

# THE ORBIT

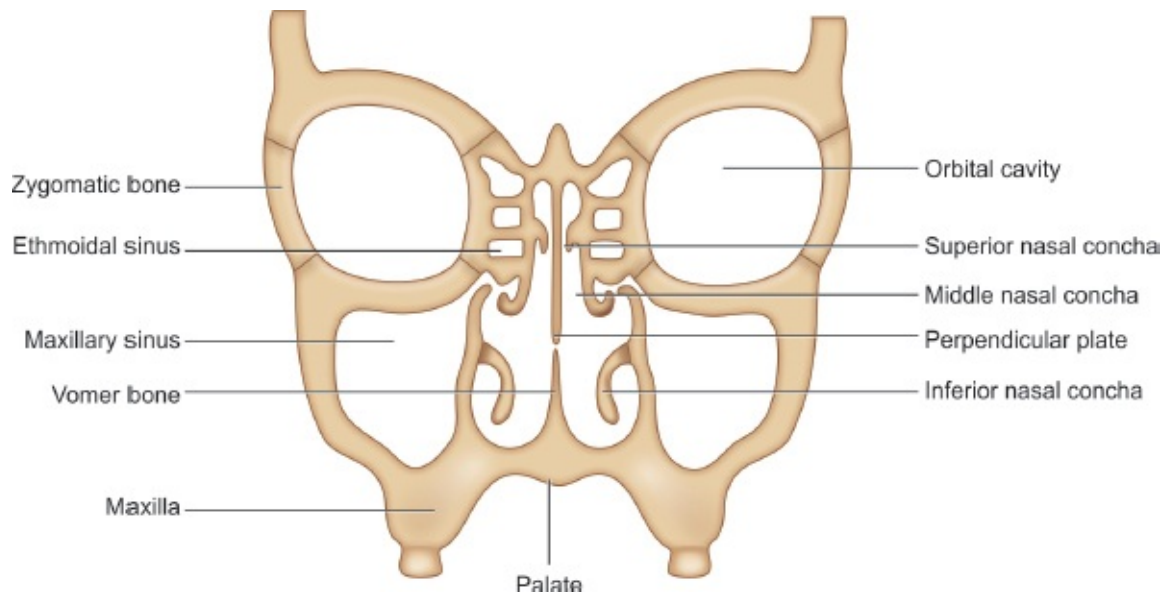
## ***BONY ORBIT***

### SHAPE AND DIMENSIONS

- *Bony orbit is formed from the mesenchyme that encircles the optic vesicle beginning as early as the 6-week of embryonic stage.*
- *Each orbit is formed by seven bones, namely: Frontal, ethmoid, lacrimal, palatine, maxilla, zygomatic and sphenoid.*

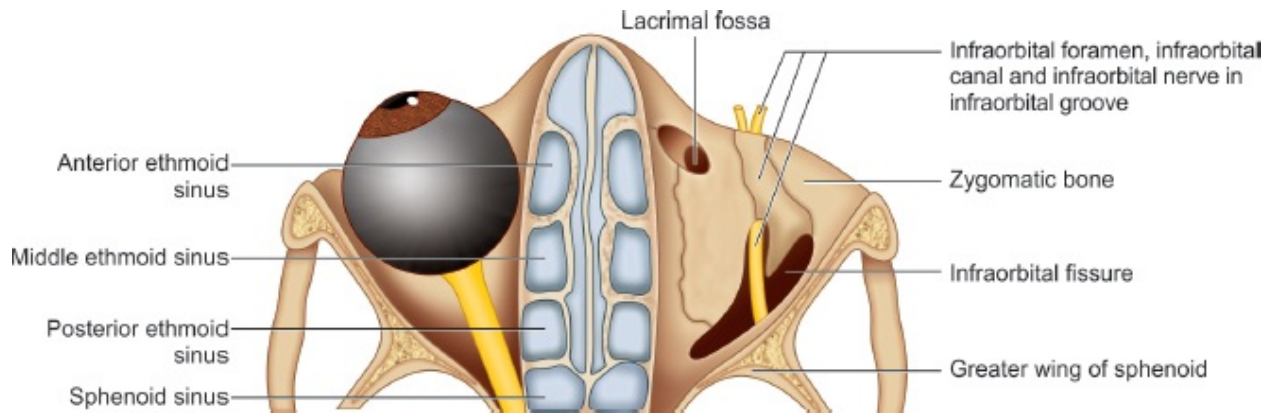
## Shape

The two bony orbits are quadrangular truncated pyramids situated between the anterior cranial fossa above and the maxillary sinuses below (Fig. 14.3). Whitnall(1932) compared the orbit to a pear, the anterior orbital aperture corresponding to the base of pear and optic canal to its stalk.



**Fig. 14.3.** Schematic coronal section through the orbits and nasal cavity.

- *Medial walls* of the two orbits are parallel to each other. They are in contact with the ethmoid and sphenoid sinuses, which separate the orbits from the nasal cavities.
- *Lateral umll* of each orbit lies at an angle of  $45^\circ$  to the medial wall. The lateral walls of the two orbits are at  $90^\circ$  to each other. The lateral wall separates the orbit from the middle cranial fossa posteriorly and the muscular temporal fossa anteriorly (Fig. 14.4).



