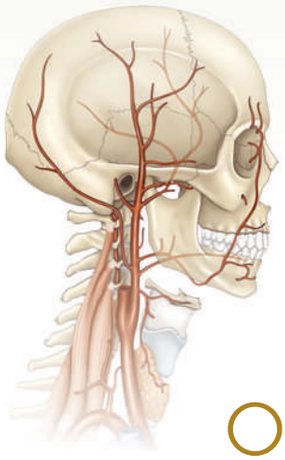


Chapter

1

Osteology of Head and Neck

The *head* is the globular uppermost part of the body, which is connected with the trunk by the *neck*. The *face* is the anterior aspect of head and the muscles present here express facial movements. The *scalp* overlies the lateral, posterior and superior aspects of skull.

Functions of Head and Neck

The head and neck region performs the following functions:

1. Protection to brain, endocrine glands and special senses.
2. Gives passage to food and air and connects their upper parts to their respective lower parts.
3. Produces voice for communication.

Peculiar Features of Human Head and Neck

1. The head comprises skull and lodges the brain covered by meninges, hypophysis cerebri, special senses, teeth and blood vessels. Brain is the highest seat of intelligence.
2. To accommodate the increased volume of nervous tissue, the cranial cavity had to enlarge.
3. Correspondingly, the lower jaw or mandible had to retract.
4. The eyes also had come more anteriorly, on each side of the nose.
5. The external nose also became prominent.
6. The external ear becomes vestigial and chin is pushed forwards to accommodate the broad tongue.
7. Tongue, the organ for speech, is securely placed in the oral cavity for articulation of words, i.e. speech.
8. The vocalisation centre is big to articulate various words and speak distinctly. Speech is a special and chief characteristic of the human.

Regions of Head and Neck

For study purposes, the head and neck are divided into the following regions:

1. ***Frontal region:*** Lies in front of skull.
2. ***Parietal region:*** Lies on top of skull, formed chiefly by the parietal bones. It is seen from the top.
3. ***Occipital region:*** Forms back of skull.
4. ***Temporal region:*** It is the area above the ears.
5. ***Ocular region:*** It is the region around the large orbital openings, containing the precious eyeball, muscles to move the eyeball, nerves and blood vessels to supply these muscles.
6. ***Auricular region:*** The region of the external ear with external auditory meatus comprises the auricular region.
7. ***Nasal region:*** The region of the external nose, its muscles and the associated cavity comprise the nasal region. Sense of smell is perceived from this region.
8. ***Oral region:*** Comprises upper and lower lips and the angle of the mouth, where the lips join each side. Numerous muscles are present here, to express feelings and emotions. These are parts of the muscles of facial expression. They show feelings, without words.
9. ***Oral cavity:*** It houses the organ of speech and taste. Tongue itself is not swallowed, though everything put on the tongue passes downwards.
10. ***Parotid region:*** Lies on the side of the face. It contains the biggest serous parotid salivary gland, which lies around the external auditory meatus.
11. ***Neck:*** Each half of the neck comprises two triangles between anterior median line and posterior median line.
    a. ***Posterior triangle:*** Lies between sternocleidomastoid, the *neck and chin turning muscle*; trapezius, *the shrugging muscle* and middle one-third of the clavicle. It contains spinal root of accessory nerve, proximal parts of the important brachial plexus, subclavian vessels with its branches and tributaries. Its apex is above and base is below.
    b. ***Anterior triangle:*** Lies between the anterior median line and the anterior border of sternocleidomastoid muscle. Its apex is in lower part of neck, close to sternum and base above. It contains the common carotid artery and branches of external carotid artery, last four cranial nerves, lymph nodes.

Competency:
AN26.1 Demonstrate anatomical position of skull, identify and locate individual skull bones in skull.

Bones of Head and Neck

The bones of head and neck include:
1. Skull, i.e. cranium with mandible
2. Seven cervical vertebrae
3. Hyoid
4. Six ossicles of the ear.

SKULL

The skeleton of the head is called the *skull*. It consists of several bones that are joined together to form the ***cranium***. The term skull also includes the mandible or lower jaw, which is a separate bone. However, the two terms, skull and cranium, are often used synonymously (Plate 1.1).

Parts of Skull

The skull can be divided into two main parts:
1. ***Calvaria*** or *brain box/neurocranium* is the upper part of the cranium, which encloses the brain. It consists of a skull cap/vault (intramembranous ossification) and a base (intracartilaginous ossification).
2. ***Facial skeleton***/viscerocranium constitutes the rest of the skull and includes the mandible.

Bones of the Skull

The skull consists of 28 bones, including 6 ear ossicles.
1. **Calvaria** or brain box is composed of 14 bones, including three paired ear ossicles.

Paired	*Unpaired*
1. Parietal	1. Frontal
2. Temporal	2. Occipital
3. Malleus	3. Sphenoid
4. Incus	4. Ethmoid
5. Stapes	

2. ***Facial skeleton*** is composed of 14 bones.

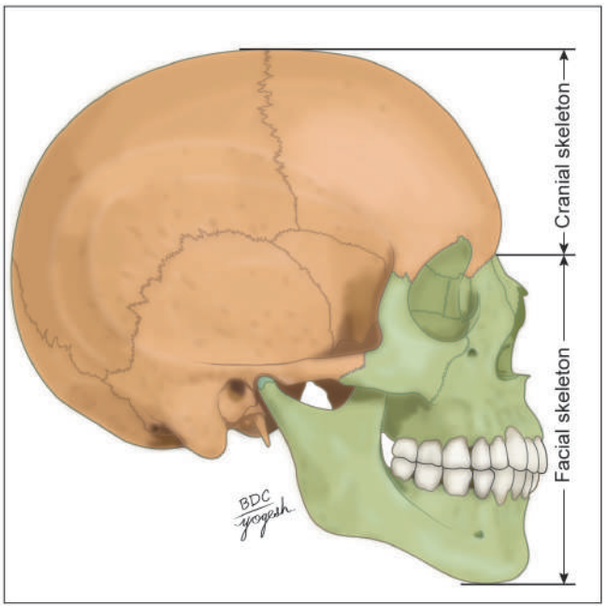
Paired	*Unpaired*
1. Maxilla	1. Mandible
2. Zygomatic	2. Vomer
3. Nasal	
4. Lacrimal	
5. Palatine	
6. Inferior nasal concha	

Skull Joints

The joints in the skull are mostly ***sutures***, a few primary cartilaginous joints and three pairs of synovial joints. The sutures can be classified into:
1. Plane suture — edges of bone are flat, e.g. internasal suture.
2. Serrate suture, e.g. coronal suture.
3. Denticulate suture, e.g. lambdoid suture.
4. Squamous suture, e.g. parietotemporal suture.
5. Schindylesis, e.g. palatomaxillary suture.

Movable joints of skull: Two pairs of synovial joints are present between the ossicles of middle ear. One pair is the largest *temporomandibular joint*.

Plate 1.1: Cranial and facial skeleton



Anatomical Position of Skull

Hold the skull in both the hands so that (Fig. 1.1):
1. The orbital cavities are directed forwards
2. The lower margin of the orbit and upper margin of the external acoustic meatus lie in the same horizontal plane (called ***Frankfurt's plane***).

Note: ***Reid's base line*** is a horizontal line obtained by joining the infraorbital margin to the centre of external acoustic meatus, i.e. auricular point (Fig. 1.1). It is used in conventional radiography when performing CT imaging.

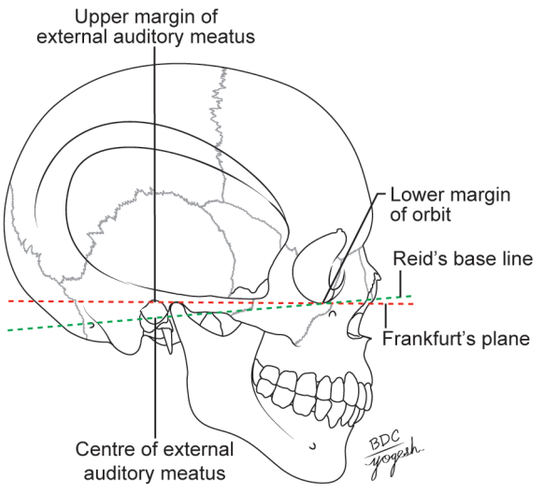


Fig. 1.1: Anatomical position of skull

Methods of Study of the Skull

The skull can be studied as a whole. The whole skull can be studied from the outside or externally in different views:

1. Superior view — norma verticalis
2. Posterior view — norma occipitalis
3. Anterior view — norma frontalis
4. Lateral view — norma lateralis
5. Inferior view — norma basalis.

The whole skull can be studied from the inside or internally after removing the roof of the calvaria or skull cap:

a. Internal surface of the ***cranial vault***.
b. Internal surface of the ***cranial base*** that shows a natural subdivision into anterior, middle and posterior cranial fossae.

