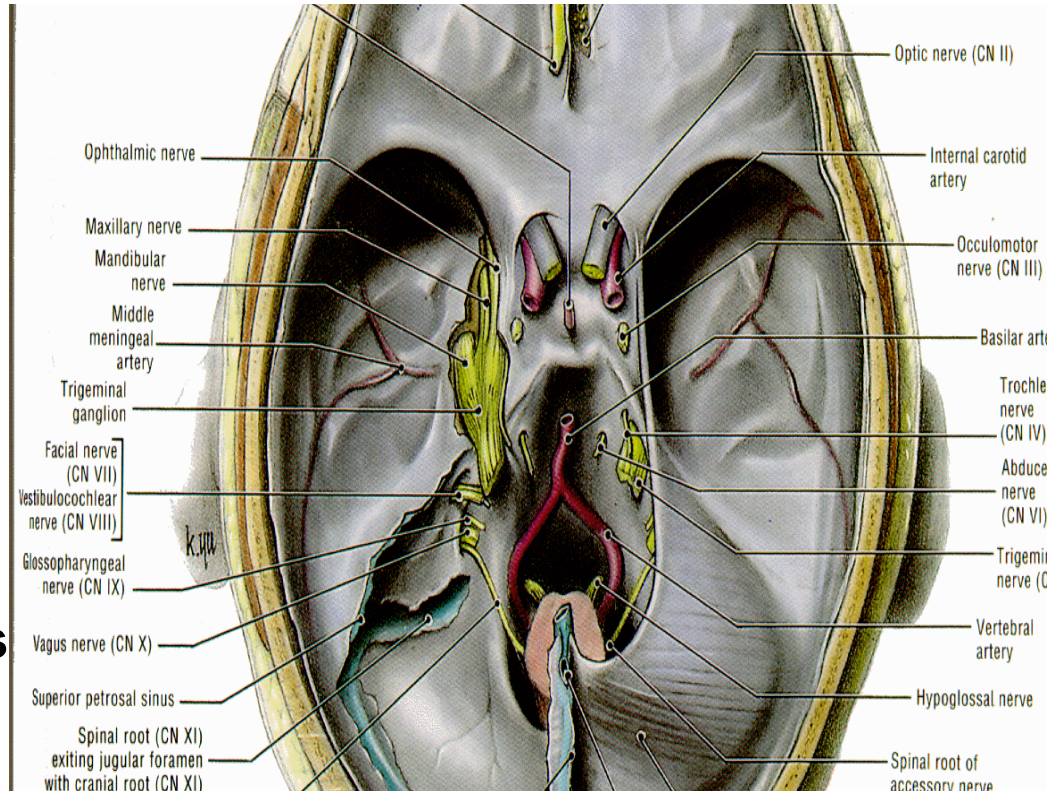
Contents

- **Important structures found in the middle fossa include, the temporal lobe, pituitary gland, trigeminal or gasserian ganglion, the greater superficial petrosal nerve (GSPN), the intracranial portion of the internal carotid artery, and the cavernous sinus and its contents.**



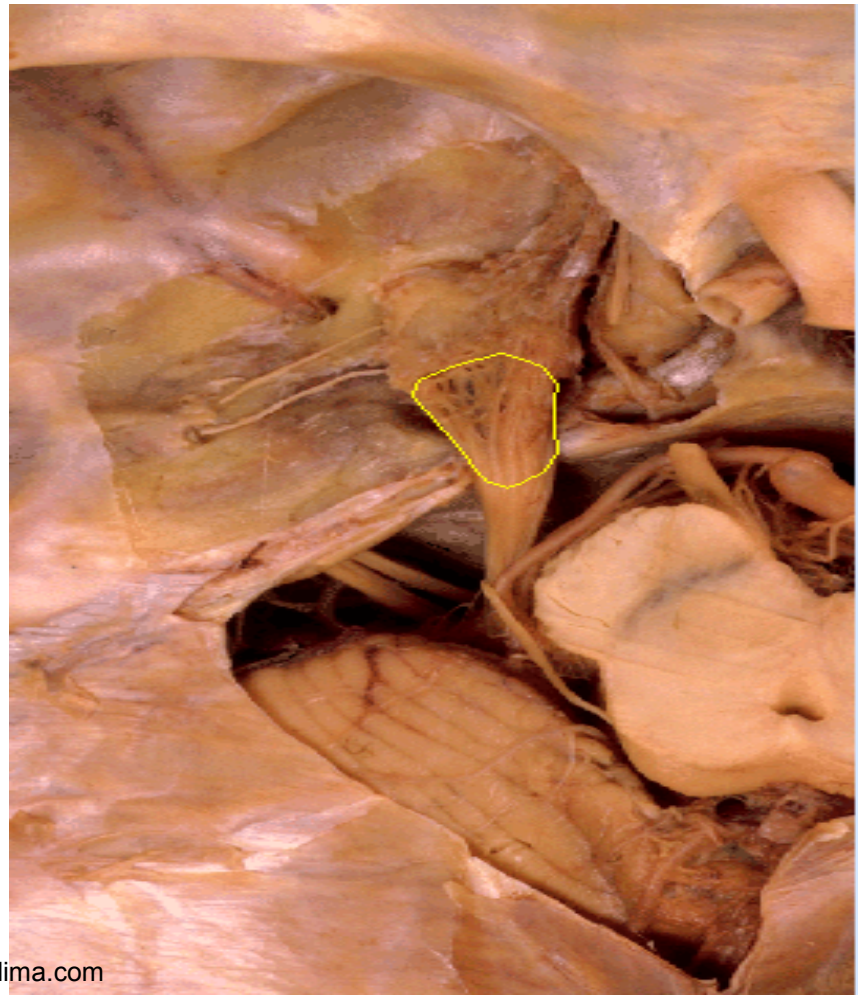
Contents

- In the middle fossa, the dura is strongly adherent to the clinoid processes, petrous and sphenoid ridges, and the basal foramina. In the midline, it forms the diaphragma sellae – a circular dural plate - which covers the pituitary gland and is perforated by the pituitary stalk or infundibulum and hypophyseal veins.
- The cavernous sinus resides on both sides of the sella turcica and the body of the sphenoid bone.



Contents

- The temporal lobe takes up most of the space of the middle fossa and extends to the inferior portion of the anterior fossa.
- The GSPN branches from the geniculate ganglion and passes through a small hiatus into the middle fossa before coursing parallel to the petrous ridge of the temporal bone and entering the foramen lacerum.
- The greater superficial petrosal nerve (GSPN), is composed of parasympathetic fibers from the facial nerve to the lacrimal gland,.
- The GSPN and rostral lesser superficial petrosal nerve (LSPN) run along the floor beneath the dura and parallel the anterior edge of the petrous bone into foramen lacerum. Here, the GSPN joins with the deep petrosal nerve to form the vidian nerve or the nerve of the pterygoid canal..



Extracranial Aspects-

lateral Relationships and boundaries

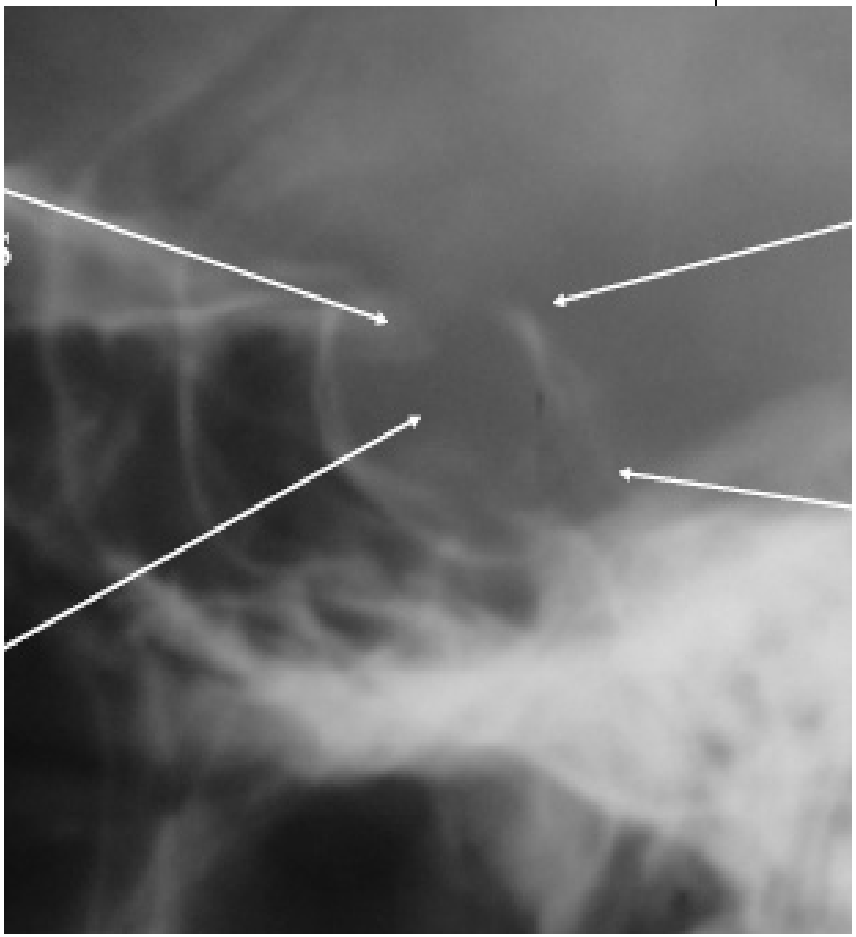
- The petro-occipital fissure divides the middle cranial fossae into a central and lateral component
- The middle cranial fossa is bounded anteriorly by the posterolateral wall of the maxillary sinuses and the petro-occipital sutures posteriorly. The lateral margin consists primarily of the squamous and petrous portions of the temporal bone.

Contents – Extracranial Aspects

- The infratemporal fossa lies below the temporal bone, inferomedial to the zygomatic arch, and posterior to the maxilla.
- The nasopharynx lies posterior and inferior to the sphenoid sinus along the midline.
- The investing fascia of the nasopharynx, also known as the pharyngobasilar fascia, is suspended from the skull base and clivus located superiorly. The clivus is formed by the sphenoid and occipital bones.
- The vertebrobasilar artery and the brainstem lie posterior to the clivus.

SELLA TURCICA

- The sella turcica can be found between the anterior and posterior clinoid processes and is composed of three sections.
- The tuberculum sellae is an olive shaped swelling and sits on the anterior slope between the chiasmal sulcus and the sella turcica.
- The hypophyseal or pituitary fossa lies immediately posterior to the tuberculum sellae.
- The dorsum sellae is the furthest posterior.
- In this region lies the sigmoid groove for the internal carotid artery as it traverses the petrous apex through the cavernous sinus.

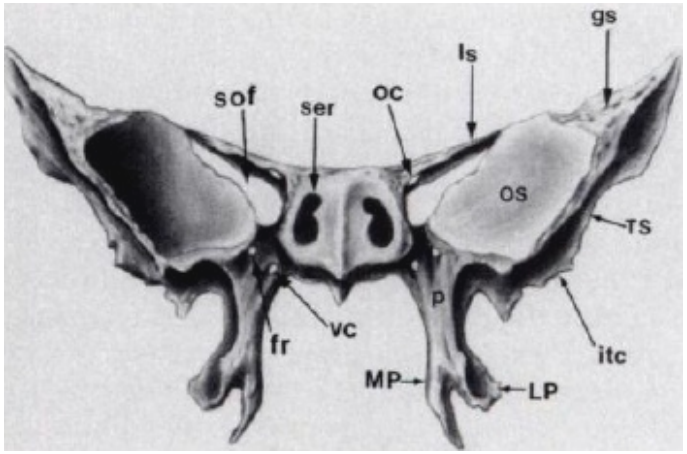


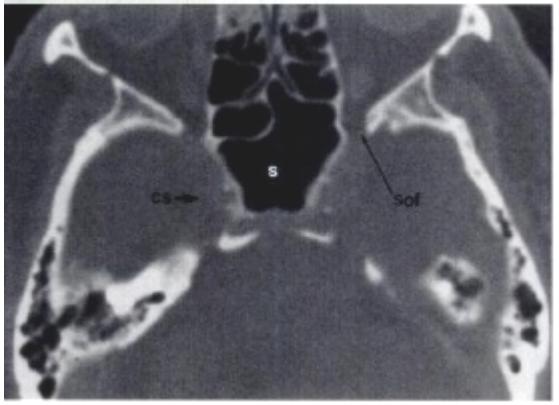
Foramina

- The superior orbital fissure
- Foramen rotundum
- Foramen ovale
- Foramen spinosum
- Foramen lacerum
- Foramen vesalius

SUPERIOR ORBITAL FISSURE

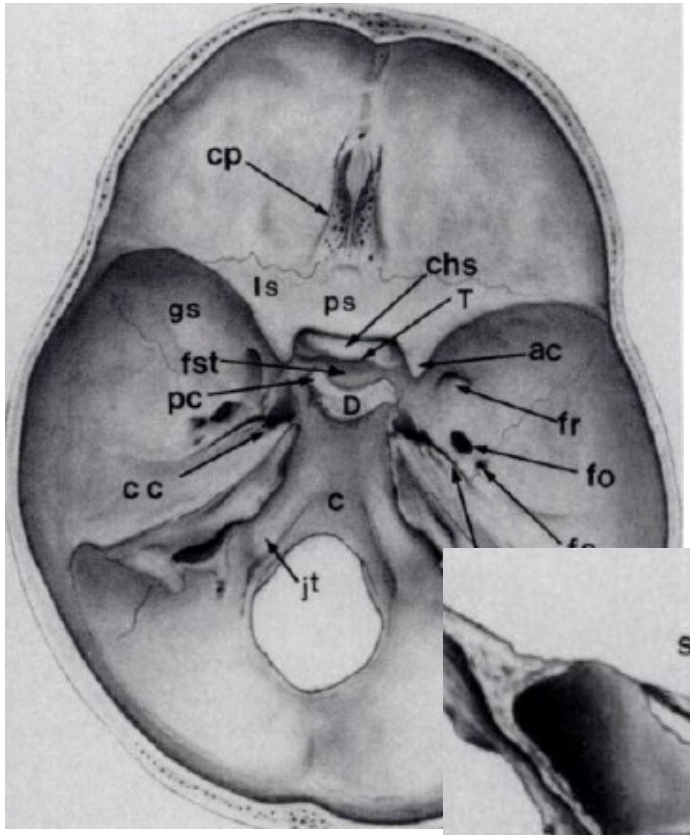
- Boundaries
  - Medially- sphenoid body
  - Above by lesser wing
  - Below by greater wing
  - Laterally completed by converging greater and lesser wings.
- Contents-
  - 3rd, CN (lacrimal,frontal, nasociliary branches).
  - 4th,6th CN's,
  - ophthalmic div of CN V,
  - orbital branch of middle meningeal artery,
  - sympahetic filaments of internal carotid plexus,
  - recurrent meningeal branches of lacrimal artery
  - ophth veins.

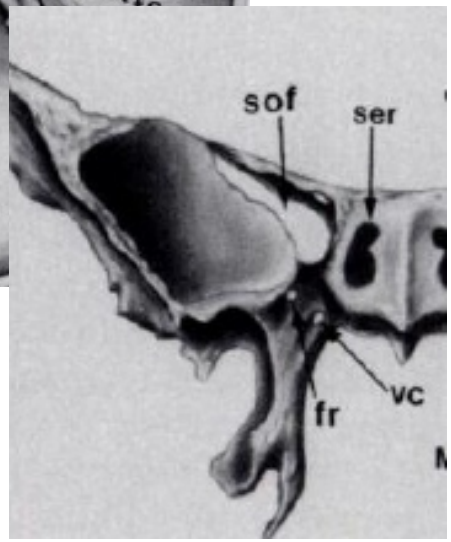


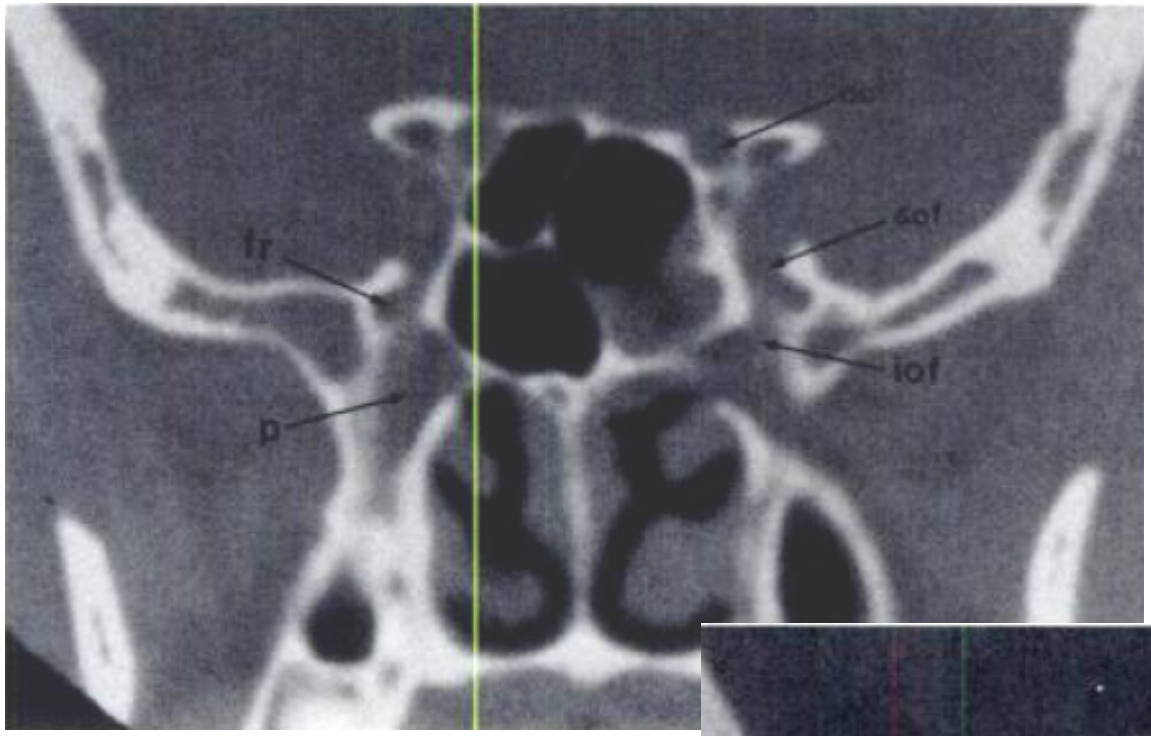


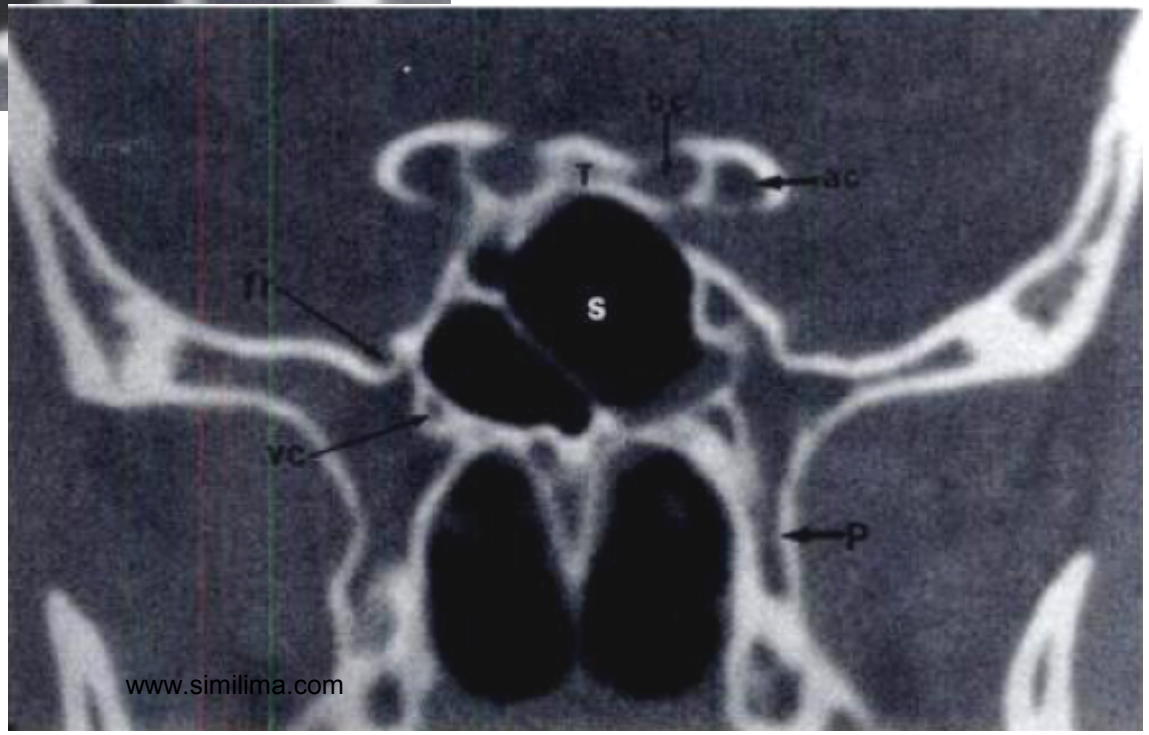
FORAMEN ROTUNDUM

- Actually, a canal in the base of greater sphenoid wing.
- Situated just inferior and lateral to SOF.
- Canal extends obliquely forward and slightly inferiorly, connecting the middle cranial fossa to pterygopalatine fossa.
- Transmits
  - Maxillary nerve(CN V2)
  - Artery of f. rotundum
  - Emissary veins
- Best visualised by means of coronal CT.



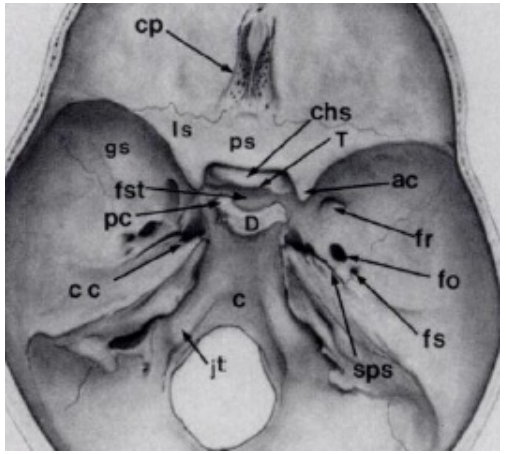


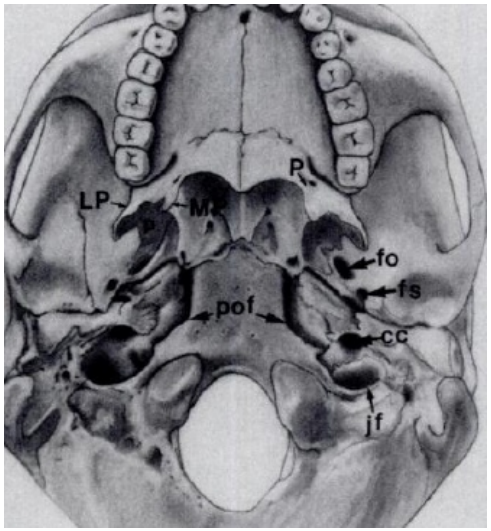


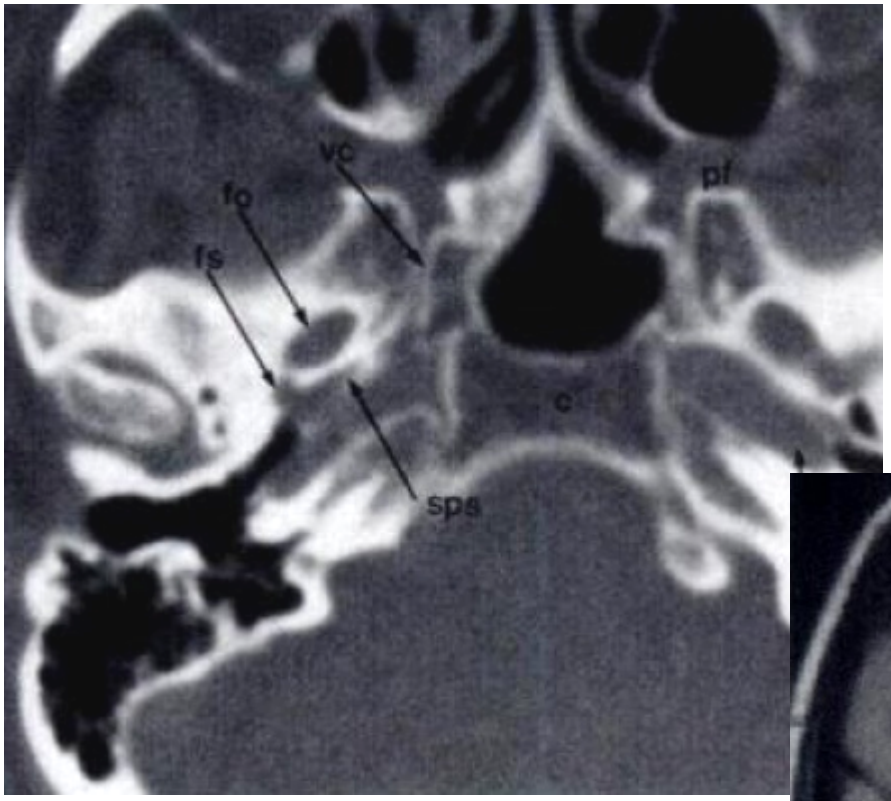


FORAMEN OVALE

- Situated in medial aspect of the body of sphenoid, posterolateral to f.rotundum,endocranially
- Exocranially at base of lateral pterygoid plate opening into infratemporal fossa.
- Transmits
  - Mandibular nerve
  - Accessory meningeal artery
  - Lesser petrosal nerve
  - Emissary veins
- Normal size varies considerably
- Visulised on both axial and coronal CT
- Soft tissue lesions trsversing it are best seen on coronal MRI.



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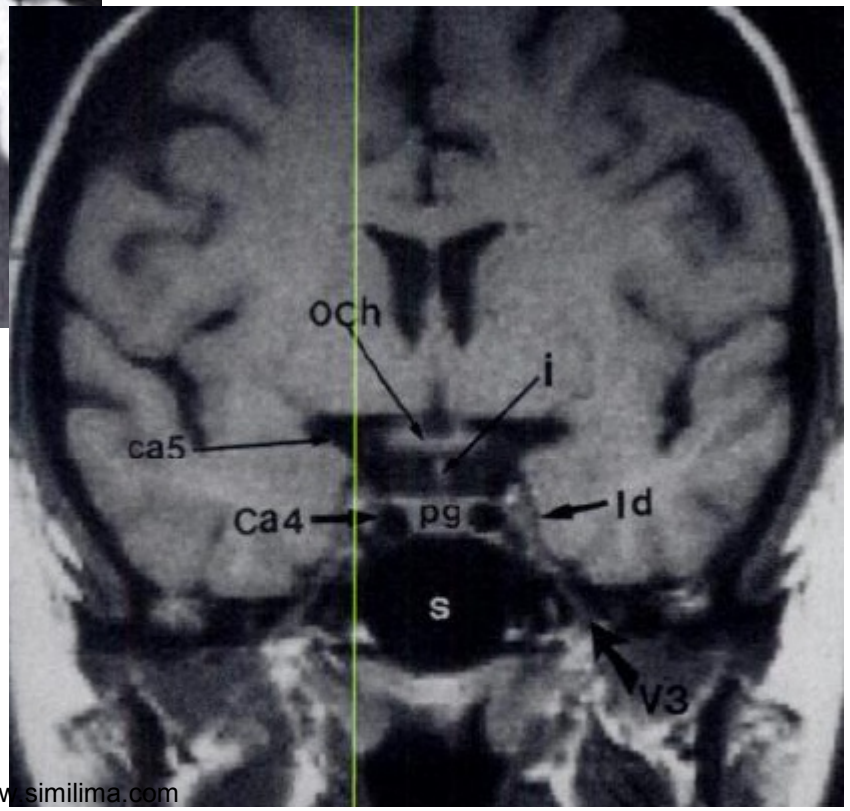
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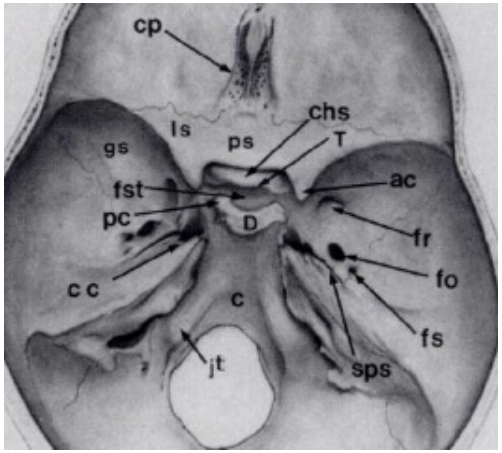
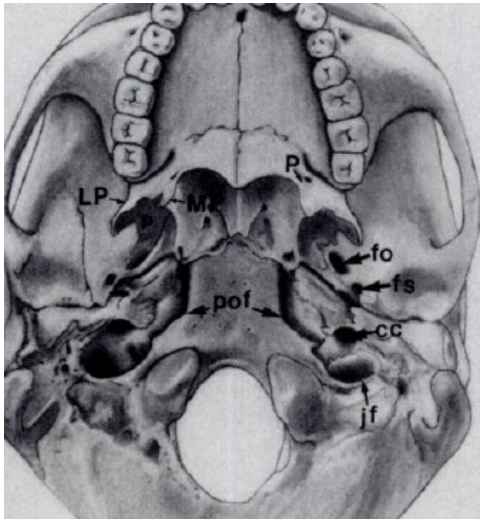
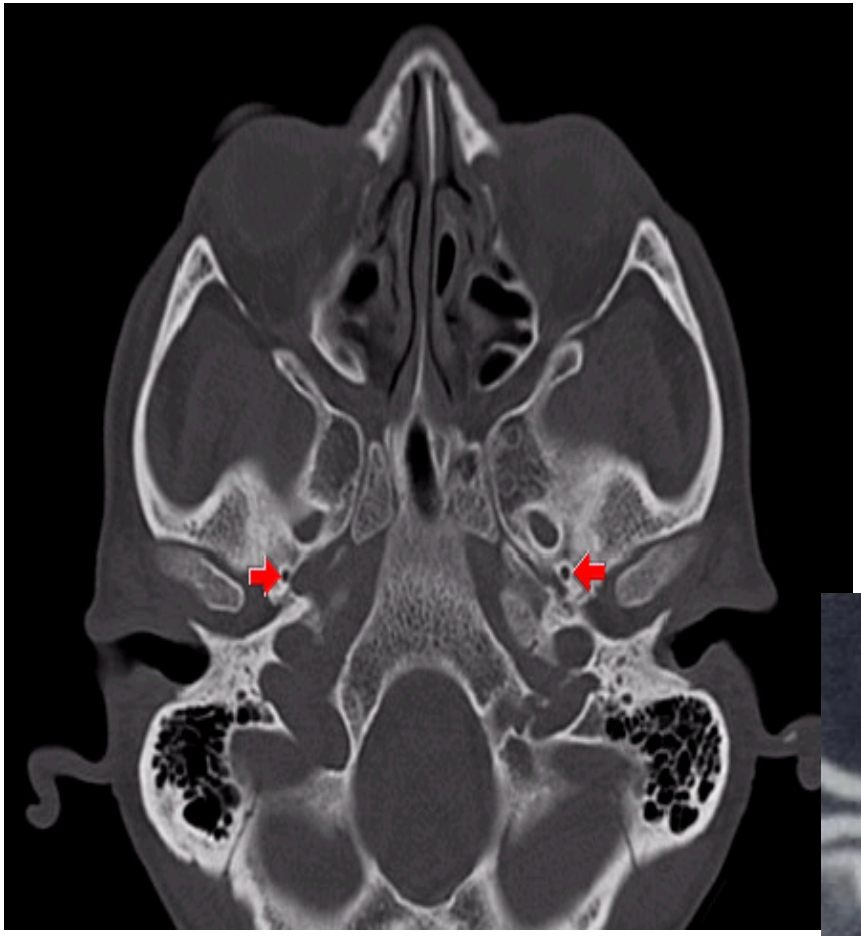
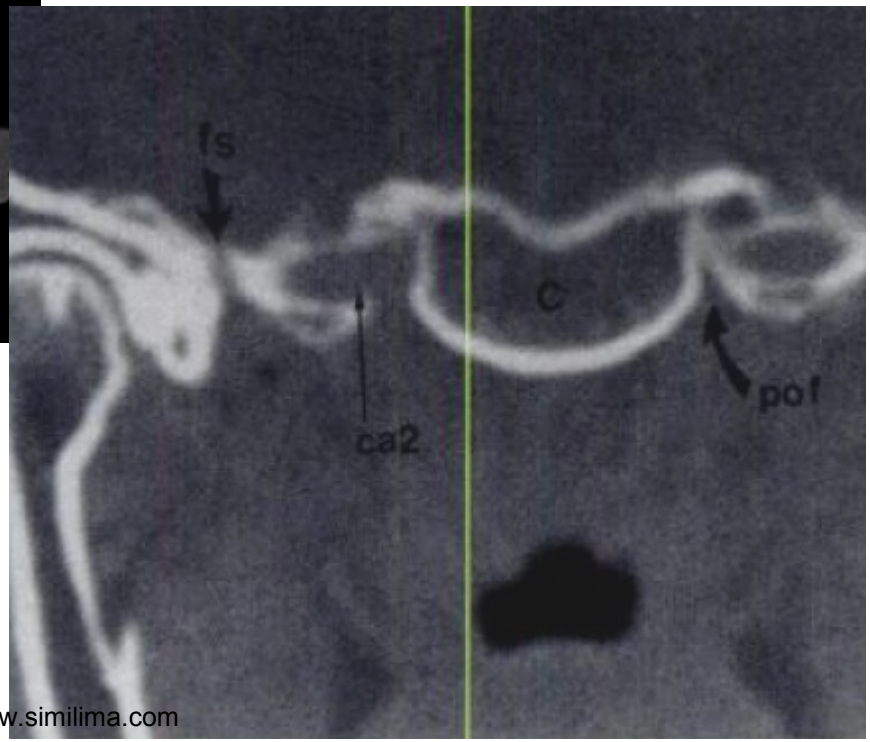
FORAMEN SPINOSUM

- Posteromedial aspect of greaterwing,just posterolateral to f.ovale endocranially.
- Lateral to eustachian tube exocranially.
- Transmits
  - Midlemeningeal artery and vein
  - Recurrent branch of mandibular nerve.
- Best visualised with axial CT.





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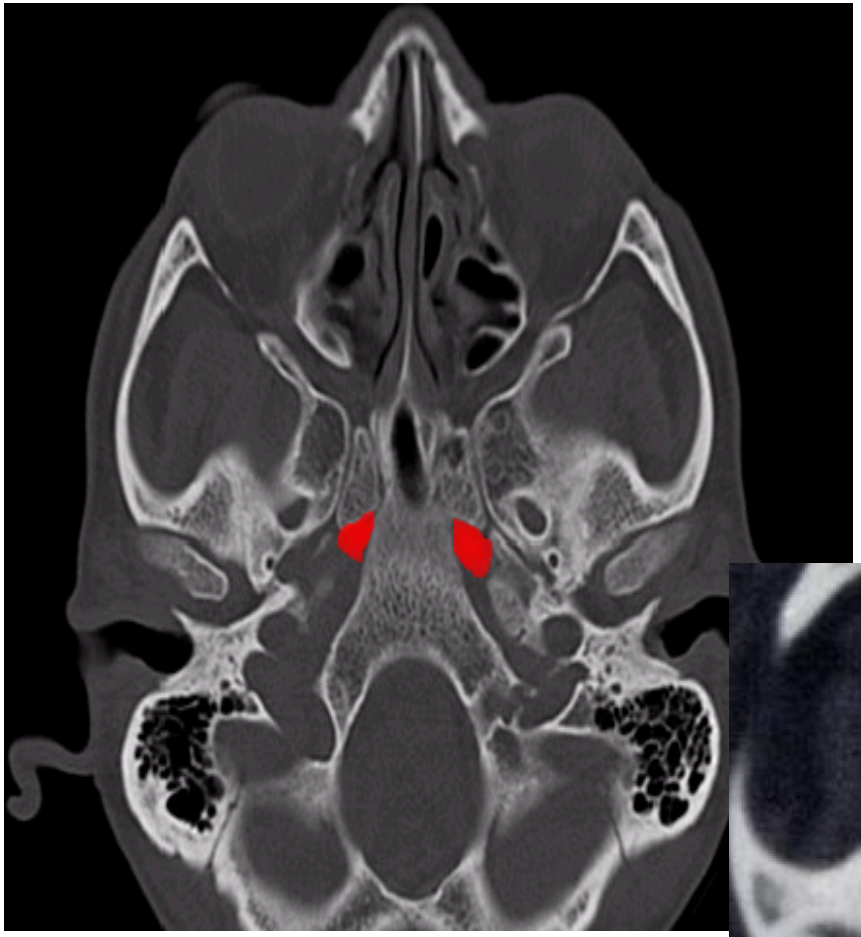
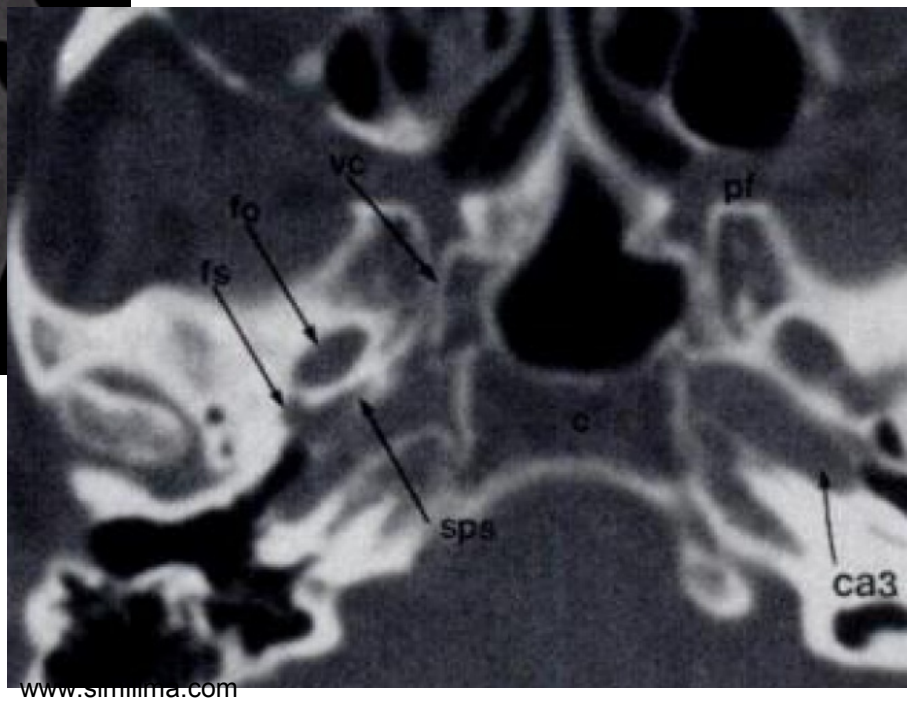
FORAMEN LACERUM

- Not a foramen in reality
- Is covered by fibrocartillage on it's floor and carotid artery rests on it.
- An inconstant meningeal branch of asc pharyngeal artery may pierce it.
- Nerve of pterygoid canal is formed by the union of GSPN and deep petrosal nerve.
- Visualised on both axial and coronal CT or MRI.