**Fig. 14.4.** *Schematic transverse sections through the orbits and nasal cavity. On left side, eyeball is shown in relation to medial and lateral walls of the orbit. Note that anterior half of the eyeball is not protected by bone on lateral surface. On right is shown floor of the orbit, presenting inferior orbital fissure and inferior orbital groove, canal and foramen.*

## Dimensions

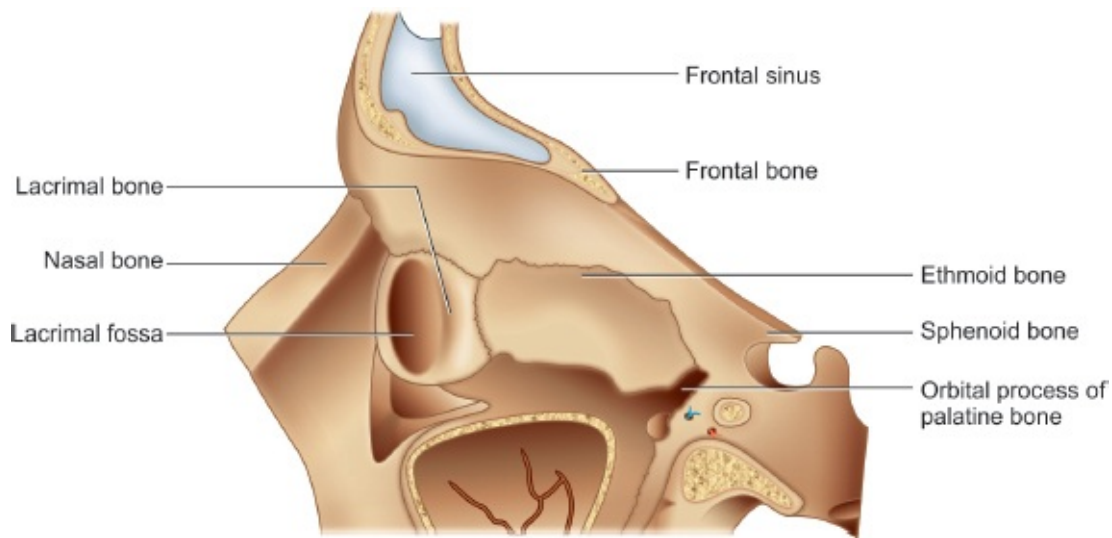
- *Depth* of the orbit is about 42 mm (range 40–45 mm) along the medial wall and about 50 mm along the lateral wall.
- *Base* of the orbit is 40 mm in width and 35 mm in height.
- *Intraorbital zwidth*, i.e. the distance between the medial margins of the right and left orbits is 25 mm.
- *Extraorbital zwidth*, i.e. the distance between the right and left lateral orbital margins is 100 mm.
- *Relationship between the height and zwidth* of the orbit is expressed by the orbital index.  $\text{Orbital index} = (\text{Height}/\text{Width}) \times 100$ . The index shows racial variation. Races having an orbital index greater than 89 are termed *megasenes* (e.g. orientals). *Mesosenes* (e.g. Caucasians) have an orbital index between 83 and 89. Blacks with an index of less than 83 are termed *microsenes*.
- *Volume* of each orbit is about 29–30 ml. The ratio between the volume of the orbit and of the eyeball is 4.5 : 1.

## **WALLS OF THE ORBIT**

The bony orbit has four walls: medial wall, lateral wall, roof and floor. These four walls meet at the superior internal, superior external, inferior internal and inferior external angles of the orbit.

## Medial wall

The medial wall of the orbit is quadrilateral in shape and is formed (from front to back) by the frontal process of the maxilla, the lacrimal bone, the orbital plate of the ethmoid bone (main) and the body of the sphenoid (Fig. 14.5). The anterior part of the medial wall bears the lacrimal sac fossa, which is continuous inferiorly with the nasolacrimal canal. The lacrimal fossa is bounded anteriorly by the anterior lacrimal crest of the maxillary bone (thick part) and posteriorly by the posterior lacrimal crest of the lacrimal bone (thin part).



**Fig. 14.5.** *Medial wall of the orbit (formed by four bones, frontal process of the maxilla, the lacrimal bone, the orbital plates of the ethmoid bone and the body of sphenoid).*

Medial to the lacrimal fossa lie the anterior ethmoidal sinuses in the upper part and middle meatus of the nose in the lower part. Lacrimal sac along with its fascia lies in the lacrimal fossa. Just behind the posterior lacrimal crest, following structures have their attachment:

- Horner's muscle (lacrimal fibres of the orbicularis)
- Septum orbitale
- Check ligament of the medial rectus muscle.

## Relations

- **Medial to the medial wall** (towards the nose) lie anterior ethmoidal air sinuses, middle meatus of nose, middle and posterior ethmoidal sinuses

and sphenoidal air sinus.

- ***Orbital surface of the medial wall*** is related to superior oblique muscle in the upper part near the roof and medial rectus muscle in the middle part. In between these two muscles, lie the anterior ethmoidal nerve, posterior ethmoidal nerve, infratrochlear nerve and terminal branch of the ophthalmic artery.

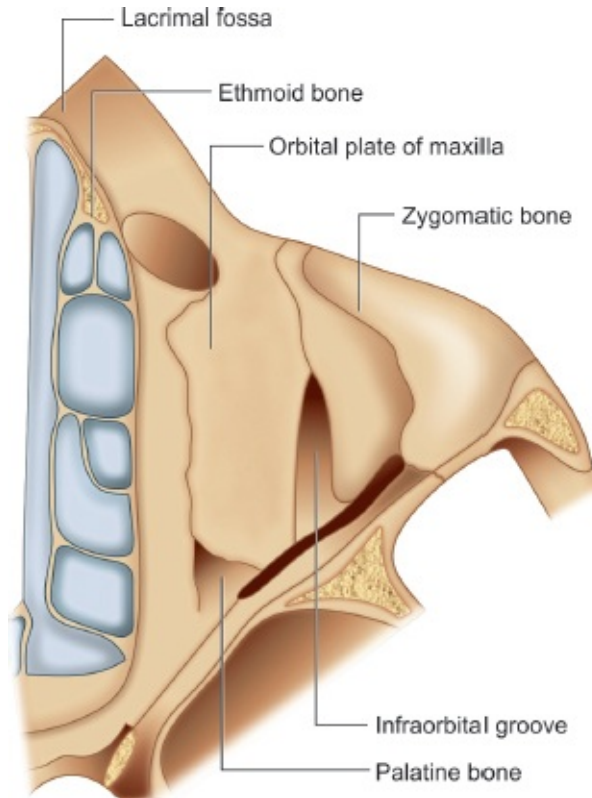
### ***Clinical applications***

Medial orbital wall is the thinnest wall of the orbit (0.2–0.4 mm) and so also called as lamina papyracea. This accounts for:

- Ethmoiditis being the commonest cause of orbital cellulitis, especially in children.
- The medial wall is frequently eroded by chronic inflammatory lesions, cysts and neoplasms that originate in the adjacent air sinuses.
- It is easily fractured during injuries as well as during orbitotomy operations.
- During surgery along this wall, haemorrhage is most troublesome due to injury to ethmoidal vessels. In addition, the medial palpebral, frontal and dorsal nasal arteries pass forward near the medial wall.
- The medial wall can be easily visualised with routine PA radiographs of the orbit.