Competency:
AN27.2 Describe emissary veins with its role in spread of infection from extracranial route to intracranial venous sinuses

Peculiarities of Skull Bones

1. Base of skull ossifies in cartilage, while the skull cap ossifies in membrane.
2. At birth, skull comprises one table only. By 4 years or so, two tables are formed. Between the two tables, there are *diploes* (Greek *double*), i.e. spaces containing red bone marrow forming RBCs, granular series of WBCs and platelets. Four diploic veins on each side drain the formed blood cells into neighbouring veins.
3. At birth, the 4 angles of parietal bone have membranous gaps or fontanelles. These allow overlapping of bones during vaginal delivery, if required. These also allow skull bones to increase in size after birth, for housing the delicate brain.
4. Some skull bones have air cells in them and are called pneumatic bones, e.g. frontal and maxilla.
   a. They reduce the weight of skull.
   b. They maintain humidity of inspired air.
   c. They give resonance to voice.
   d. These may get infected resulting in sinusitis.
5. Skull bones are united mostly by sutures.
6. Skull has foramina for 'emissary veins', which connect intracranial venous sinuses with extracranial veins. These try to relieve raised intracranial pressure. Infection may reach through the emissary veins into cranial venous sinuses as these veins are valveless (Table 1.1).
7. Petrous temporal is the densest bone of the body. It lodges internal ear, middle ear, including three ossicles, i.e. malleus, incus and stapes. Ossicles are 'bones within the bone' and are fully formed at birth.
8. Skull lodges brain, meninges, CSF, glands like hypophysis cerebri and pineal, venous sinuses, teeth, special senses like retina of eyeball, taste buds of tongue, olfactory epithelium, cochlear and vestibular nerve endings.

Competency:
AN26.2 Describe the features of norma frontalis, verticalis, occipitalis, lateralis and basalis.

EXTERIOR OF THE SKULL

NORMA VERTICALIS

Shape

When viewed from above, the skull is usually oval in shape. It is wider posteriorly than anteriorly. The shape may be more nearly circular (Fig. 1.2, Flowchart 1.1).

Bones

1. Frontal bone anteriorly.
2. Occipital bone posteriorly.
3. Parietal bone on each side.

Sutures

1. ***Coronal suture*** is placed between the frontal and the two parietal bones. The suture crosses the cranial vault from side-to-side (Fig. 1.2).
2. ***Sagittal suture*** is placed in the median plane between the two parietal bones.
3. ***Lambdoid suture*** lies posteriorly between the occipital and the two parietal bones. It is labda-shaped, hence the name.

Note: ***Metopic*** (Latin *forehead*) ***suture*** is occasionally present in about 3% to 8% of individuals. It lies in the median plane and separates the two halves of the frontal bone. Normally, it fuses at 6 years of age.

TABLE 1.1: The emissary veins of the skull

Name	*Foramen of skull*	*Veins outside skull*	*Venous sinus*
1. Parietal emissary vein	Parietal foramen	Veins of scalp	Superior sagittal sinus
2. Mastoid emissary vein	Mastoid foramen	Veins of scalp	Sigmoid sinus
3. Emissary vein	Hypoglossal canal	Internal jugular vein	Sigmoid sinus
4. Condylar emissary vein	Posterior condylar foramen	Suboccipital venous plexus	Sigmoid sinus
5. 2–3 emissary veins	Foramen lacerum	Pharyngeal venous plexus	Cavernous sinus
6. Emissary vein	Foramen ovale	Pterygoid venous plexus	Cavernous sinus
7. Emissary vein	Foramen caecum	Veins from upper part of nose	Superior sagittal sinus

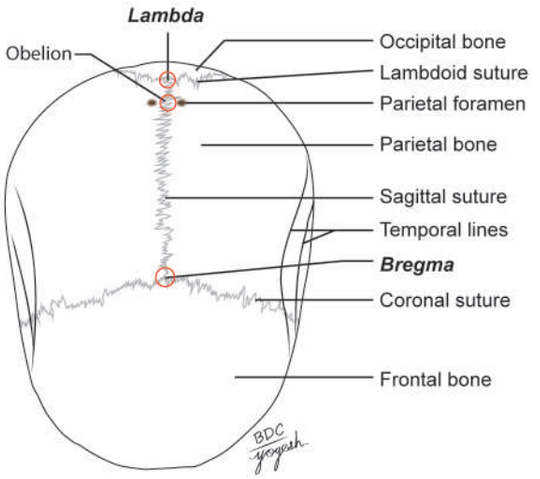
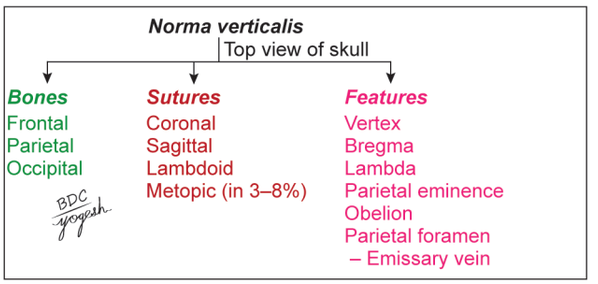


Fig. 1.2: Norma verticalis

Flowchart 1.1: Features of norma verticalis



Features (Fig. 1.2)

1. ***Vertex*** is the highest point on sagittal suture.
2. ***Vault*** of skull is the arched roof for the dome of skull.
3. ***Bregma*** is the meeting point between the coronal and sagittal sutures. In the foetal skull, this is the site of a membranous gap, called the *anterior fontanelle*, which closes at 18 to 24 months of age. It allows growth of brain.
4. ***Lambda*** is the meeting point between the sagittal and lambdoid sutures. In the foetal skull, this is the site of the *posterior fontanelle*, which closes at birth—2 to 3 months of age.
5. ***Parietal tuber*** *(eminence)* is the area of maximum convexity of the parietal bone. This is a common site of fracture of the skull.
6. ***Parietal foramen***, one on each side, pierces the parietal bone near its upper border, 2.5 to 4 cm in front of the lambda. The parietal foramen transmits an emissary vein from the veins of scalp to superior sagittal sinus.
7. ***Obelion*** is the point on the sagittal suture between the two parietal foramina.
8. ***Temporal lines*** begin at the zygomatic process of the frontal bone, arch backwards and upwards and cross the frontal bone, the coronal suture and the parietal bone. Over the parietal bone, there are two lines—superior and inferior. Traced anteriorly, they fuse to form a single line. Traced posteriorly, the superior line fades out over the posterior part of the parietal bone, but the inferior temporal line continues downwards and forwards with zygomatic arch.
9. A pair of anterolateral/sphenoidal fontanelle and a pair of posterolateral or mastoid fontanelles are also present. These fontanelles close within 3–4 months after birth.

NORMA OCCIPITALIS

Norma occipitalis is convex upwards and on each side and is flattened below (Fig. 1.3, Flowchart 1.2).

Bones

1. Parietal bones above.
2. Squamous part of the occipital bone below.
3. Mastoid part of the temporal bone on each side.

Sutures

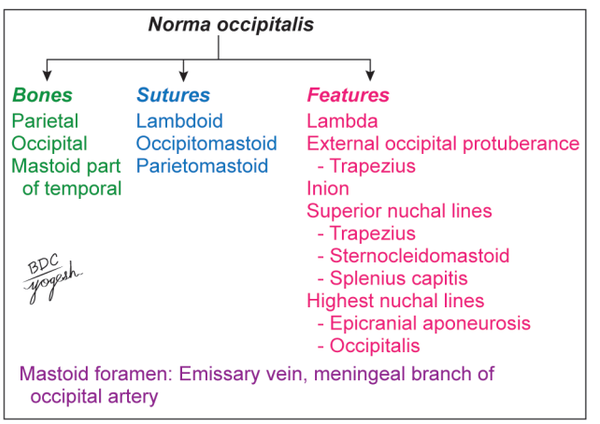
1. ***Lambdoid suture*** lies between the occipital bone and the two parietal bones. Sutural or wormian bones are common along this suture.
2. ***Occipitomastoid suture*** lies between the occipital bone and mastoid part of the temporal bone.
3. ***Parietomastoid suture*** lies between the parietal bone and mastoid part of the temporal bone.

The posterior part of the ***sagittal suture*** is also seen.

Features

1. *Lambda, parietal foramina* and *obelion* have been examined in the norma verticalis.
2. ***External occipital protuberance*** is a median prominence in the lower part of this norma. It marks the junction of the head and the neck. The most prominent point on this protuberance is called the *inion*.
3. ***Superior nuchal lines*** are curved bony ridges passing laterally from the protuberance. These also mark the junction of the head and the neck. The area below the superior nuchal lines will be studied with the norma basalis.
4. ***Highest nuchal lines*** are not always present. They are curved bony ridges situated about 1 cm above the superior nuchal lines. They begin from the upper part of the external occipital protuberance and are more arched than the superior nuchal lines.

Flowchart 1.2: Features of norma occipitalis



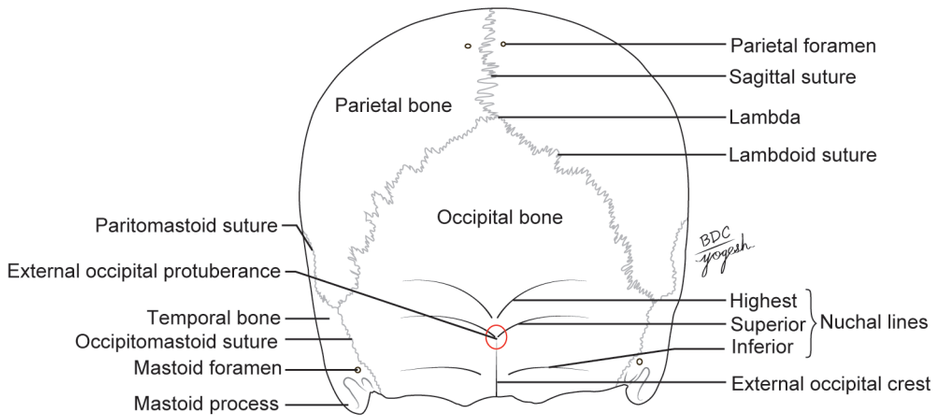


Fig. 1.3: Norma occipitalis

5. ***Occipital point*** is a median point, a little above the inion. It is the point farthest from the glabella.
6. ***Mastoid*** (Greek *breast*) ***foramen*** is located on the mastoid part of the temporal bone at or near the occipitomastoid suture. Internally, it opens at the sigmoid sulcus. The mastoid foramen transmits an emissary vein (Table 1.1) and the meningeal branch of the occipital artery.