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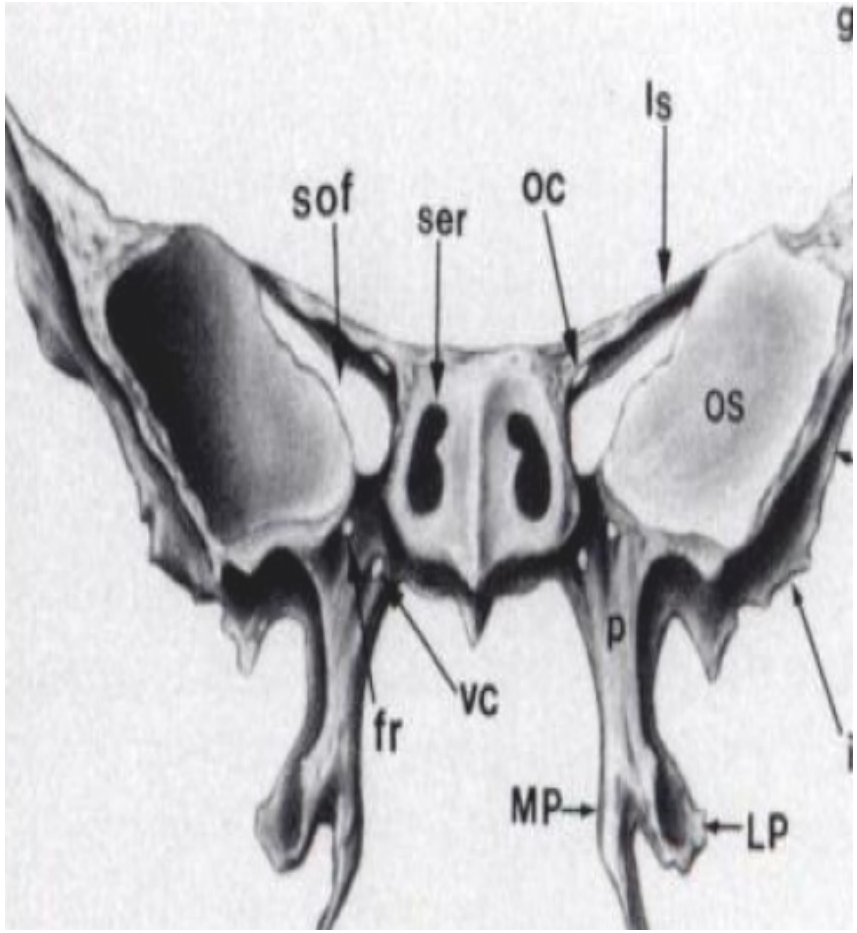
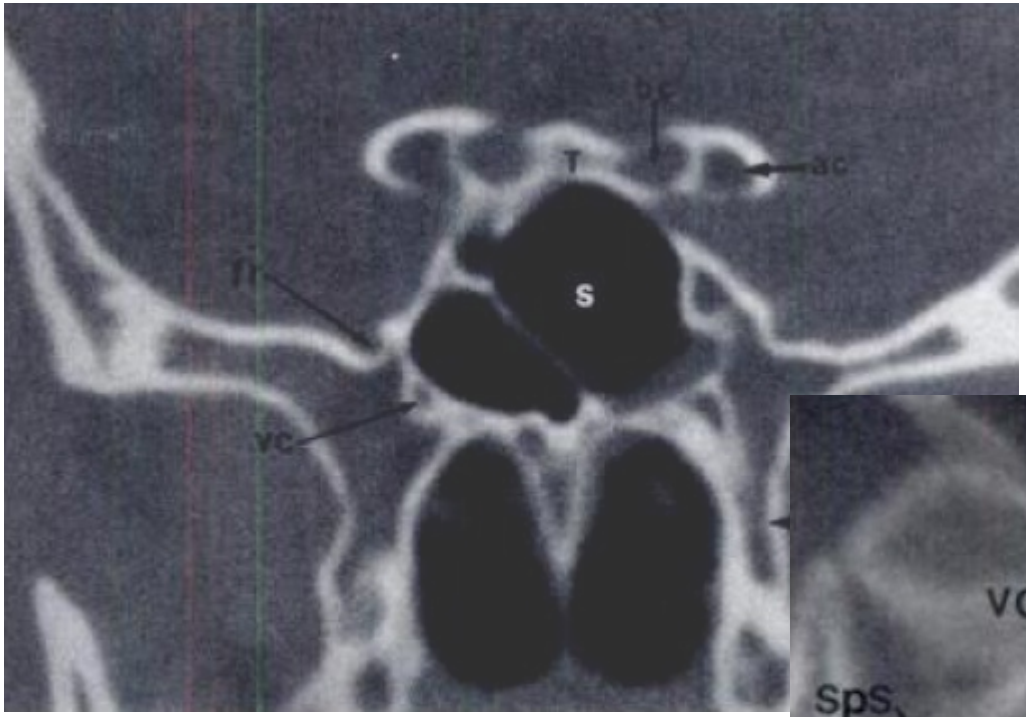
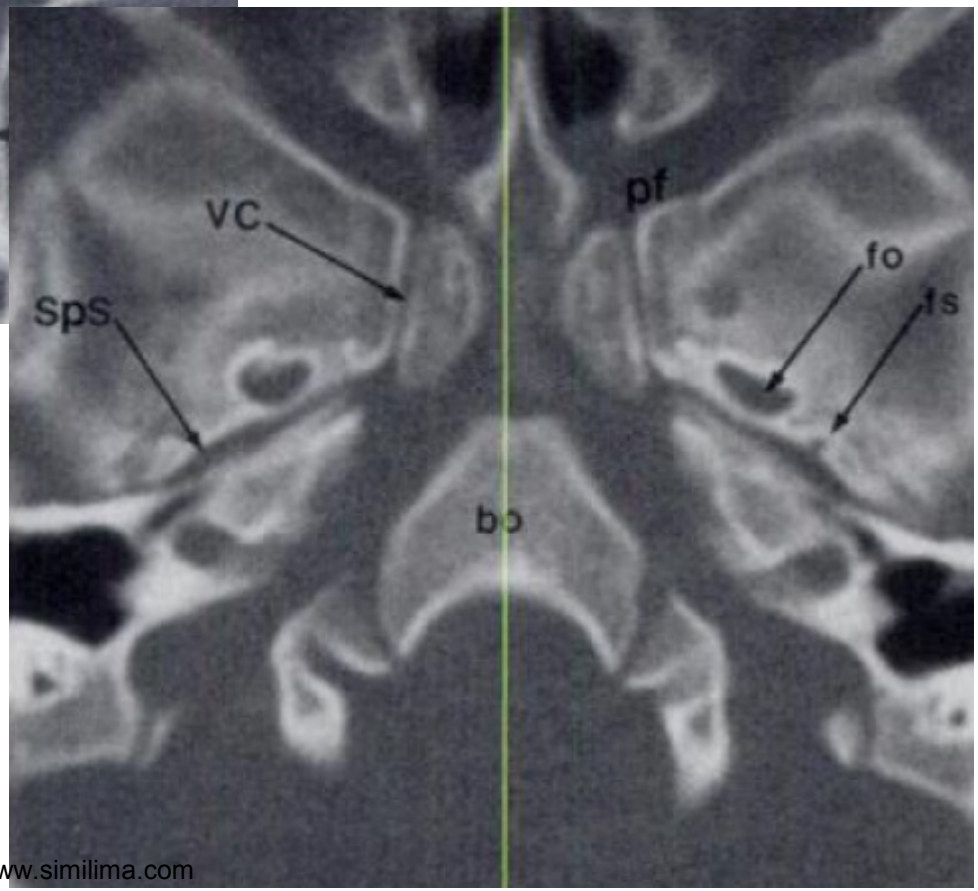
PTERYGOID CANAL

- Also known as vidian canal.
- Situated in the base of pterygoid plates,below Foramen Rotundum.
- Connects pterygopalatine fossa anteriorly to Foramen lacerum posteriorly.
- Transmits vidian artery and nerve.
- Vidian artery- branch of terminal portion of maxillary artery, arises in PPF. Because of it's proximity to f.lacerum, it often provides important collateral to ICA>
- Best visualised on axial and coronal CT scans.

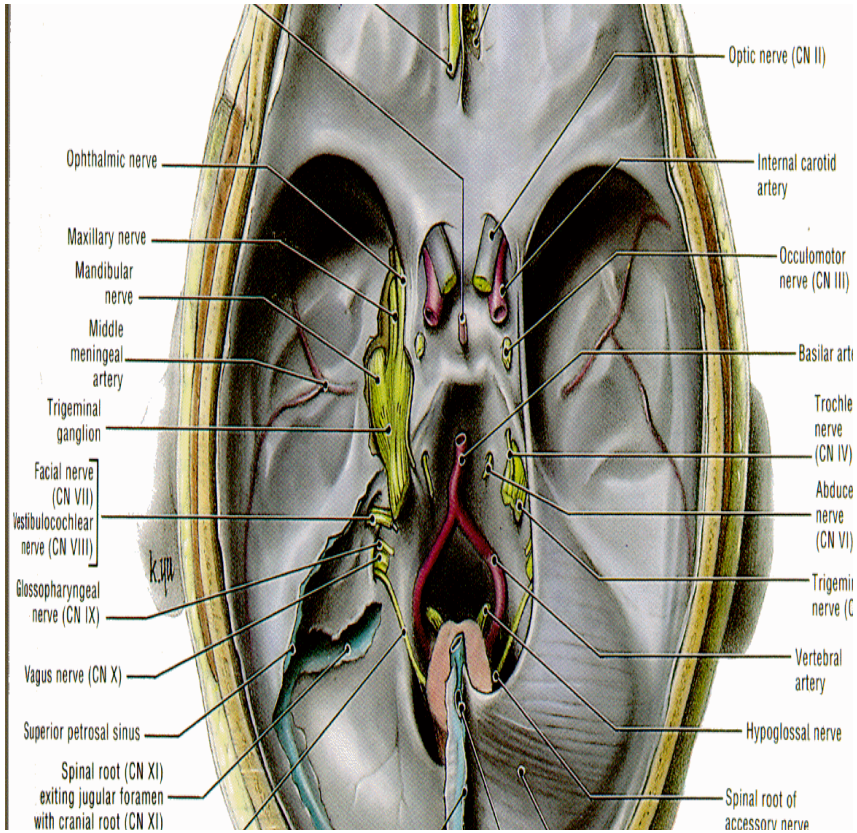






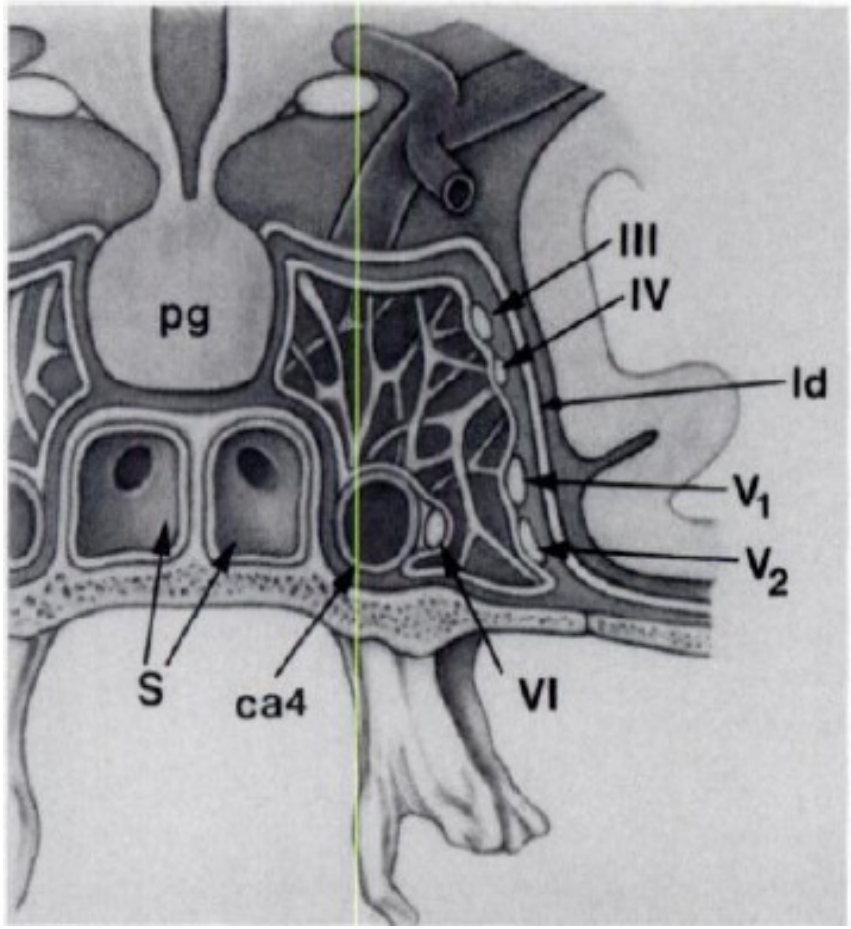
Cavernous Sinus

- The cavernous sinus is a complex plexus of veins within the dura that can be found lateral to the sphenoid sinus. It extends from the superior orbital fissure to the apex of the petrous temporal bone. The anterior and posterior petroclinoid folds serve as the lateral borders. Through it, runs the ICA.
- Running lateral to the ICA, the abducens (VI) nerve enters the dura superior to the clivus and enters the Dorello canal. Infection of the petrous apex presents classically with abducens palsy, as a result of inflammation in the Dorello canal.



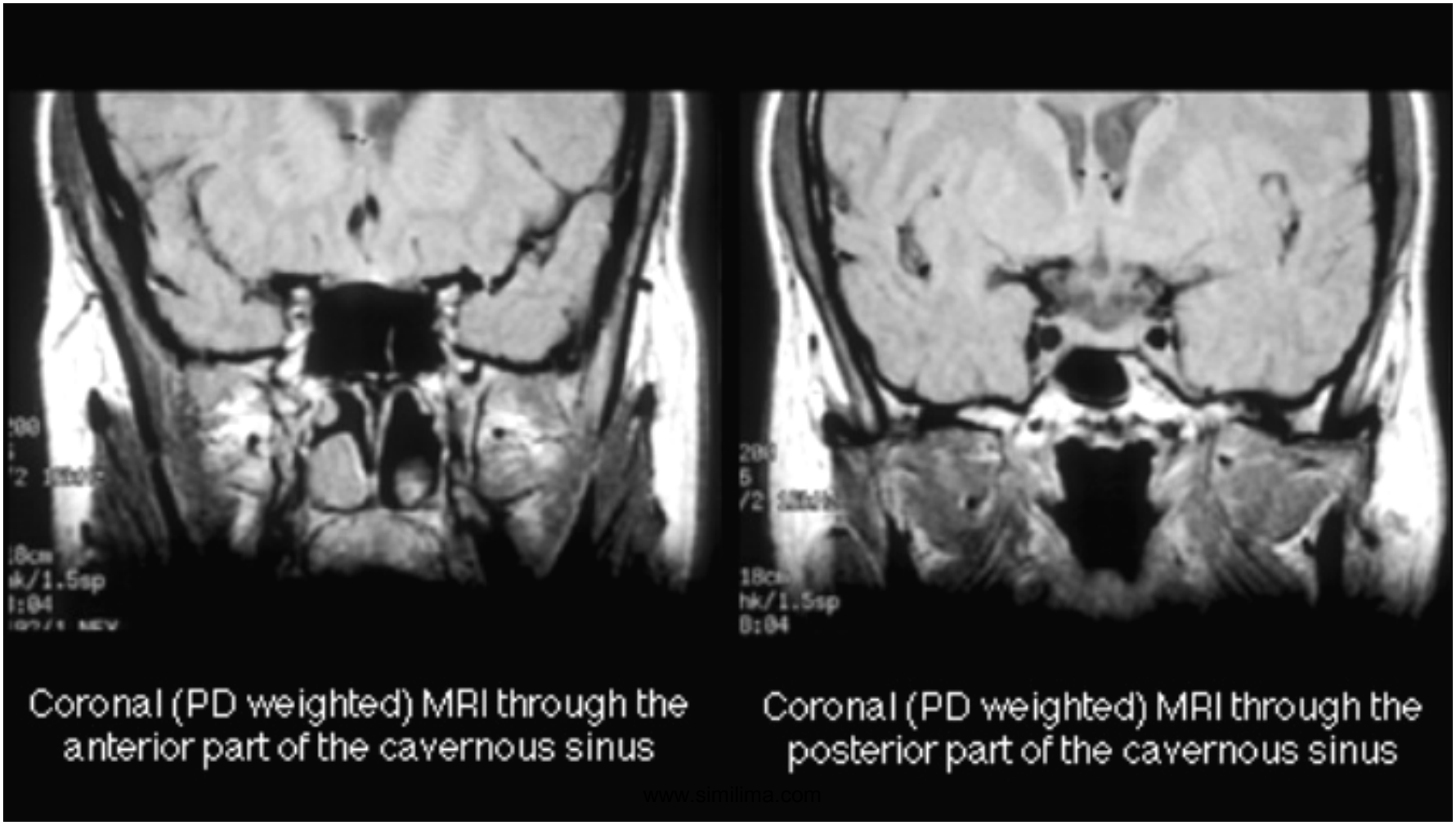
Cavernous Sinus

- Running superoinferiorly within the lateral wall are the oculomotor (III), trochlear (IV), ophthalmic (V1), and maxillary (V2) nerves respectively.
- The oculomotor nerve divides into superior and inferior divisions at the most anterior portion of the cavernous sinus.
- The trochlear nerve enters at the angle between the anterior and posterior petroclinoid folds and courses the lateral wall.
- The 3 divisions of the trigeminal traverse inferior to the tentorium cerebelli into the Meckel cave, within the subarachnoid space. From here, V1, V2, and V3 pass into the lateral wall of the cavernous sinus.



Coronal CT through the anterior part of the cavernous sinus

Coronal CT through the posterior part of the cavernous sinus

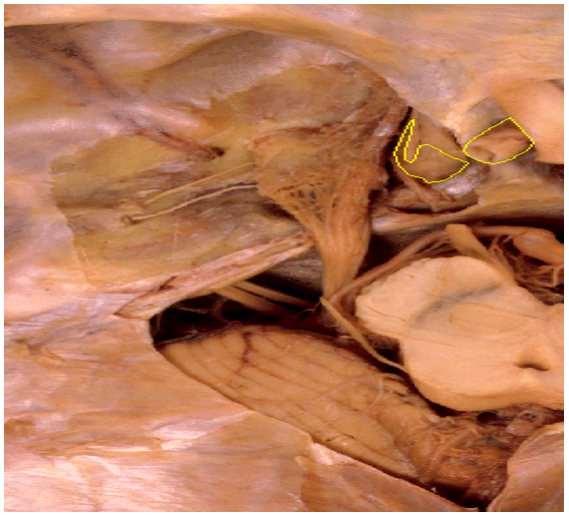


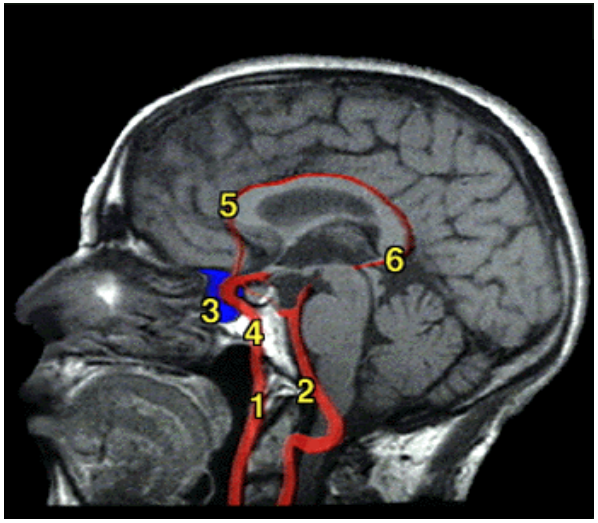
Coronal (PD weighted) MRI through the anterior part of the cavernous sinus

Coronal (PD weighted) MRI through the posterior part of the cavernous sinus

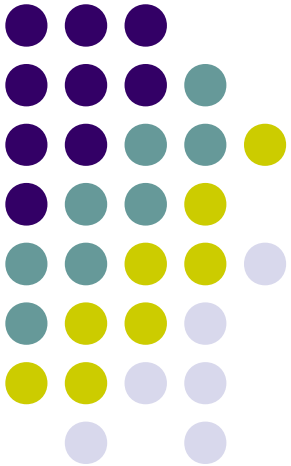
Internal carotid artery

- The course of the ICA is complex, and can be divided into 4 parts: cervical, intratemporal, cavernous, and supracavernous
- The temporal carotid artery runs forward along the petrous bone, giving off the caroticotympanic and pterygoid branches.
- At this point, the artery is superior and lateral to the sphenoid bone, in an area referred to as the carotid siphon.
- The artery then enters the cavernous sinus medial to the abducens nerve (VI). Upon traversing the roof of the cavernous sinus,it is medial to the anterior clinoid process,
- The ICA now enters the supracavernous portion. The last segment turns backward under the optic nerve to the anterior perforated substance where it joins the circle of Willis via its terminal anterior and middle cerebral arteries





POSTERIOR SKULL BASE

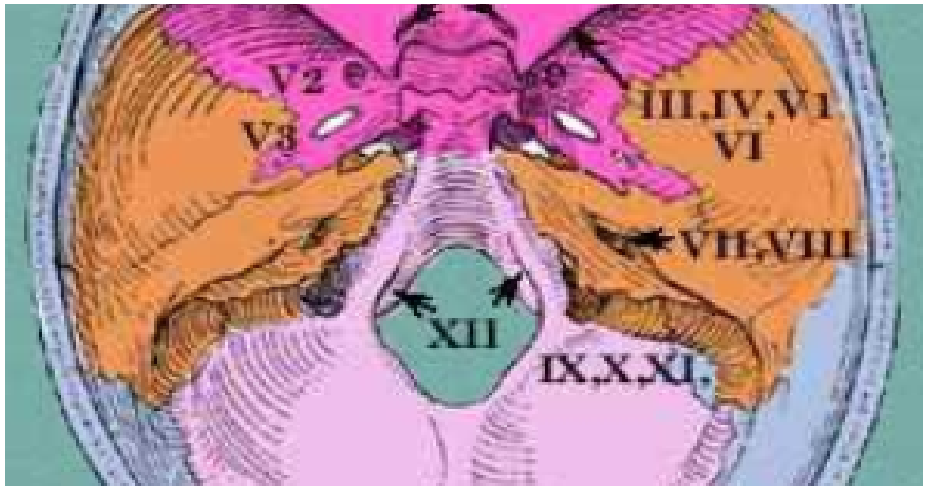


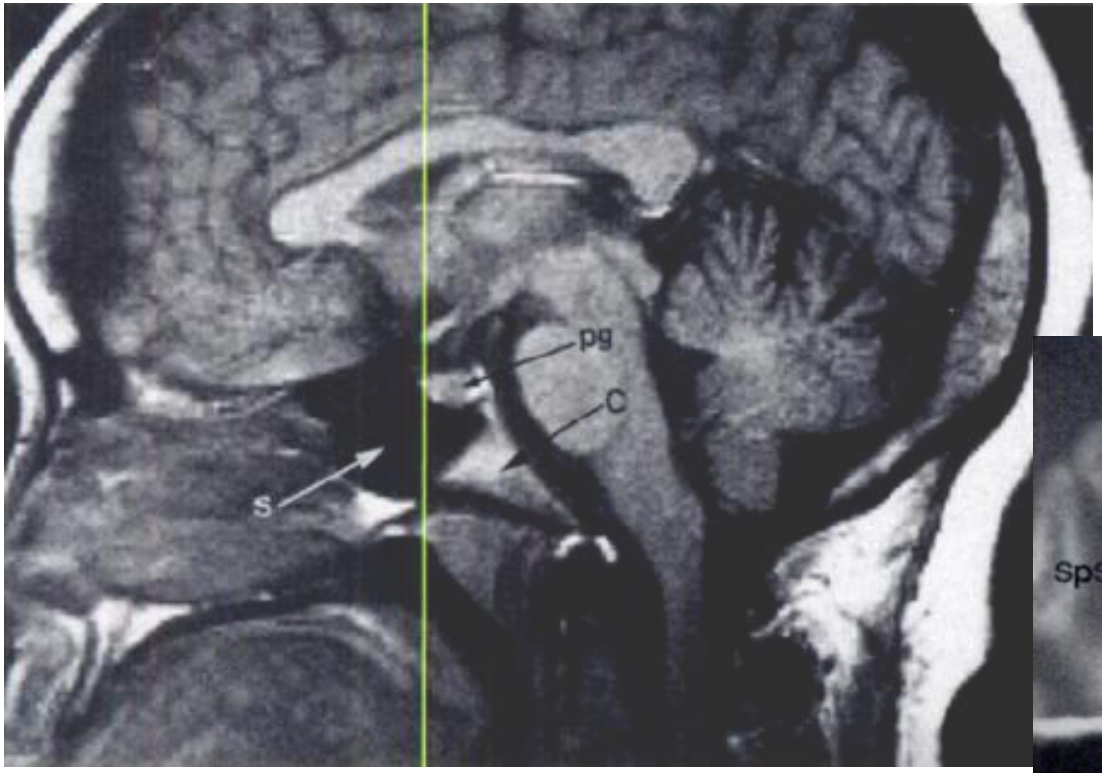
POSTERIOR SKULL BASE -Boundaries

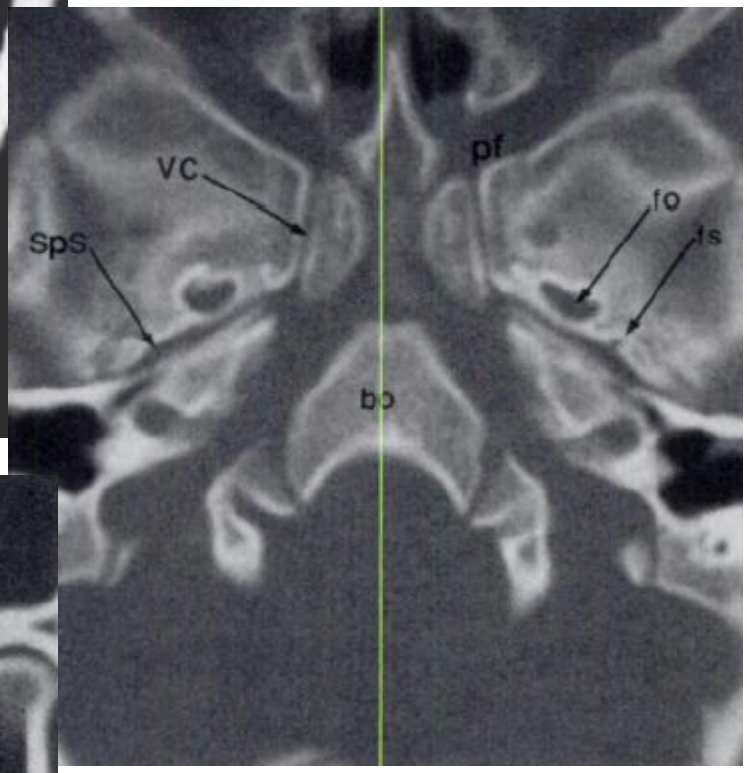
- The posterior skull base consists primarily of the occipital bone, with contributions from the sphenoid and temporal bones.
- The anterior portion of the posterior skull base is formed by the basal portion of the occipital bone (also known as the basiocciput) and the basisphenoid.
- These two regions combine to form the midline clivus.

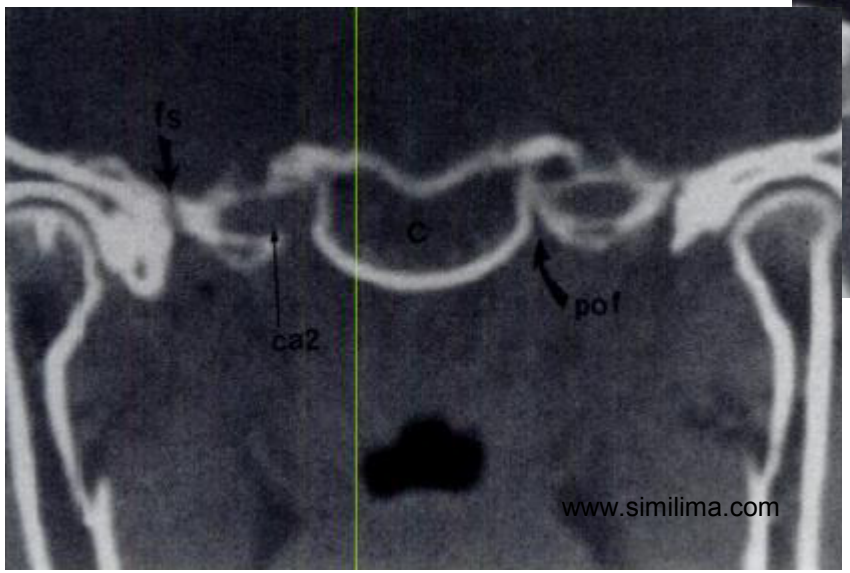
CLIVUS

- Part of skull base between foramen magnum and dorsum sellae.
- Include basioccipital bone and sphenoidal bone.
- Anterior lateral margin formed by petrooccipital fissure.
- Posterior lateral margins by synchondrosis between basioccipital and exoccipital bones.
- Anterior margin blends into the sphenoid sinus,while posteroinferiorly, it slopes gently to form anterior aspect of foramen magnum.
- Inferiorly, it is bounded by nasopharynx.



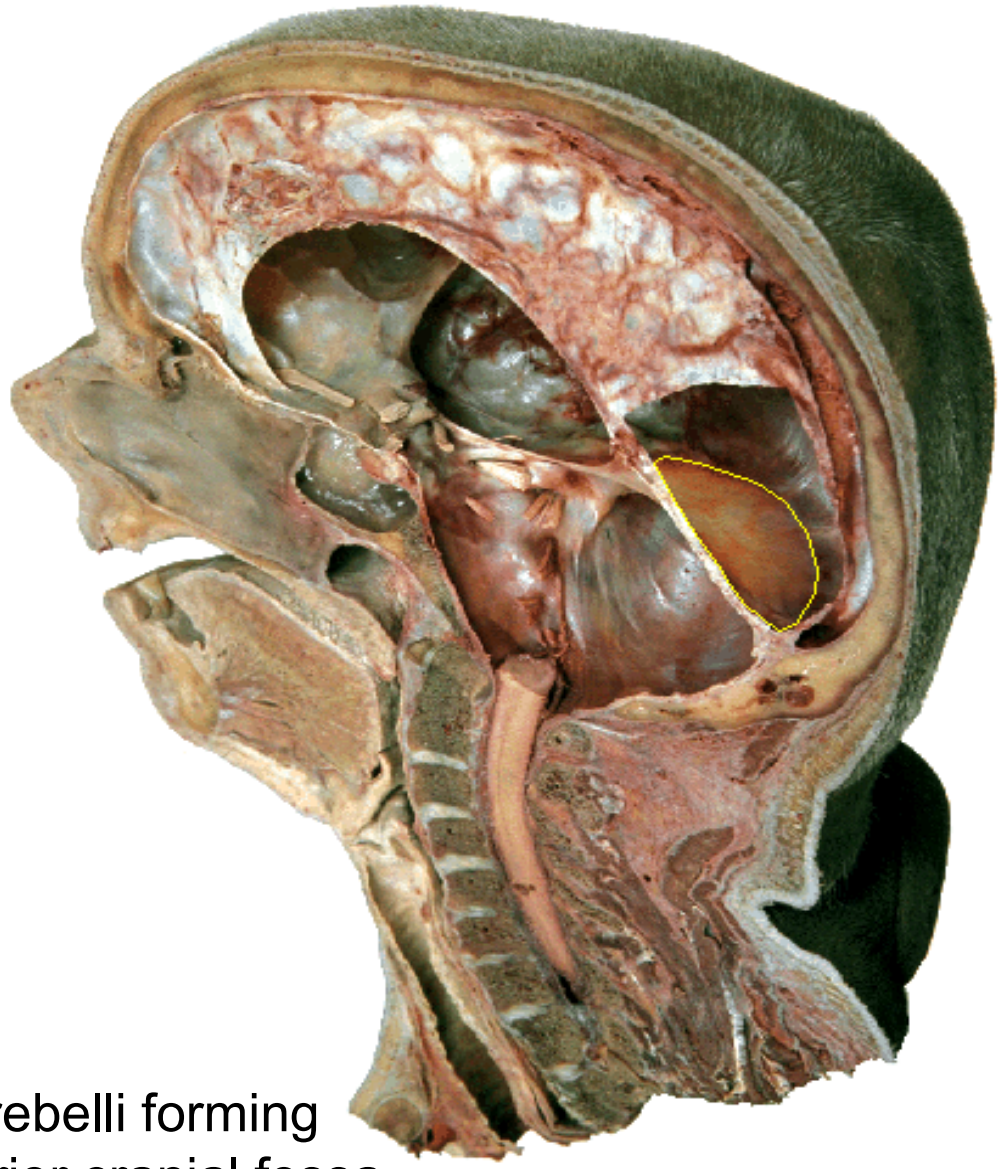






POSTERIOR SKULL BASE -Boundaries

- The lateral wall is formed by the posterior surface of the petrous temporal bone and the lateral aspect of the occipital bone.
- The occipital bone also fuses with the mastoid portion of the temporal bone to form the occipitomastoid suture
- Tentorium cerebelli separates the cerebellum from the cerebral hemispheres above, while the lateral walls and floor are formed from the occipital bone.



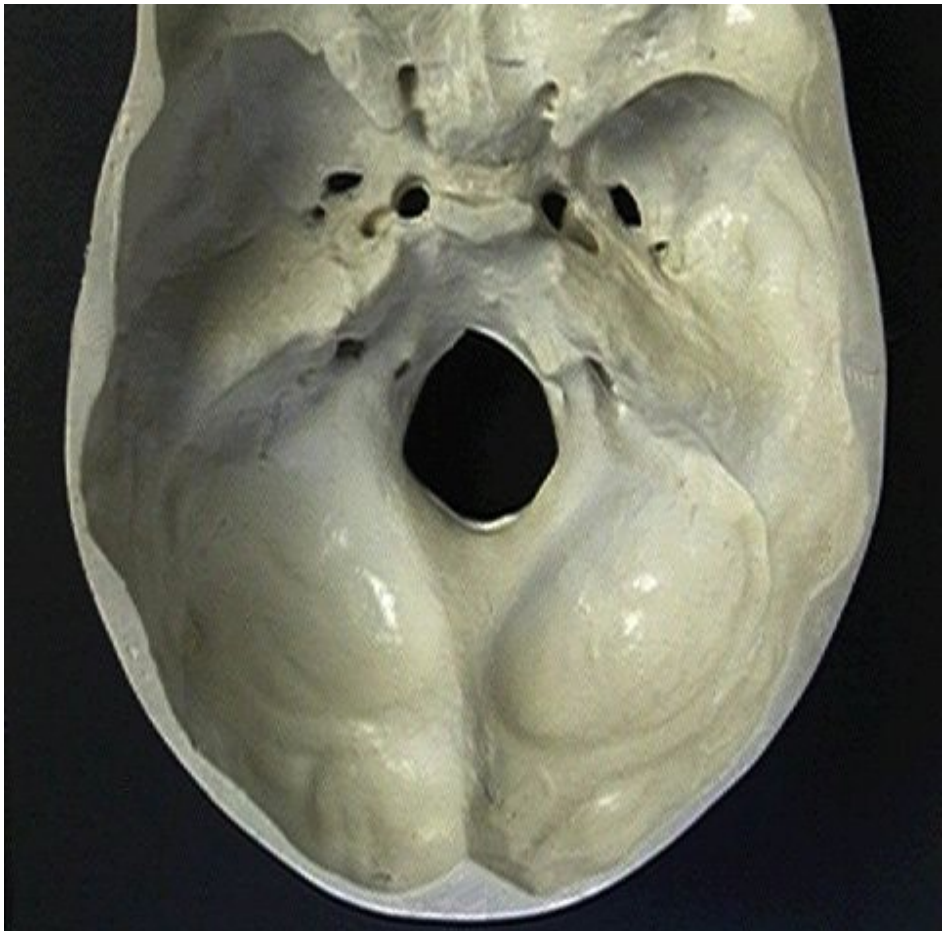
Tentorium cerebelli forming
Roof of posterior cranial fossa

POSTERIOR SKULL BASE -Boundaries

- The floor is grooved for the cerebellar hemispheres and the midline internal occipital crest runs from the foramen magnum to the internal occipital protuberance (IOP).
- The crest serves as an attachment for the falx cerebelli, which contains the occipital sinus.
- Grooves for the superior sagittal sinus are superior to the IOP.
- The horizontal grooves for the paired transverse sinuses can be found lateral to the IOP, and descend to the mastoid angle of the parietal bone to become continuous with the sigmoid sulcus.