## 2. Inferior orbital wall (floor)

- Floor of the orbit is triangular in shape. It is the shortest of all the walls. Extending back only about 35–40 mm from the inferior rim.
- It is *formed by three bones*: The orbital surface of the maxillary bone medially, the orbital surface of the zygomatic bone laterally and the palatine bone posteriorly (Fig. 14.6).



**Fig. 14.6.** Floor of the orbit.

- Floor of the orbit slopes downward approximately 20° from posterior to anterior.
- Posterior part of the floor of the orbit is separated from the lateral wall by the *inferior orbital fissure*. This fissure is continuous anteriorly with the infraorbital groove which extends anteriorly as a canal.
- Posteriorly, the floor extends up to the posterior limit of maxillary sinus, therefore, does not extend to the orbital apex.
- The canal opens at the infraorbital foramen located just below the infraorbital rim. The foramen transmits the infraorbital nerve, the

infraorbital artery and the infraorbital vein (which connects the inferior ophthalmic vein to the facial vein) (Fig. 14.4).

### ***Relations***

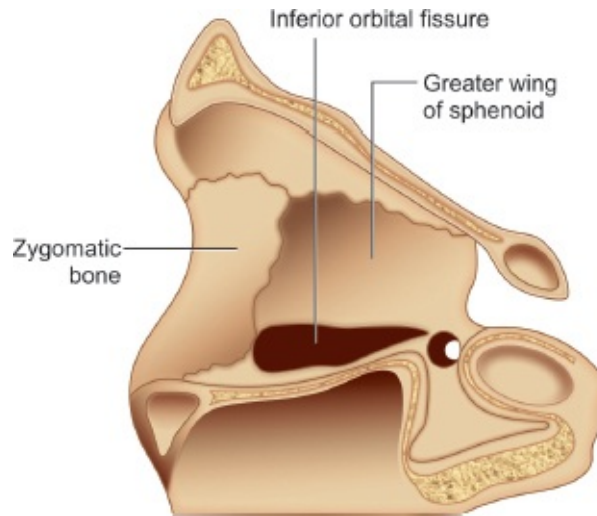
- *Below*, it is related to maxillary air sinus and palatine air cells.
- *Above*, it is related to inferior rectus muscle, inferior oblique muscle and nerve to inferior oblique. Inferior oblique muscle arises just lateral to the opening of the nasolacrimal duct. It is only extraocular muscle that doesn't originate from the orbital apex.

### ***Clinical applications***

- Orbital floor ***being quite thin*** (thinnest just medial to infraorbital canal) is commonly involved in 'blow-out fractures' and is easily invaded by tumours of the maxillary antrum.
- Floor of the orbit is *best visualised* with standard posteroanterior radiographs.
- Orbital floor can be approached by inferior orbitotomy (antral approach) easily. However, the utility of this approach is limited as only a small proportion of tumours are found in this area.

### 3. Lateral wall

- Lateral wall of the orbit is thickest and strongest. It is triangular in shape, and is formed anteriorly by the zygomatic bone and posteriorly by the greater wing of the sphenoid bone (Fig. 14.7).



**Fig. 14.7.** Lateral wall of the orbit.

- On the posterior part of the lateral wall, there is a small bony projection (*spina recti lateralis*) which gives origin to a part of the lateral rectus muscle.
- More anteriorly, the wall is marked by the *zygomatic groove* and foramina (which are traversed by the zygomatic nerve and vessels). On the anterior part of the wall, about 1 mm below the frontozygomatic sutures, there is a projection, *the lateral orbital tubercle of VJhitnall*. It gives attachment to the check ligament of the lateral rectus muscle, and to the suspensory ligament of the eyeball, lateral palpebral ligament and aponeurosis of levator muscle.
- Posteriorly, the lateral wall is separated from the roof by the superior orbital fissure and from the floor by the inferior orbital fissure.

### **Relations**

- *Laterally*, the lateral wall separates the orbit from temporal fossa anteriorly and from the middle cranial fossa posteriorly.
- *Medially*, i.e. its orbital surface is related to lateral rectus, lacrimal nerve

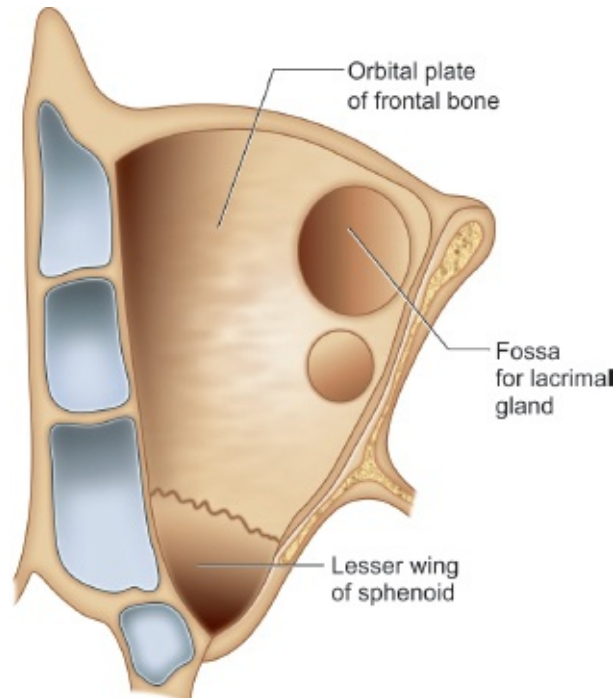
and vessels, zygomatic nerve and the communication between zygomatic and lacrimal nerves.