Note: ***Interparietal bone*** (inca bone) is occasionally present. It is a large triangular bone located at the apex of the squamous occipital. This is not a sutural or accessory bone but represents the membranous part of the occipital bone which has failed to fuse with the rest of the bone.

Attachments

1. The upper part of the external occipital protuberance gives origin to the trapezius, and the lower part gives attachment to the upper end of the ligamentum nuchae.
2. The medial 1/3rd of the superior nuchal line gives origin to the trapezius, and the lateral part provides insertion to the sternocleidomastoid above and to the splenius capitis below.
3. The highest nuchal lines, if present, provide attachment to the epicranial aponeurosis medially, and give origin to the occipitalis or occipital belly of occipitofrontalis muscle laterally. In case of absence of highest nuchal lines, these structures are attached to superior nuchal lines.

NORMA FRONTALIS

The norma frontalis is roughly oval in outline, being wider above than below (Plate 1.2, Fig. 1.4, Flowchart 1.3).

Bones

1. *Frontal* bone forms the forehead. Its upper part is smooth and convex, but the lower part is irregular and is interrupted by the orbits and by the anterior bony aperture of nose.
2. Right and left *maxillae* form the upper jaw.
3. Right and left *nasal* bones form the bridge of the nose.
4. *Zygomatic* (Greek *yoke*) bones form the bony prominence of the superolateral part of the cheeks.
5. *Mandible* forms the lower jaw.

Descriptive Subdivisions

The *norma frontalis* can be studied under the following heads.

1. Frontal region
2. Orbital openings
3. Anterior nasal aperture
4. Lower part of the face.

Frontal Region

The frontal region presents the following features:

1. ***Superciliary arch*** is a rounded, curved elevation situated just above the medial part of each orbit. It overlies the frontal sinus and is better marked in males than in females.

Flowchart 1.3: Features of norma frontalis

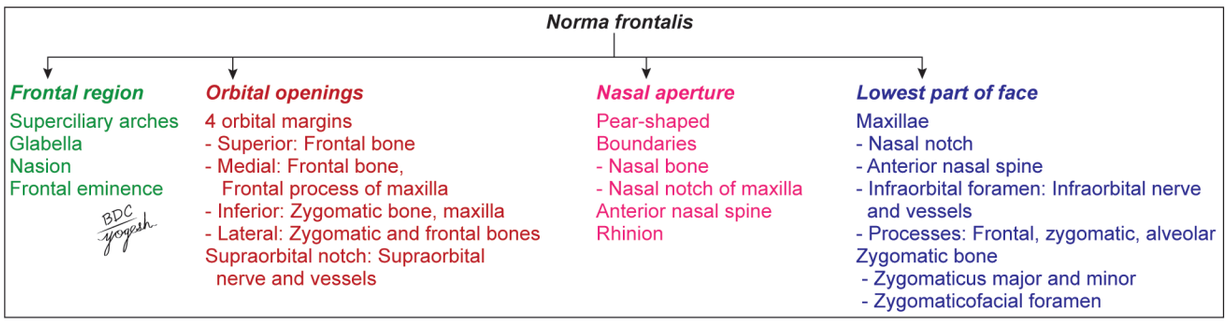
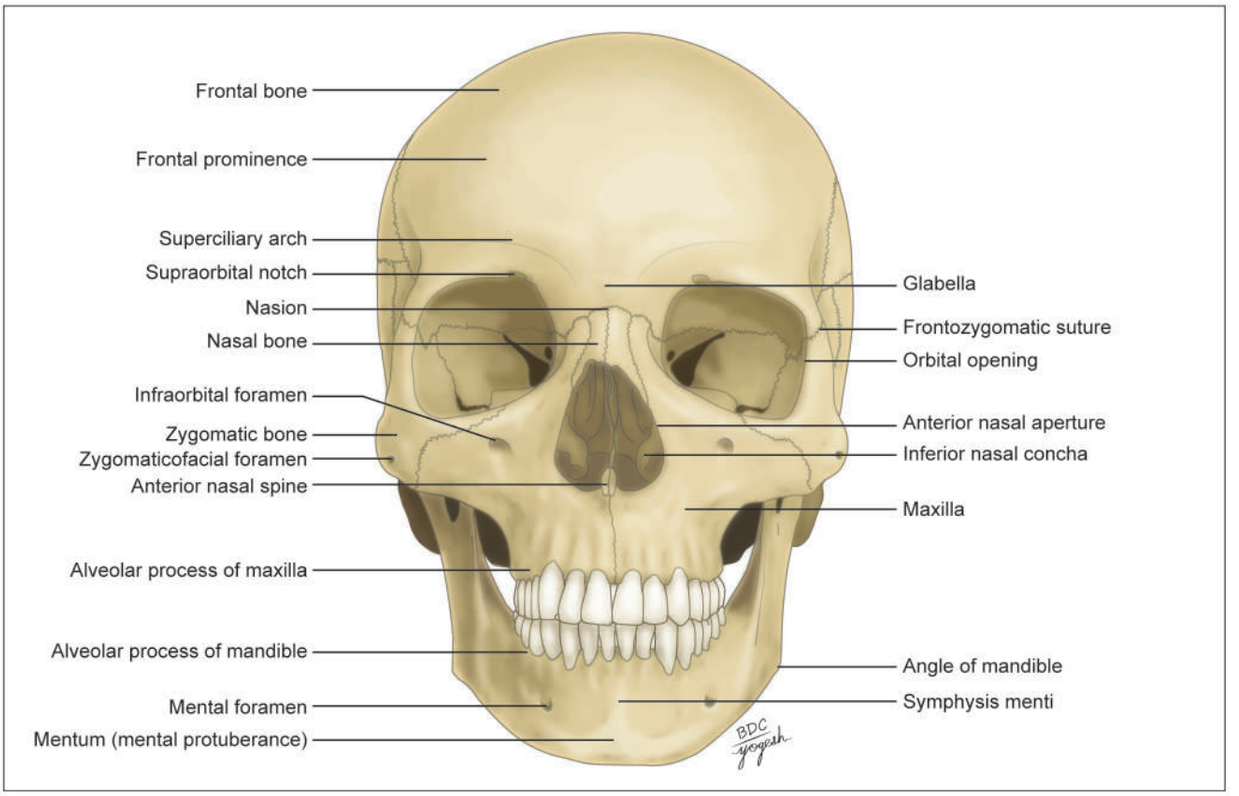


Plate 1.2: Norma frontalis



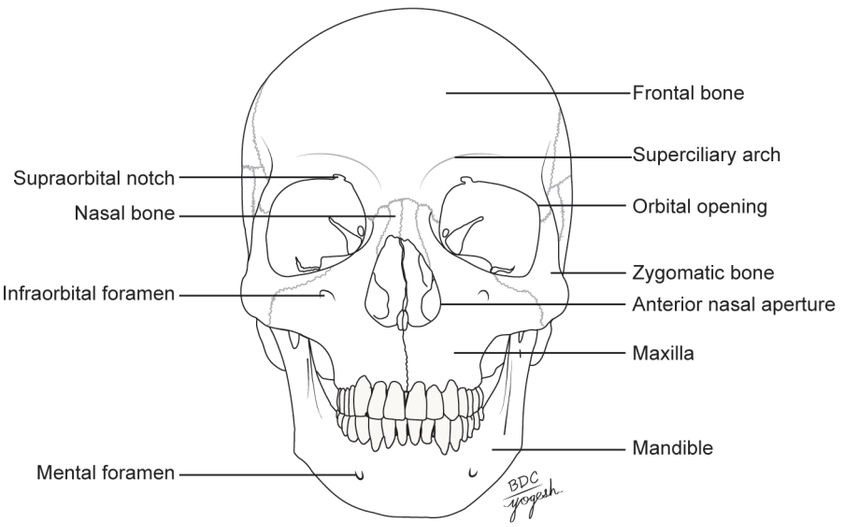


Fig. 1.4: Norma frontalis: Walls of orbit, nasal aperture and lower part of face

2. ***Glabella*** is a median elevation connecting the two superciliary arches. Below the glabella, the skull recedes to frontonasal suture at root of the nose.
3. ***Nasion*** is a median point at the root of the nose where the internasal suture meets with the frontonasal suture.
4. ***Frontal tuber*** or *eminence* is a low rounded elevation above the superciliary arch – one on each side. It is more prominent in females and in children.

Orbital Openings

Each orbital (Latin *circle*) opening is quadrangular in shape and is bounded by the following four margins.

1. ***Supraorbital margin*** is formed by the frontal bone. At the junction of its lateral 2/3rd and its medial 1/3rd, it presents the supraorbital notch or foramen.
2. ***Infraorbital margin*** is formed by the zygomatic bone laterally, and maxilla medially.

3. ***Medial orbital margin*** is ill-defined. It is formed by the frontal bone above, and by the lacrimal crest of the frontal process of the maxilla below.
4. ***Lateral orbital margin*** is formed mostly by the frontal process of zygomatic bone but is completed above by the zygomatic process of frontal bone. *Frontozygomatic suture* lies at their union.

Anterior Nasal Aperture

The anterior bony aperture of the nose is pear-shaped, being wide below and narrow above.