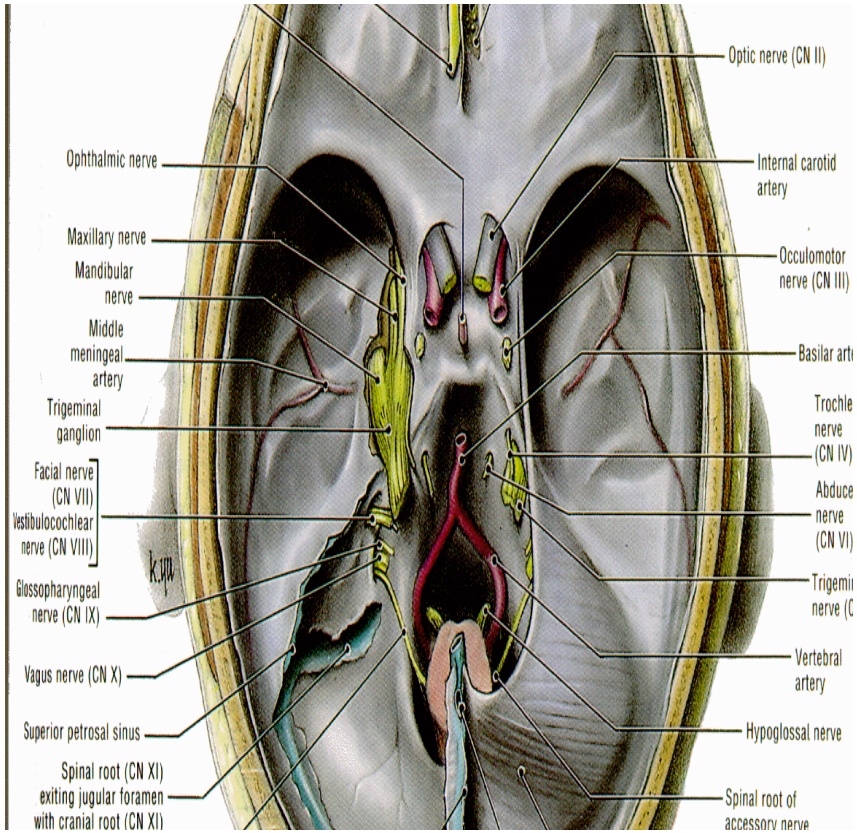
POSTERIOR SKULL BASE -Boundaries

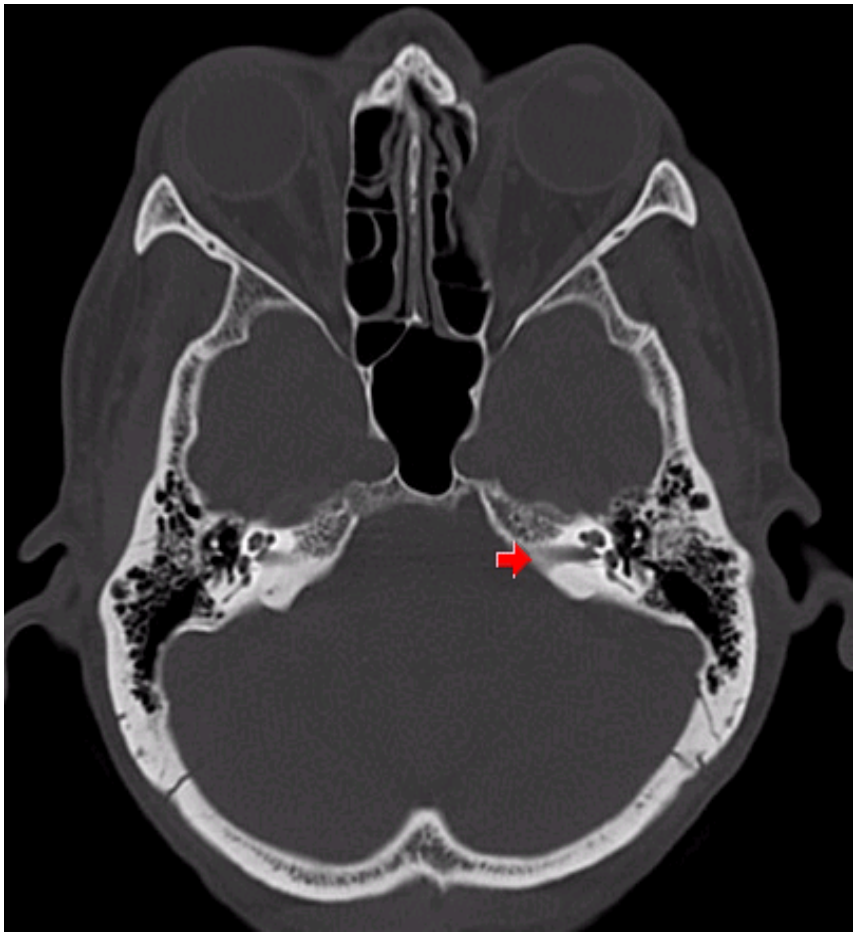
- The sigmoid sulcus can be found within the lateral aspect of the posterior cranial fossa, within the mastoid portion of the temporal bone.
- It ends at the jugular foramen.
- The sulcus for the inferior petrosal sinus sits posterior to the clivus and anterior to the petrous apex



POSTERIOR SKULL BASE -foramina

- The porus acousticus is the opening of the internal auditory canal (IAC).
- It can be found on the posterior surface of the petrous bone, and it transmits the cranial nerves VII and VIII, the nervus intermedius, and the labyrinthine vessels (branches of the anterior inferior cerebellar artery en route to the inner ear).
- The vestibular aqueduct can be found postero inferiorly to the IAC. It transmits the endolymphatic duct.





POSTERIOR SKULL BASE -foramina

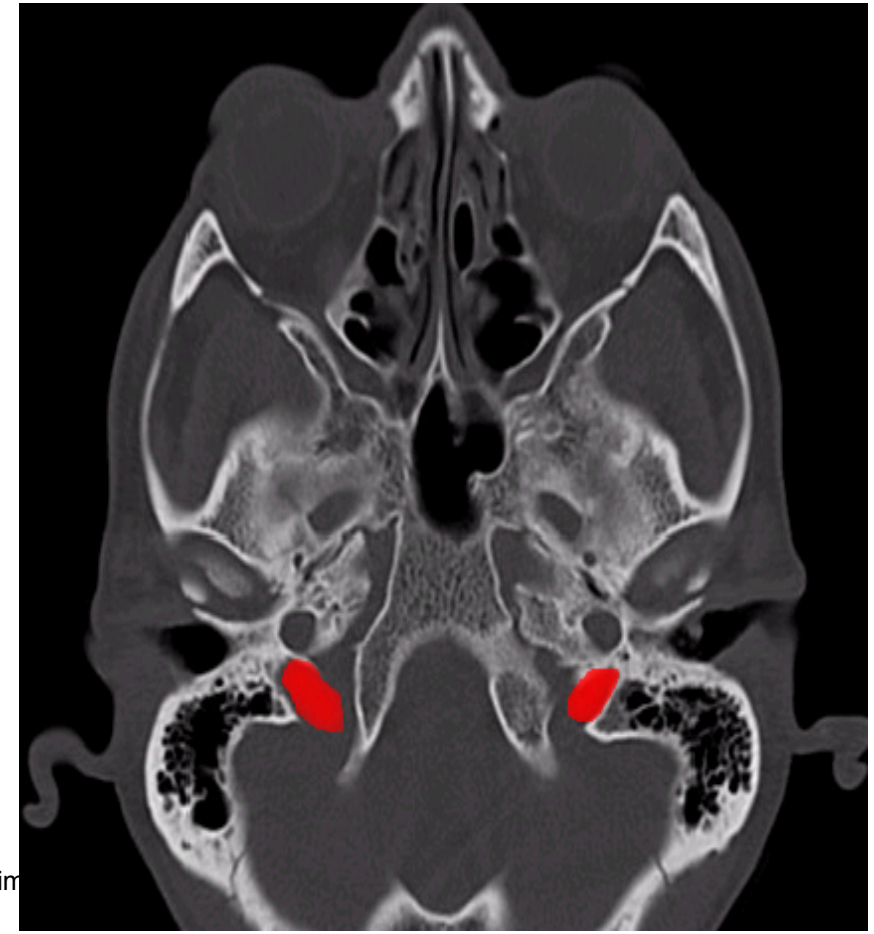
- The jugular foramen can be found extending laterally from the posterior aspect of the occipital condyle.
- It is formed by the anterior processus jugularis of the petrous bone and the occipital bone posteriorly and lies at the posterior end of the petro-occipital fissure.
- The sigmoid sinus and jugular bulb enter the foramen at its smooth, posterior end (pars venosa) and cranial nerves IX, X, and XI enter its rougher, anterior end (pars nervosa).

POSTERIOR SKULL BASE -foramina

- The inferior petrosal sinus usually enters jugular foramen between cranial nerves IX and X, but its path is highly variable
- It may even enter the internal jugular vein below the skull base.
- Lastly, the ascending pharyngeal artery may send a posterior meningeal branch via the jugular foramen.

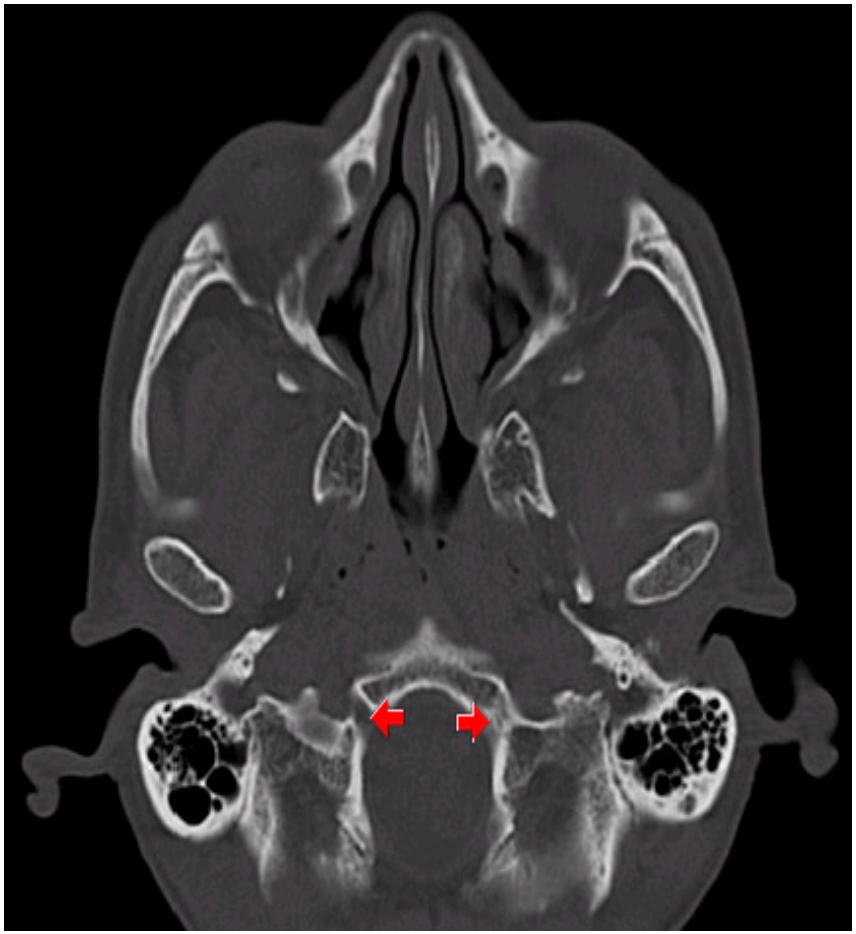
Jugular tubercle of occipital bone
(roof of hypoglossal canal)

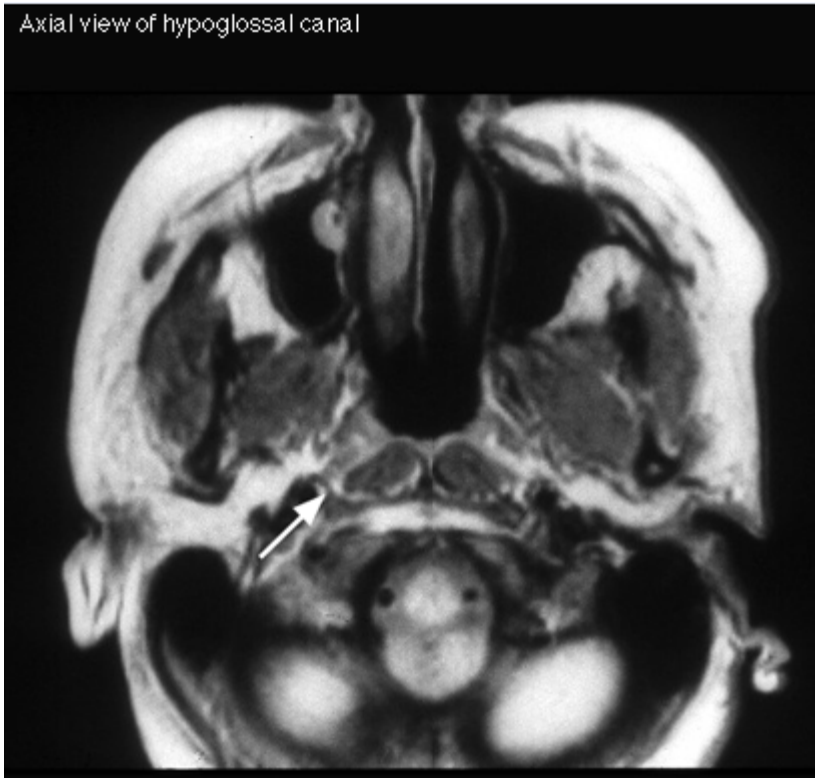
•Jugular foramen becoming sigmoid sinus

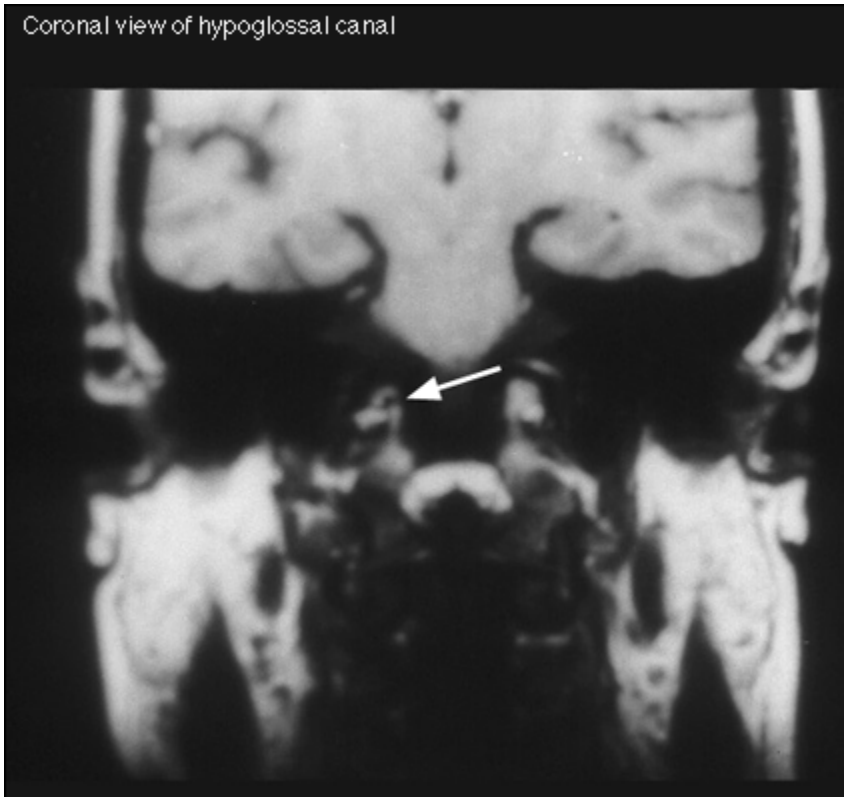


POSTERIOR SKULL BASE -foramina

- The jugular tubercle may be found medial to the lower aspect of the jugular foramen, and serves as a landmark for the hypoglossal foramen
- The hypoglossal foramen is located inferomedially to the jugular foramen and in close proximity to the jugular tubercle. It transmits the hypoglossal nerve (XII), a meningeal branch of the ascending pharyngeal artery, and the hypoglossal venous plexus.

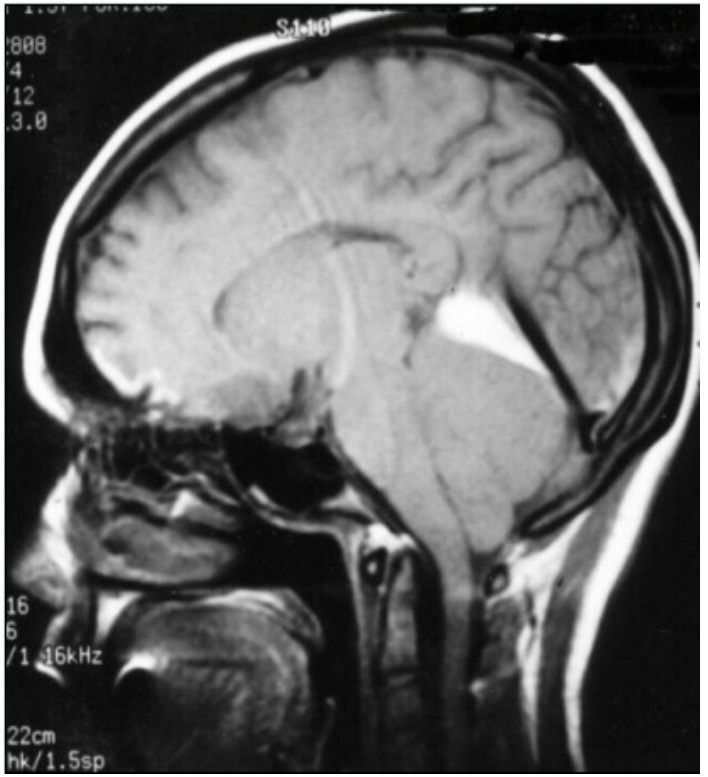



Axial view of hypoglossal canal

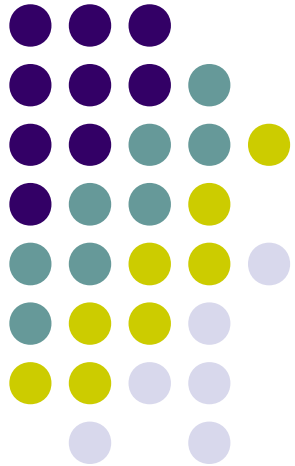

Coronal view of hypoglossal canal

POSTERIOR SKULL BASE -foramina

- The brainstem communicates with the vertebral canal via the foramen magnum. The structures that pass through are the medulla oblongata, spinal accessory nerve, vertebral and posterior spinal arteries, and the apical ligament of the dens and membrane tectoria.



BORDERING SOFT TISSUES

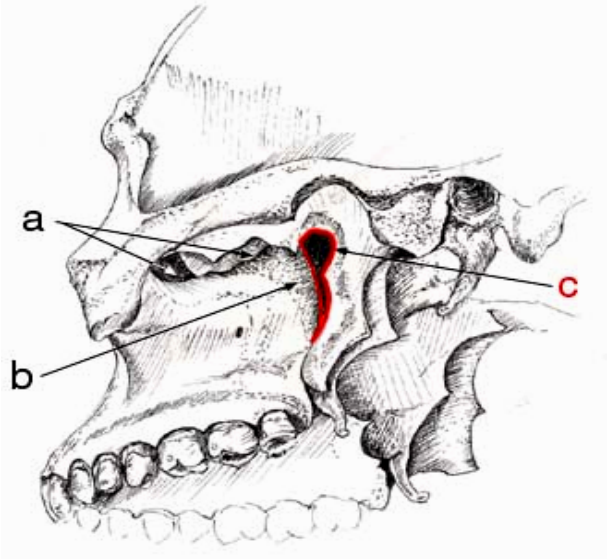


EXTRA CRANIAL SOFT TISSUES

- Extracranial openings of the fissures and foramina of skull base are bordered by soft tissues, primarily fat, which is important in imaging analysis of skull base, by providing excellent contrast between normal tissues and lesions.
- Optic canal and SOF opens into orbit, and although optic nerve and extraocular muscle occupy space in orbital apex,there is still sufficient fat for detecting most of the lesions.
- Also, orbital fat normally protrdes slightly through the SOF into the region of anterior cavernous sinus.
- Foramen ovale opens into masticator/ infratemporal fossa.
- Mandibular nerve exits out of skull through this foramen and emerges into fat along medial margin of lateral ptrygoid muscle.

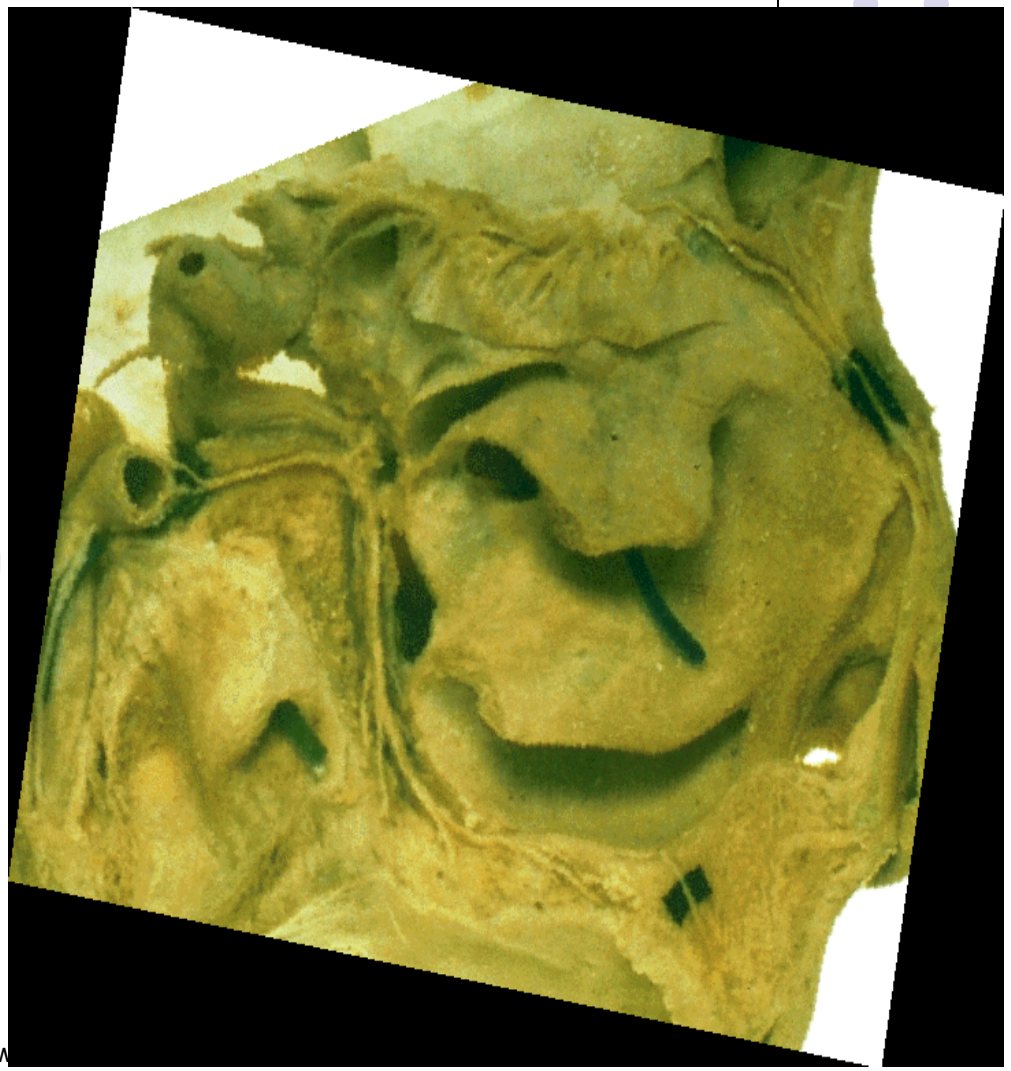
PTERYGOPALATINE FOSSA

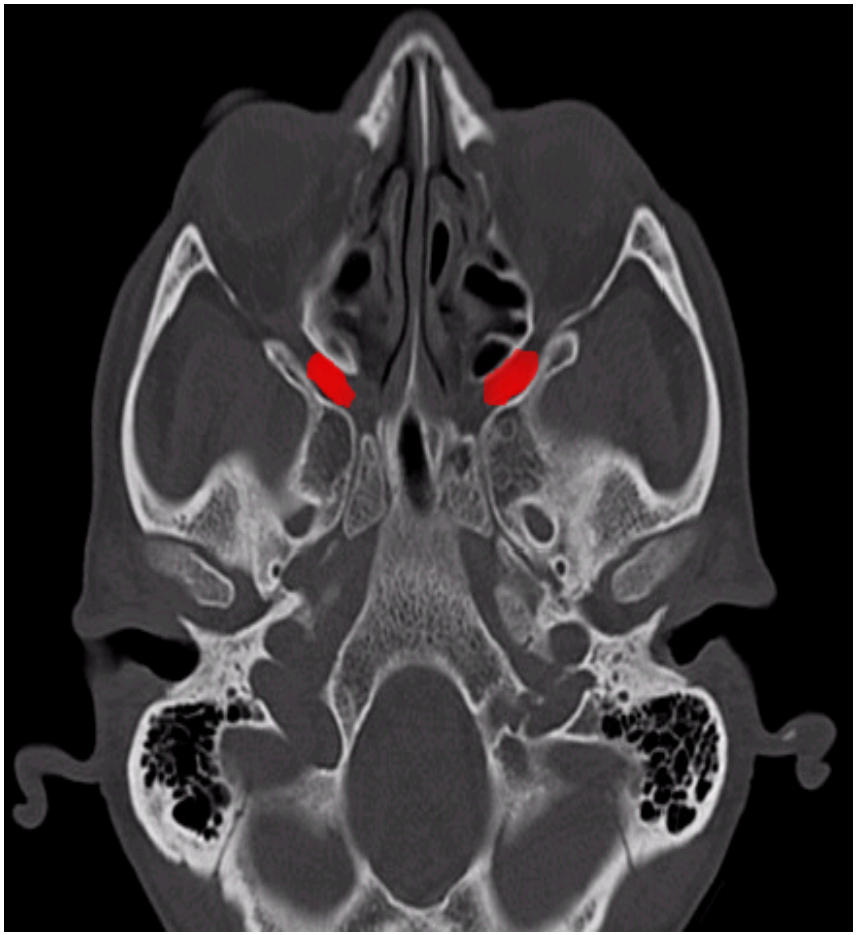
- **Narrow cleft behind** the medial posterior wall of maxillary sinus.
- Pterygoid process of sphenoid forms posterior wall
- Anterior wall formed by superiorly projecting orbital process of palatine bone.
- Connects 5 spaces
  - **MCF via vidian canal and F.Rotundum**
  - **Orbit via IOF**
  - **Infratemporal fossa via pterygomaxillary fissure**
  - **Nasal cavity via sphenopalatine foramen**
  - **Oral cavity via pterygopalatine canals**



PTERYGOPALATINE FOSSA

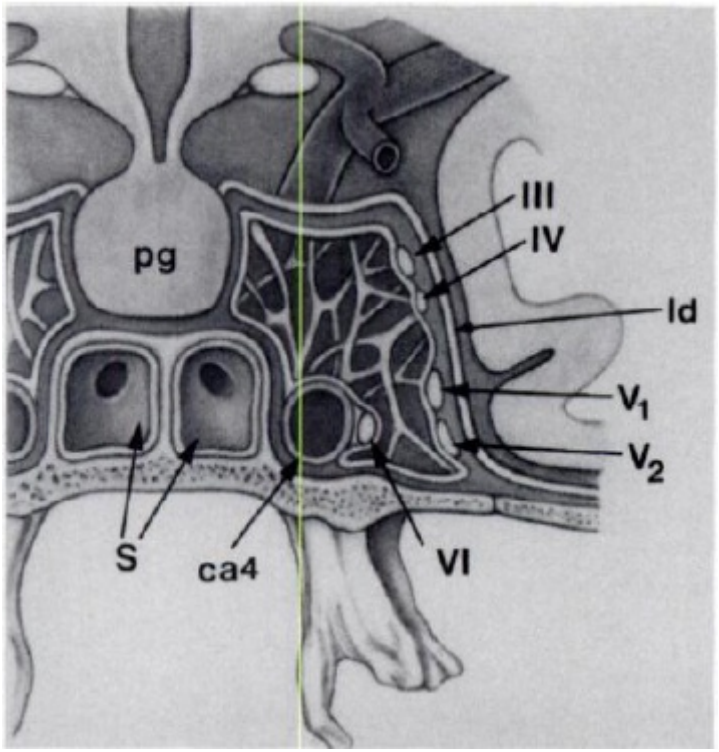
- Thus due to it's crucial location, pterygopalatine fossa forms an important landmark in staging head and neck tumors
- Contents
  - Pterygopalatine ganglion
  - Blood vessels
  - Fat, which foms the predominant imaging finding and serves as an important land mark in tumor spread.





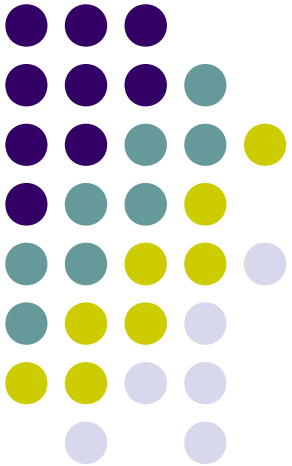
INTRACRANIAL SOFT TISSUES

- Intracranially, most of the foramina converge on to the region of cavernous sinus and meckel's cave.
- Optic canal opens into suprasellar cistern
- Cavernous sinus forms much of the medial wall of MCF.
- The dural organisation of meckels cave and cavernous sinus is derived from the dural coverings of the contiguous inner surfaces of the skull.
- Outer endosteal layer of dura follows bones of skull base.
- Inner meningeal layer reflected upward, forming lateral wall of meckel's cave and cavernous sinus before attatching to clinoids.

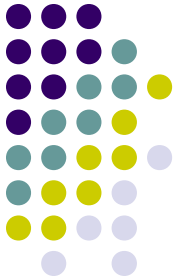


SKULL BASE

....imaging



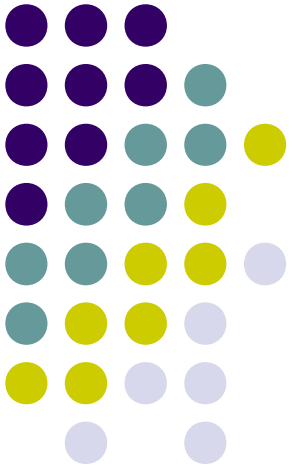
SKULL BASE IMAGING



- **Modalities**
  - **Plain X ray**
  - **CT scan**
  - **MRI**
  - **Fusion CT/MRI**

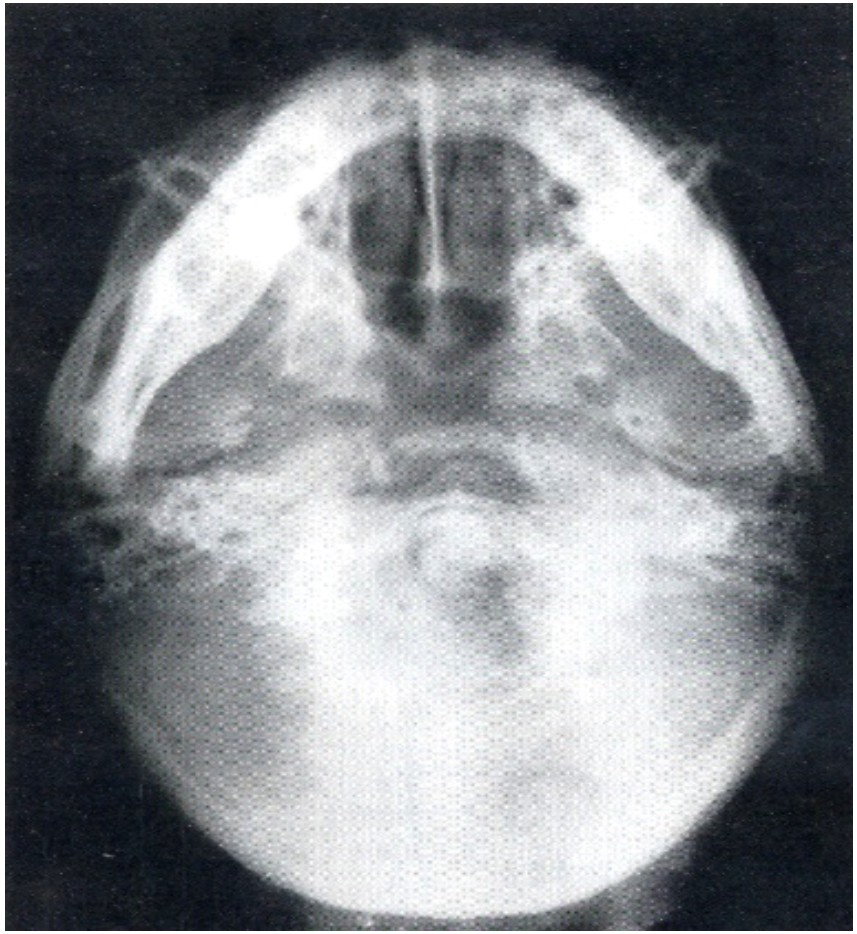
Plain X ray

Submento-vertical view



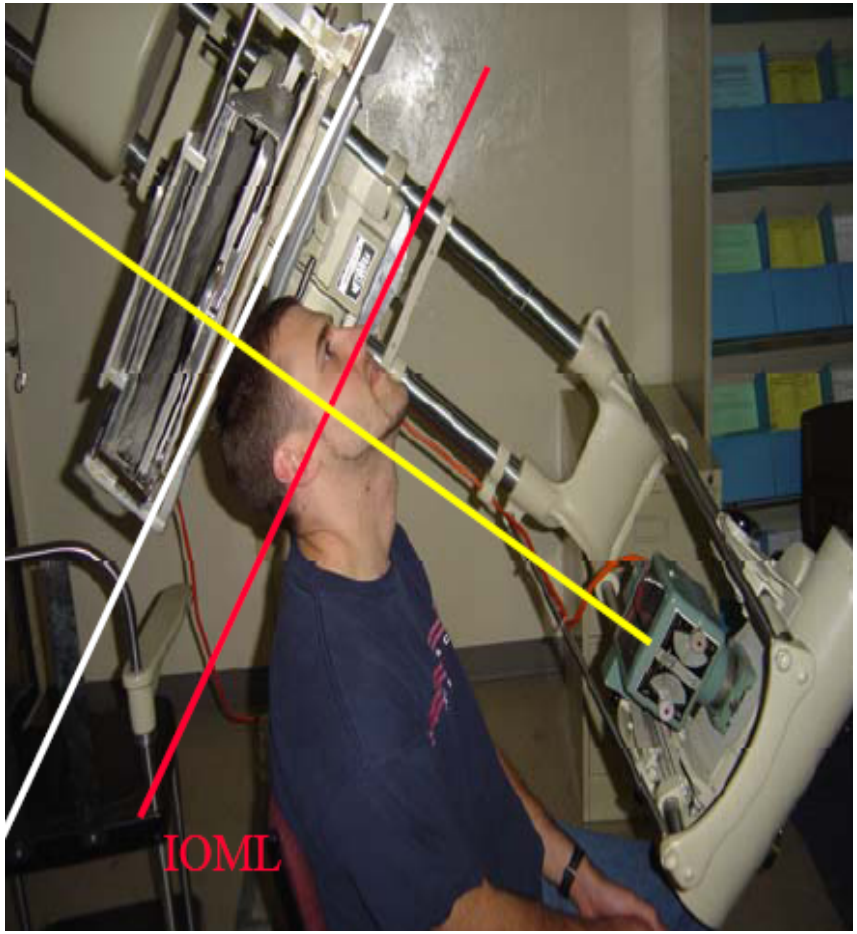
Submento-vertical view

- Also known as BASE VIEW.
- Uniquely valuable for structures in the skull base, even though other views also helps.
- May be imaged either erect or supine.



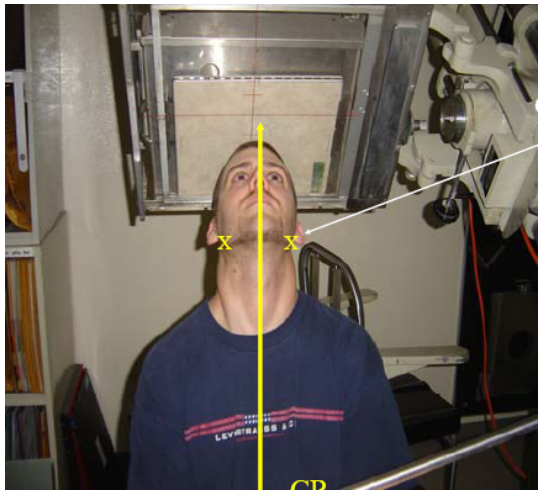
Submento-vertical view

- Supine
  - Neck hyperextended, to bring vertex in contact with grid cassette.
  - MSP at right angles to cassette along it's midline
  - Head adjusted to bring the EAM equidistant from cassette.
  - Orbitomeatal plane should be as near as possible parallel to cassette.
- Erect
  - Patients sits short distance away from vertical bucky.
  - Neck hyperextended to allow the head to fall back untill the vertex of the skull makes contact with the centrenof vertical bucky.