### ***Clinical applications***

- The lateral wall of the orbit protects only the posterior half of the eyeball. The anterior half of globe is not covered by bone on the lateral side (Fig. 14.4). Hence, palpation of retrobulbar tumours is easier from the lateral rather than from the nasal side of the eyeball.
- Because of its advantageous anatomical position, a lateral orbital surgical approach is popular. Further, the lateral wall is almost devoid of foramina, so its anterior portion can be broached without serious haemorrhage (zygomaticotemporal vessels usually do not pose a problem). However, the lateral rim of the orbit, which is the forward extension of the lateral wall, is the strongest portion of the orbit and needs to be sawed open in lateral orbitotomy. The *zygomaticosphenoid suture* is an important landmark in creating the flap in Kronlein's operation and its all modifications. Behind the thick lateral orbital rim, the wall becomes quite thin where the zygomatic bone joins the greater wing of sphenoid at a vertical suture line. During the lateral orbitotomy, cutting the rim through this thin plate allows easy outward fracture of the bone. Once this bone flap has been turned, the surgeon has direct access to the superolateral, inferolateral and retrobulbar quadrants of the orbit. Since these quadrants are the common sites of orbital tumours, the surgical anatomy of this area is important.
- About half way along the lateral wall, the sphenoid wing near the frontosphenoid suture, is a small canal carrying an anastomosing branch between the lacrimal and meningeal arteries. This may cause bleeding during lateral orbital dissection.

## 4. Roof

- Roof or vault of the orbit is triangular in shape and is formed mainly by the orbital plate of the frontal bone. Behind this, it is formed by the lesser wing of sphenoid at apex (Fig. 14.8).



**Fig. 14.8.** Roof of the orbit as seen from below.

- Anterolateral part of the roof has a depression called the **fossa for the lacrimal gland**. It is usually quite smooth but may be pitted by the attachments of the suspensory ligament of the lacrimal gland.
- Fovea for the pulley of the superior oblique (**trochlear fossa**) is a small depression situated close to the orbital margin, at the junction of the roof and the medial wall.
- Roof slopes backward and downward towards the apex, where it ends at the optic canal and superior orbital fissure.

### **Relations**

- Above, the roof is related to the frontal lobe of cerebrum and meninges and also frontal sinuses.
- Below the roof are periorbita, frontal nerve, levator palpebrae superioris,

superior rectus, superior oblique, trochlear nerve and lacrimal gland.

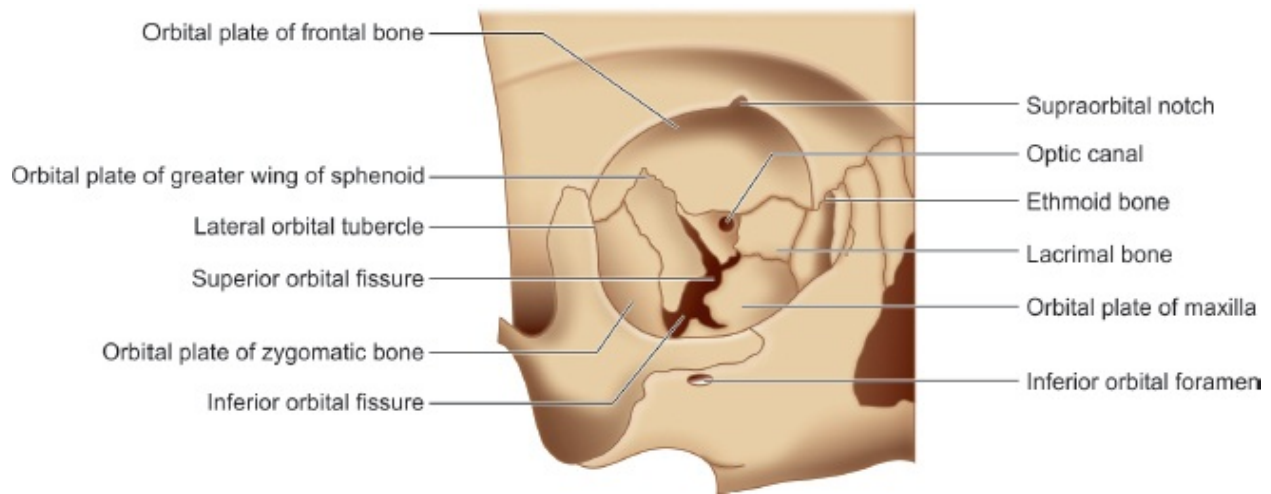
- At the junction of the roof and the medial wall, i.e. frontoethmoid suture line are the anterior and posterior ethmoidal canals. Anterior ethmoidal canal is 20–25 mm behind the anterior lacrimal crest and posterior ethmoidal canal is 32–35 mm behind the anterior lacrimal crest and 5–10 mm anterior to the optic nerve. Ethmoidal canals transmit branches of ophthalmic artery and nasociliary nerve into the ethmoid sinus and the nose. Vessels from the ethmoidal canals are source of subperiosteal haematoma following orbital trauma.
- At the junction of roof, with lateral wall is a gap posteriorly, the superior orbital fissure.

### ***Clinical applications***

- The superior wall is rather thin throughout its whole extent and the periorbita easily peels away from its undersurface.
- A sharp object, like walking stick or umbrella, introduced into the orbit through the upper lid penetrates the roof and may damage the frontal lobe.
- On the cranial side, the dura can be lifted almost easily. Because the roof is perforated neither by major nerves nor by blood vessels, it can be easily nibbled away in transfrontal orbitotomy.

## BASE OF THE ORBIT

The anterior open end of the orbit is referred to as base. It is bounded by the orbital margins (Fig. 14.9). The margins are formed by a ring of compact bone. It gives attachment to the septum orbitale. The orbital margin can be described under four parts:



**Fig. 14.9.** Schematic view of the orbital cavity and orbital margin.

**Superior orbital margin.** It is formed entirely by the orbital arch of the frontal bone! Its lateral two-thirds is sharp and the medial one-third is rounded. Junction of the two parts is the highest point of the orbital arch; and here lies the supraorbital notch, which transmits the supraorbital nerve and artery. About 10 mm medial to the supraorbital notch is the supratrochlear groove, transmitting supratrochlear nerve and artery.

**Lateral orbital margin.** It is the strongest and is formed by zygomatic process of the frontal bone and the zygomatic bone. It does not reach as far anterior as the medial margin and thus anterior half of the globe is not protected by the bone laterally (Fig. 14.4).