Boundaries

Above: By the lower border of the nasal bones.

Below: By the nasal notch of the body of maxilla on each side.

Features

1. *Articulations of the nasal bone:*
   Anteriorly — with the opposite bone at the internasal suture.
   Posteriorly — with the frontal process of the maxilla.
   Superiorly — with the frontal bone at the frontonasal suture.
   Inferiorly — the upper nasal cartilage is attached to it.
2. ***Anterior nasal spine*** is a sharp projection in the median plane in the lower boundary of the piriform aperture.
3. ***Rhinion*** is the lowermost point of the internasal suture.

Lower Part of the Face

The lower part of the face is formed by the following bones:

1. Maxilla forms upper jaw.
2. Zygomatic bone forms malar prominences.
3. Mandible forms lower jaw.

Maxilla

Maxilla contributes a large share in the formation of the facial skeleton. The anterior surface of the body of the maxilla presents:

1. N*asal notch* medially
2. *Anterior nasal spine*
3. ***Infraorbital foramen***, 1 cm below the infraorbital margin
4. ***Incisive fossa*** above the incisor teeth
5. ***Canine fossa*** lateral to the canine eminence.

In addition, three out of four ***processes of the maxilla*** are also seen in this norma.

1. ***Frontal process*** *of the maxilla* is directed upwards. It articulates anteriorly with the nasal bone, posteriorly with the lacrimal bone and superiorly with the frontal bone (Fig. 1.7).
2. ***Zygomatic process*** *of the maxilla* is short but stout and articulates with the zygomatic bone.
3. ***Alveolar process*** *of the maxilla* bears sockets for the upper teeth.

Zygomatic Bone (Malar Bone)

1. Zygomatic bone forms the prominence of the cheek.
2. ***Zygomaticofacial foramen*** is seen on its surface.

Mandible (Lower Jaw Bone)

Mandible (Latin *to chew*) forms the lower jaw. Its following features are seen in norma frontalis:

1. *Upper border* or *alveolar arch* lodges the lower teeth.
2. *Lower border* or *base* is rounded.
3. Middle point of the base is called the *mental point or* ***gnathion***.
4. The point on the angle of mandible is called ***gonion***.
5. A*nterior surface* of the body of the mandible presents:
   a. *Symphysis menti*, the *mental protuberance* and the *mental tubercles*, anteriorly.
   b. ***Mental foramen*** below the interval between the two premolar teeth, transmitting the *mental nerve and vessels*.
   c. ***Oblique line*** runs upwards and backwards from the mental tubercle to the anterior border of the *ramus* (Latin branch) of the mandible.

Sutures of the Norma Frontalis

1. Internasal
2. Frontonasal
3. Nasomaxillary
4. Lacrimomaxillary
5. Frontomaxillary
6. Intermaxillary
7. Zygomaticomaxillary
8. Zygomaticofrontal.

Attachments

1. The medial part of the superciliary arch gives origin to the corrugator supercilii muscle (Fig. 1.5).
2. Procerus muscle arises from the nasal bone near the median plane.
3. The orbital part of the orbicularis oculi arises from the frontal process of the maxilla and from the nasal part of the frontal bone.
4. Medial palpebral ligament is attached to the frontal process of the maxilla between the frontal and maxillary origins of the orbicularis oculi.
5. Levator labii superioris alaeque nasi arises from the frontal process of the maxilla in front of the orbicularis oculi.
6. Levator labii superioris arises from the maxilla between the infraorbital margin and the infraorbital foramen.
7. Levator anguli oris arises from the canine fossa.
8. Nasalis and the depressor septi arise from the surface of the maxilla bordering the nasal notch.
9. Incisivus labii superioris muscle arises from an area just below the depressor septi. It forms part of orbicularis oris.
10. Zygomaticus major and minor arise from the surface of the zygomatic bone. The zygomaticus minor

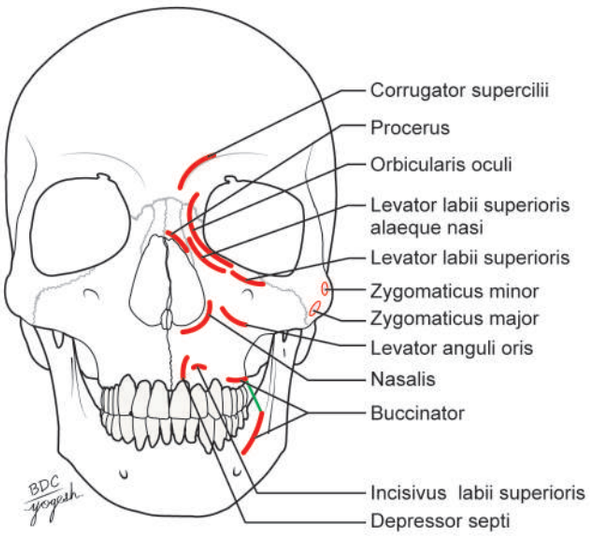


Fig. 1.5: Attachments of muscles to the norma frontalis

muscle arises below the zygomaticofacial foramen. The zygomaticus major arises lateral to the minor muscle.

11. Buccinator arises from maxilla and mandible opposite molar teeth and from *pterygomandibular raphe*. It also forms part of orbicularis oris.

Structures Passing Through Foramina

1. *Supraorbital notch or foramen* transmits the *supraorbital nerves and vessels*.
2. *External nasal nerve* emerges between the nasal bone and upper nasal cartilage.
3. *Infraorbital foramen* transmits the *infraorbital nerve* and *vessels*.
4. *Zygomaticofacial foramen* transmits the nerve of the same name, a branch of *maxillary nerve*.
5. *Mental foramen* on the mandible transmits the mental nerve and vessels.

CLINICAL ANATOMY

The *nasal bone is one of the most commonly fractured bones of the face*. Mandible and parietal eminence are the next bones to be fractured.

NORMA LATERALIS

Bones (Plate 1.3, Figs 1.6a and b, Flowchart 1.4)

1. Frontal
2. Parietal
3. Occipital
4. Temporal
5. Sphenoid
6. Zygomatic
7. Mandible
8. Maxilla
9. Nasal

Features

Temporal Lines

The *temporal lines* have been studied in the norma verticalis. The inferior temporal line, in its posterior part, turns downwards and forwards and becomes continuous with the ***supramastoid crest*** on the squamous temporal bone near its junction with the mastoid temporal. This crest is continuous anteriorly with the posterior root of the zygomatic arch (Flowchart 1.4, Plate 1.3, Figs 1.6a to c).

Zygomatic Arch or Zygoma

The *zygomatic arch* is a horizontal bar on the side of the head, in front of the ear, a little above the tragus. It is formed by the temporal process of the zygomatic bone in anterior 1/3rd and the zygomatic process of the temporal bone in posterior 2/3rd. The ***zygomaticotemporal suture*** crosses the arch obliquely downwards and backwards.

Features

1. The arch comprises 2 surfaces (medial and lateral) and 2 borders (upper and lower).
2. Medially, the arch is separated from the side of the skull by a gap, which is deeper in front than behind. The *lateral surface* of the arch is subcutaneous.
3. *Upper border* is continuous with temporal line in front and with supramastoid crest behind. The anterior end of the upper border is called the ***jugal point***.
4. The *posterior end* of the zygomatic arch is attached to the squamous temporal bone by *anterior* and *posterior roots*.
5. The ***tubercle of the root of the zygoma*** lies on its lower border at the junction of the anterior and posterior roots.