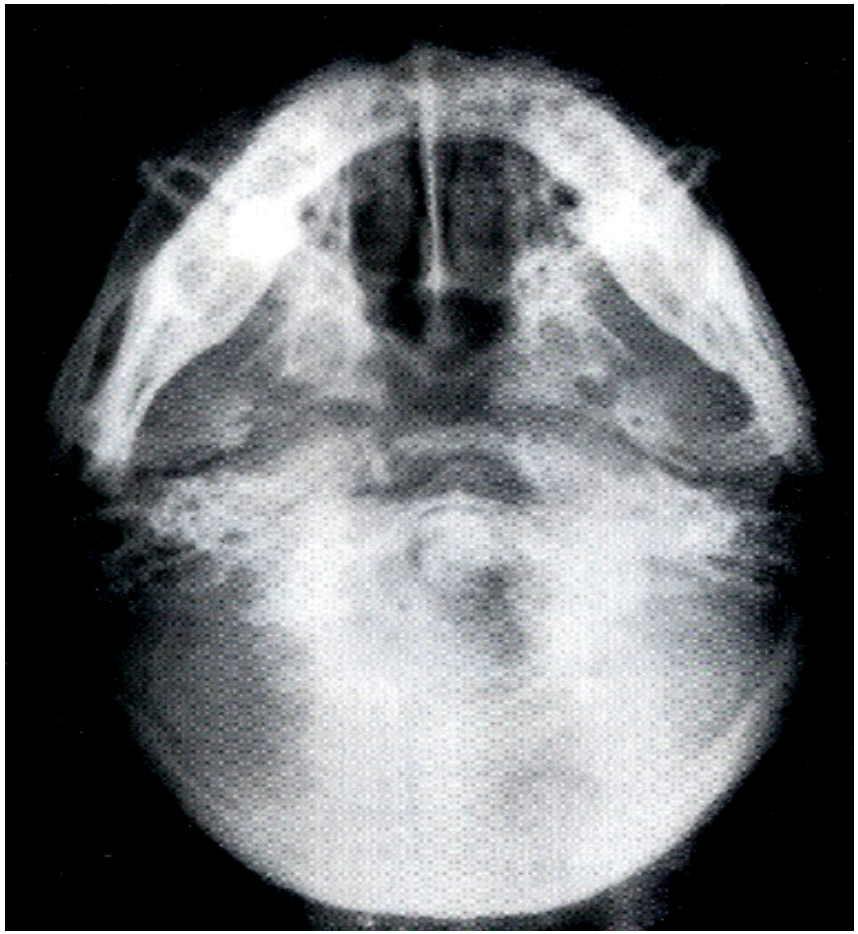
Submento-vertical view

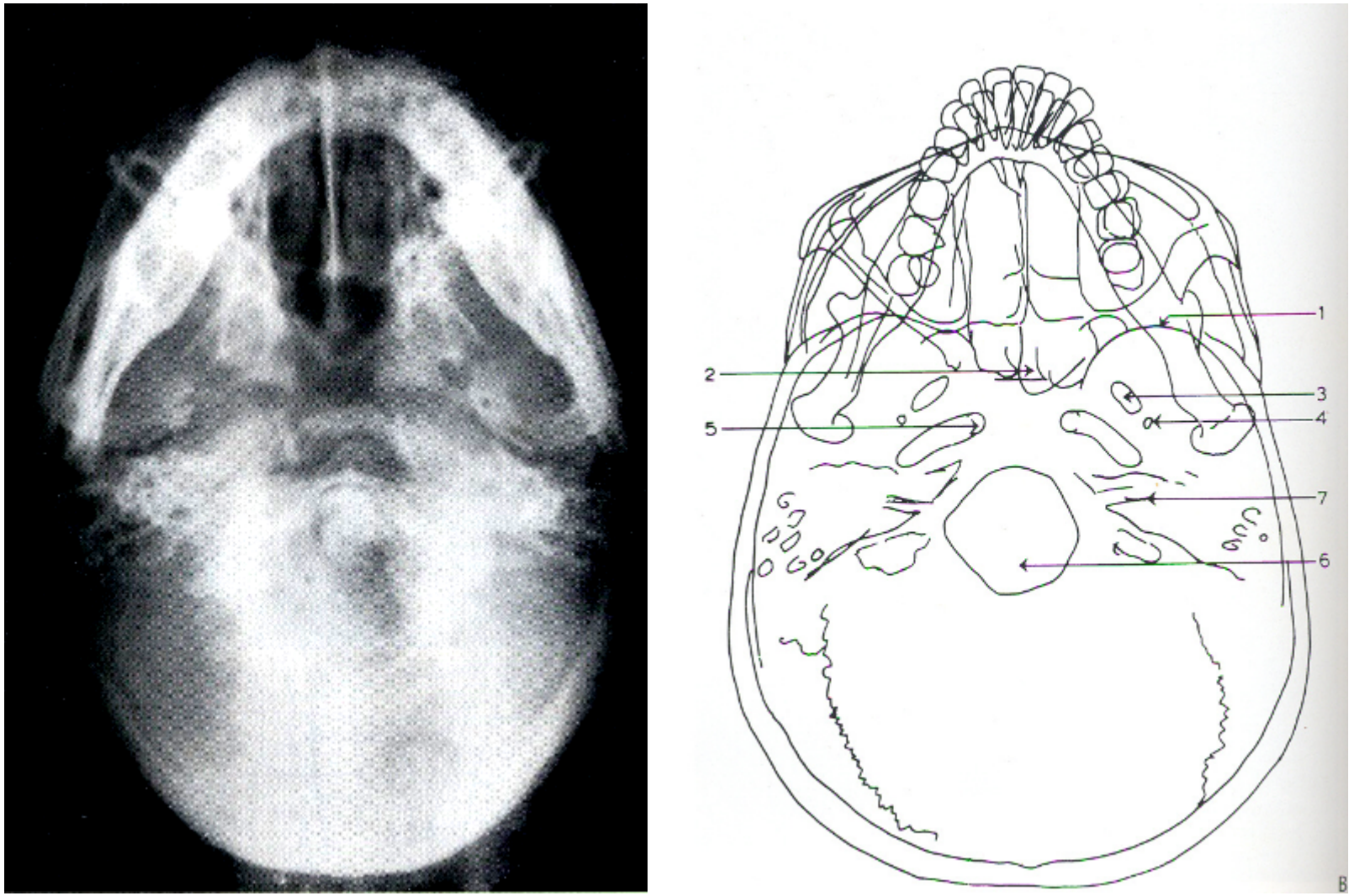
- CENTRAL RAY directed at right angles to orbitomeatal plane and centered midway between the ext aud meatuses.
- 75-85 kVp,
- 100 -160 mAs
- With grid using large focal spot, distance 100cms



Submento-vertical view

- Correct projection will show angles of mandible clear of petrous temporal bone.
- Foramina of middle cranial fossa should be seen symmetrically on either side of midline.





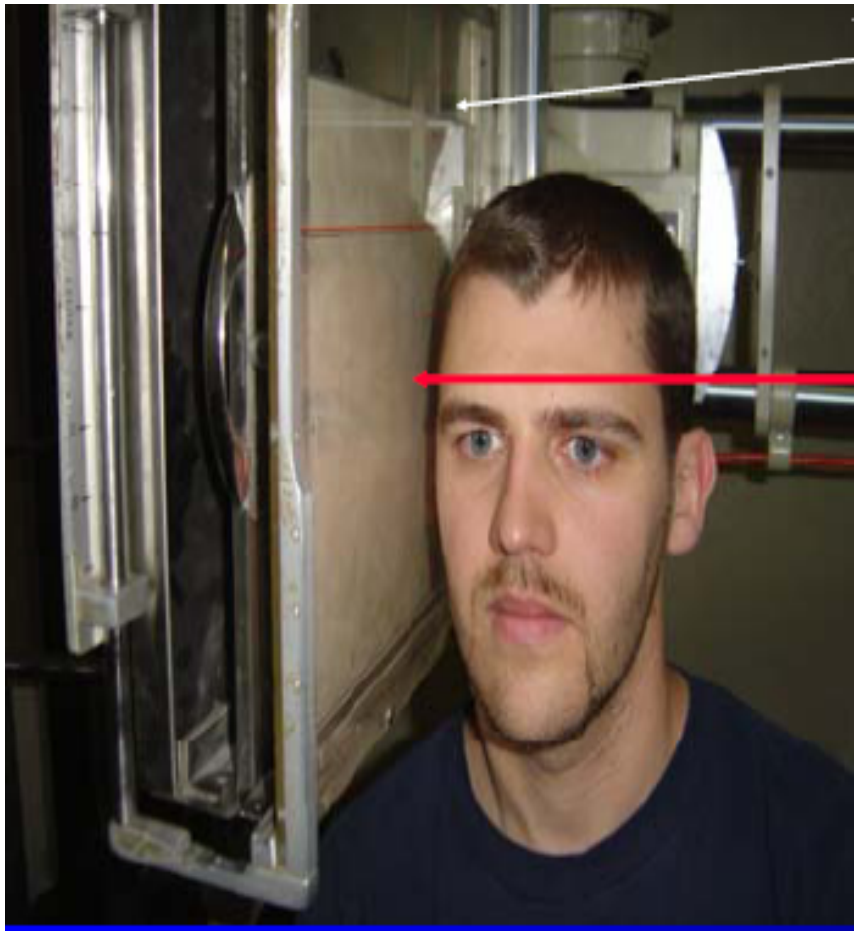
A. X-ray film taken in standard basal view. **B.** Diagram to illustrate **A.** 1 = greater sphenoidal wing; 2 = sphenoidal sinus; 3 = foramen ovale; 4 = foramen spinosum; 5 = foramen lacerum medium; 6 = foramen magnum; 7 = internal auditory meatus.

JUGULAR FORAMEN VIEW

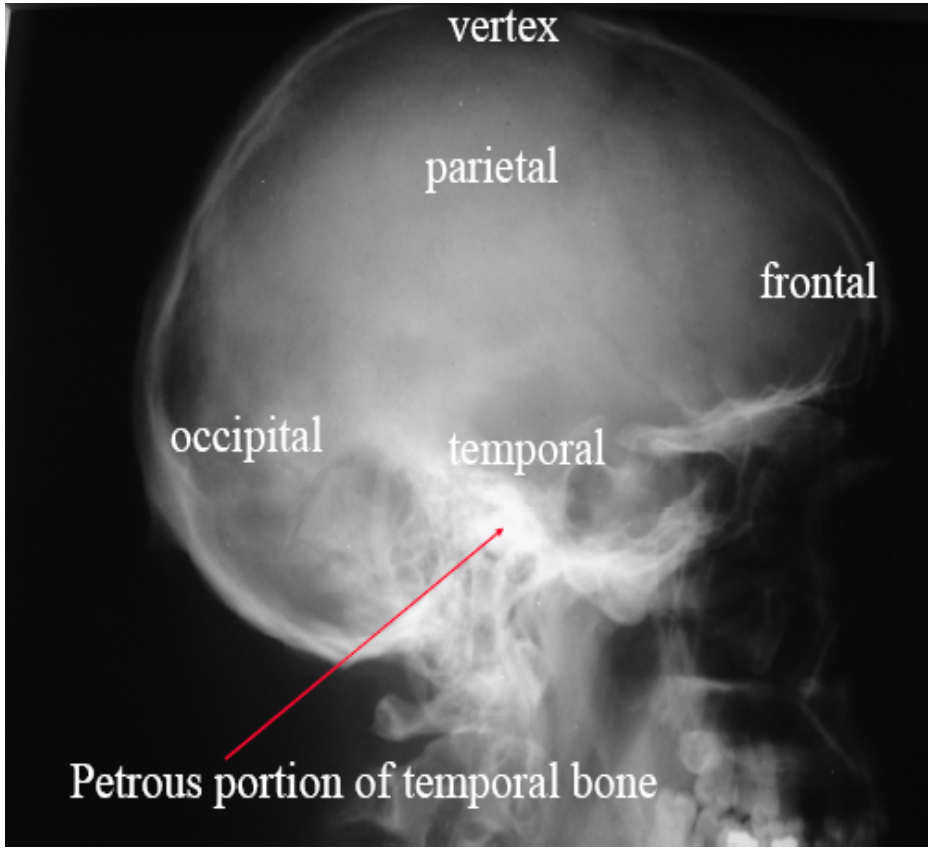
- Submento-vertical view with 20º caudal angulation.
- Central ray is angled caudally so that it makes an angle of 70 degrees to the orbito meatal plane and centered in midline to pass midway between the EAM.
- Alternatively, patient's neck less extended, head positioned with orbitomeatal plane at an angle of 20 degrees to the bucky, and thus central ray making 70 degree to base plane.

SKULL – lateral view

- Positioned such that, MSP is parallel to bucky, and inter orbital plane perpendicular to it.
- Cassette placed such that, it's upper border is 5 cm above vertex of skull.
- Central ray midway between glabella and external occipital protuberance to a point approximately 5 cm superior to EAM.



SKULL – lateral view

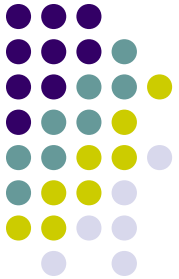


Sella seen ¾ inch anterior and superior to EAM

COMPUTERISED TOMOGRAPHY

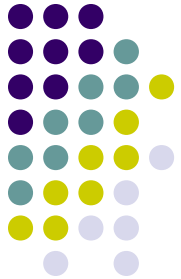
- CT scaning performed in axial and coronal planes.
- A slice thickness of no greater than 3mm should be used, with thinner scans to get more detailed imaging of smaller skull base foramina.
- The axial study is performed in the plane of orbito meatal line.
- Scans areobtained from foramen magnum to suprasellar cistern.
- Direct coronal images are obtained in plane perpendicular to reid's base line.
- Contrast is used whenever cavernous sinus is examined or intra cranial tumor suspected.

COMPUTERISED TOMOGRAPHY



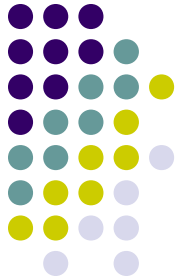
- **Bone algorithms are utilised to optimally visualise the thin cortices around various foramina, and soft tissue algorithms allow evaluation of soft tissues adjescent to skull base.**
- **Advent of multidetector scanners with slice thickness approaching dimensions of pixels allows high quality reformatting in any plane.**
- **MDCT also lessens or eliminates the need to perform direct coronal imaging,thus eliminating the image-degrading beam- hardening artifacts from dental restorations.**

MAGNETIC RESONANCE IMAGING



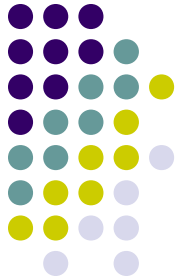
- The skull base is imaged with standard head coil.
- Routine examinations include imaging in sagittal, axial,and coronal planes.
- T1 weghted images are obtained withrepetition times of 600 1000 msec and echo times of 17-20 msec for anatomic definition.
- A section thickness of 3-5 mm is used.
- A mid sagittal image is first obtained and serves as a scout view. It also shows superior and inferior extent of disease in midline.
- Little use is made of parasagittal sections because of confusing aspects of anatomy.

MAGNETIC RESONANCE IMAGING



- Axial images are obtained from the suprasellar cistern to the nasopharynx
- The axial study is then repeated after the iv administration of gadolinium diethyl enetriamine pentaacetic acid (0.1 mmol/kg).
- Coronal images are then obtained.
- T2- weighted sequences are of lesser value in examining skull base because
  - They add significant time to the total examination
  - The additional soft tissue contrast obtained can be achieved in most cases with the shorter T1 sequences and with Gd-DTPA enhancement.
- If a T2 weighted sequence is warranted, a repitition time of 2000-3000msec is employed with a double echo-time of 20-45 msec(first echo) and 90 msec(second echo).

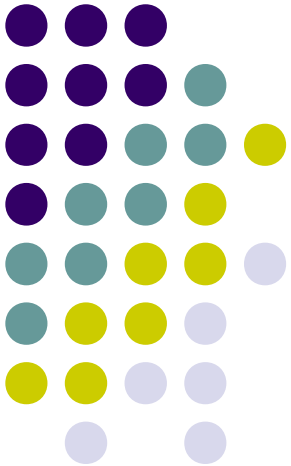
MAGNETIC RESONANCE IMAGING



- **Some enhancing lesions are as bright as fat, so that interface between lesion and fat planes can be lost, unless either a precontrast sequence or fat supression is used.**
- **When fat supression is used, the interface between sphenoid sinus air and it's wall often results in significant susceptibility effect. This BLOOMING can void signals from important structures such as cavernous sinus and foramen rotundum.**
- **So radiologist must be confident that the foramen has been adequately visualised either with or with out fat supression.**

RADIOLOGICAL ANATOMY

....through C T sections

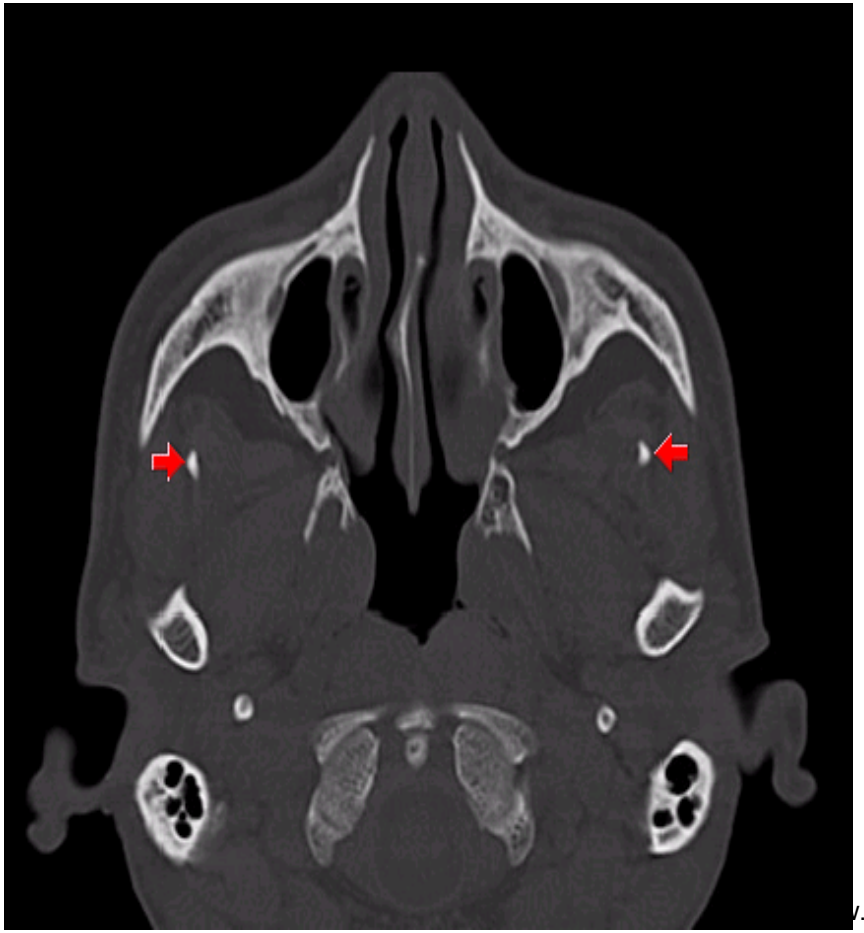


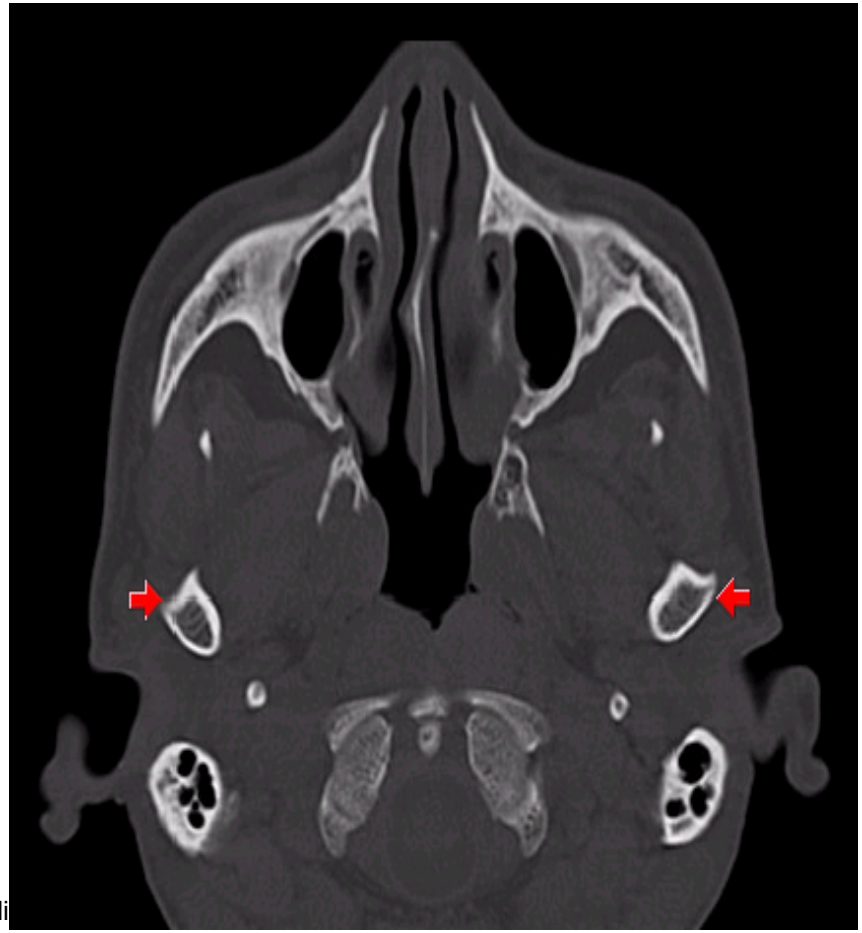
- . Mastoid process

•Occipital condyle

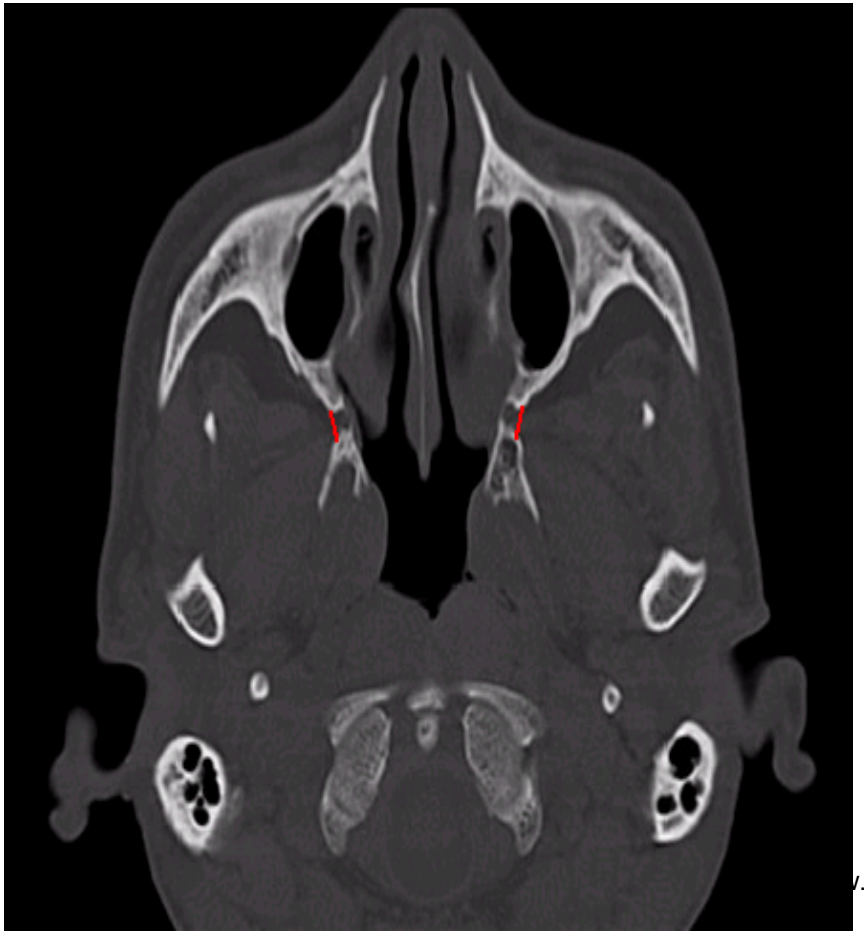
- Mandible, coronoid proc

- Mandible, neck

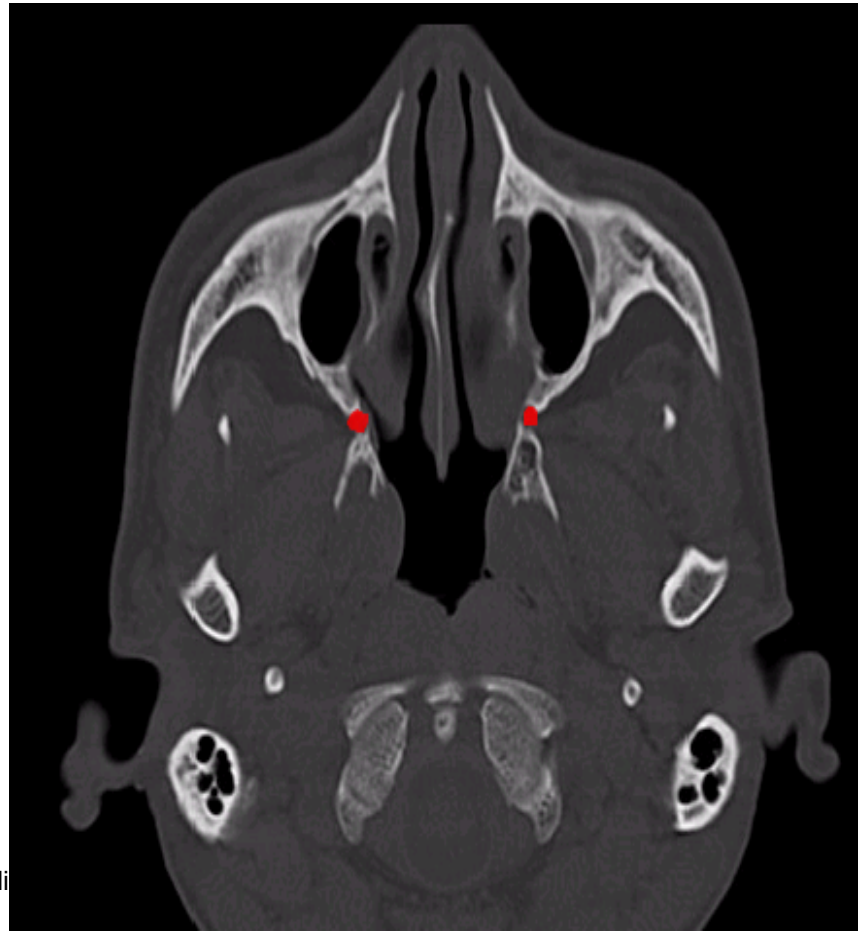




- Pterygomaxillary fissure

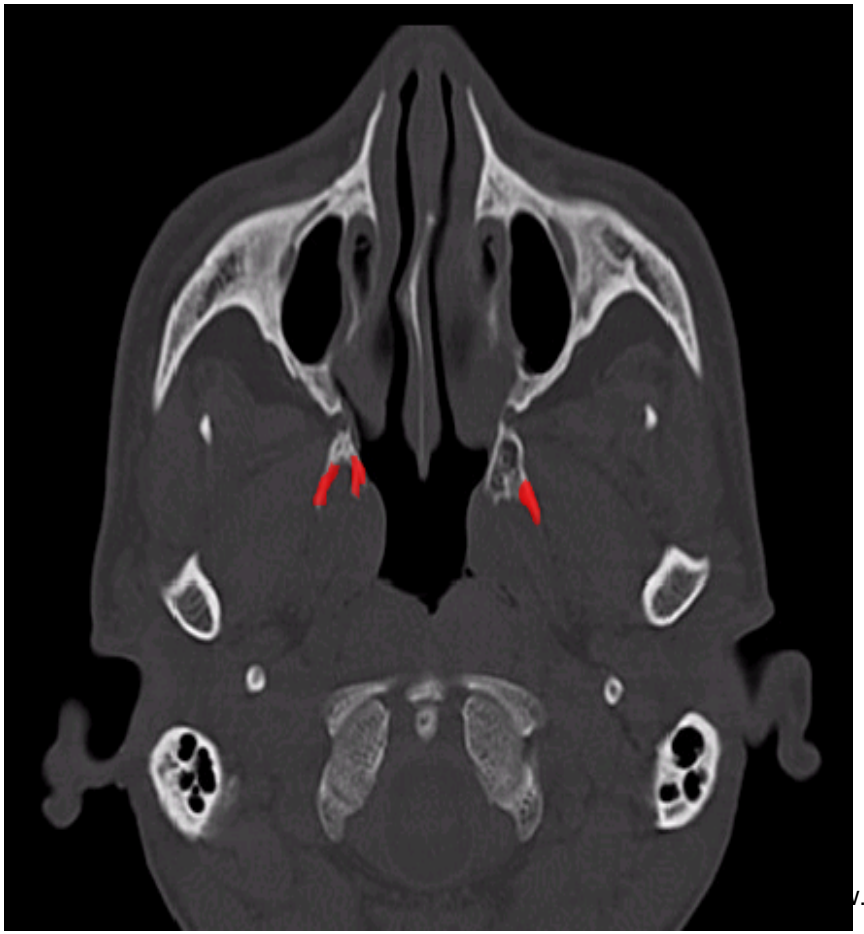


- Pterygopalatine fossa



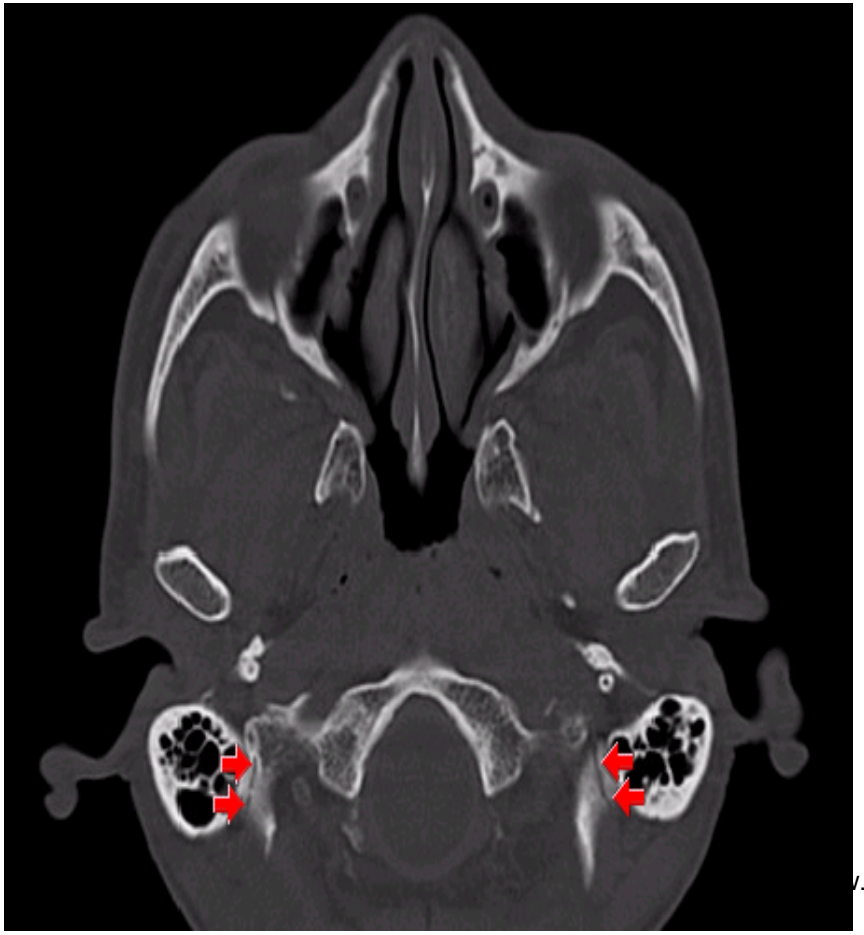
- **Pterygoid plates**

•Pterygoid process



- **Styloid process**

- Occipitomastoid suture

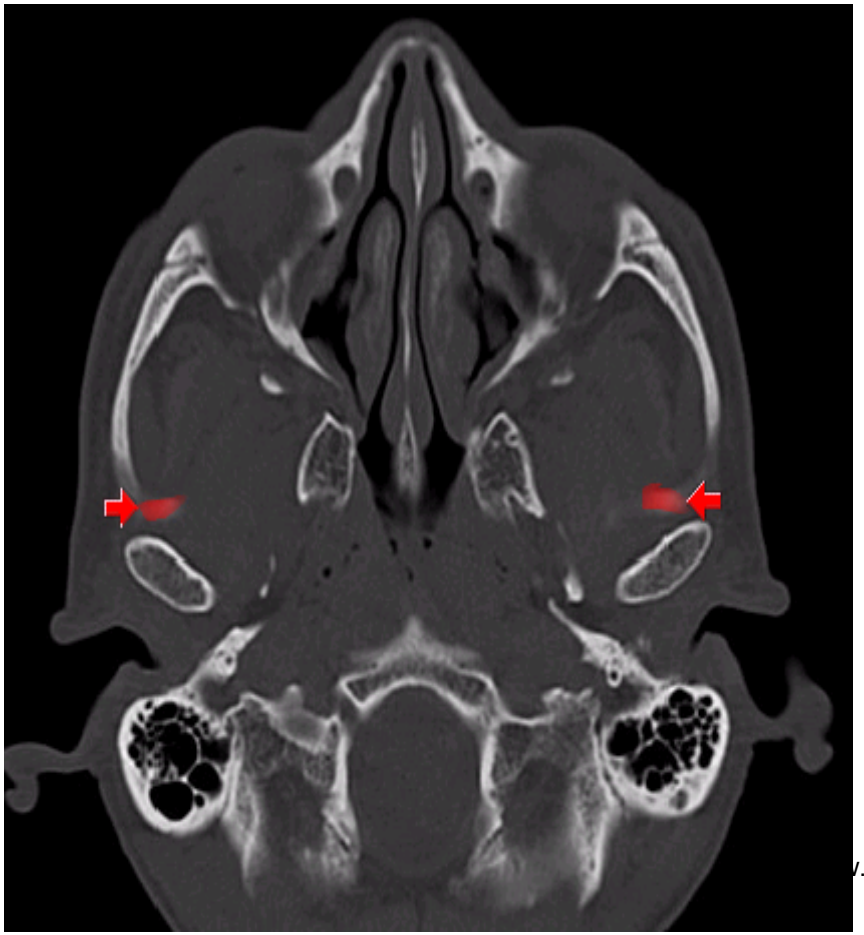


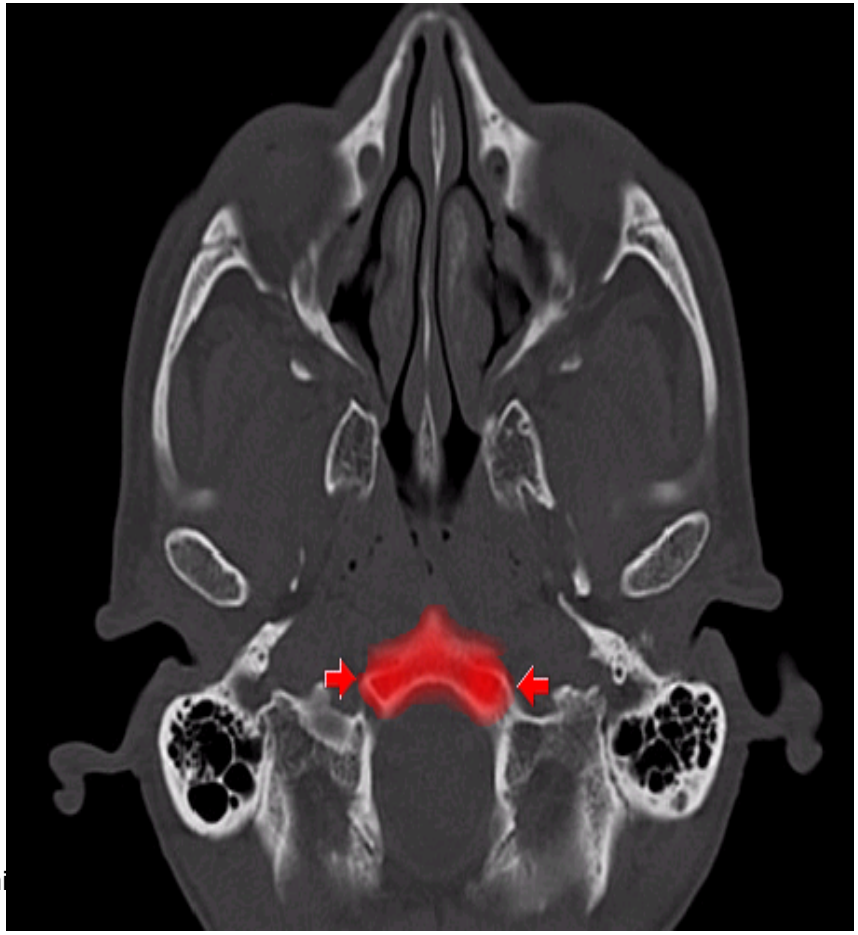
•Sphenoid spine, left

- Zygomatic bone

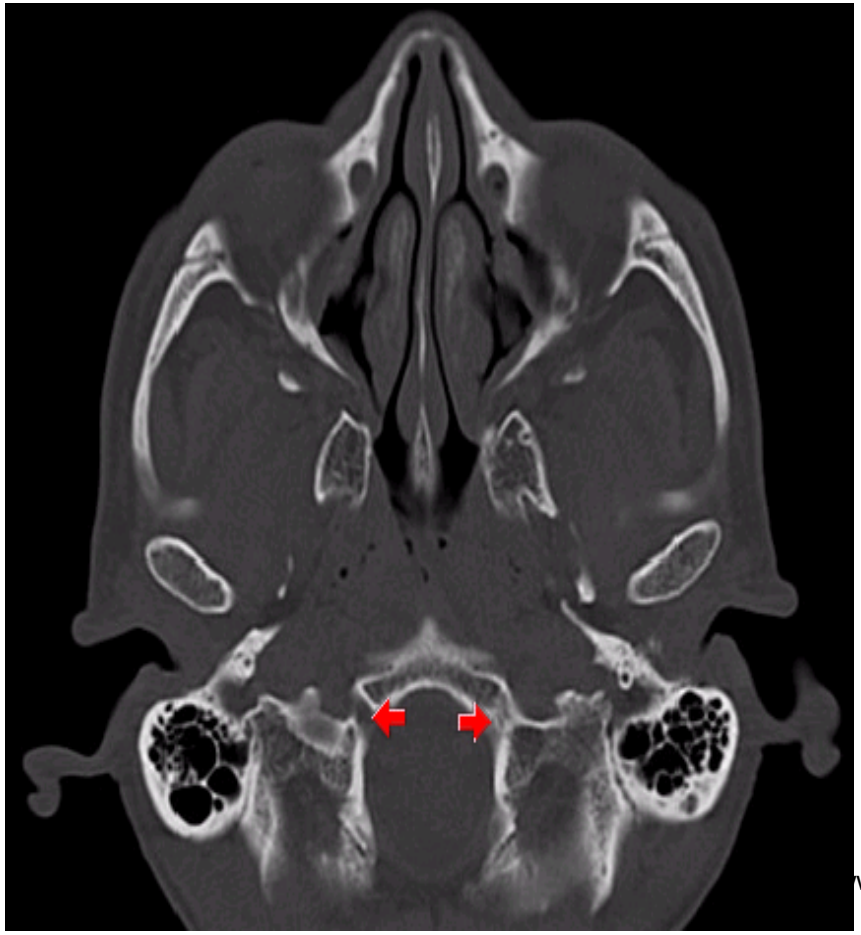
- Articular tubercle (at ant

Basiocciput (posterior clivus)