**Inferior orbital margin.** It is formed by the zygomatic bone laterally and maxilla medially, almost in equal proportion. It is slightly raised than the floor. Medially, it becomes continuous with the anterior lacrimal crest. The infraorbital foramen transmitting infraorbital nerves and vessels is situated 4–5 mm below the orbital margin in line with the supraorbital foramen.

***Medial orbital margin.*** Below it is formed by the anterior lacrimal crest on the frontal process of maxilla and above by the frontal bone. Its upper part becomes continuous with the posterior lacrimal crest.

## **APEX OF ORBIT**

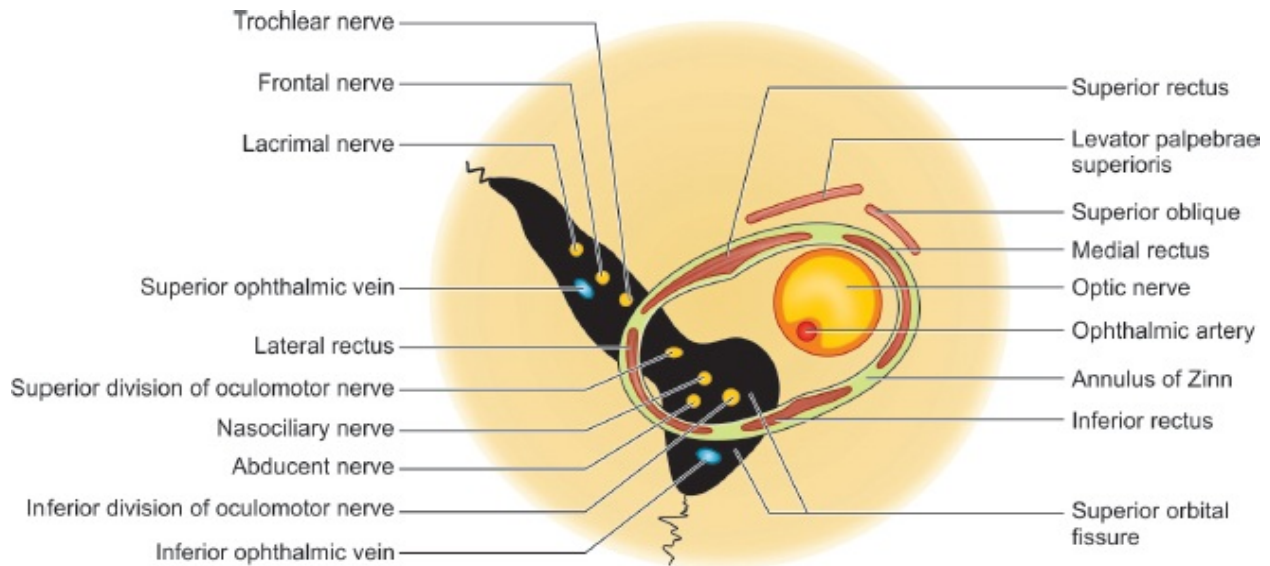
Orbital apex is the posterior end of the orbit. Here the four orbital walls converge. The apex has two orifices: the optic canal and the superior orbital fissure which are situated in the sphenoid bone (where the body, greater wing and lesser wing meet each other) ([Fig. 14.9](#)). At the orbital apex, just below the optic canal, inferior orbital fissure joins the superior orbital fissure and is contiguous with the foramen rotundum.

## **Optic canal**

It connects the orbit to the middle cranial fossa. It transmits the optic nerve (surrounded by meninges) and the ophthalmic artery. Normal adult dimensions of the optic canal are attained by the age of 4–5 years. Its average length is 6–11 mm (lateral wall is shortest and medial wall is longest). Its orbital end is vertically oval ( $6 \times 4.5$  mm), centre is circular (5x5 mm) and cranial end is horizontally oval ( $4.5 \times 6$  mm). Tumours such as optic nerve glioma and meningioma may lead to unilateral enlargement of the optic canal, which may be detected on X-ray films.

## Superior orbital fissure

It is a comma-shaped aperture in the orbital cavity. It is bounded by lesser and greater wings of the sphenoid. It is situated lateral to the optic foramen at the orbital apex. The fissure is divided into upper, middle and lower parts by the common tendinous ring (for origin of the recti). The structures passing through the upper and lateral parts are the lacrimal and frontal nerves (branches of ophthalmic division of Vth nerve), trochlear nerve, superior ophthalmic vein and recurrent branch of the ophthalmic artery. The middle part of the fissure (within tendinous ring) transmits the superior and inferior divisions of the oculomotor nerve, the nasociliary branch of the ophthalmic division of the trigeminal nerve and the abducent nerve. The lower and medial parts of the fissure transmit the inferior ophthalmic vein (Fig. 14.10).



**Fig. 14.10.** Structures passing through the superior orbital fissure, optic canal, common tendinous ring and origin of extraocular muscles.

## **Inferior orbital fissure**

The inferior orbital fissure lies just below the superior orbital fissure between the lateral wall and floor of the orbit, giving access to the pterygopalatine and inferotemporal fossae. Hence, it is close to the foramen rotundum and the pterygoid canal. It transmits the following structures:

- Infraorbital and zygomatic branches of the maxillary division of the fifth cranial nerve,
- Orbital branch of the pterygopalatine ganglion, and
- A branch of inferior ophthalmic vein which communicates with the pterygoid plexus

## PERIORBITA

- *Periorbita* refers to periosteum lining the orbital surface of the bones of orbit. Generally, it is loosely adherent to bone. However, it is firmly adherent at the orbital margin, superior and inferior orbital fissures, the optic canal, the lacrimal fossa and at the sutures.
- *In the optic canal*, the dural sheath of the optic nerve is closely adherent to periorbita.
- *At the orbital margin*, periorbita is thickened to form the arcus marginale to which the septum orbitale is attached. So trauma or surgery in this area may be complicated by CSF leak.
- *At the posterior lacrimal crest*, the periorbita splits into two layers which reunite at the anterior lacrimal crest. These two layers enclose the lacrimal sac (in the form of lacrimal fascia).
- *At the apex of orbit*, the periorbita is thickened to form the common tendinous ring of Zinn.