Flowchart 1.4: Features of norma lateralis

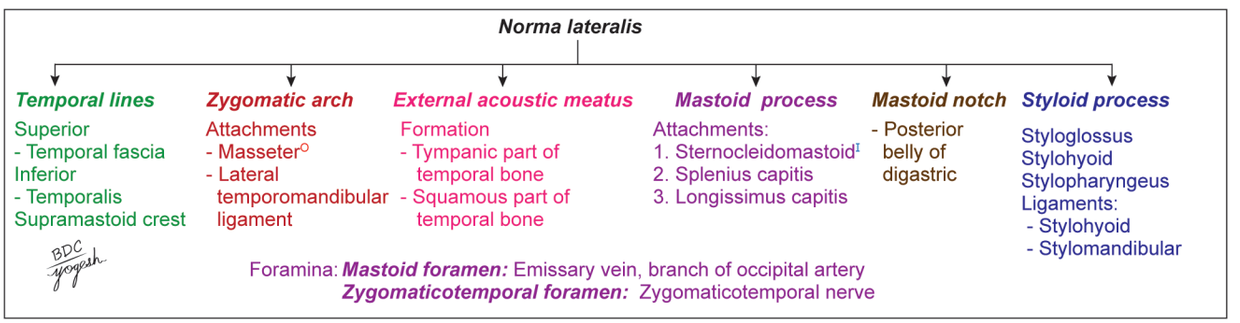
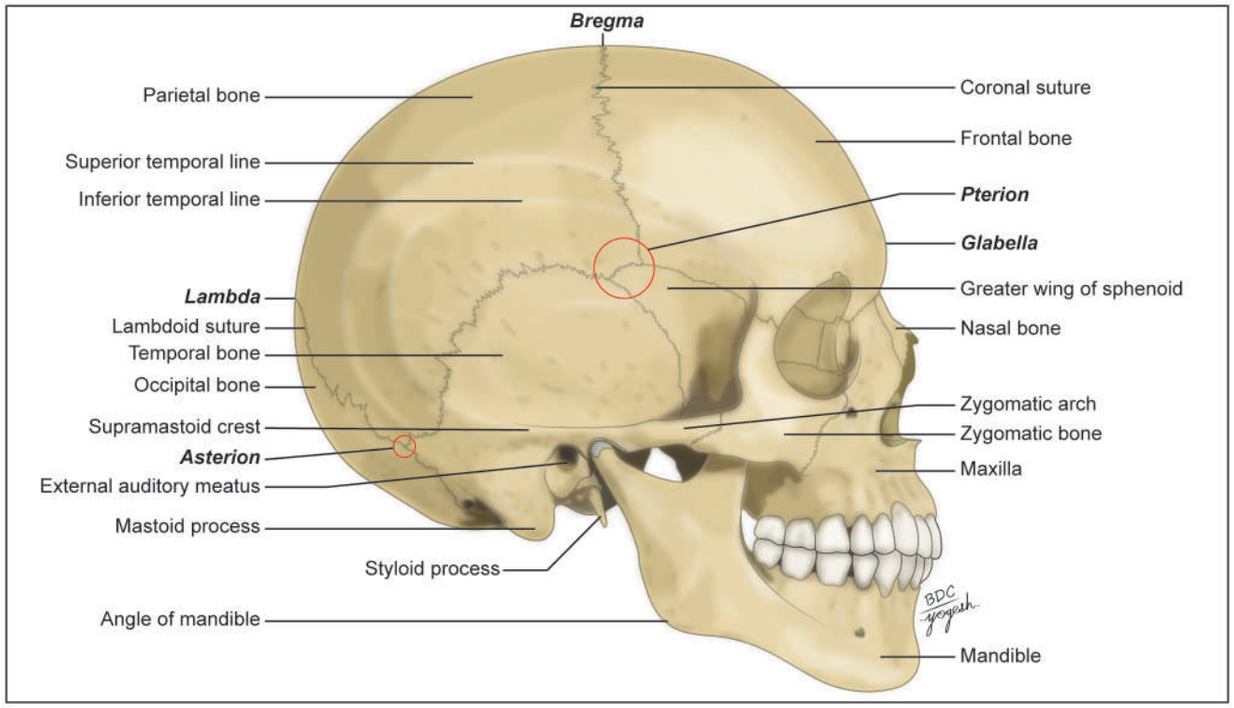
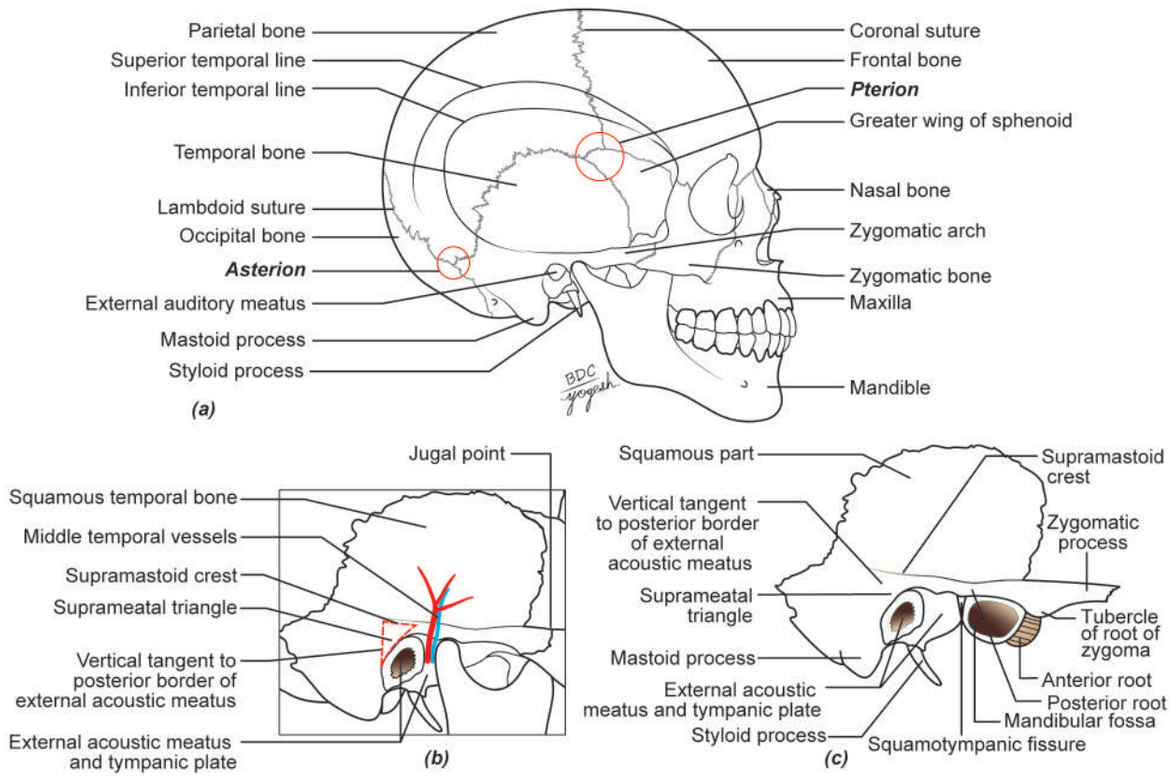


Plate 1.3: Norma lateralis





Figs 1.6a to c: (a) Norma lateralis, (b) bones forming norma lateralis, and (c) tympanic plate forming margins of external acoustic meatus

6. The ***anterior root*** (articular tubercle) passes medially in front of the *mandibular fossa*. The ***posterior root*** passes backwards along the lateral margin of the mandibular or articular fossa, then above the external acoustic meatus to become continuous with the supramastoid crest.

7. Two projections are visible in relation to these roots.
   a. One is ***tubercle of root of zygoma*** at its lower border.
   b. Another tubercle is visible just behind the mandibular or articular fossa and is known as ***postglenoid tubercle***.

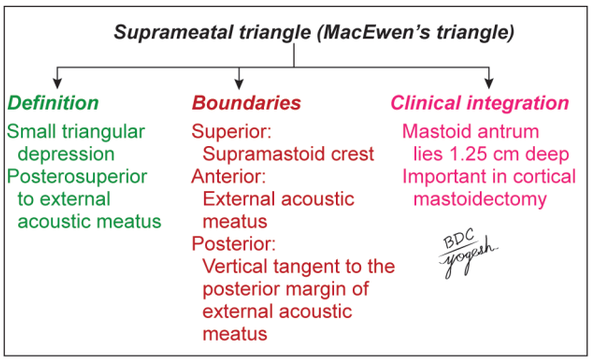
External Acoustic Meatus

1. The *external acoustic meatus* opens just below the posterior part of the posterior root of zygoma. Its anterior and inferior margins and the lower part of the posterior margin are formed by the tympanic plate, and the posterosuperior margin is formed by the squamous temporal bone. The margins are roughened for the attachment of auricular cartilage.
2. The ***suprameatal triangle*** *(triangle of Mc-Ewen)* is a small depression posterosuperior to the meatus. (Flowchart 1.5)
   Boundaries
   Superior: Supramastoid crest
   Anterior: Posterosuperior margin of external acoustic meatus
   Posterior: Vertical tangent to the posterior margin of the meatus.
   Clinical aspects: The triangle forms the lateral wall of the tympanic or mastoid antrum (Fig. 1.9c). The mastoid antrum lies 1.25 cm deep to the suprameatal triangle. This triangle is an important landmark in cortical mastoidectomy.
3. The ***suprameatal spine*** *(of Henle)* may be present on the anteroinferior margin of the triangle. It serves as a surgical landmark while performing middle ear surgeries.

Mastoid Part of the Temporal Bone

1. The *mastoid part of the temporal bone* lies just behind the external acoustic meatus.
2. The mastoid temporal bone articulates posterosuperiorly with the posteroinferior part of the parietal bone at the horizontal *parietomastoid suture*, and posteriorly with the squamous occipital bone at the *occipitomastoid suture*. These two sutures meet at the lateral end of the lambdoid suture. The ***asterion*** is the point where the parietomastoid, occipitomastoid and lambdoid sutures meet. In infants, the asterion is the site of the ***posterolateral*** **or** ***mastoid fontanelle***, which closes by 12 months (Fig. 1.3).

Flowchart 1.5: Suprameatal triangle



3. The ***mastoid process*** is a breast-like projection from the lower part of the mastoid temporal bone, posteroinferior to the external acoustic meatus. It appears during the 2nd year of life. The *tympanomastoid fissure* is placed on the anterior aspect of the base of the mastoid process. The *mastoid foramen* lies at or near the occipitomastoid suture (Fig. 1.5).

Styloid Process

The *styloid* (Latin *pen*) *process* is a needle-like thin, long projection from the temporal bone seen in norma basalis situated anteromedial to the mastoid process. It is directed downwards, forwards and slightly medially. Its base is partly ensheathed by the tympanic plate. The apex or tip is usually hidden from view by the posterior border of the ramus of the mandible.

Temporal Fossa

It is a shallow depression on the side of the skull.

Boundaries

1. *Above:* Superior temporal line.
2. *Below:* Upper border of the zygomatic arch laterally, and by the infratemporal crest of the greater wing of the sphenoid bone medially. Through the gap deep to the zygomatic arch, temporal fossa communicates with the infratemporal fossa.
3. *Anterior wall:* Formed by the zygomatic bone and by parts of the frontal and sphenoid bones. This wall separates the fossa from the orbit.
4. *Floor:* The anterior part of the floor is crossed by an H-shaped suture where four bones—frontal, parietal, greater wing of sphenoid and temporal adjoin each other. This area is termed the ***pterion***.