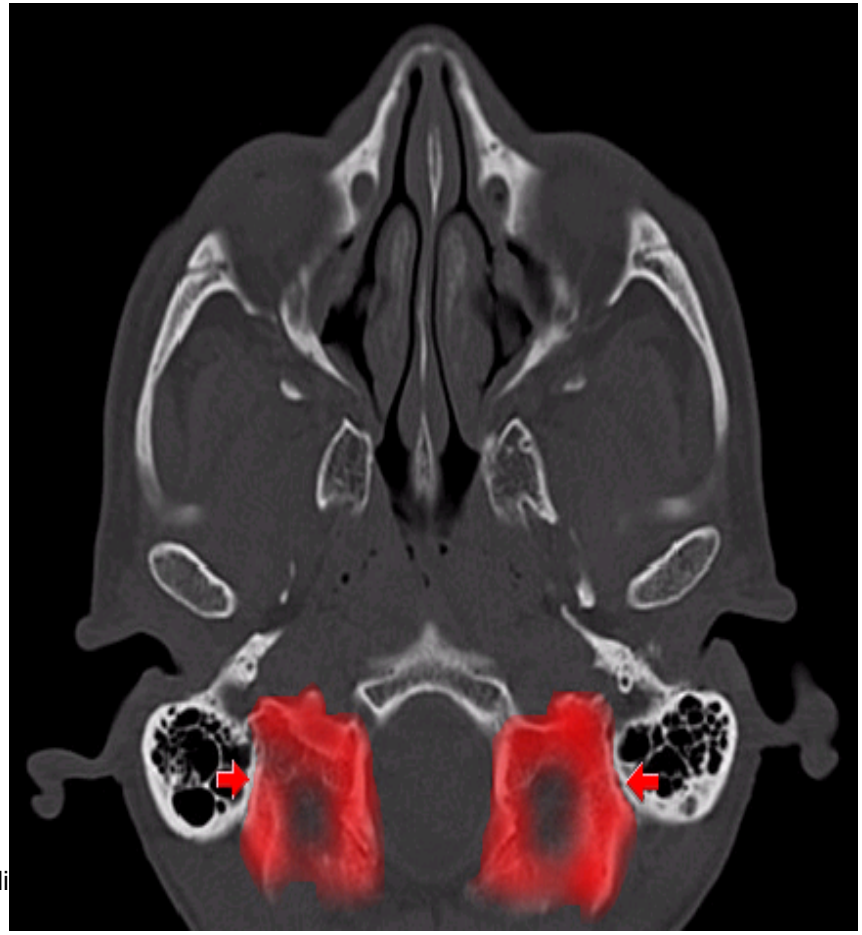




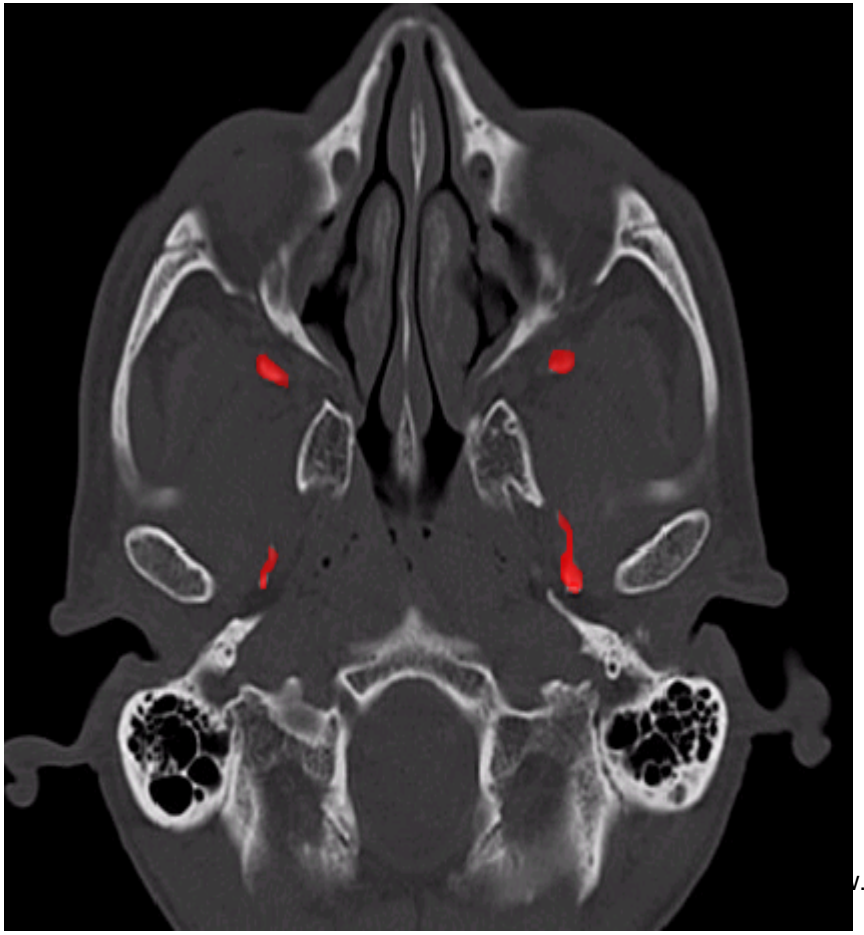
- Hypoglossal canal



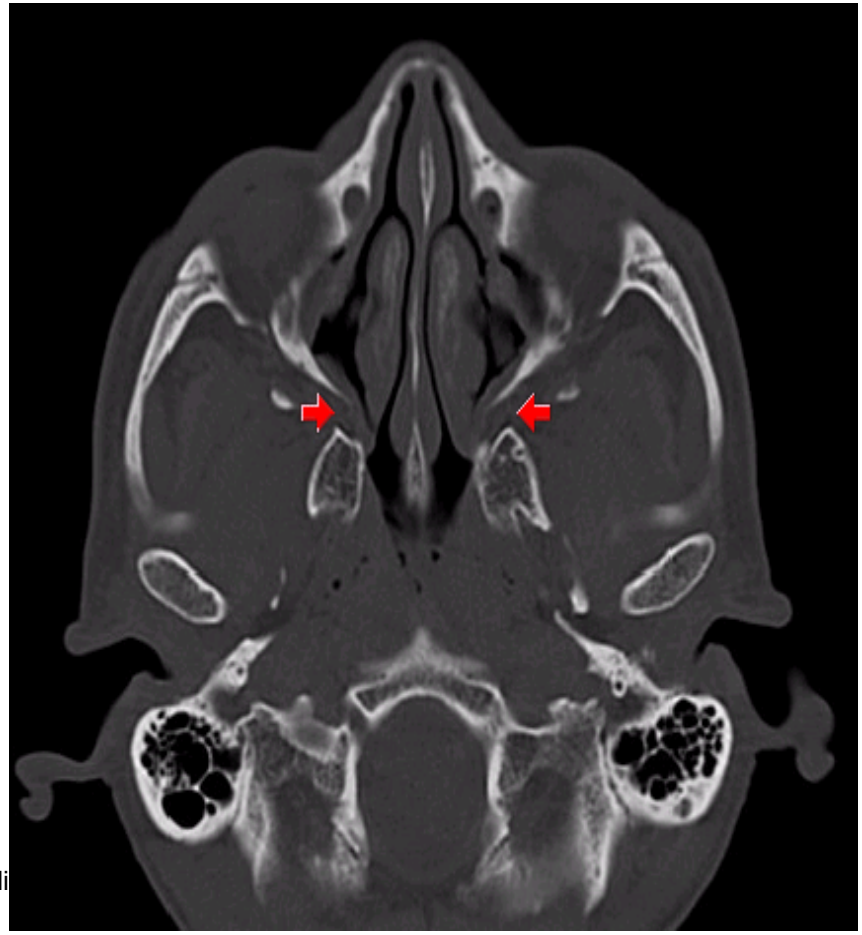
Occipital bone (squamous part)



- Sphenoid, greater wing

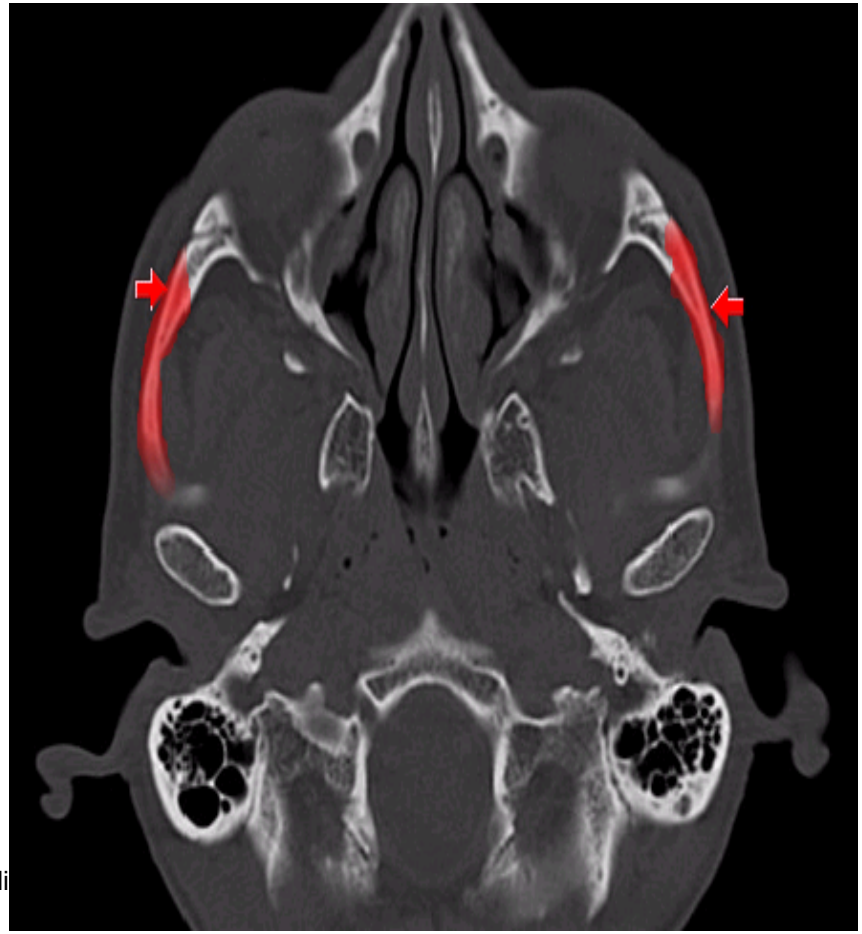


•Pterygomaxillary fissure



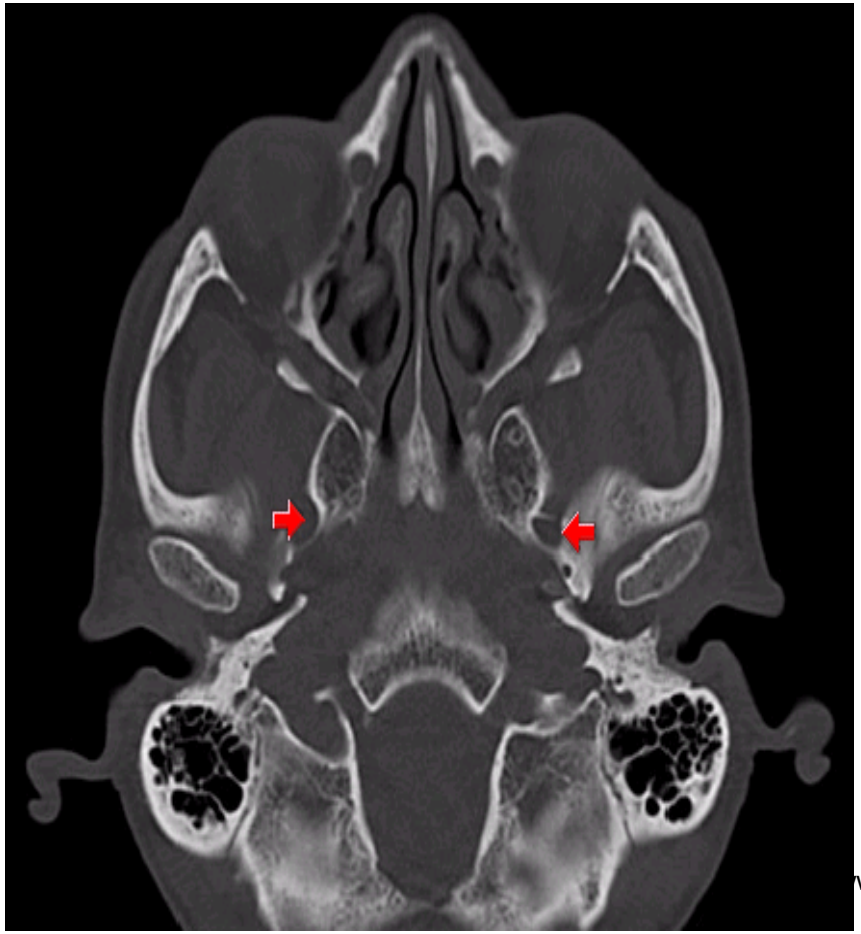
- Sphenopalatine foramer

•Zygomatic arch

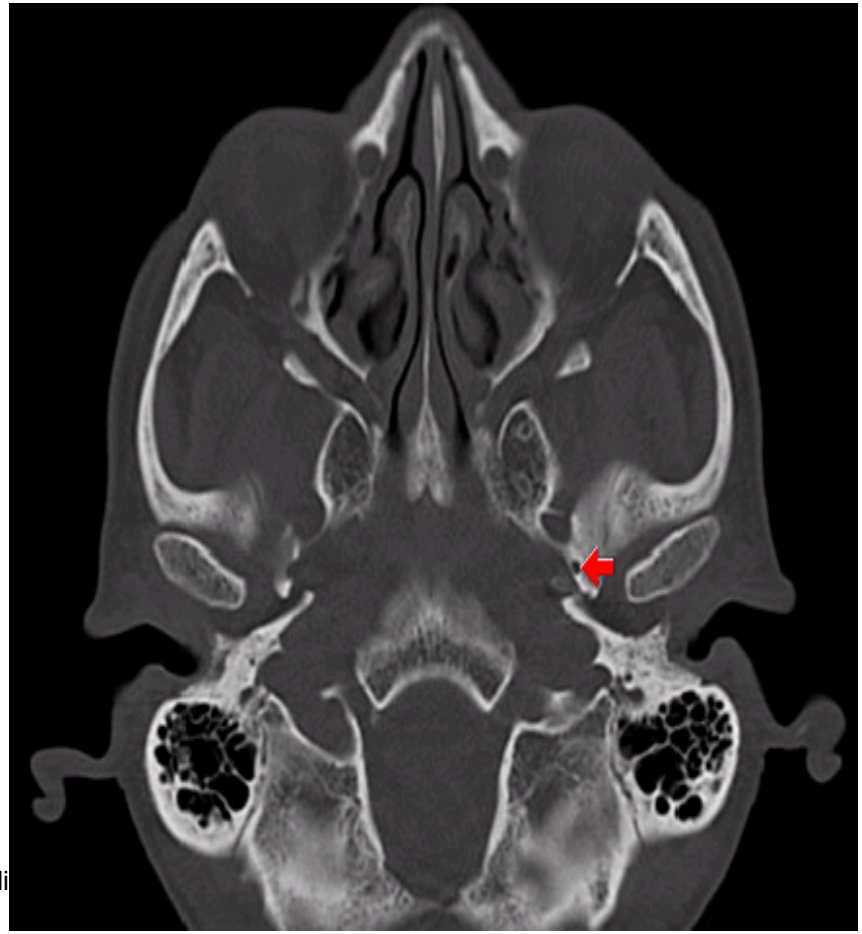


- Zygomaticofacial forame

- Foramen ovale

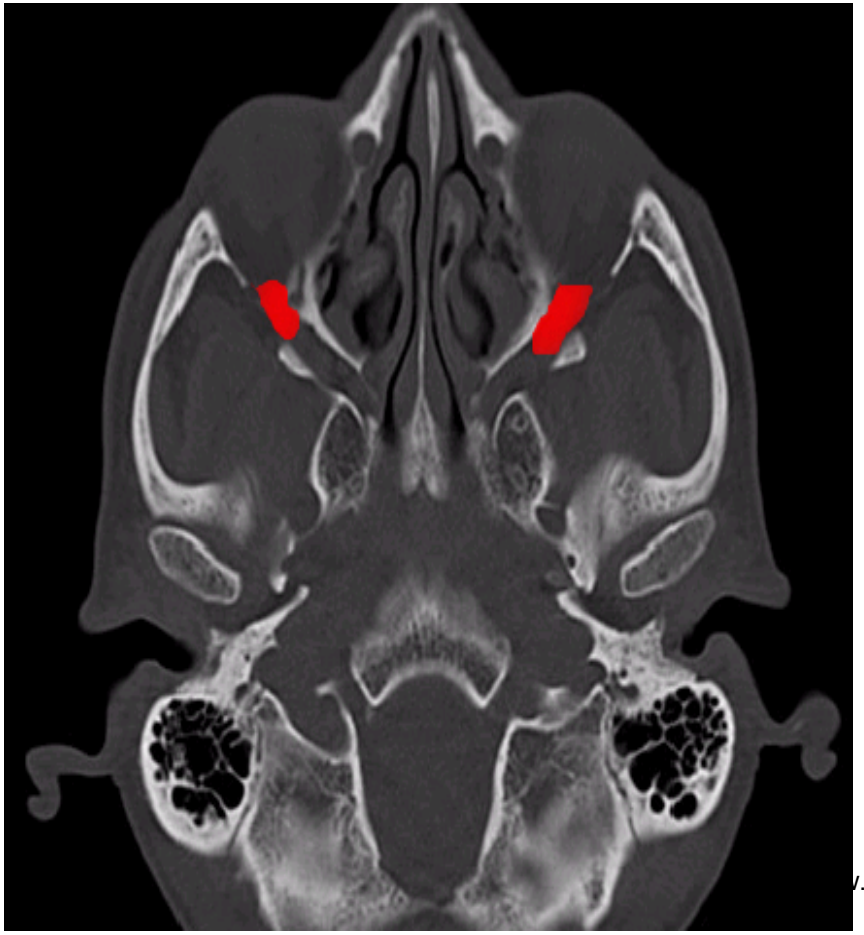


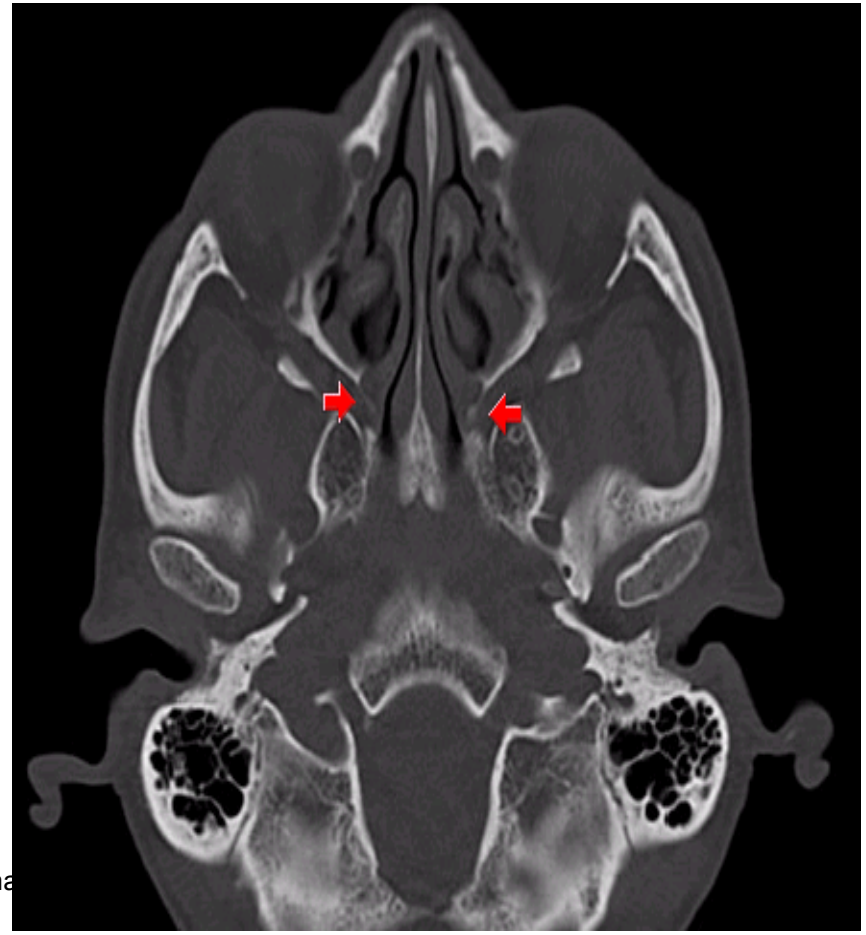
- Foramen spinosum



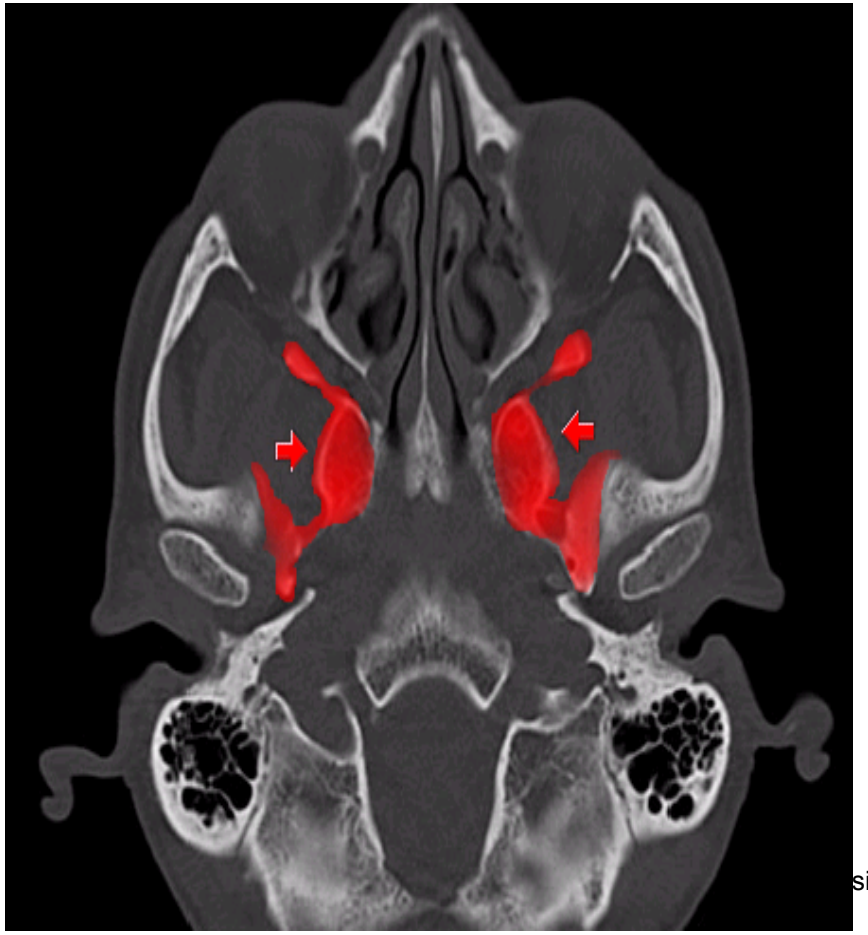
- **Inferior orbital fissure**

•Pterygopalatine fossa





- **Sphenoid, greater wing**

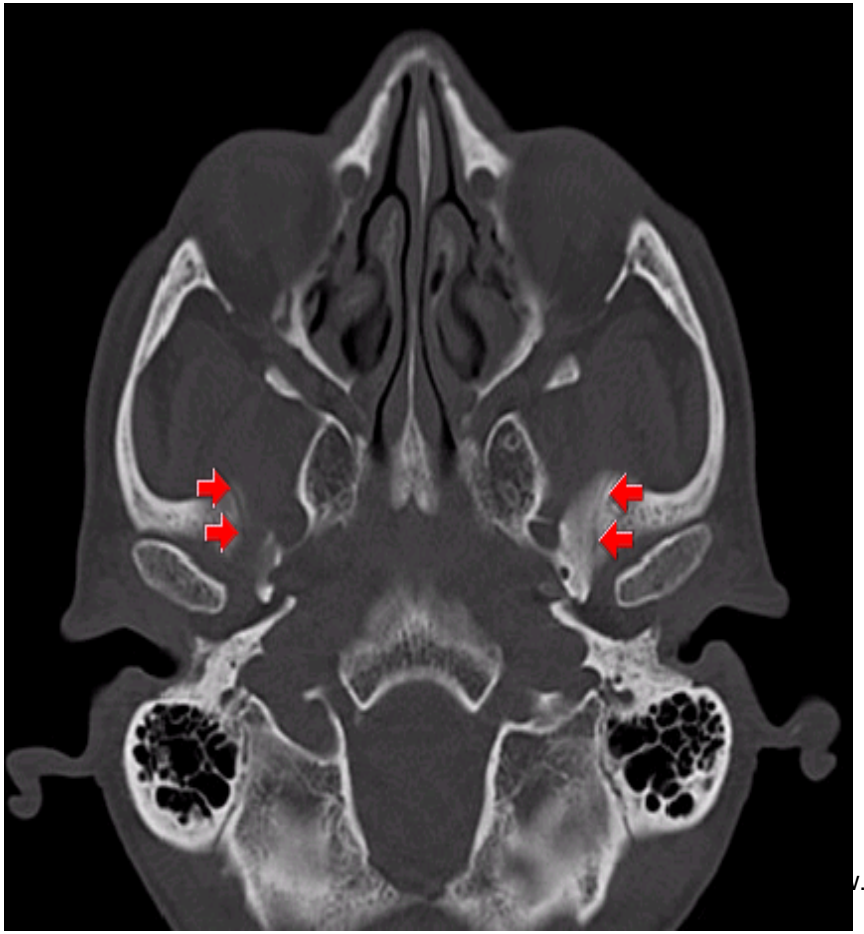


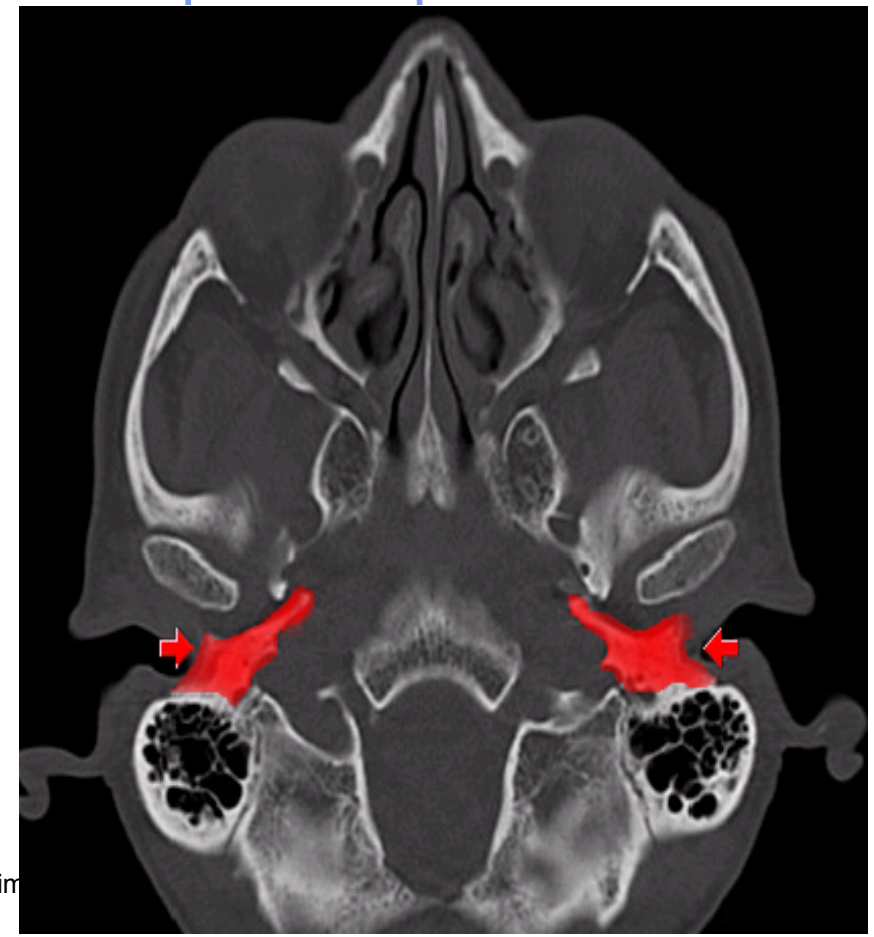
similim

- Sphenoid spine (right)

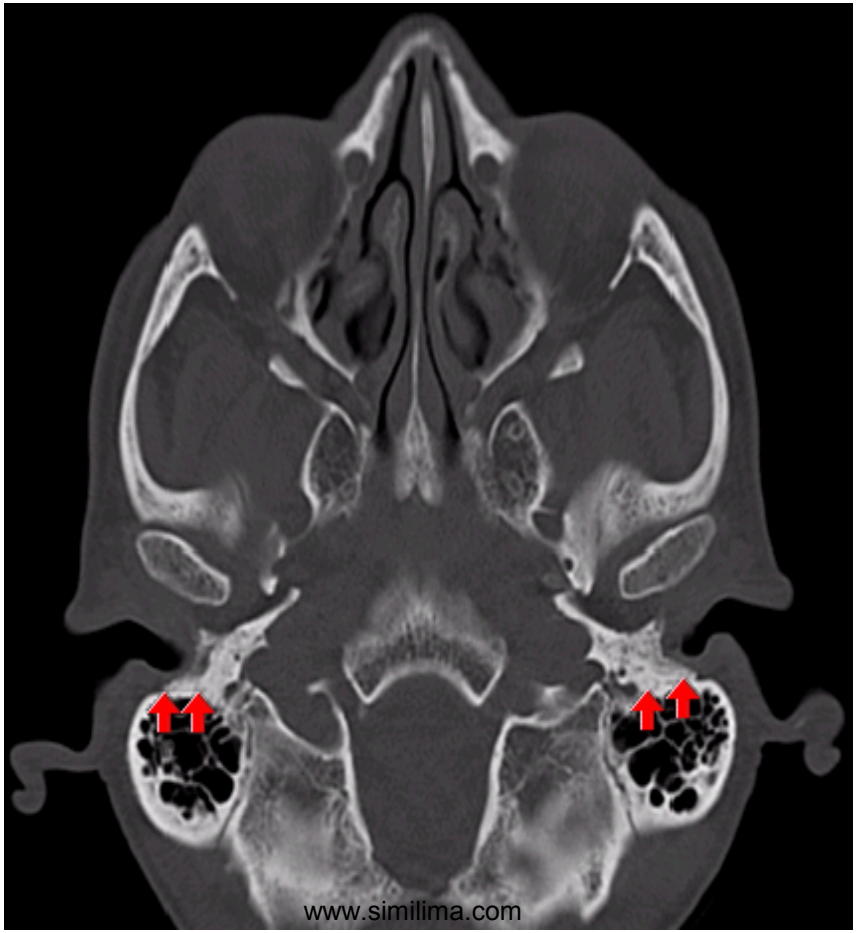
- **Sphenosquamous sutur**

- Temporal bone, tympanic and petrous portions

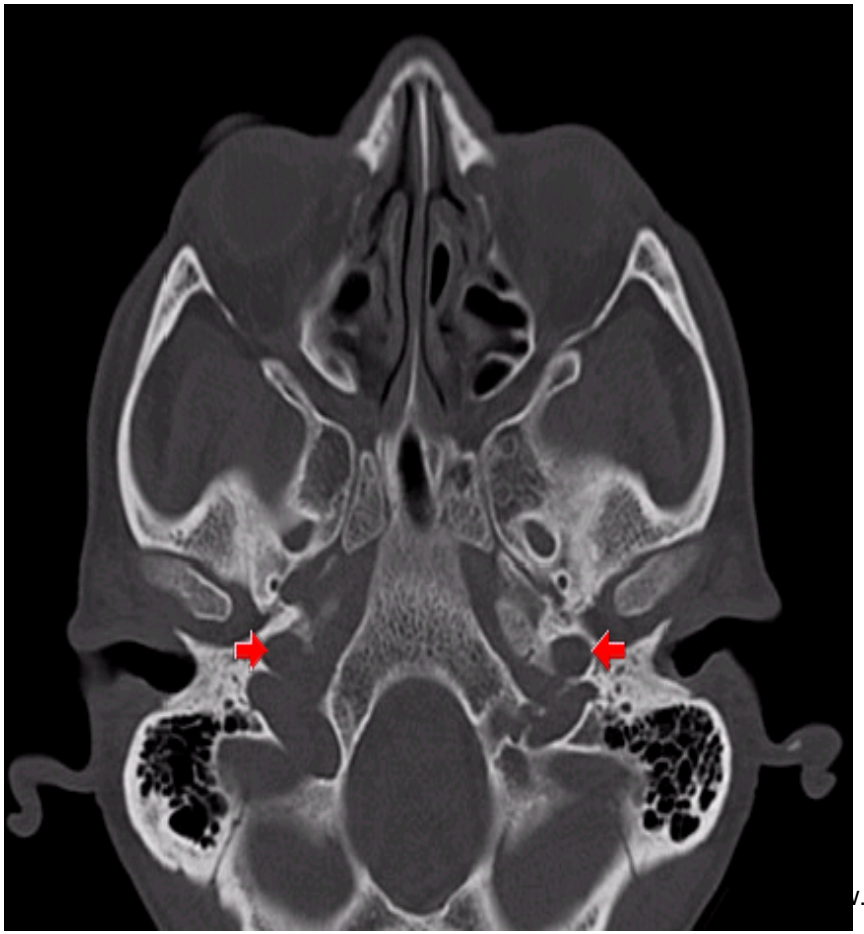




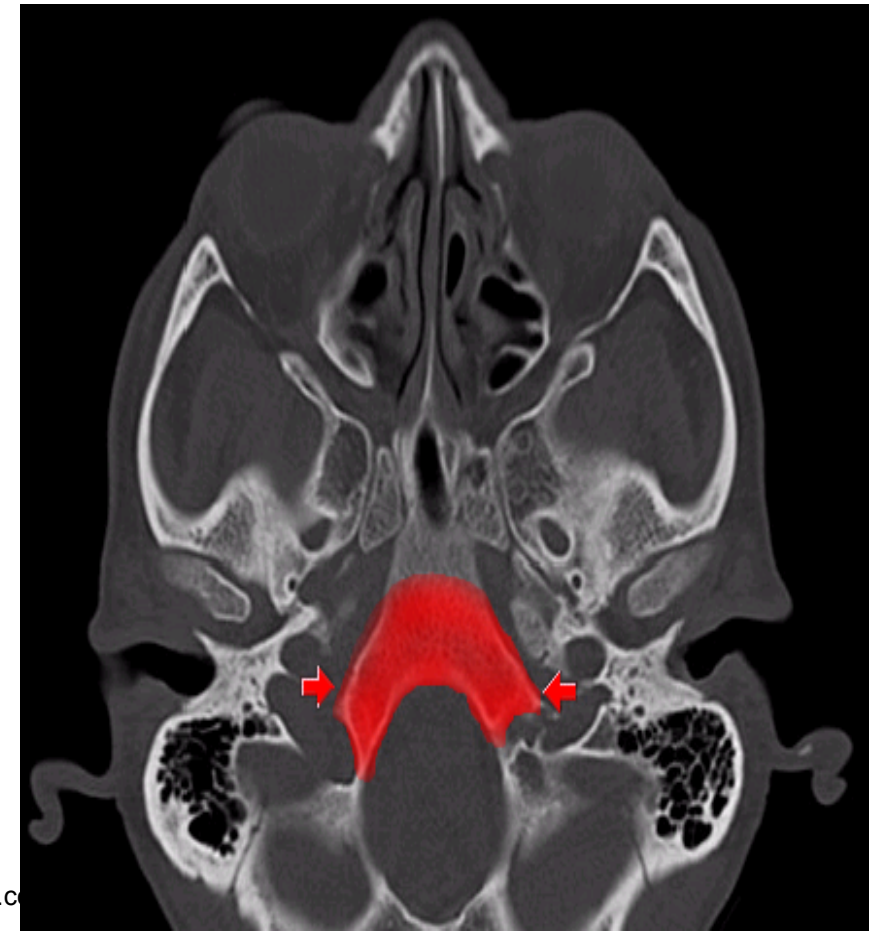
- Tympanomastoid fissure



- Carotid canal, external opening

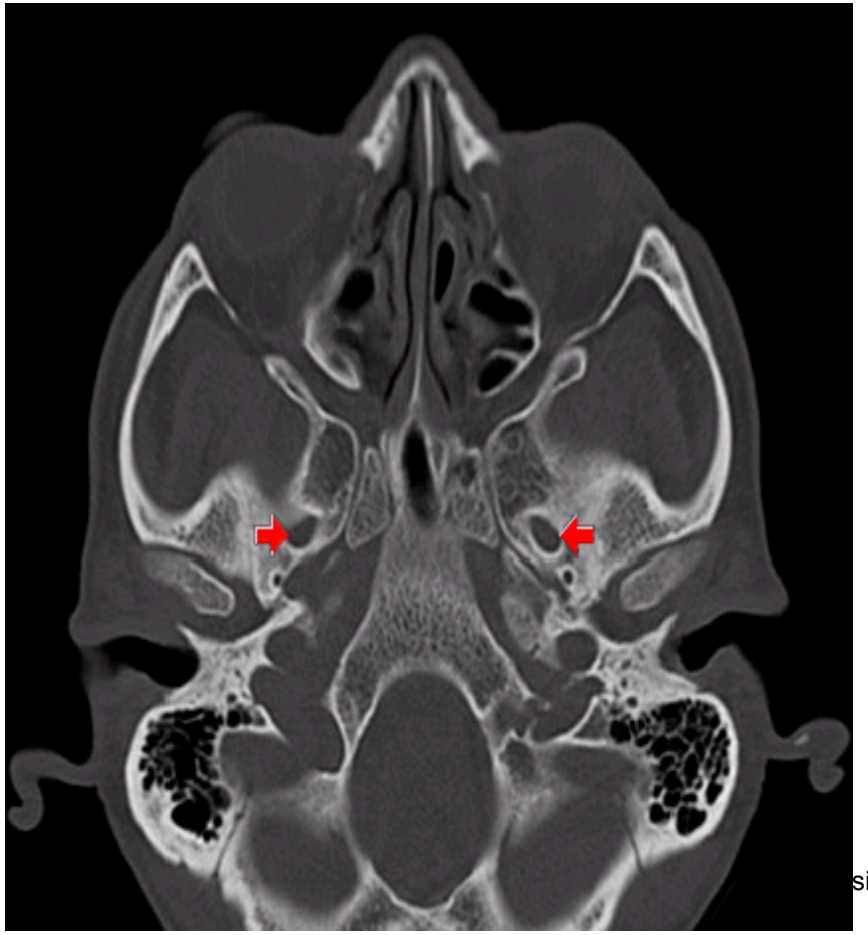


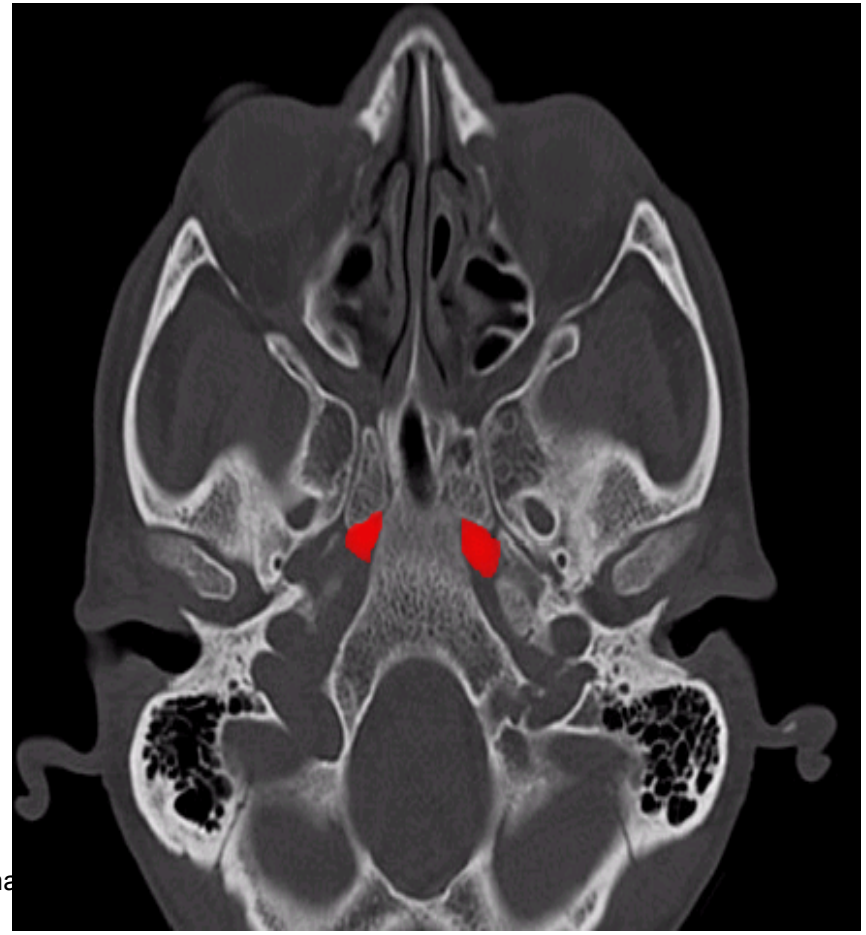
- Clivus (occipital part)