## **ORBITAL FASCIA**

The orbital fascia is a thin connective tissue membrane lining the various intraorbital structures. Recent studies have shown that this is a complex interwoven connective tissue joining the various intraorbital contents. Though the orbital fascia is one tissue, for descriptive convenience, it can be described under the heads of fascia bulbi, muscular sheaths, intermuscular septa, membranous expansions of the extraocular muscles, and ligament of Lockwood (Fig. 14.11).

## **Fascia bulbi**

Fascia bulbi, or Tenon's capsule, is a dense, elastic and vascular connective tissue that envelops the globe from the limbus to the optic disc. Its inner surface is well defined and lies in close contact with sclera to which it is connected by fine trabeculae. Schwalbe described the fascia as having two opposing layers lined by endothelium with a potential space in between, thus forming an articular socket in which the eyeball could move freely. However, it is now considered that the globe and the capsule move together in the surrounding fat. The outer surface of the fascia bulbi lies in contact with orbital fat posteriorly and with subconjunctival tissue anteriorly with which it merges near the limbus. Tenon's capsule is separated from the sclera by episcleral space (Tenon's space), which can be readily injected.

The lower part of the fascia bulbi is thickened and takes part in the formation of a sling or hammock on which the globe rests (*suspensory ligament of Lockwood*).

Around the distal end of optic nerve, the fascia is fused with the dural sheath of the optic nerve. Schwalbe, however, considered it to be continuous as a membrane surrounding the dural sheath to form a supravaginal lymph space, a view which is now considered doubtful. Fascia bulbi is pierced posteriorly by the optic nerve, ciliary nerves and vessels, just behind the equator by venae vorticosae, and anteriorly by six extraocular muscles; where it becomes continuous with the fascial sheaths of these muscles.

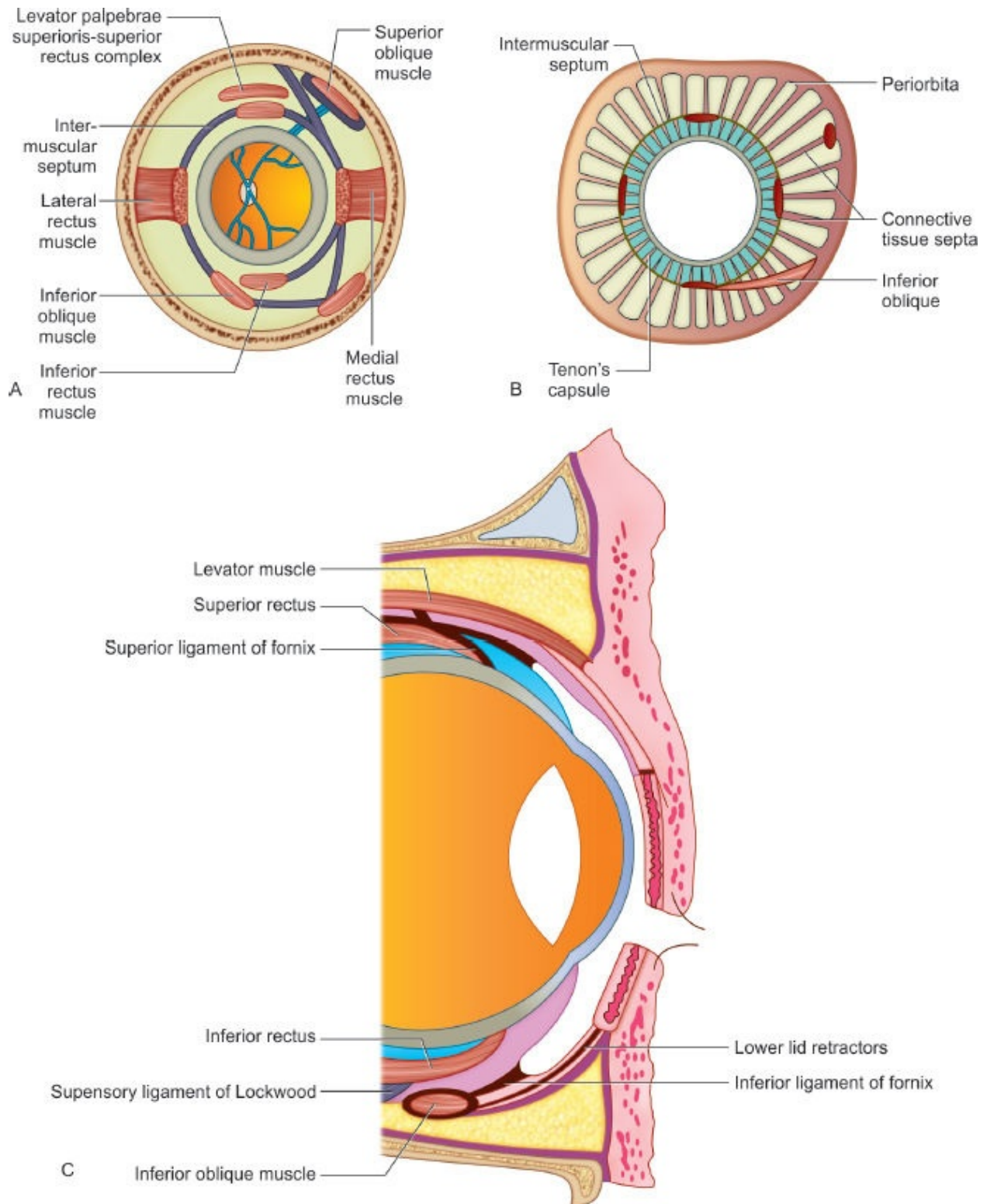
## **Fascial sheaths of extraocular muscles**

There are two views about the origin of the extraocular muscle sheaths. Some consider them to be a separate membranous lining of muscles which blend anteriorly with the Tenon's capsule. However, most workers consider them to be parts of the orbital fascia; at the points where the fascia bulbi is pierced by an extraocular muscle it sends a tubular reflection, which clothes the muscles like a glove. These muscular sheaths become continuous with the perimysium.