Note:

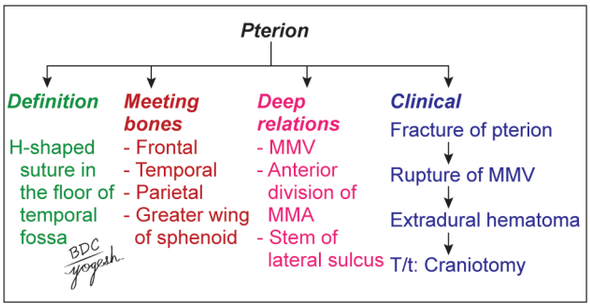
The ***pterion*** lies 4 cm above the midpoint of the zygomatic arch and 2.5 cm behind the frontozygomatic suture. Deep to the pterion lie, *middle meningeal vein*, *anterior division of the middle meningeal artery* and *stem of the lateral sulcus of brain (Sylvian point)* (Flowchart 1.6).

On the temporal surface of the zygomatic bone forming the anterior wall of the fossa, there is the *zygomaticotemporal foramen.*

Attachments (Fig. 1.7)

1. Temporal fascia is attached to the superior temporal line and to the area between the two temporal lines. Inferiorly, it is attached to the outer and inner lips of the upper border of the zygomatic arch.
2. Temporalis muscle arises from the whole of the temporal fossa.
3. The medial surface and lower border of the zygomatic arch give origin to the masseter.
4. Lateral ligament of the temporomandibular joint is attached to the tubercle of the root of the zygoma.
5. The sternocleidomastoid, splenius capitis and longissimus capitis are inserted from before backwards on the posterior part of the lateral surface of the mastoid process. Posterior belly of digastric arises from mastoid notch. The groove obliquely placed behind mastoid notch is due to occipital artery.

Flowchart 1.6: Pterion



(MAA: Middle meningeal artery, MMV: Middle meningeal vein)

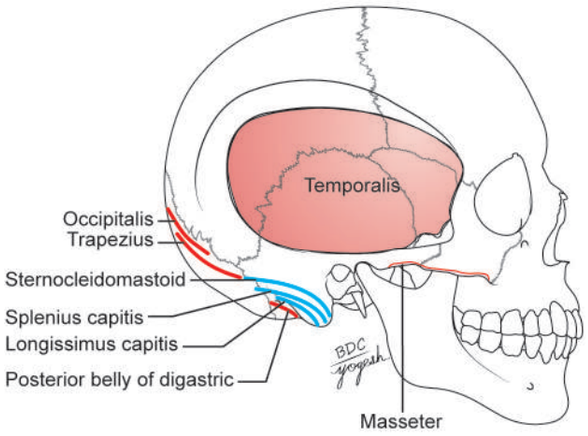


Fig. 1.7: Attachments of norma lateralis

6. The *gap* between the zygomatic arch and the side of the skull transmits:
   a. Tendon of the temporalis muscle
   b. Deep temporal vessels
   c. Deep temporal nerves
   d. Zygomaticotemporal vessels and nerve

Note: For infratemporal fossa, *see* Chapter 6. For pterygopalatine fossa, *see* Chapter 15.

Structures Passing Through Foramina

1. *Tympanomastoid fissure* on the anterior aspect of the base of the mastoid process transmits the *auricular branch* of *vagus nerve.*
2. Mastoid foramen transmits:
   a. *Emissary vein* connecting the *sigmoid sinus* with the *posterior auricular vein* (Table 1.1).
   b. Meningeal branch of the occipital artery.
3. *Zygomaticotemporal foramen* transmits the nerve of the same name and a minute artery.

CLINICAL ANATOMY

***Pterion**, the site of anterolateral fontanelle,* is the thin part of skull. In roadside accidents, the anterior division of middle meningeal artery at pterion (Fig. 1.8) may be ruptured, leading to clot formation between the skull bone and dura mater or extradural haemorrhage (Fig. 1.9). The clot compresses the motor area of brain, leading to paralysis of the opposite side. The clot must be sucked out at the earliest by trephining. The head must be protected by a helmet during driving a two-wheeler.

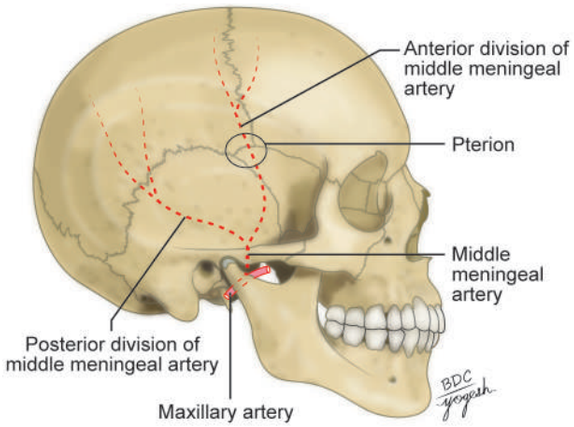


Fig. 1.8: Position of anterior division of middle meningeal artery against the pterion

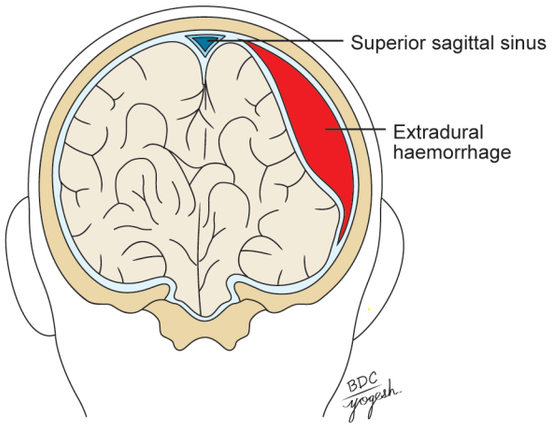


Fig. 1.9: Extradural haemorrhage

NORMA BASALIS

The inferior view of the skull is norma basalis. For the descriptive purposes, the norma basalis is divided into anterior, middle and posterior parts by two imaginary transverse lines:

1. ***Anterior transverse line:*** It passes along the posterior margin of the hard palate.
2. ***Posterior transverse line:*** It passes along the anterior margin of the foramen magnum (Plate 1.4, Fig. 1.10).

Anterior Part of Norma Basalis

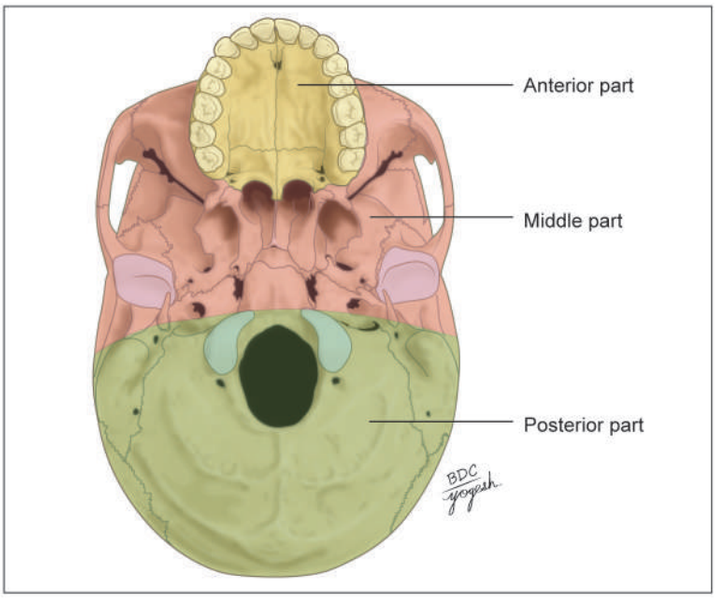
The anterior part of norma basalis consists of two parts (Plate 1.5, Flowchart 1.7):

1. Alveolar processes of maxillae or alveolar arch
2. Hard palate

Alveolar Arch

Alveolar processes of maxillae form U-shaped alveolar arch that bears sockets for the roots of the upper teeth.