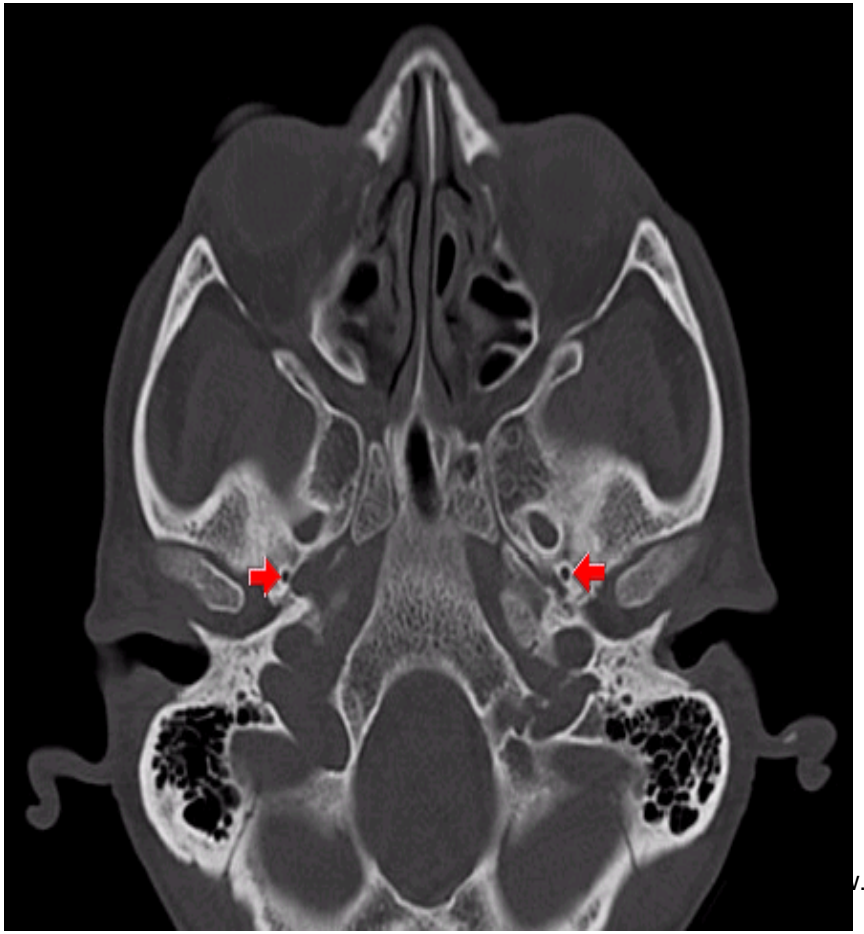
- **Foramen ovale**

•Foramen lacerum

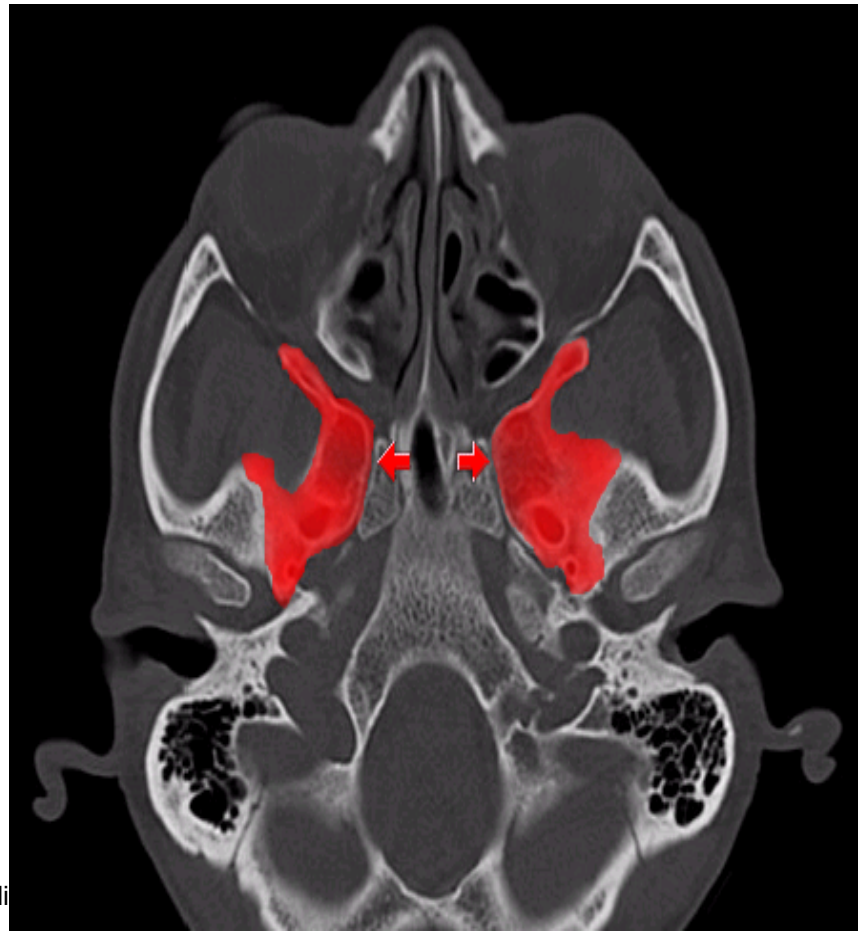




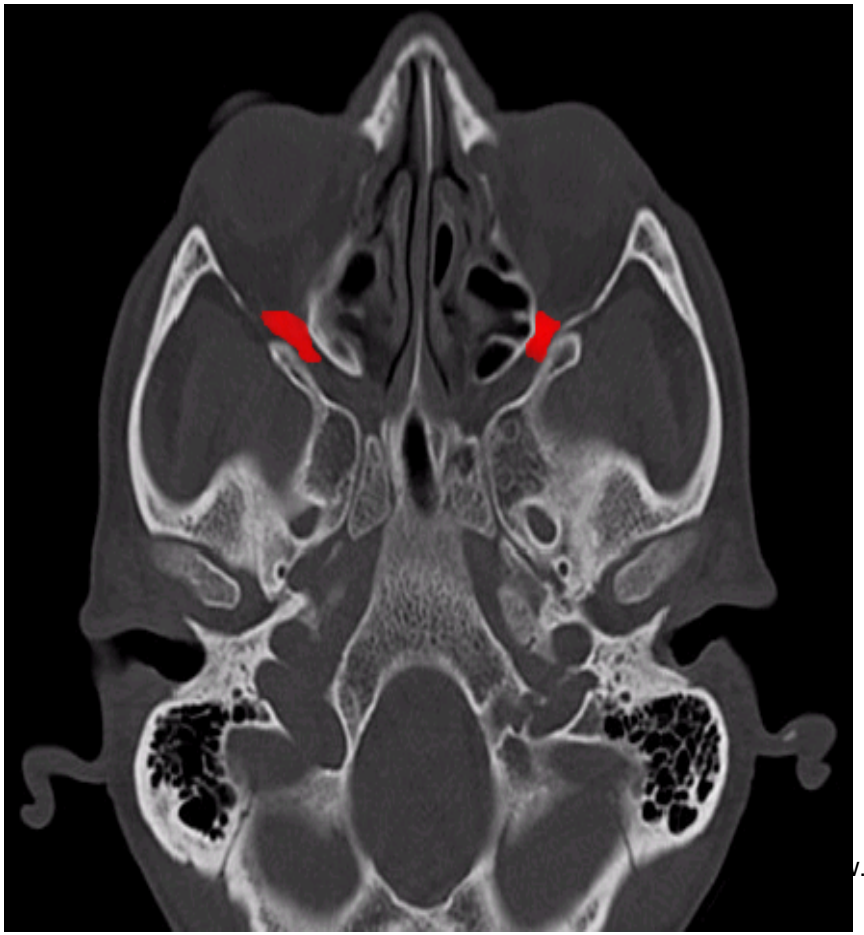
- **Foramen spinosum**



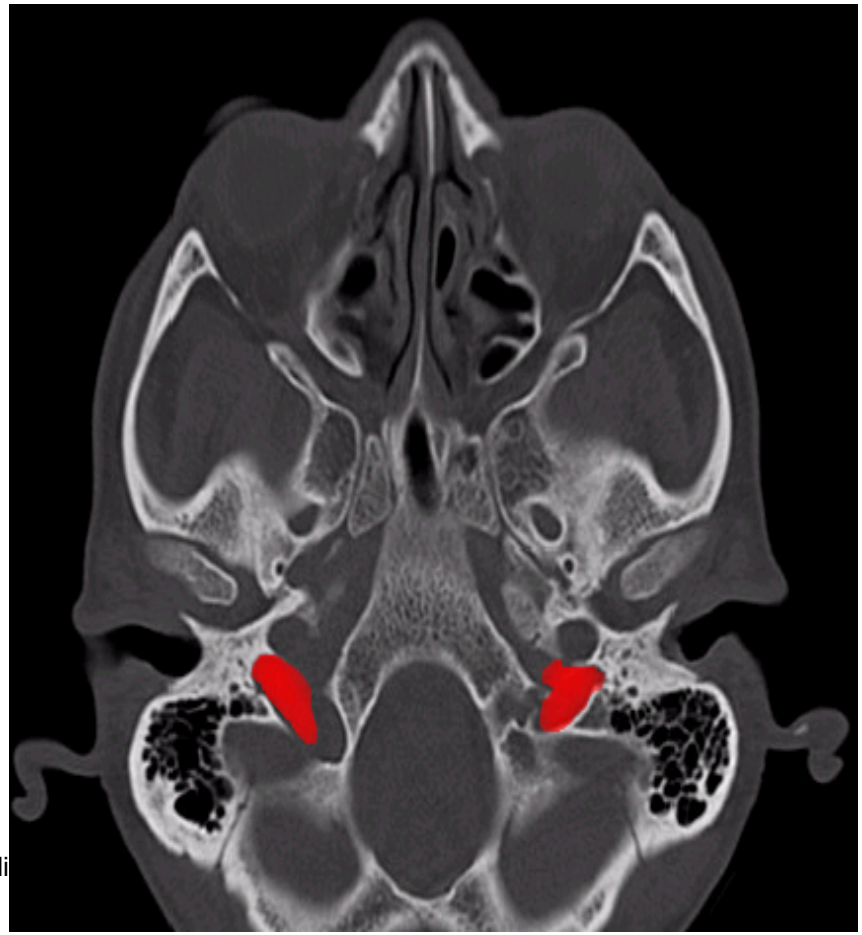
- Sphenoid bone, greater wing



- **Inferior orbital fissure**



- Jugular foramen

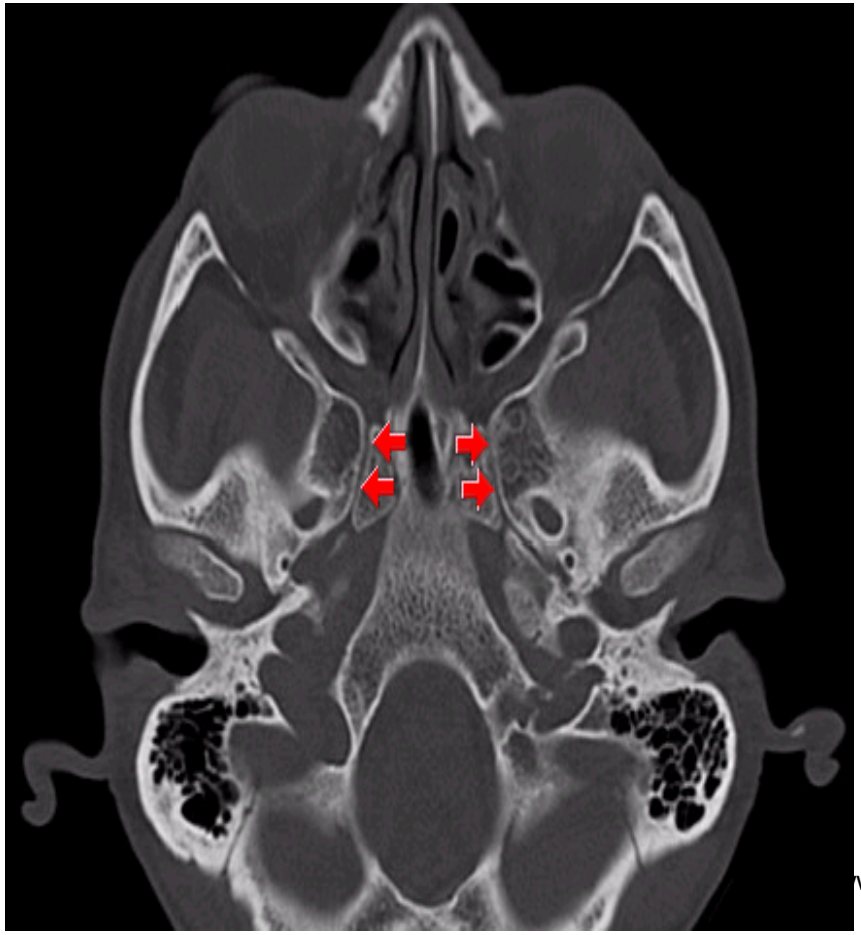


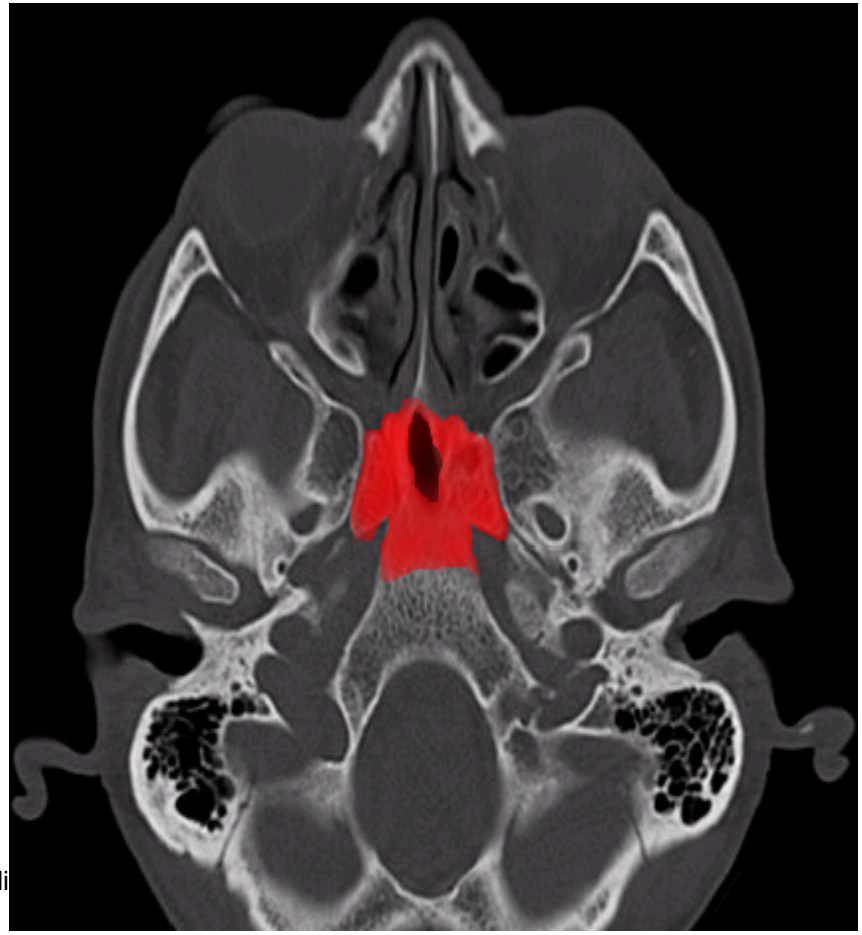
- **Petrooccipital fissure**

•Petrosphenoidal fissure

- **Pterygoid canal**

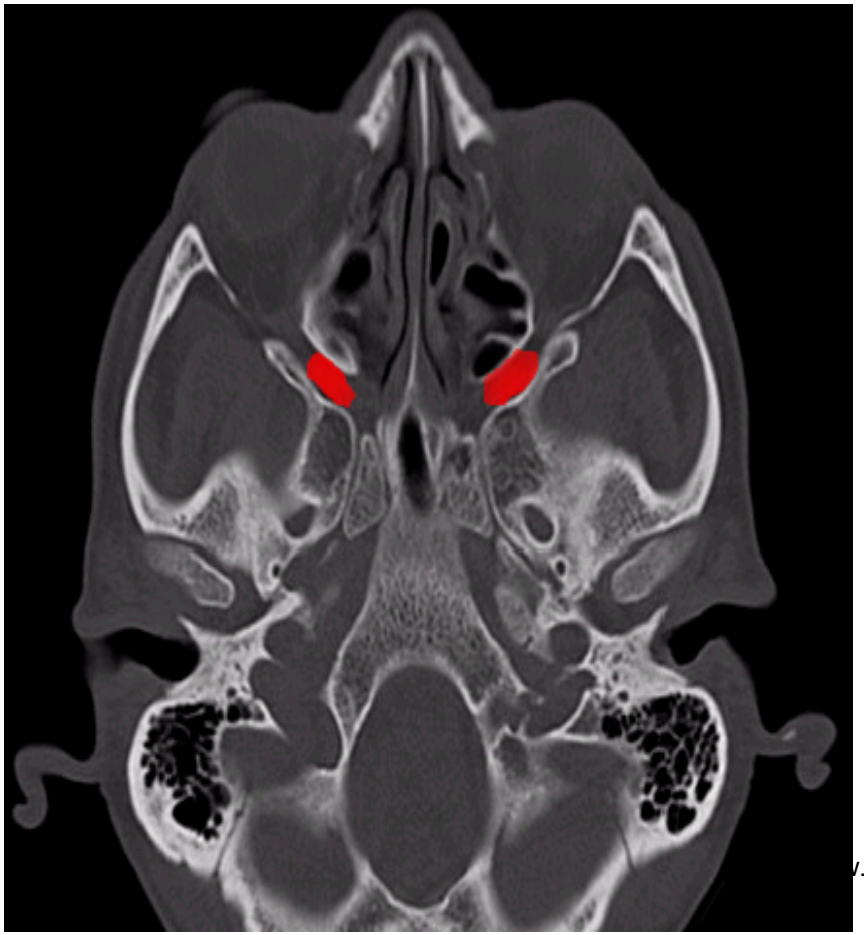
- Sphenoid bone, body





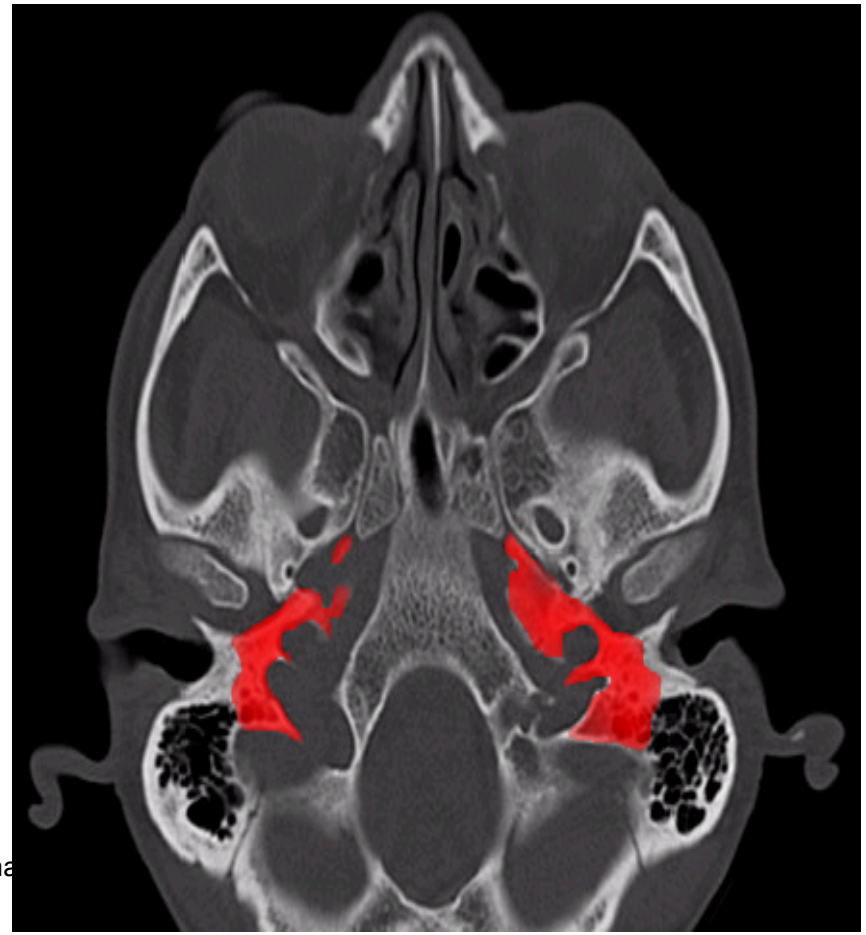
- **Pterygopalatine fossa**

•Sphenopalatine foramen



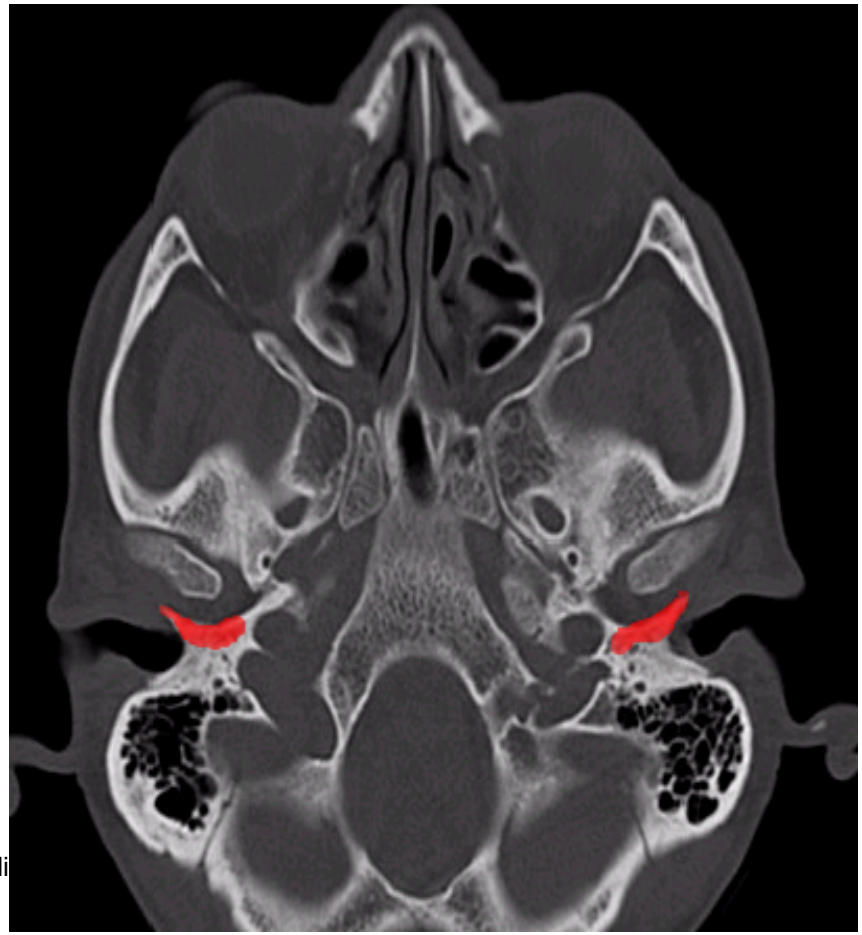
- **Sphenosquamous suture**

•Temporal bone, petrous part



- **Temporal bone, squamous**

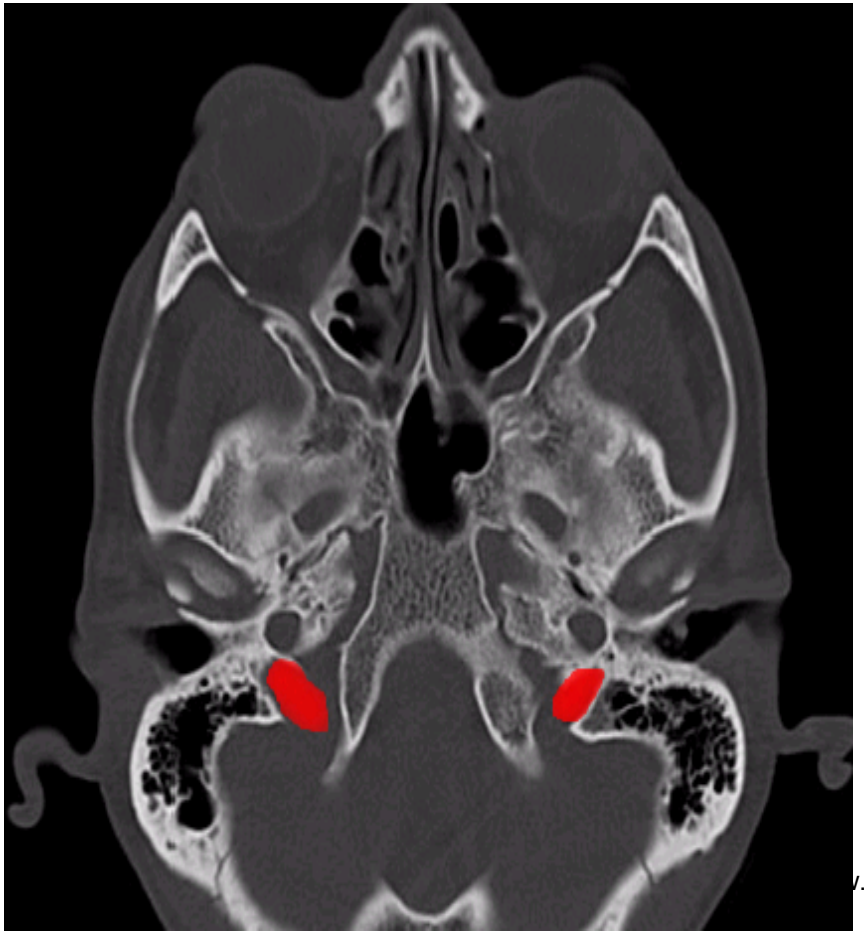
- Temporal bone, tympanic part



simili

- **Tympanomastoid fissure**

- Jugular foramen becoming sigmoid s
- Jugular tubercle of occipital bone (roc

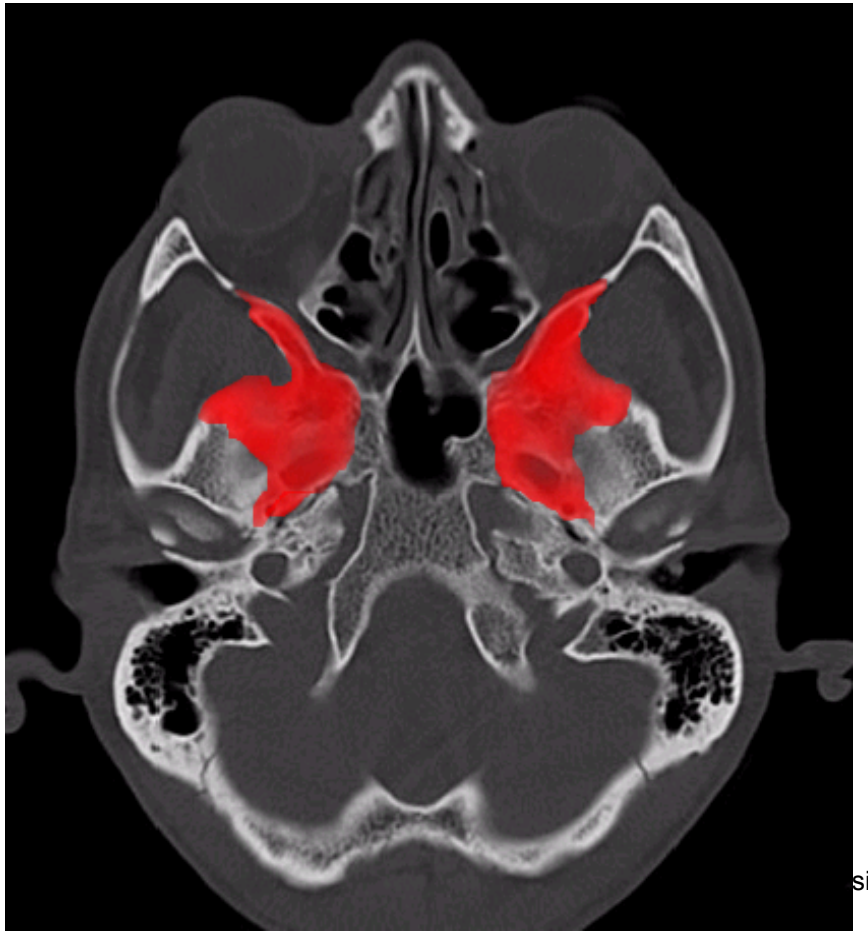


- **Petrosphenoidal fissure**

- Sphenoid bone, body

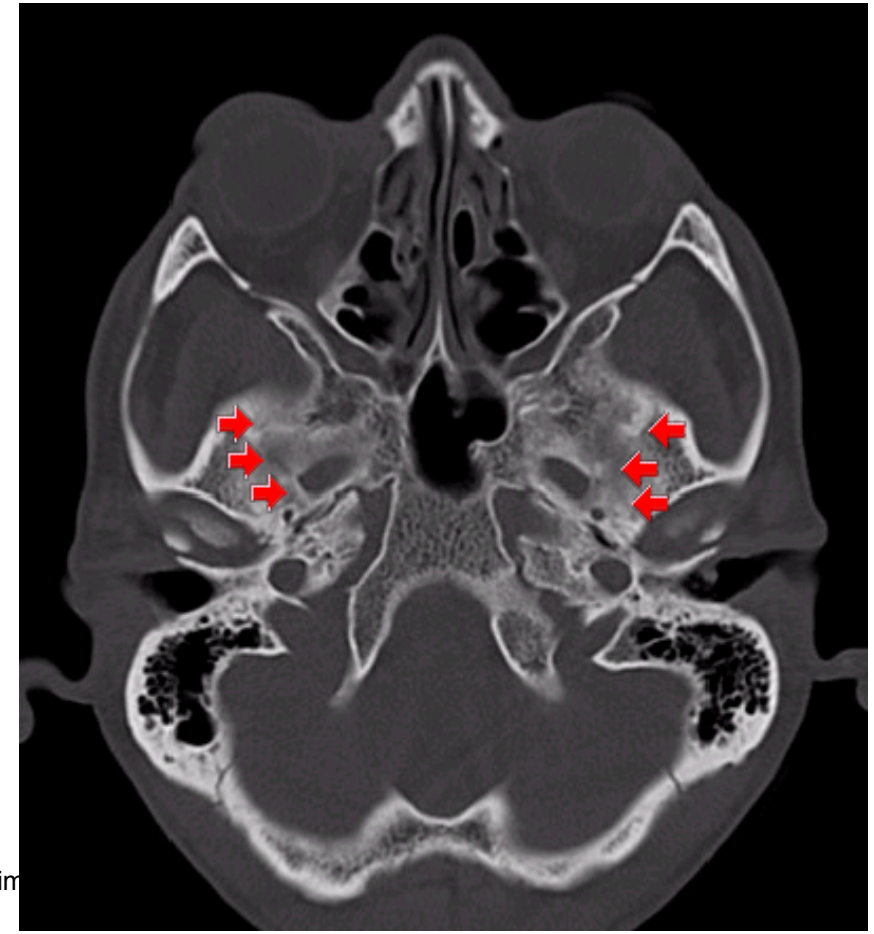
similim

- **Sphenoid bone, greater wing**

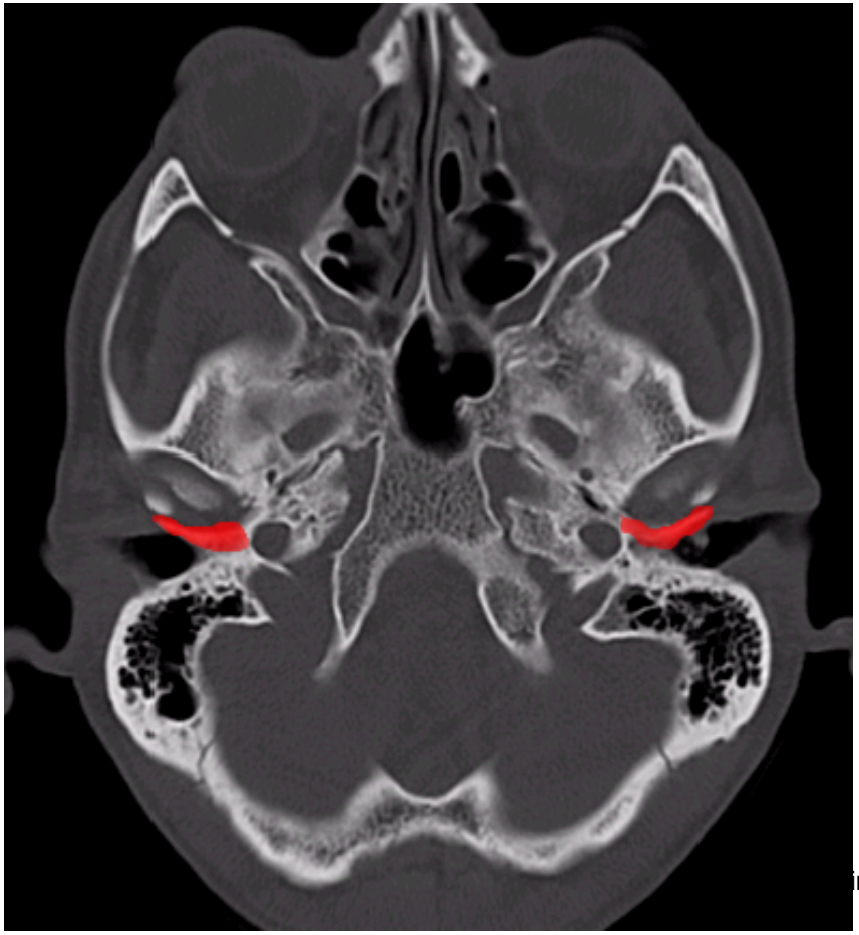


similim

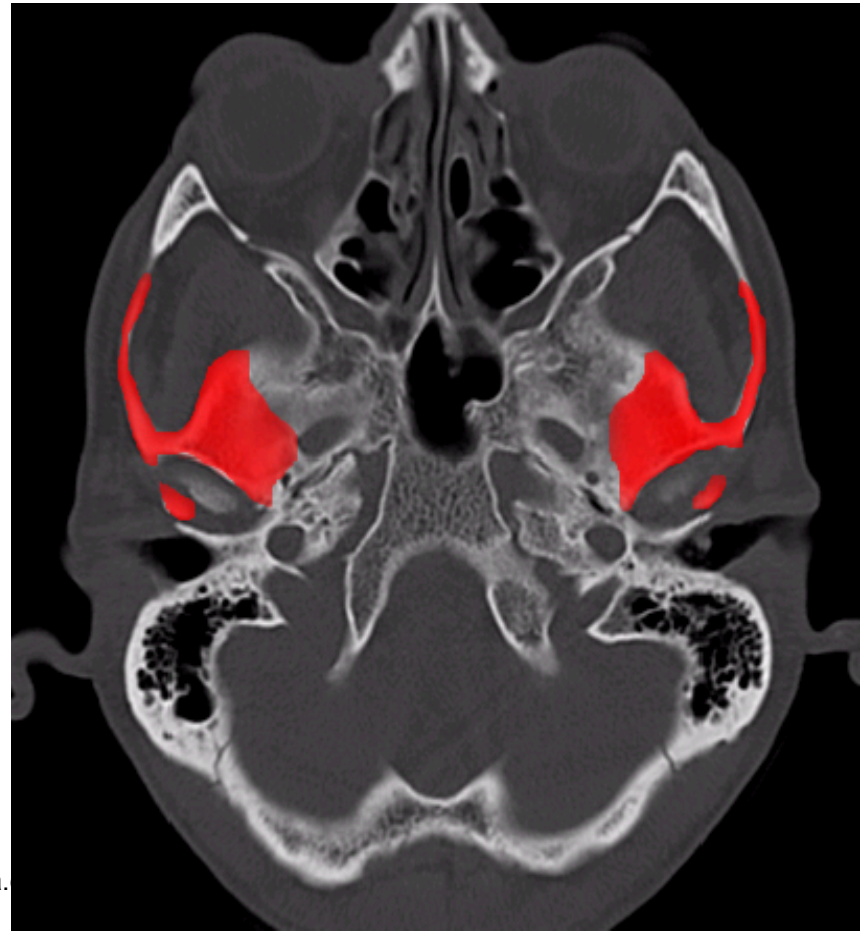
•Sphenosquamous suture



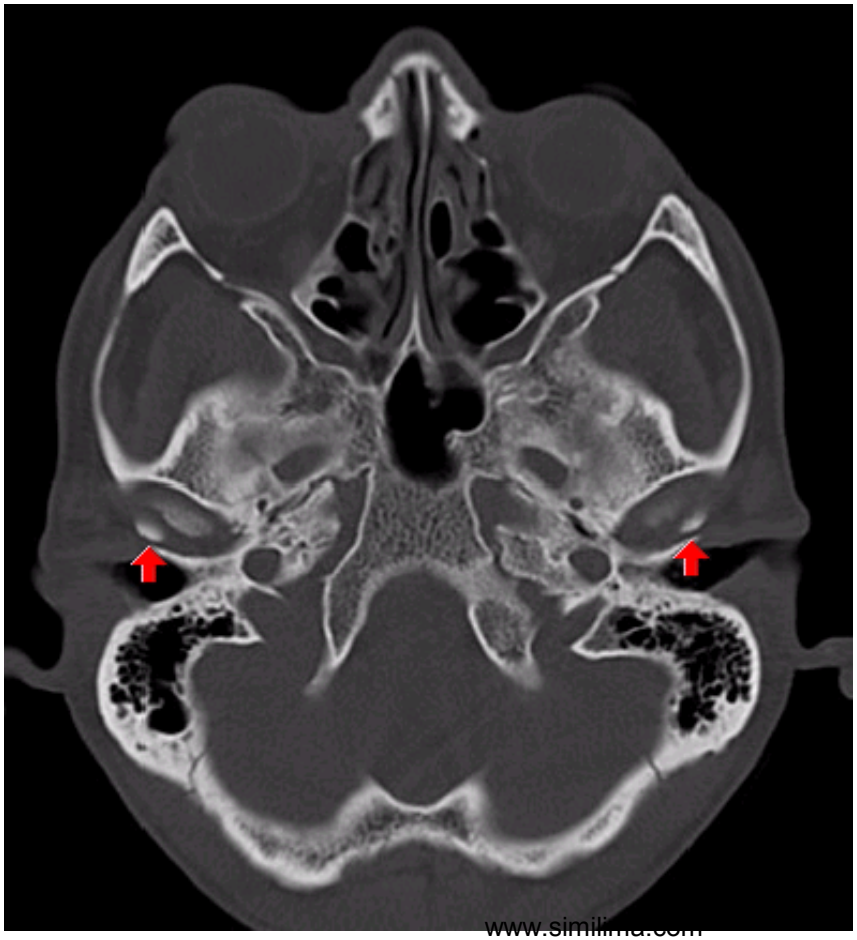
- Temporal bone, tympanic



- Temporal bone, squamous

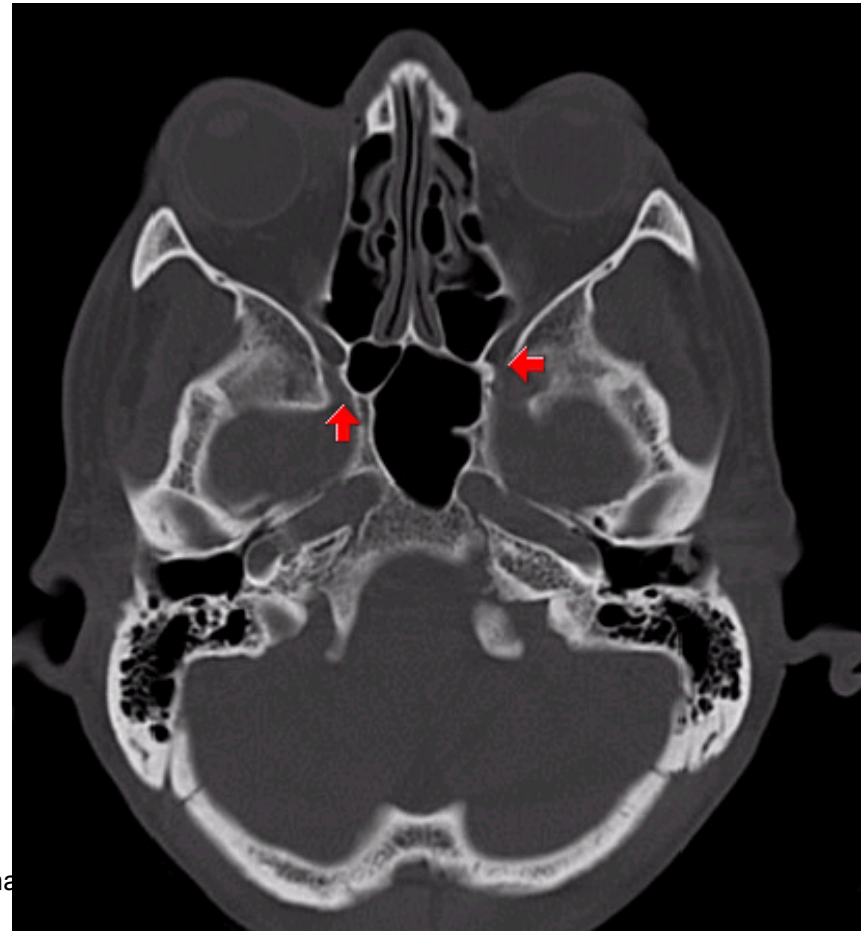


- Tympanosquamous fissure



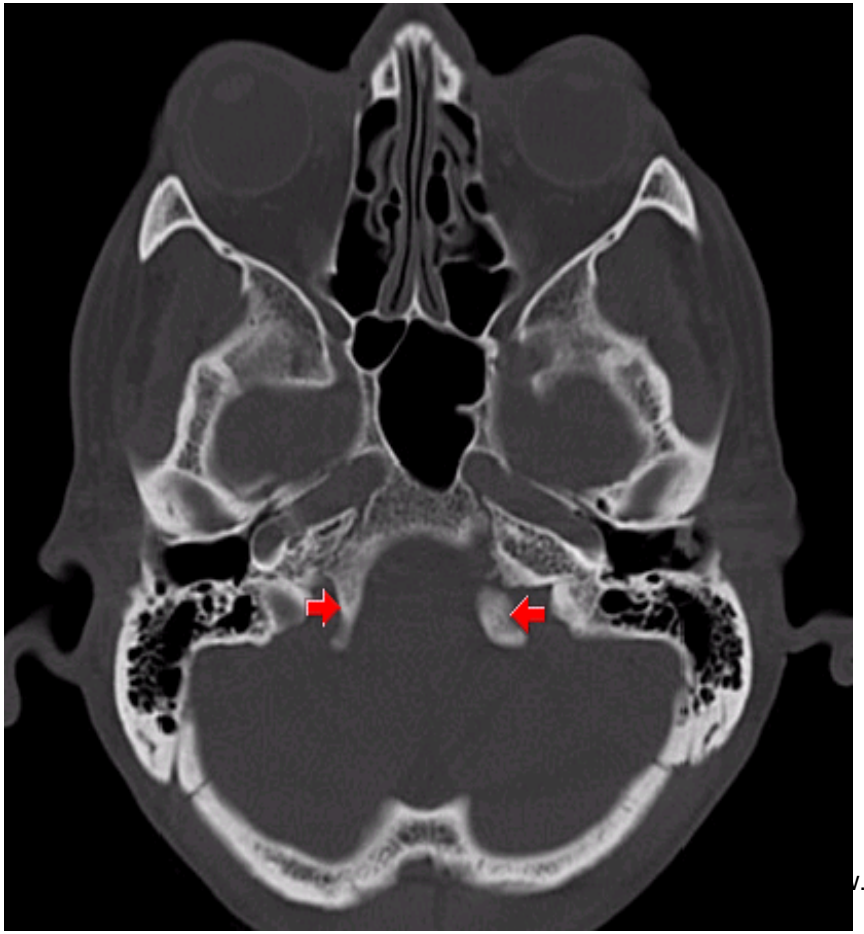
- **Carotid canal**

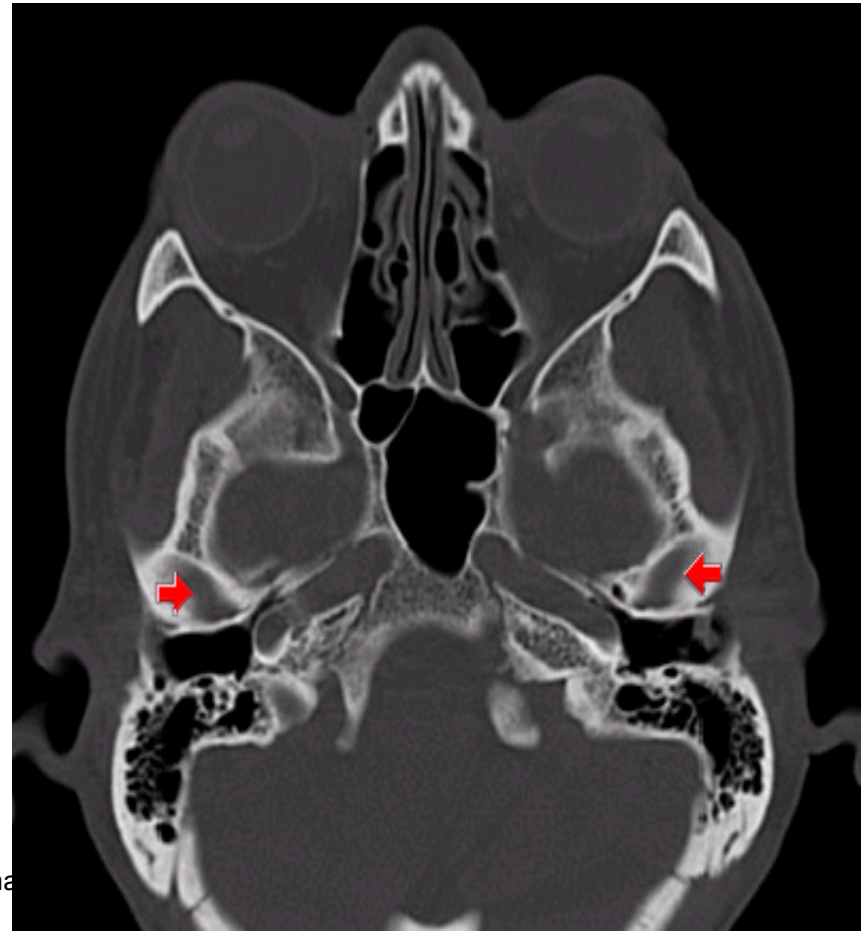
•Foramen rotundum



- **Jugular tubercle of occipital l**

•Mandibular fossa, roof





- **Middle ear**

- Sphenoid bone, body

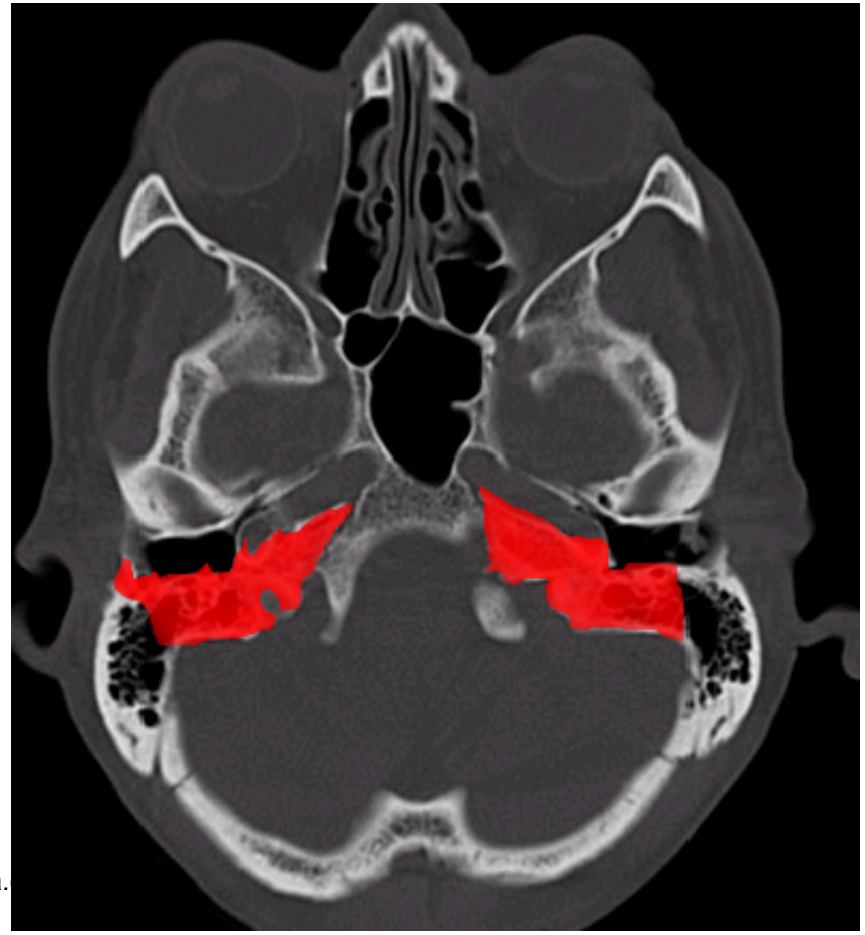
- **Sphenoid bone, greater wing**

similim

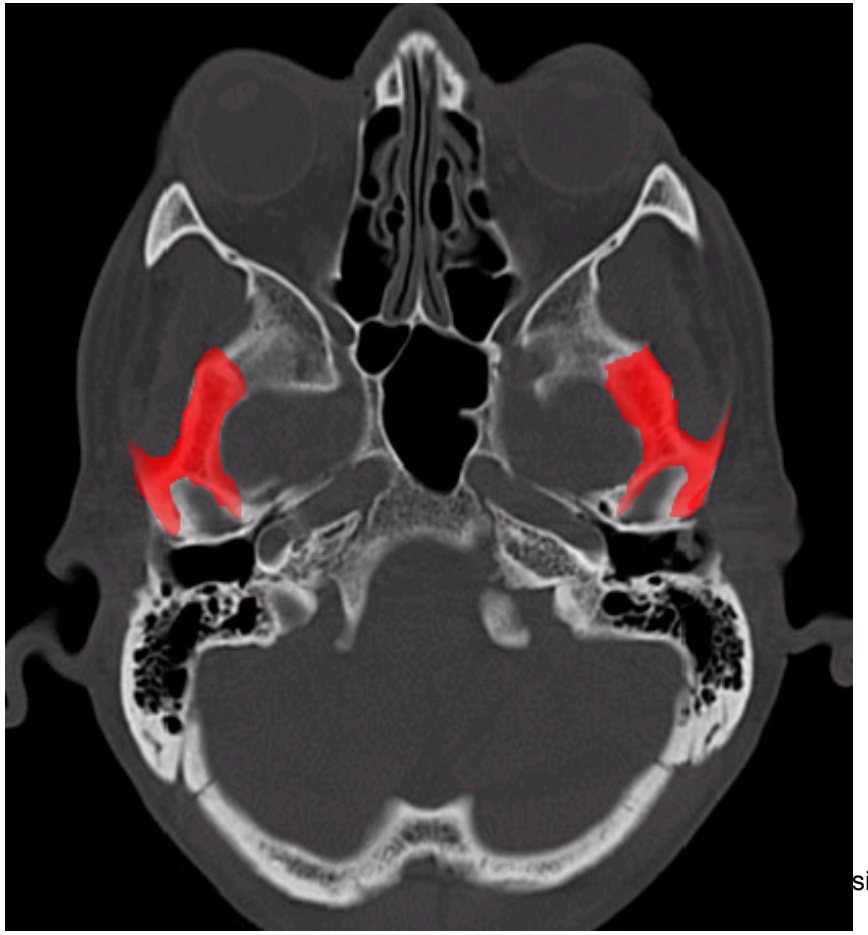
- Sphenosquamous suture_

- **Sphenozygomatic suture**

- Temporal bone, petrous part



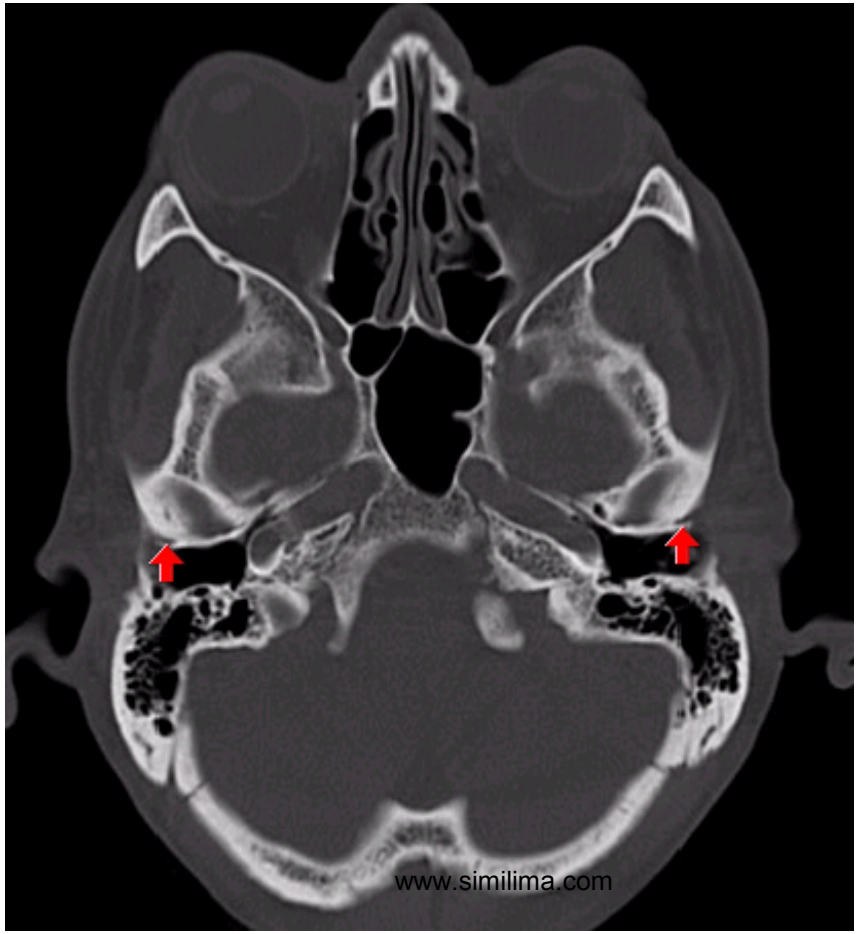
- **Temporal bone, squamous**



- Temporal bone, tympanic part

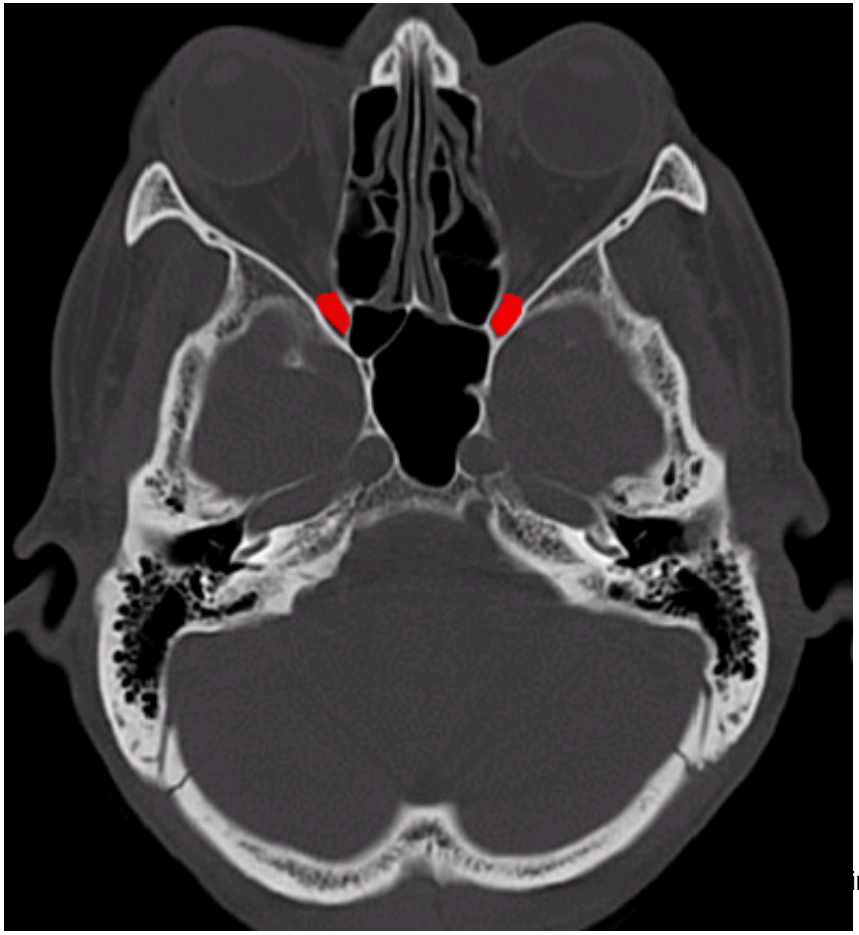
similim

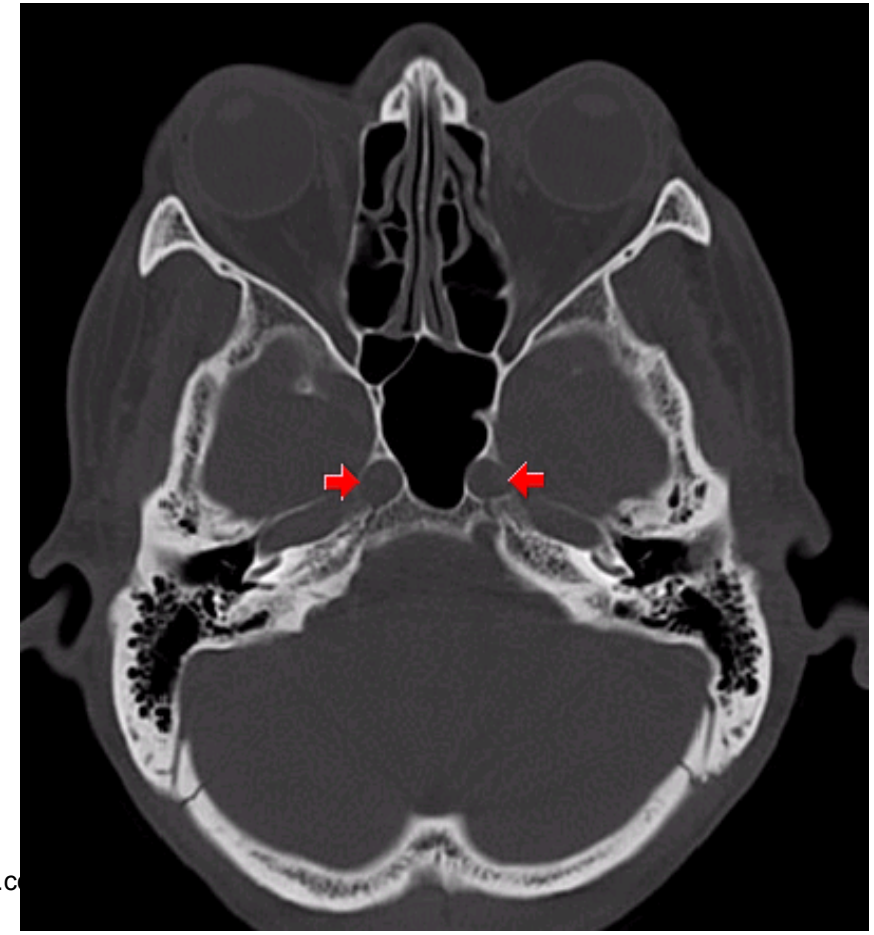
- **Tympanosquamous fissure**



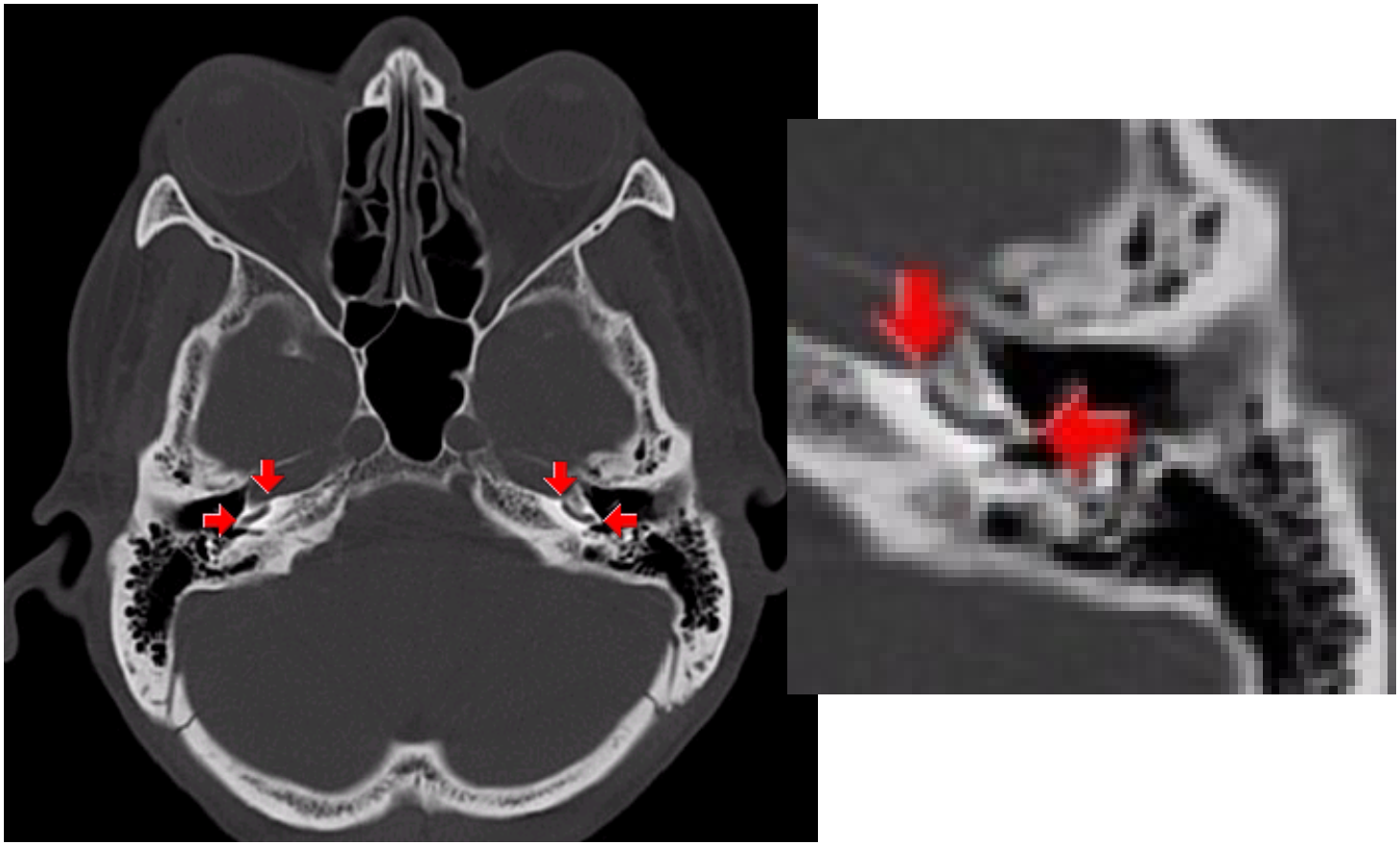
- Space connecting superior and

•Groove in body of sphenoid