## Fascial expansions of extraocular muscles

The muscular sheath of each extraocular muscle sends expansions to the surrounding structures (Fig. 14.11).

- Fascial expansions of lateral and medial rectus muscles are strong and are attached to orbital tubercle on the zygomatic bone and to the lacrimal bone, respectively. These are also called lateral and medial *check ligaments*.
- *Rectus muscle pulleys* of connective tissue and some smooth muscle fibres have recently been described being located close to the equator of globe. These are suspended from the orbital walls through which the rectus muscles pass. It is thought that these pulleys become the functional origin of the muscles and thus effectively modify the direction of pull of rectus muscles. The pulleys are most developed around the horizontal recti, particularly the medial rectus. These are stabilized by septa which are attached to fascia bulbi, intermuscular septa and periorbita.
- Expansion of superior rectus muscle is attached to the levator palpebrae superioris. This attachment ensures synergic action of the two muscles. Thus, when the superior rectus makes the eye look up, the upper lid is also raised. In maximal levator resection for ptosis, hypotropia can be induced, if these connections are not severed.
- An expansion from the inferior rectus muscle is attached to the capsulopalpebral fascia, a tissue analogous to levator aponeurosis in the lower lid. An expansion from the superior oblique passes up to the trochlea.
- An expansion from the inferior oblique passes to lateral part of the roof of the orbit.
- *Suspensory ligament of Lockwood* (Fig. 14.11C): It is a thickened sling or hammock of fascial sheath extending from the posterior lacrimal crest to the lateral orbital tubercle, on which rests the eyeball. It is formed by fusion of expansions from the muscular sheaths of the medial rectus, inferior oblique, inferior rectus and lateral rectus muscle joined with the thickened inferior part of Tenon's capsule.



**Fig. 14.11.** Schematic coronal section of the orbit at the level of equator of the eyeball to show various components of orbital fascia (A), and arrangement of orbital septa in the anterior orbit in the region of globe (B). Schematic section of

*the lower eyelid showing suspensory ligament of Lockwood and inferior suspensory ligament of the fornix and upper lid showing superior suspensory ligament of fornix (C).*

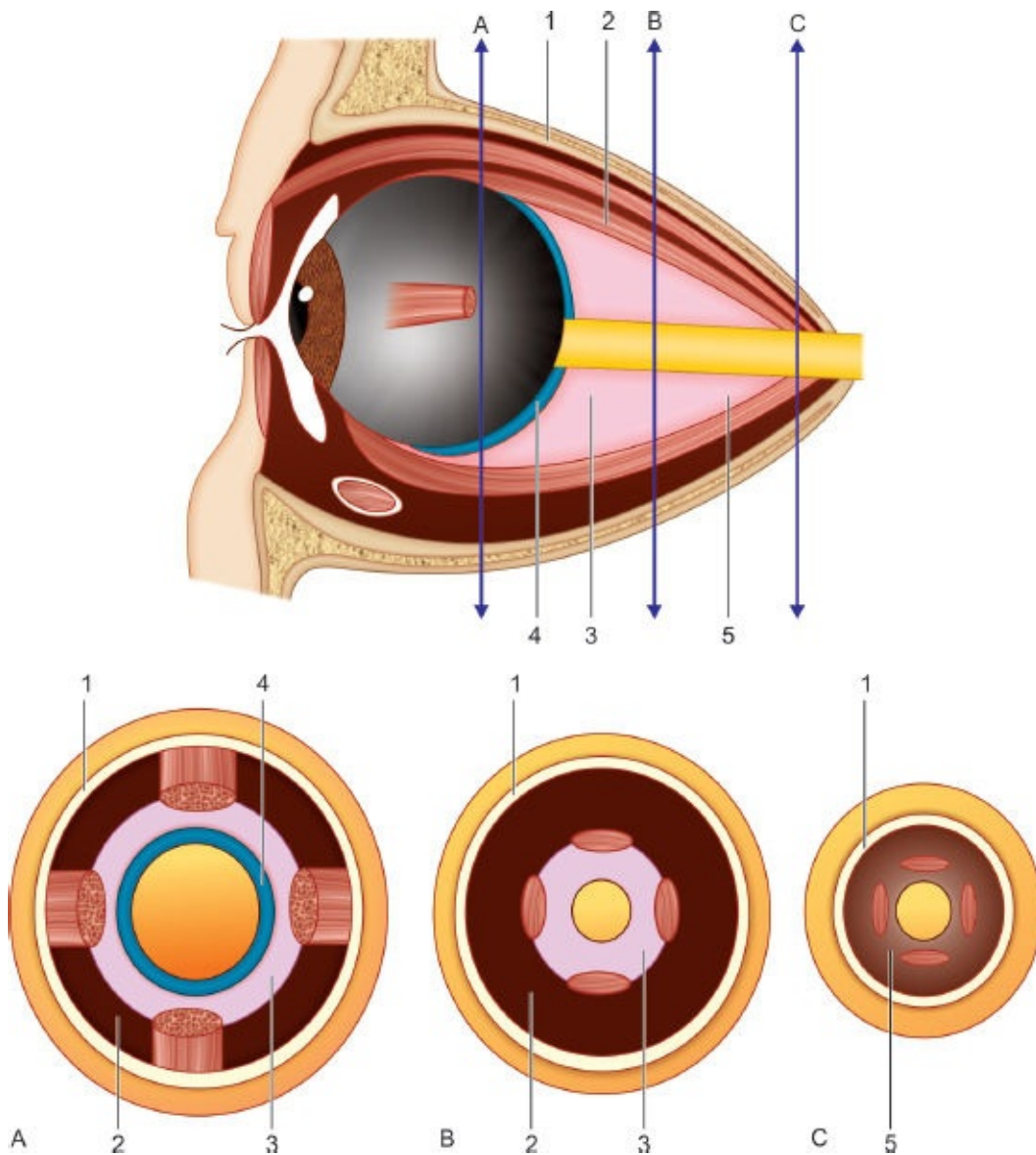
- *Superior transverse ligament of the Wliitnall:* It is a thickened band of orbital fascia which extends from the trochlear pulley to the lacrimal gland and its fossa. It is formed by a condensation of the superior sheaths of the levator muscle joined medially by the sheath of the reflected tendon of superior oblique muscle. It forms a true check ligament of the levator muscle.
- *Suspensory ligaments of the fornices* are also well recognized. Superior suspensory ligament of the fornix is formed by the continuation forward of the fibrous tissue between the superior rectus and levator muscles to the upper fornix. During ptosis surgery, if this ligament is cut, fornix conjunctiva can prolapse. Similarly, the *inferior suspensory ligament of the fornix* is formed by the continuation forward up to the inferior fornix of the fibrous tissue of lower lid retractors ([Fig. 14.11C](#)).
- *Orbital septa* of elastic and collagenous tissue are well developed in the adults. These septa pass inward from the periorbital fascia to the fascia bulbi ([Fig. 14.11B](#)). Such septa also pass to and between the extraocular muscles and provide specific supportive channels for the ophthalmic veins.
- In addition to these well-established expansions, there are many more complex fascial attachments from the sheath of each extraocular muscle. About five different fascial expansions have been described for the medial rectus muscle.
- Further, from the anterior end of the expansion of each extraocular muscle, a fibrous band passes to be attached to the conjunctival cul-de-sac. These connections account for the retraction of the conjunctival sac when these muscles contract.