Plate 1.4: Parts of norma basalis



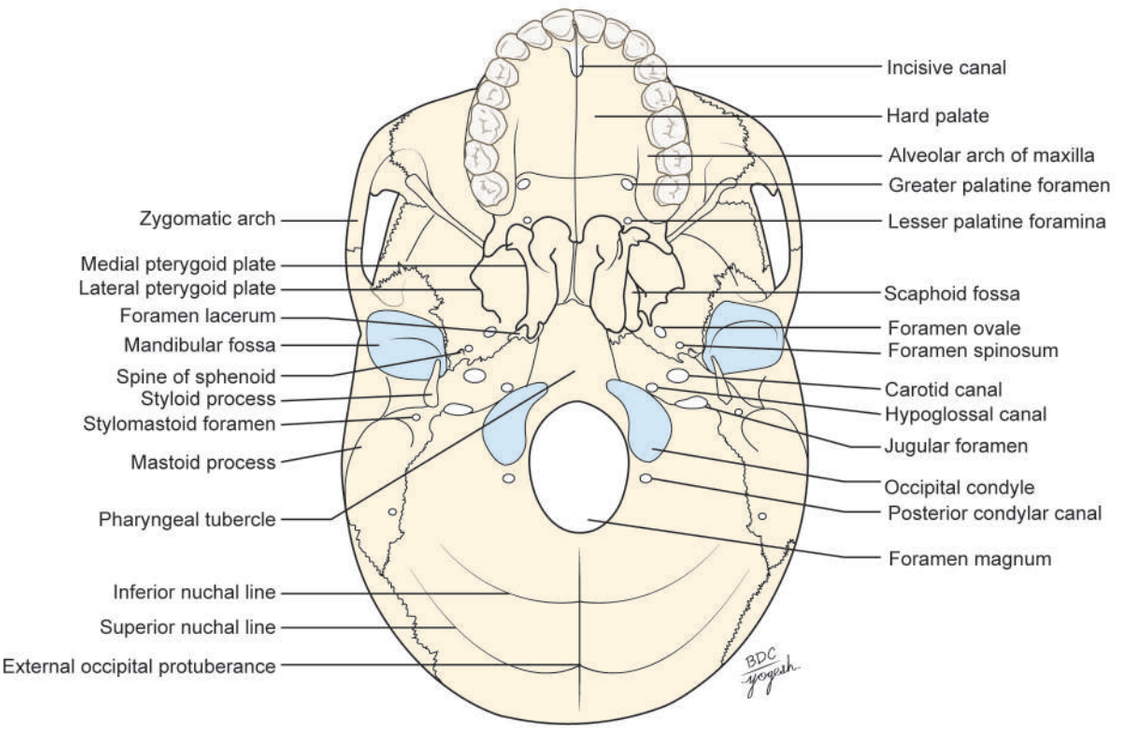
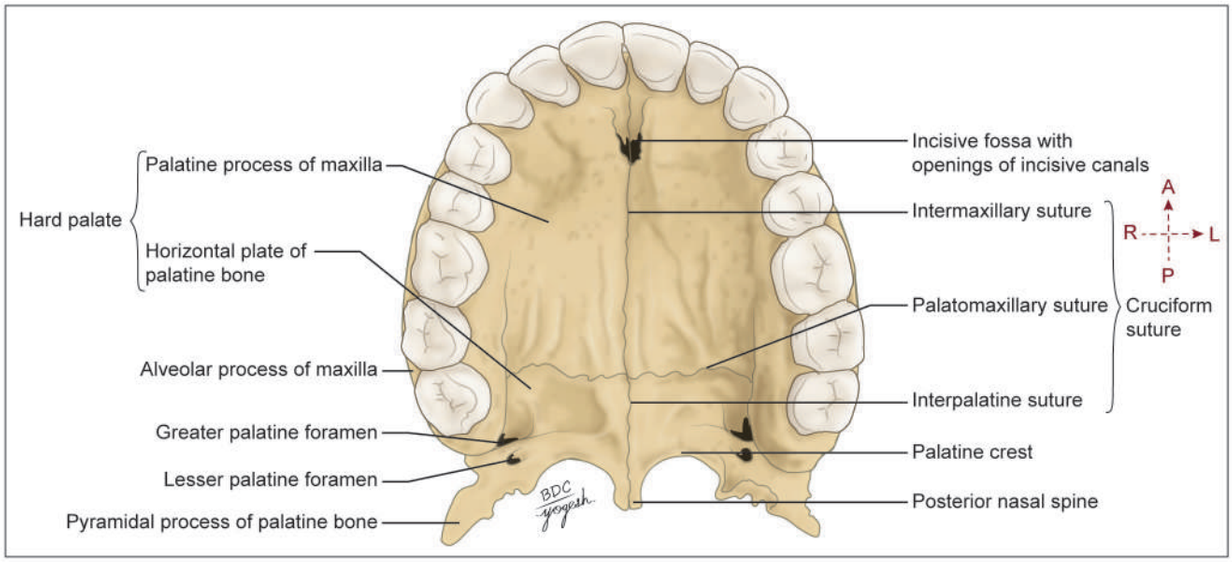


Fig. 1.10: Norma basalis

Hard Palate

1. *Formation:*
   a. Anterior 2/3rd, by the palatine processes of the maxillae.
   b. Posterior 1/3rd, by the horizontal plates of the palatine bones.
2. *Sutures:* The palate is crossed by a cruciform suture made up of intermaxillary, interpalatine and palatomaxillary sutures.
3. It is arched in all directions. It shows pits for the palatine glands.
4. The *posterior border* of the hard palate is free and presents the ***posterior nasal spine*** in the median plane.
5. The ***palatine crest*** is a curved ridge near the posterior border. It begins behind the greater palatine foramen and runs medially.
6. ***Incisive foramen*** is a deep fossa situated anteriorly in the median plane. Two ***incisive canals***, right and left,

Plate 1.5: Anterior part of norma basalis



Flowchart 1.7: Features of anterior part of norma basalis

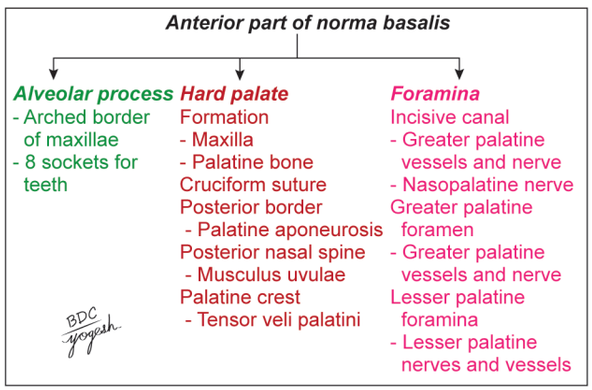
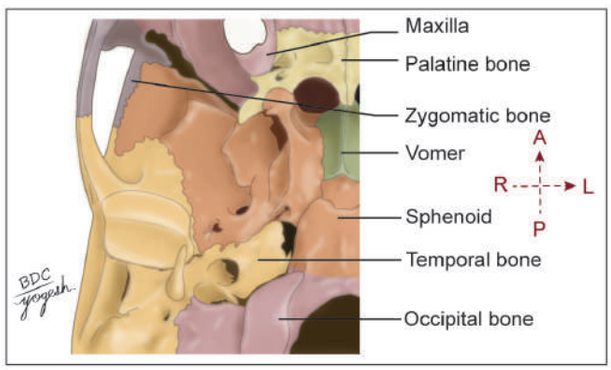


Plate 1.6: Bones of middle part of norma basalis



pierce the walls of the incisive foramen, usually one on each side, but occasionally in the median plane, the left being anterior and the right, posterior.

7. ***Greater palatine foramen***, one on each side, is situated just behind the lateral part of the palatomaxillary suture. A groove leads from the foramen towards the incisive fossa.
8. ***Lesser palatine foramina***, two or three in number on each side, lie behind the greater palatine foramen and perforate the pyramidal process of the palatine bone.

Middle Part of Norma Basalis

The middle part extends from the posterior border of the hard palate to the arbitrary transverse line passing through the anterior margin of the foramen magnum. Middle part of the norma basalis is studied as median and lateral areas (Plates 1.6 and 1.7).

Median Area

1. The median area shows (Flowchart 1.8):
   a. Posterior border of the *vomer*.
   b. A *broad bar of bone* formed by fusion of the posterior part of the body of sphenoid and the basilar part of occipital bone.
2. The ***vomer*** separates the two posterior nasal apertures. Its inferior border articulates with the bony palate. The superior border splits into two ***alae*** and articulates with the ***rostrum*** of the *sphenoid bone* (Fig. 1.11).

Flowchart 1.8: Features of median area of middle part of norma basalis

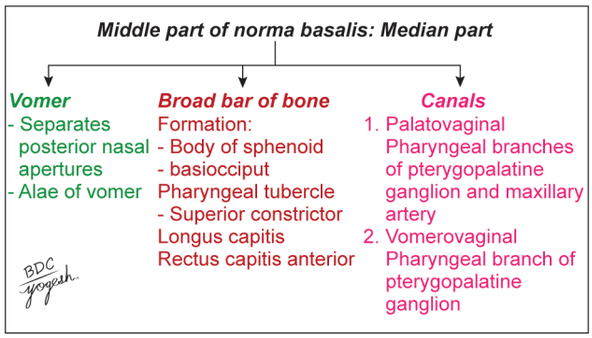
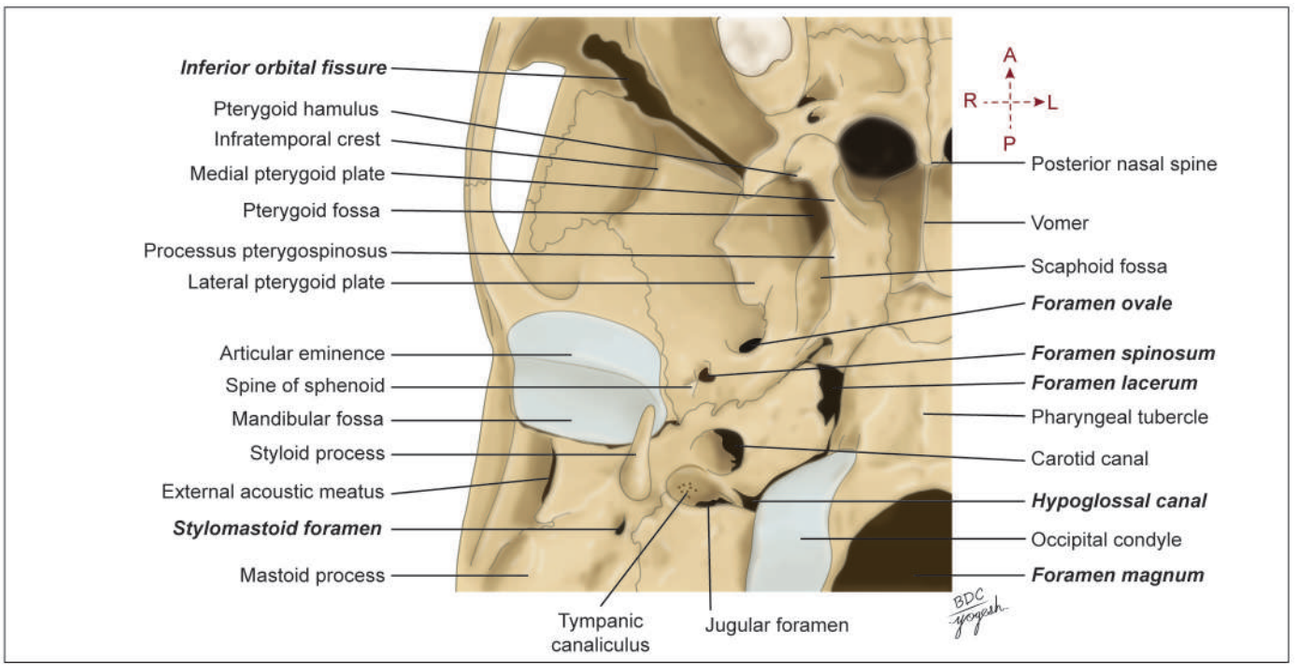