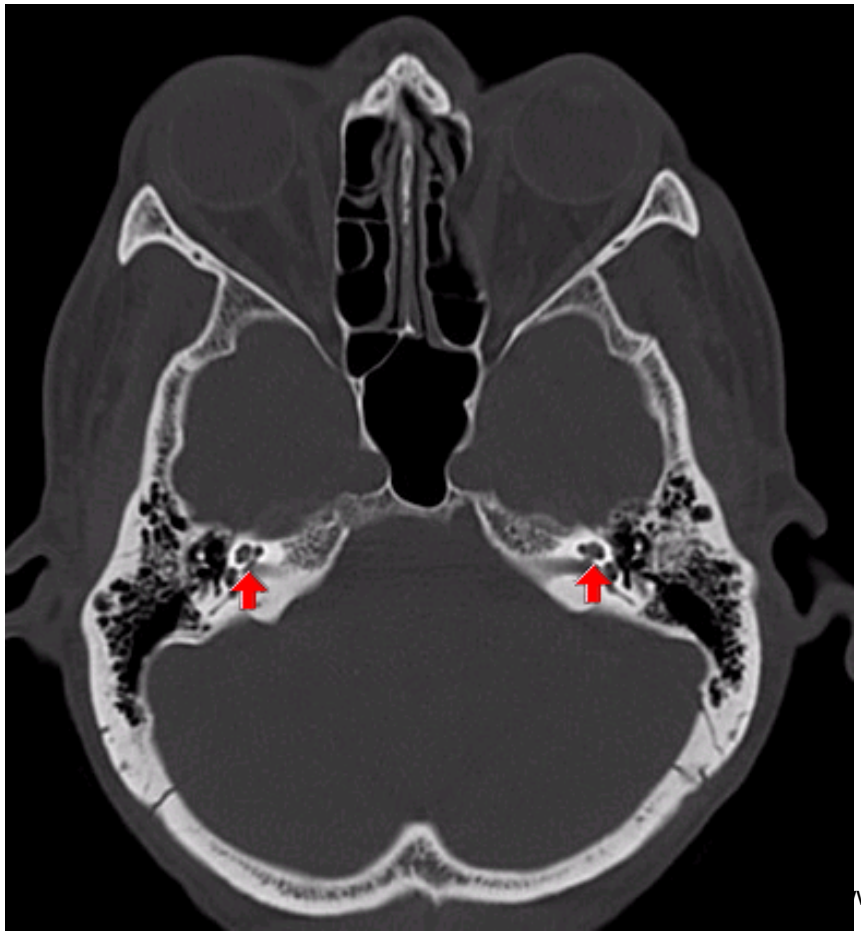




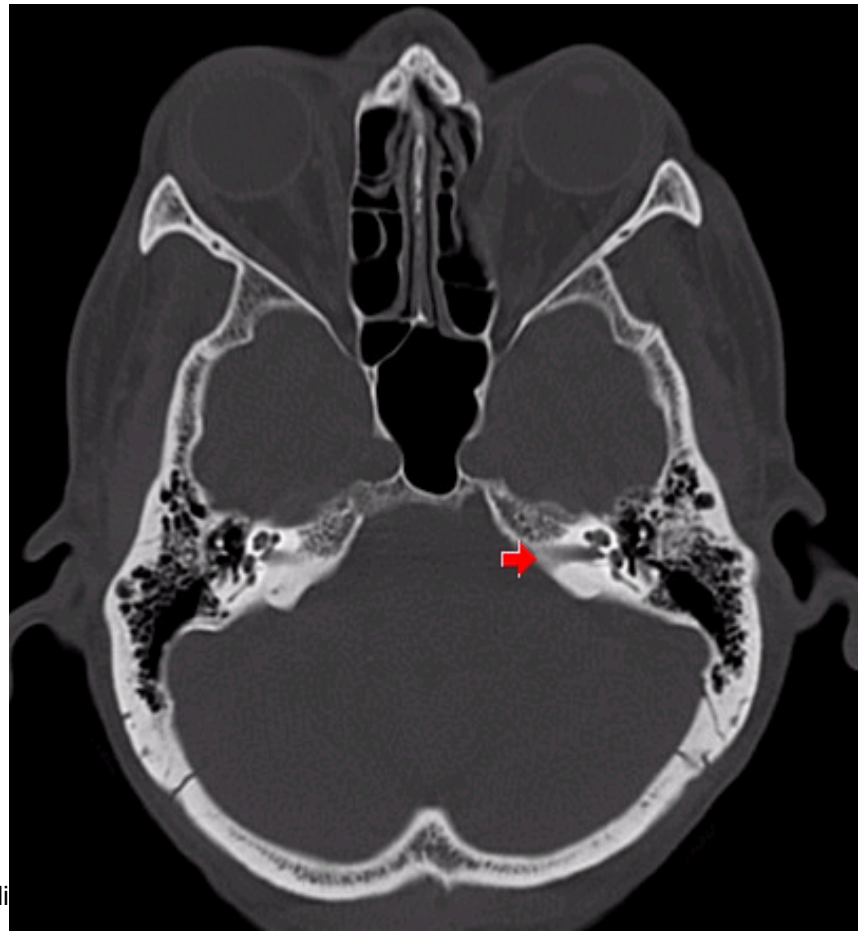
•Basal turn of cochlea



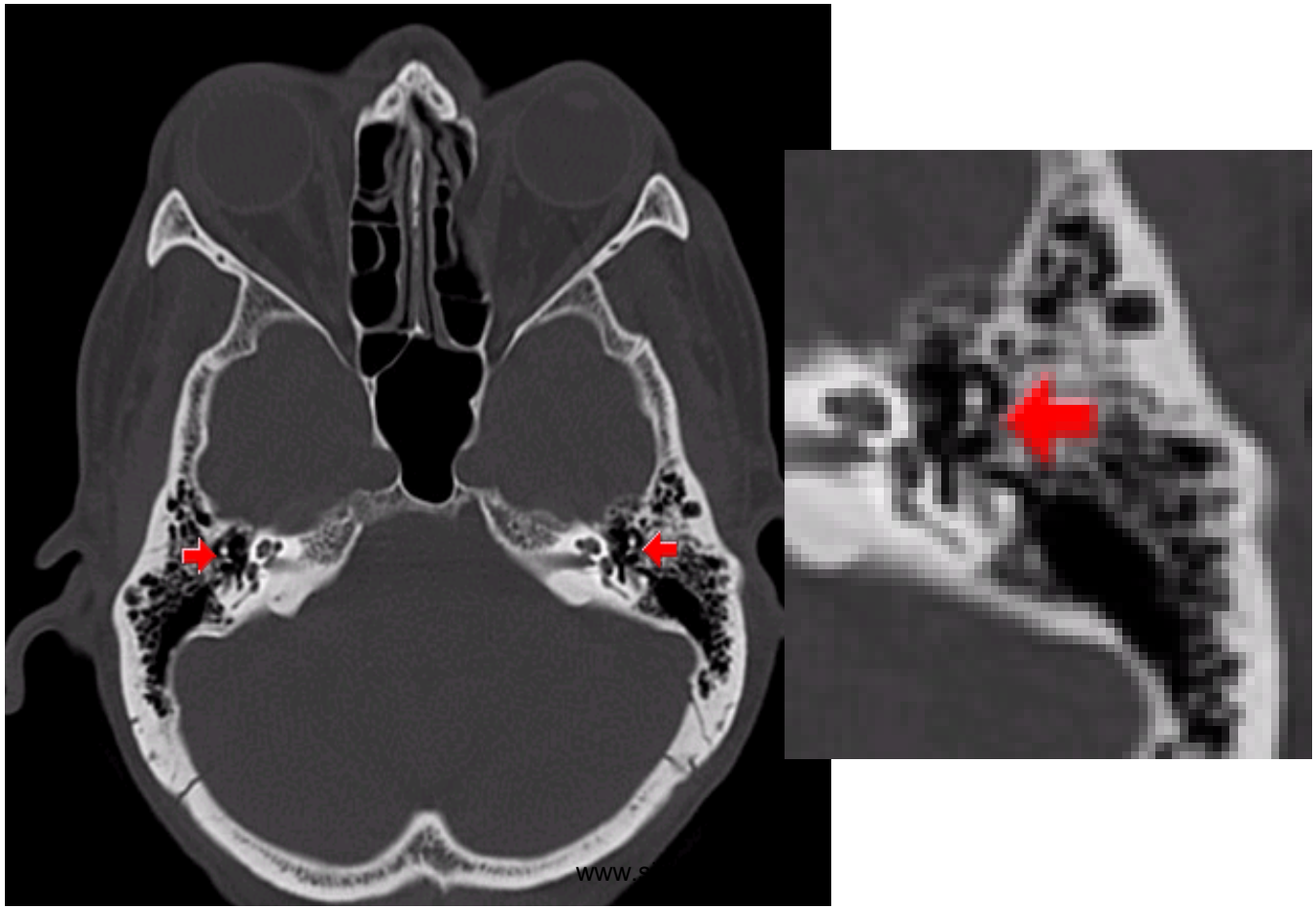
Cochlea



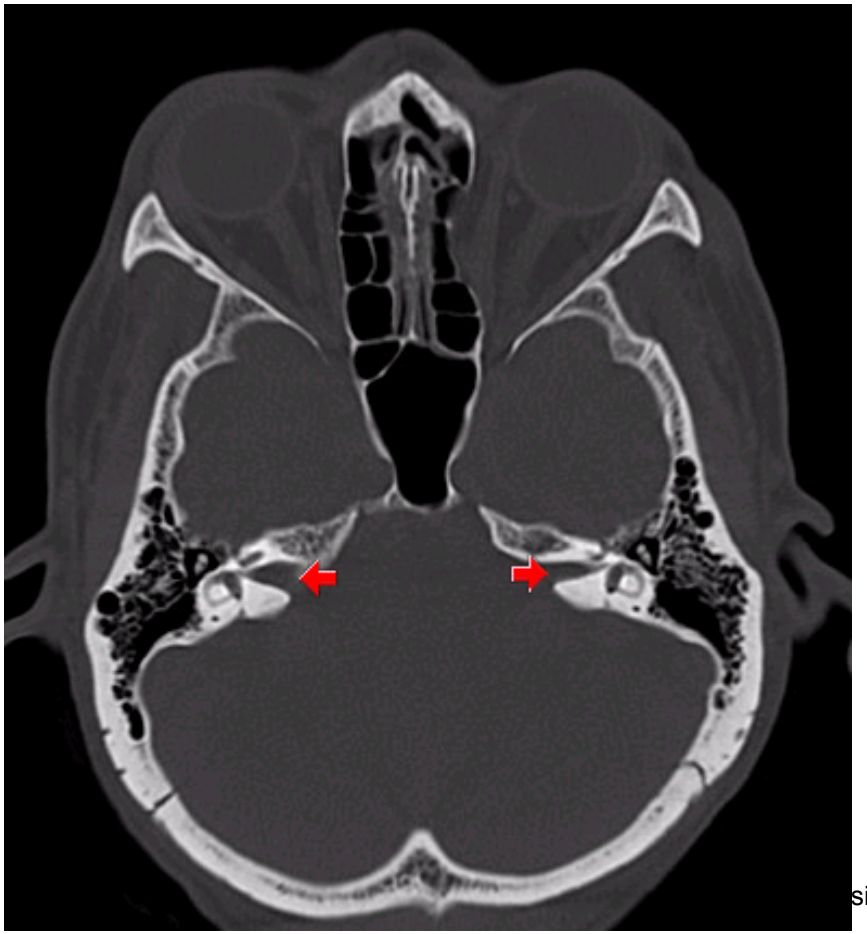
Internal auditory canal, left



- Middle ear with malleus



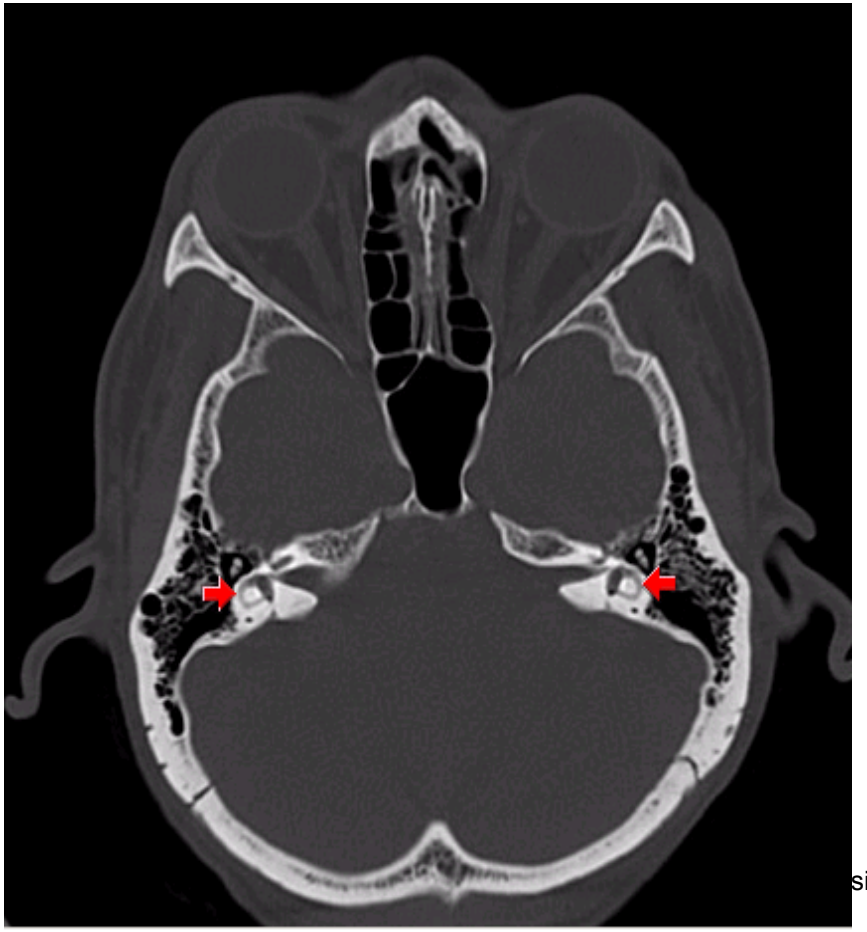
- Internal auditory canal



- Middle ear with malleus and incus

- **Vestibule with lateral semicir**

•Superior orbital fissure



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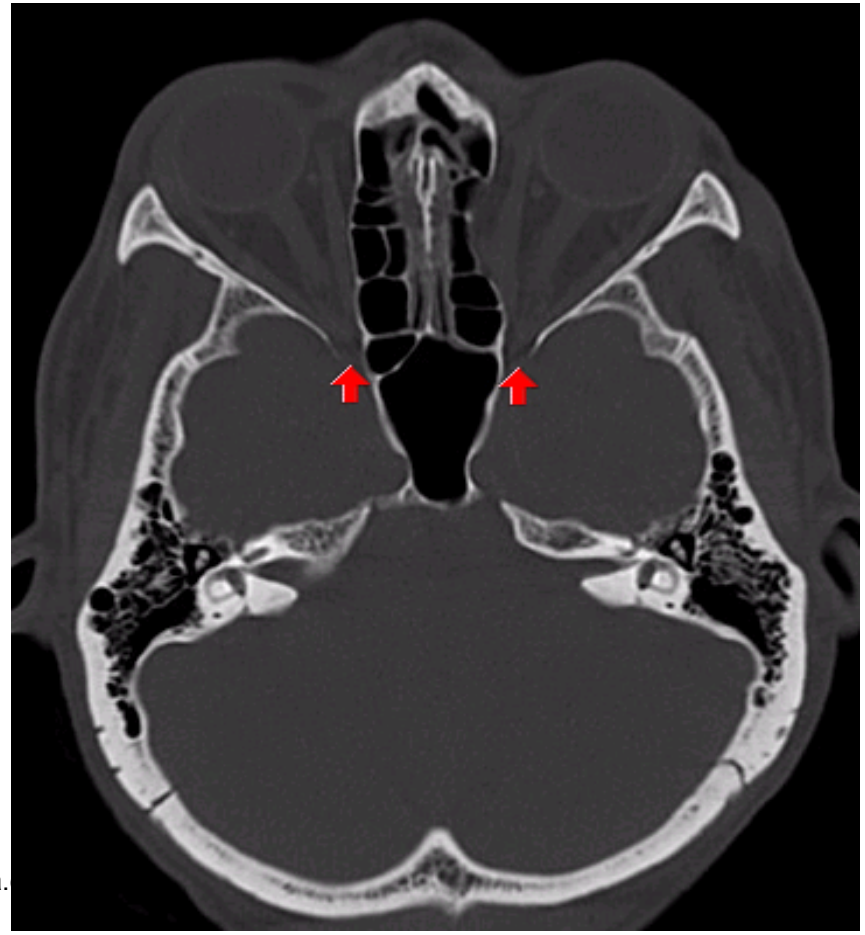
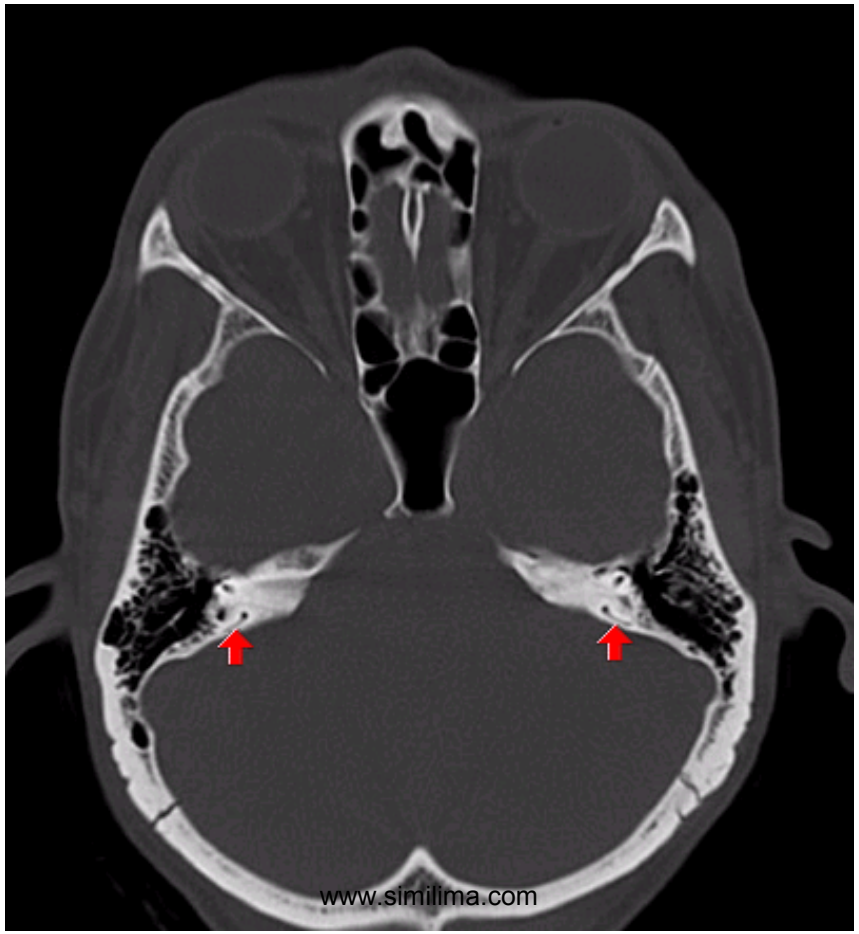
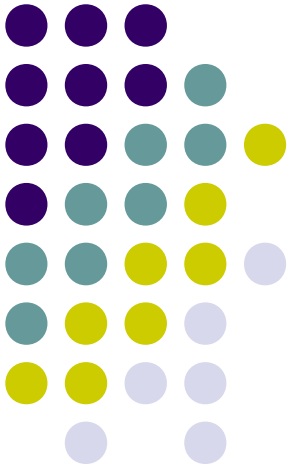


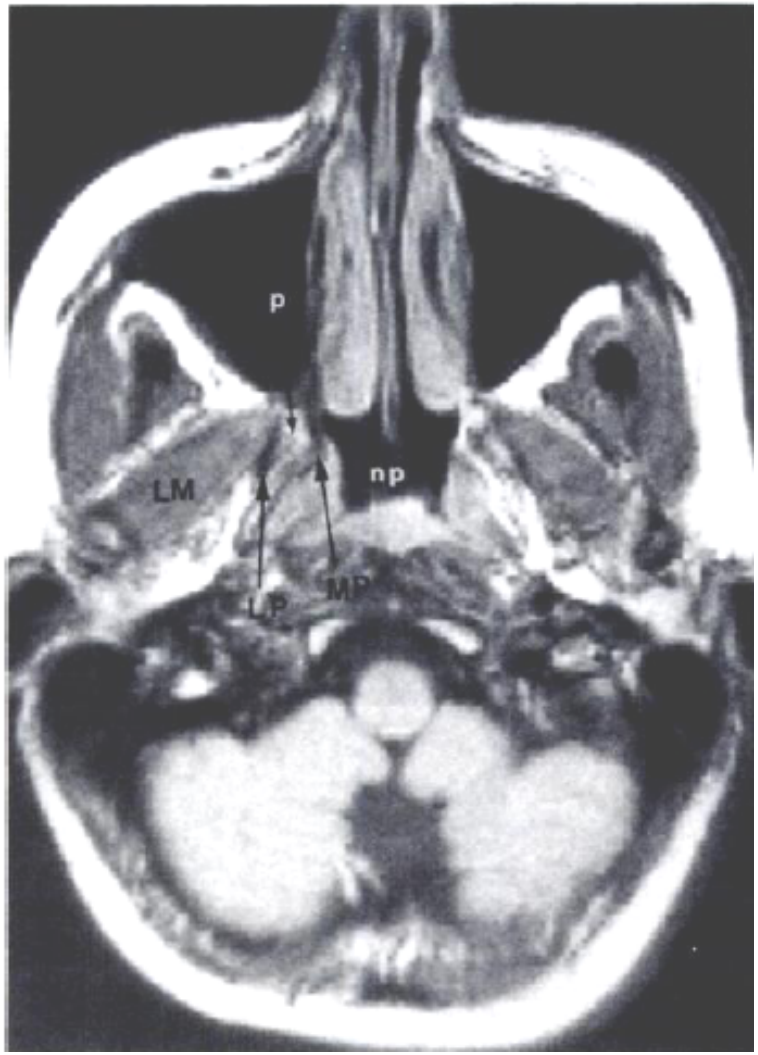
Posterior semicircular car



RADIOLOGICAL ANATOMY

....through MRI slices





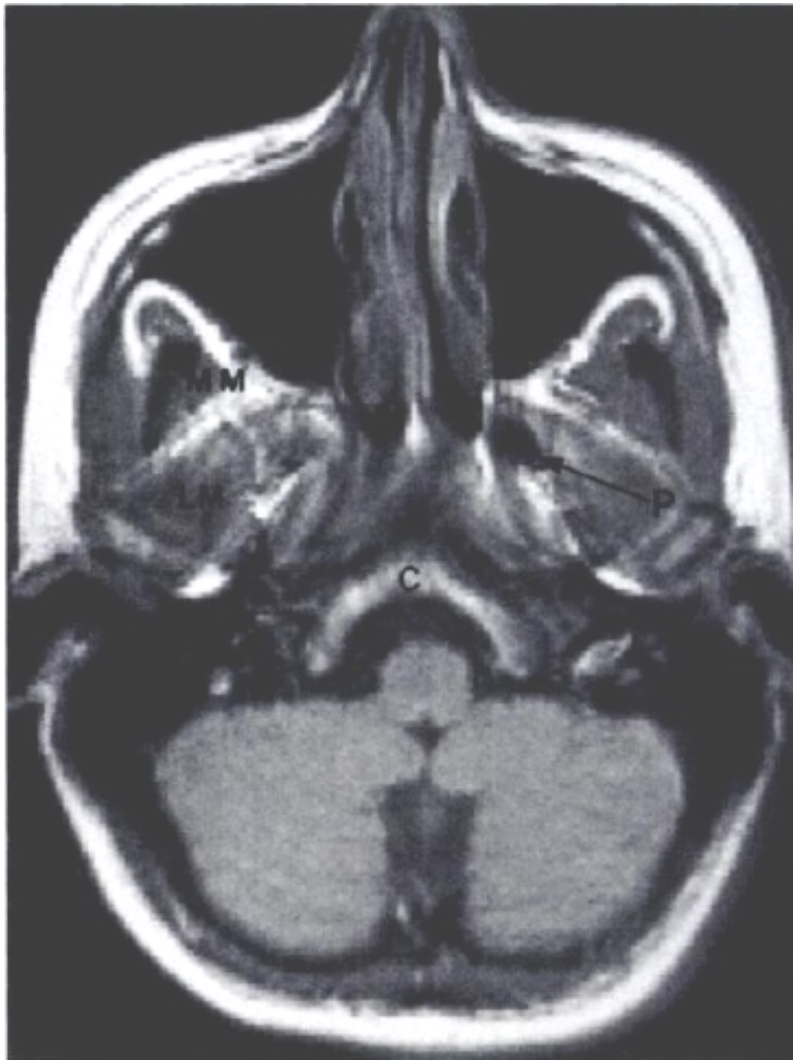
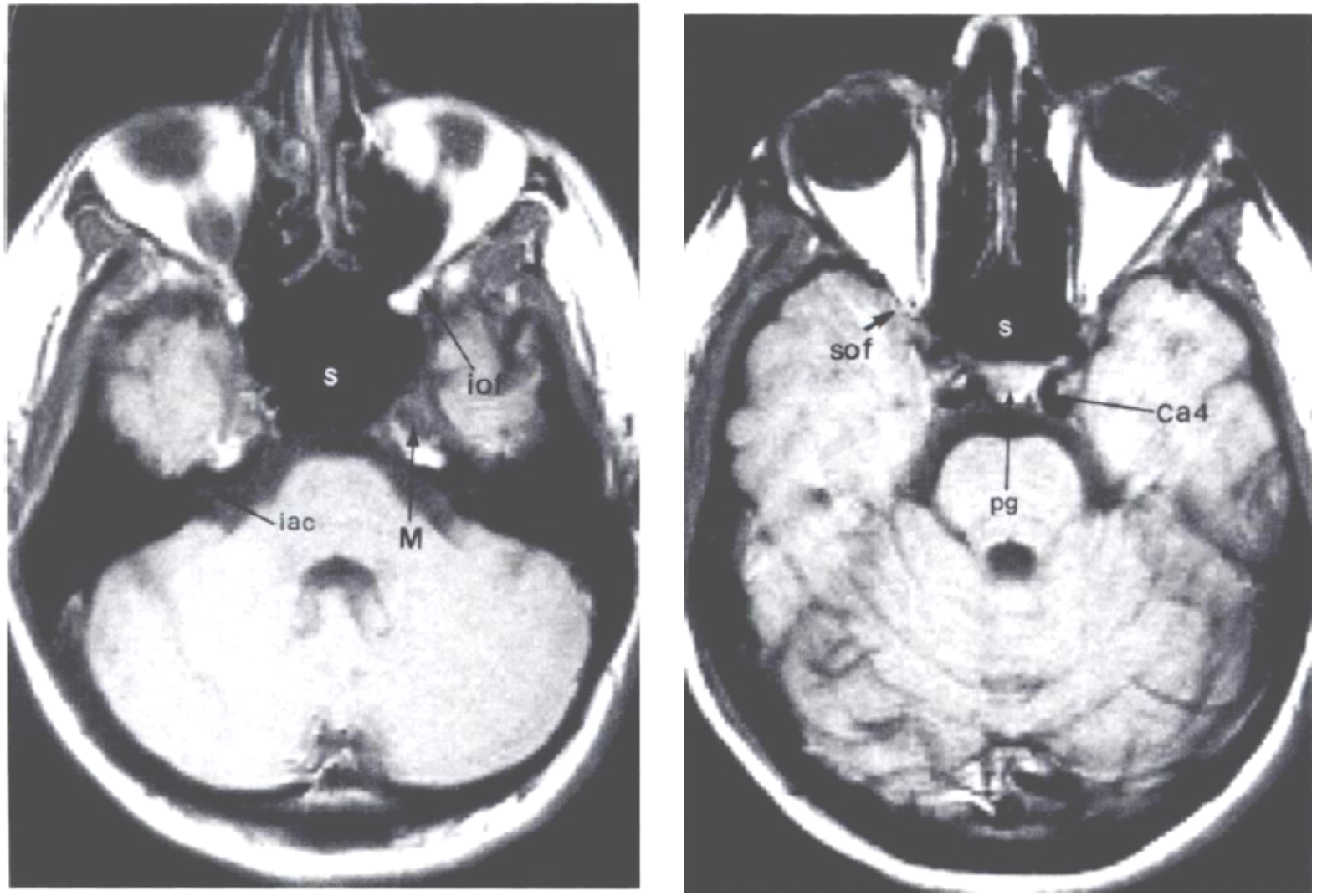


Figure 8. Axial T1-weighted MR images of the skull base, arranged from caudal **(a)** to rostral **(d)**. *C* = clivus, *ca4* = cavernous portion of carotid artery, *iac* = internal auditory canal, *iof* = inferior orbital fissure, *LM* = lateral pterygoid muscle, *LP* = lateral pterygoid plate, *M* = Meckel cave, *MM* = medial pterygoid muscle, *MP* = medial pterygoid plate, *np* = nasopharynx, *P* = pterygoid process, *p* = pterygoid fossa *pg* = pituitary gland, *S* = sphenoid sinus, *sof* = superior orbital fissure.



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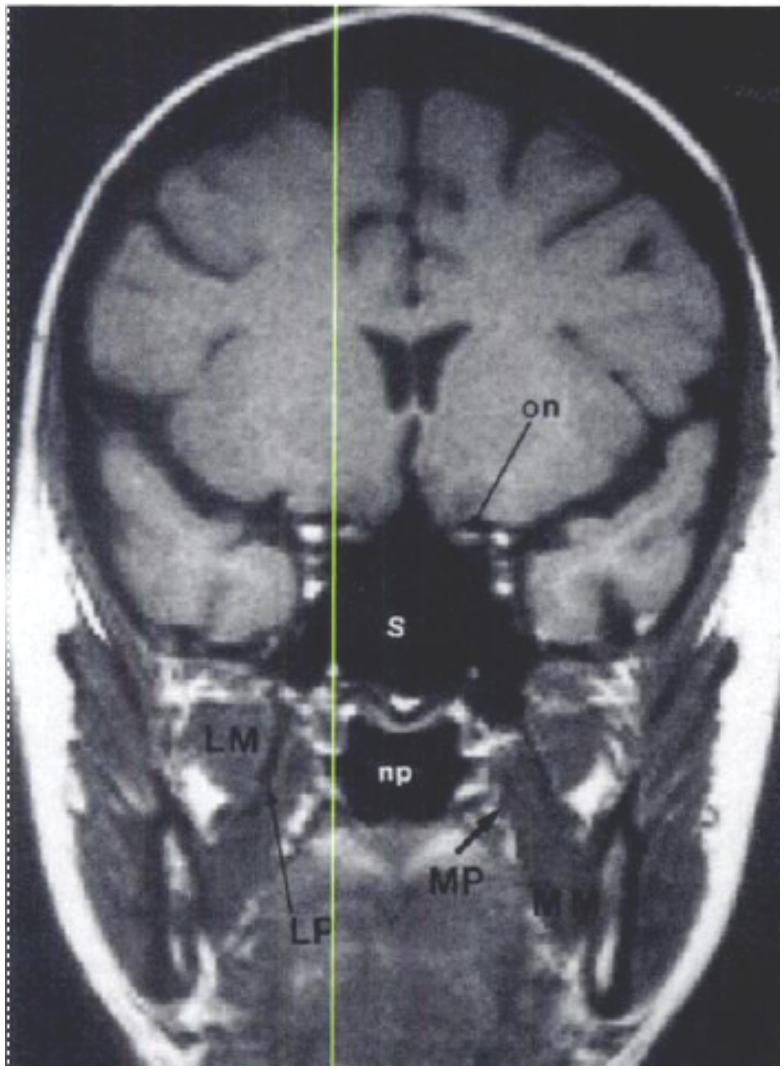


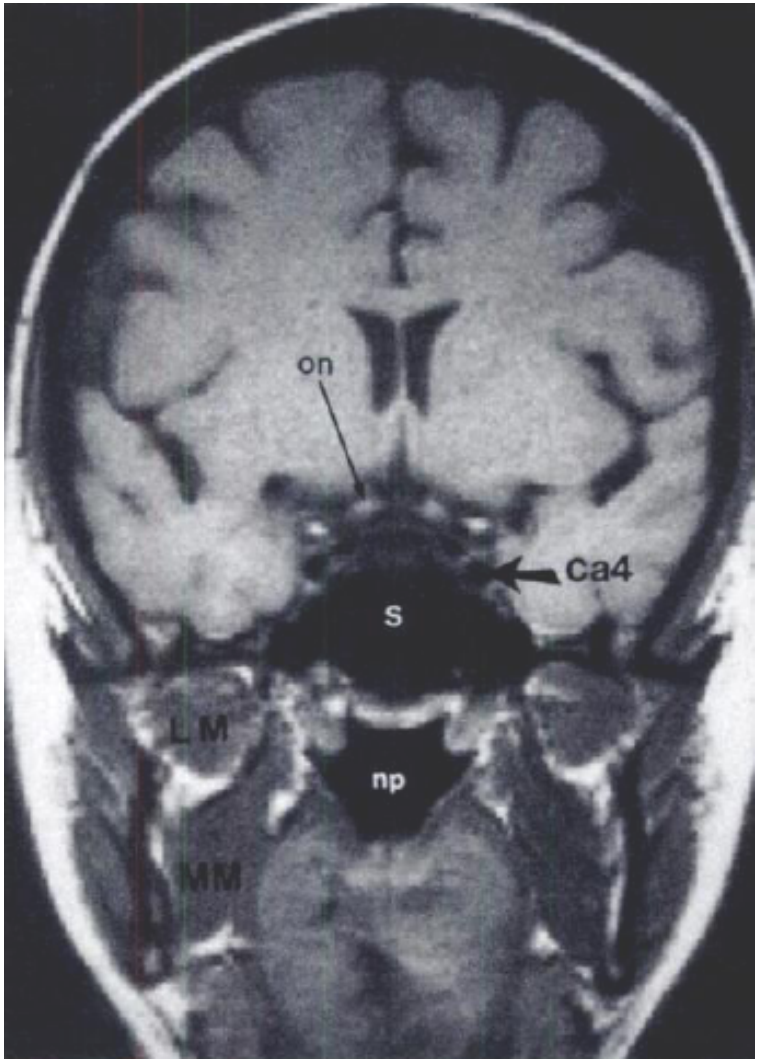
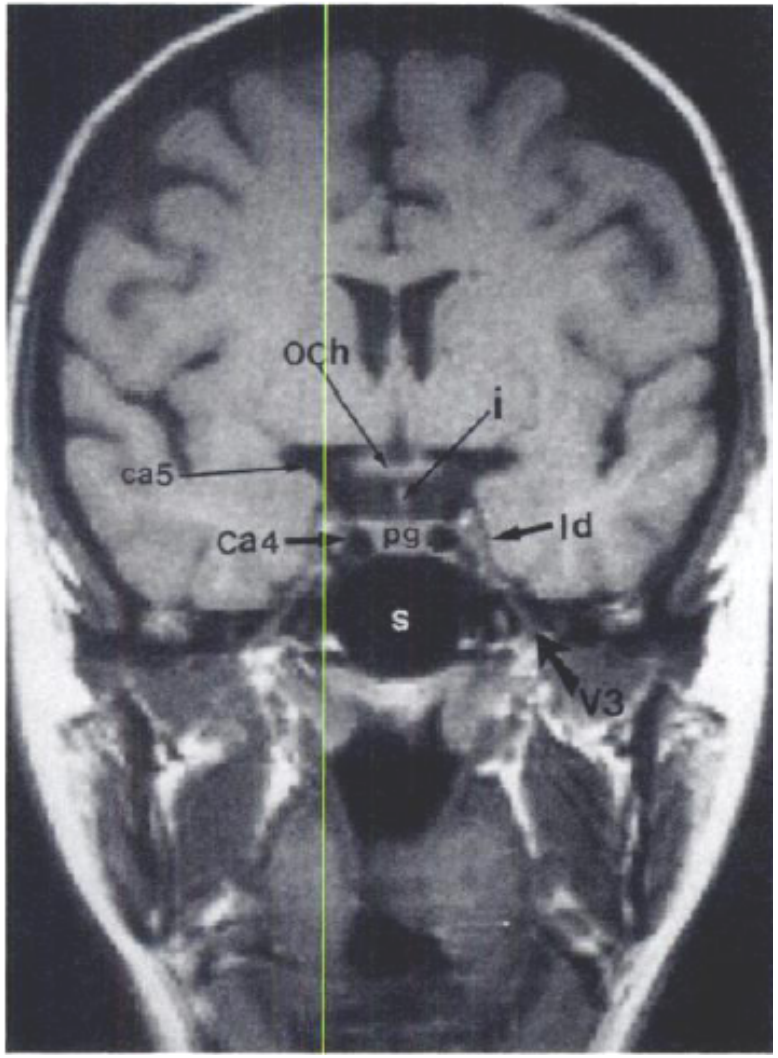
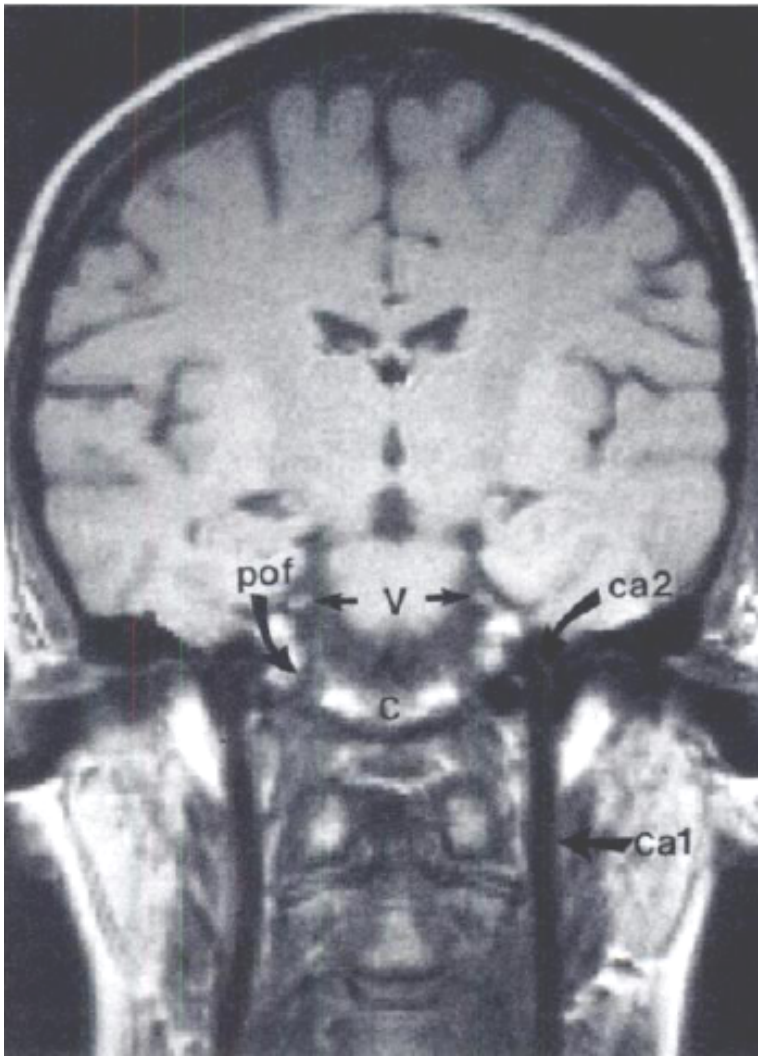


Figure 9. Coronal T1-weighted MR images of the skull base arranged from anterior **(a)** to posterior **(d)**. *C* = clivus, *ca1* = cervical portion of carotid artery, *ca2* = petrous portion of carotid artery, *ca4* = cavernous portion of carotid artery, *ca5* = supraclinoid portion of carotid artery, *i* = pituitary infundibulum, *ld* = lateral dural reflection of cavernous sinus, *LM* = lateral pterygoid muscle, *LP* = lateral pterygoid plate, *MM* = medial pterygoid muscle, *MP* = medial pterygoid plate, *np* = nasopharynx, *och* = optic chiasm, *on* = optic nerve, *pg* = pituitary gland, *pof* = petrooccipital fissure, *S* = sphenoid sinus, *V3* = mandibular branch of trigeminal nerve in foramen ovale, *V* = trigeminal nerve.