Plate 1.7: Features of middle part of norma basalis



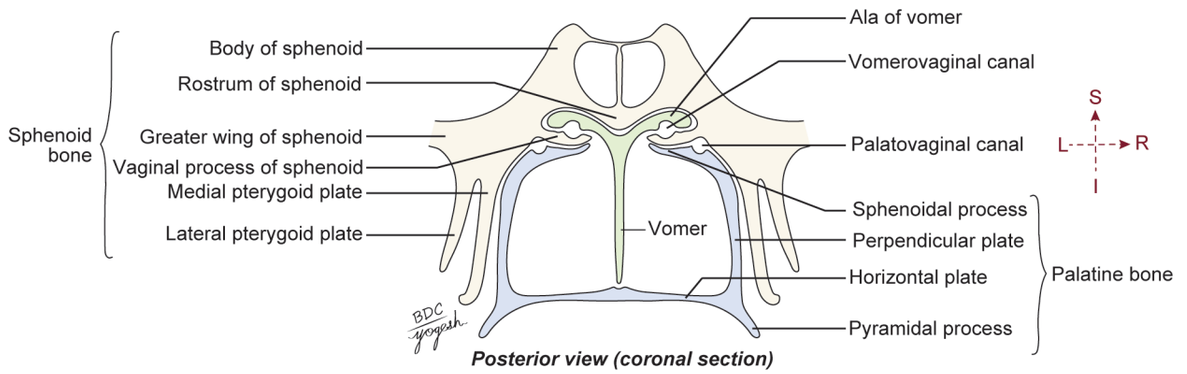


Fig. 1.11: Vomerovaginal and palatovaginal canals

3. The broad bar of the bone is marked in the median plane by the ***pharyngeal tubercle***, a little in front of the foramen magnum (Plate 1.8).

Note:

Palatinovaginal canal: The inferior surface of the vaginal process of the medial pterygoid plate is marked by an anteroposterior groove, which is converted into the palatinovaginal canal by the upper surface of the sphenoidal process of the palatine bone. The canal opens anteriorly into the posterior wall of the pterygopalatine fossa (Fig. 1.11).

Vomerovaginal canal: The lateral border of each ala of the vomer comes into relationship with the vaginal process of the medial pterygoid plate, and may overlap it from above to enclose the vomerovaginal canal (Fig. 1.11).

Lateral Area

The lateral area shows (Plate 1.8, Flowchart 1.9)

a. Two parts of the sphenoid bone — pterygoid process and greater wing.
b. Three parts of the temporal bone — petrous temporal, tympanic plate and squamous temporal.

1. **Pterygoid process** projects downwards from the junction of greater wing and the body of sphenoid behind the third molar tooth.

   Inferiorly, it divides into the *medial and lateral pterygoid plates*, which are fused together anteriorly, but are separated posteriorly by the V-shaped *pterygoid fossa.*

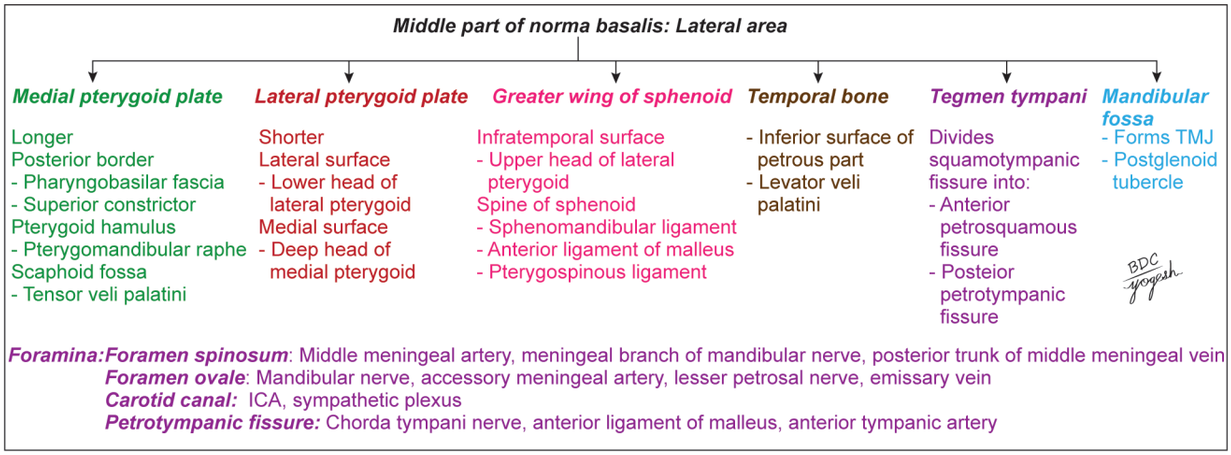
   The fused anterior borders of the two plates articulate medially with the perpendicular plate of the palatine bone, and are separated laterally from the posterior surface of the body of the maxilla by the *pterygomaxillary fissure*.

2. **Medial pterygoid plate**

   It is directed backwards. It has medial and lateral surfaces and a free posterior border.

   The upper end of posterior border divides to enclose a triangular depression called the ***scaphoid fossa***.

Flowchart 1.9: Features of lateral area of middle part of norma basalis



The lower end of the posterior border is prolonged downwards and laterally to form the ***pterygoid hamulus***.

3. **Lateral pterygoid plate**

   It is directed backwards and laterally. It has medial and lateral surfaces and a free posterior border.

   The posterior border sometimes has a projection at its middle called the *pterygospinous process*, which projects towards the spine of the sphenoid.

4. **Infratemporal surface of the greater wing of the sphenoid**

   It is pentagonal.

   It shows the following 4 foramina:

   a. ***Foramen ovale*** is large and oval. It is situated posterolateral to the upper end of the posterior border of lateral pterygoid plate.

   b. ***Foramen spinosum*** is small and circular in shape. It is situated posterolateral to the foramen ovale, and is limited posterolaterally by the spine of sphenoid.

   c. Sometimes, there is the ***emissary sphenoidal foramen*** *or foramen of Vesalius*. It is situated between the foramen ovale and the scaphoid fossa. Internally, it opens between the foramen ovale and the foramen rotundum.

   d. At times, there is a ***canaliculus innominatus*** situated between the foramen ovale and the foramen spinosum.

   There is a small, sharp, downward projection between the posterolateral and posteromedial margins called the ***spine of the sphenoid***.

   Sulcus tubae is the groove between the posteromedial margin of the greater wing of the sphenoid and the petrous temporal bone. It lodges the *cartilaginous part of the auditory tube*. Posteriorly, the groove leads to the bony part of the auditory tube, which lies within the petrous temporal bone.

5. **Inferior surface of the *petrous* part of the temporal bone** is triangular in shape with its apex directed forwards and medially (Greek petrous = *rock*). It lies between the greater wing of the sphenoid and the basiocciput.

   Its *apex* is perforated by the upper end of the carotid canal, and is separated from the sphenoid by the foramen lacerum. The *inferior surface* is perforated by the lower end of the *carotid canal* posteriorly.

   Carotid canal runs forwards and medially within the petrous temporal bone.

   Tegmen tympani: It is a part of the petrous temporal bone that is present in the middle cranial fossa. It has a down turned edge, which is seen in the *squamotympanic fissure* and divides it into the posterior *petrotympanic* and anterior *petrosquamous* fissures.

6. ***Foramen lacerum*** is a short, wide canal, 1 cm long.

   Its lower end is bounded posterolaterally by the apex of the petrous temporal, medially by the basiocciput and the body of the sphenoid and anteriorly by the root of the pterygoid process and the greater wing of the sphenoid bone (Fig. 1.13).

7. ***Tympanic part of the temporal bone****, also called the* ***tympanic plate****,* is a triangular curved plate, which lies in the angle between the petrous and squamous parts. Its apex is directed medially and lies close to the spine of the sphenoid.

   The *base or lateral border* is curved, free and roughened.

   Its *anterior surface* forms the posterior wall of the mandibular fossa. The *posterior surface* is concave and forms the anterior wall, floor and lower part of the posterior wall of the bony external acoustic meatus.

   Its *upper border* bounds the petrotympanic fissure.

   The *lower border* is sharp and free.

   Medially, the tympanic plate passes along the anterolateral margin of the lower end of the carotid canal. Laterally, it forms the anterolateral part of the *sheath of the styloid process*. Internally, the tympanic plate is fused to the petrous temporal bone.

8. ***Squamous part of the temporal bone*** forms:

   a. The anterior part of the mandibular/articular fossa, which articulates with the head of the mandible to form the temporomandibular joint.