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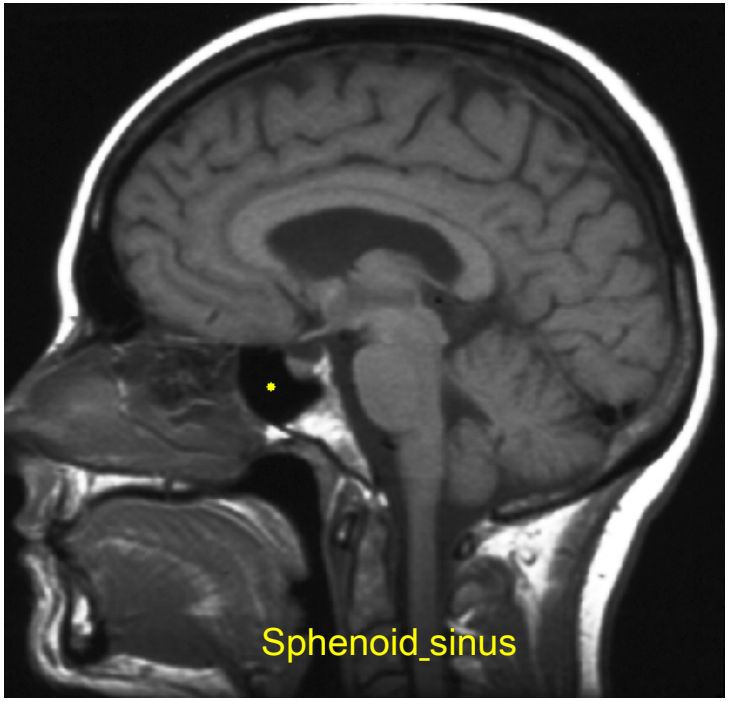
Pituitary gland


Sphenoid_sinus


Frontal sinus
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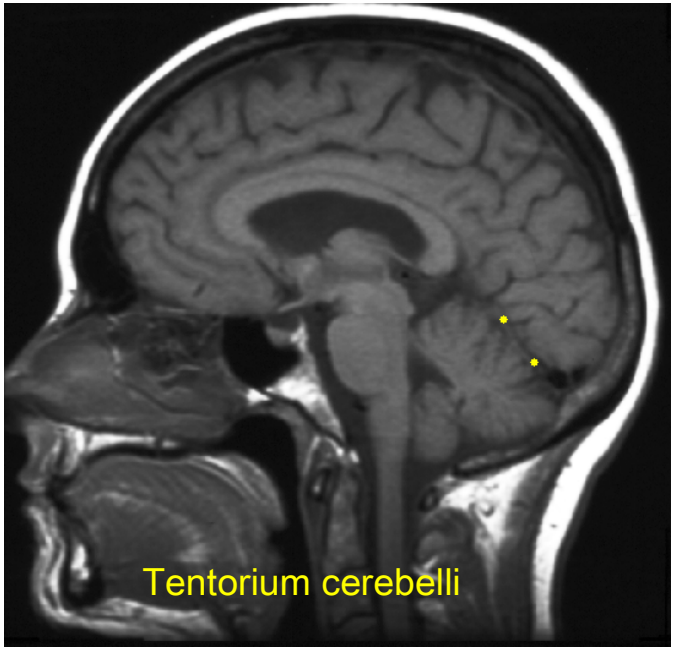
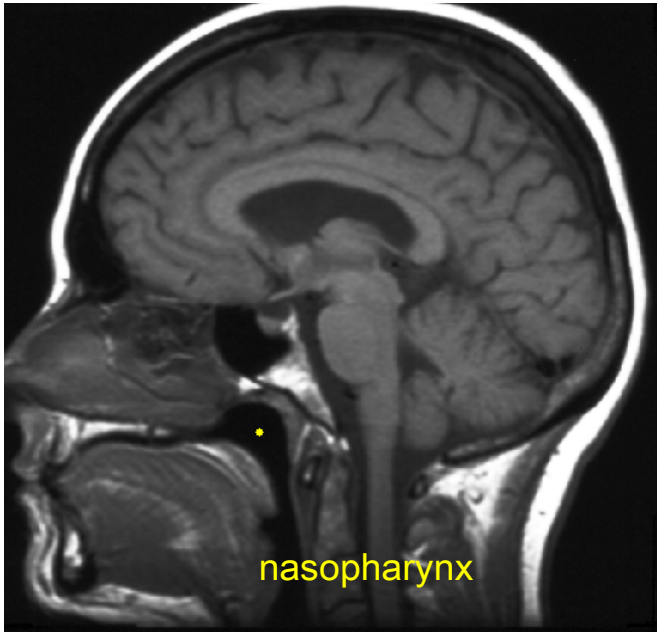

Tentorium cerebelli


Fat in marrow of clivus

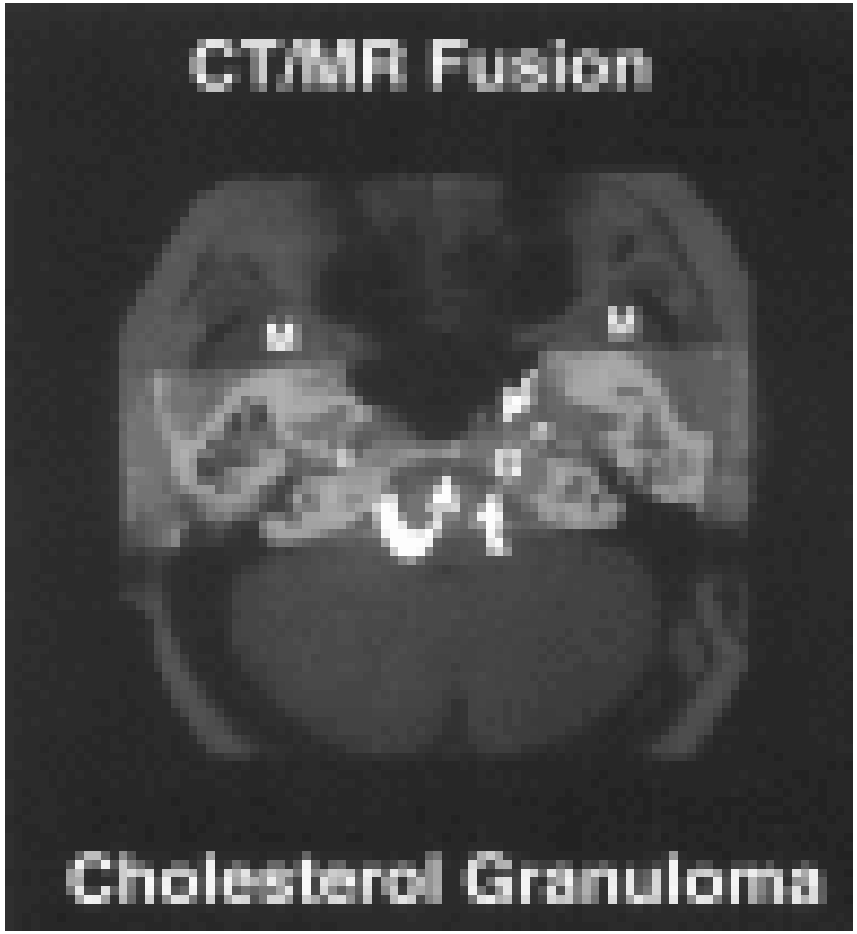

nasopharynx


Optic chiasma in suprasellar cistern


dens

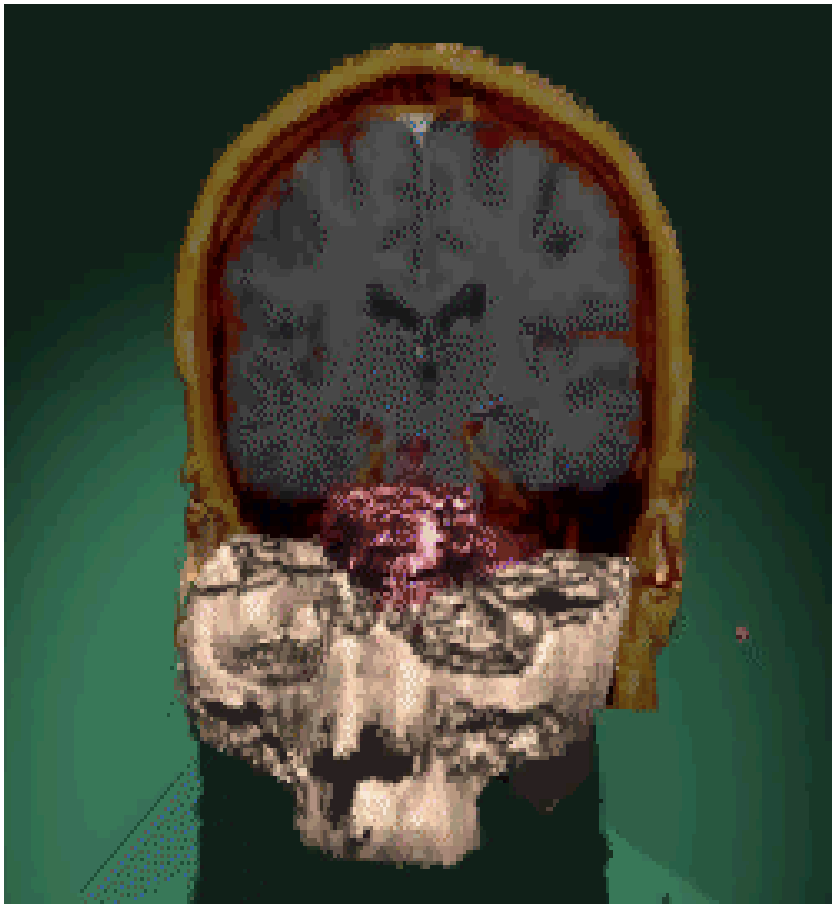
CT/MR Fusion For Skull Base Imaging

- Image fusion allows simultaneous visualization of the bony skull base anatomy (CT) and detailed soft tissue anatomy (MR) using a single image format.
- Combining both modalities was felt to provide a better assessment of the extent of lesions and improve understanding of their relationship to adjacent bony and neurovascular anatomy.
- Specifically, image fusion enhanced awareness of location of skill base lesions with respect to the cavernous sinuses. Gasserian ganglia, carotid arteries, and jugular foramina.



MERGED CT AND MRI DATASETS

- Even current diagnostic capabilities such as magnetic resonance and high resolution thin-section computed tomography do not reveal relationships as extensively as surgical exposure and surgeon commonly finds anatomical relationships that were not anticipated before surgical exposure.
- An interdisciplinary team of skull base and cranial surgeons, radiologists, and research and computer scientists are developing an interactive system for real-time manipulation of volumetric reconstructions from imaging studies, combining both computed tomography and magnetic resonance, including magnetic resonance angiography.
- This work includes developing a volume rendering system capable of real-time rendering of moderate 256(3) to high resolution 300(3)-500(3) volume data sets.
- The renderer can integrate volumetric and polygonal data so an image of a gloved hand and medical instruments can be seen with volumetric medical data.



MERGED CT AND MRI DATASETS

- *(mpeg file, 715998 byte*

Reconstruction with S

.....thank you

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