## **Intermuscular septa/membrane**

The sheaths of the four rectus muscles are joined to each other by a fascial membrane called the intermuscular septum ([Fig. 14.11 A](#)). This membrane divides the orbital cavity and orbital fat into a central and a peripheral part.

## SURGICAL SPACES IN THE ORBIT

The orbit is divisible into a number of spaces. These are of importance as most orbital tumours tend to remain within the space in which they are formed (unless they are large or malignant or unless they represent an infiltrative process such as pseudotumours). Therefore, a knowledge of the main compartments of the orbit and their boundaries helps the surgeon in choosing the most direct approach to the tumour. From the surgical point of view, four spaces can be described in the orbit (Fig. 14.12):



**Fig. 14.12.** Schematic sections of the orbital cavity to demonstrate surgical

*spaces of the orbit. Above, sagittal section; below, coronal sections at levels A, B and C; 1. subperiosteal space; 2. peripheral space; 3. central space; 4. sub-Tenon's space; 5. peripheral and central spaces merged with each other at the orbital apex (apical space).*

## **1. Subperiosteal space**

This is a potential space between orbital bones and the periorbital fat, limited anteriorly by the strong adhesions of periorbital fat to the orbital rim. Tumours arising from the bones separate periorbital fat from the bones, which then becomes thicker and tougher, forming an effective barrier against the spread of tumour towards the eye, unless subjected to extreme pressure for a long time. Dermoid cyst, epidermoid cyst, mucocele, subperiosteal abscess, myeloma, osteomatous tumour, haematoma and fibrous dysplasia are commonly seen in this space. Plain X-rays are most useful in diagnosing the tumours of this space.

## **2. Peripheral orbital space (anterior space)**

This space is bounded peripherally by periorbita, internally by the four extraocular muscles with their intermuscular septa and anteriorly by the septum orbitale (including tarsal plates and tarsal ligaments). Posteriorly, it merges with the central space. Tumours present in this space produce eccentric proptosis and can usually be palpated. Common tumours found in this space are malignant lymphoma, capillary haemangioma of childhood, intrinsic neoplasms of the lacrimal gland and pseudotumours. Tumours residing in this space are explored usually by anterior orbitotomy and sometimes by lateral orbitotomy. Contents of this space are peripheral orbital fat, superior oblique, inferior oblique and levator palpebrae superioris muscles; lacrimal, frontal, trochlear, anterior ethmoidal and posterior ethmoidal nerves; superior and inferior ophthalmic veins; lacrimal gland; and half of the lacrimal sac.

### **3. Central space**

It is also called *muscular cone* or posterior or *retrobulbar space*. This space is bounded anteriorly by Tenon's capsule lining the back of the eye and peripherally by the extraocular rectus muscles and their intermuscular septa (in the anterior part). In the posterior part, where intermuscular septa are imperceptible, this space becomes continuous with the peripheral orbital space. Contents of the central space include optic nerve and its meninges, superior and inferior divisions of oculomotor nerve, abducent nerve, nasociliary nerve, ciliary ganglion, ophthalmic artery, superior ophthalmic vein and the central orbital fat. Many of the circumscribed orbital tumours, such as cavernous haemangioma of adults, solitary neurofibroma, neurilemmomas, nodular orbital meningiomas and optic nerve gliomas, occur in this space and usually produce an axial proptosis. Such tumours are often removed through a lateral orbitotomy.

#### **4. Sub-Tenon's space**

It is a potential space around the eyeball between the sclera and Tenon's capsule. Pus collected in this space is drained by incision of Tenon's capsule through the conjunctiva.

## **Alternative nomenclature for surgical spaces of the orbit**

In the preceding paragraphs, the surgical spaces have been described using classical nomenclature. However, some alternative terms are also used. As at the apical part of the orbit, the peripheral (anterior) and central (posterior) spaces merge with each other to form a single space; hence, it will be more appropriate to divide the orbit into the following five surgical spaces ([Fig. 14.12](#)):

1. *Subperiosteal space.*
2. *Anterior (peripheral) space* extending posteriorly up to the posterior limit of the intermuscular membrane.
3. *Posterior (central) space*, also extending posteriorly up to the posterior limit of the intermuscular membrane.
4. *Apical space*, bounded peripherally by periorbita; anteriorly becoming continuous with the anterior (peripheral) and posterior (central) spaces, at the level of posterior limit of intermuscular membrane and ending posteriorly at the apex of the orbit.
5. *Sub-Tenon's space.*

## ORBITAL FAT AND RETICULAR TISSUE

Normally, most of the orbital cavity is occupied by orbital fat, which extends from the optic nerve to the orbital wall and from the apex of the orbit to the septum orbitale. The fat lobules lie in the interstices of a web of reticular tissue called the *orbital reticulum*. This tissue is the supporting framework of the orbital fat, anchoring it to the orbital fascia.

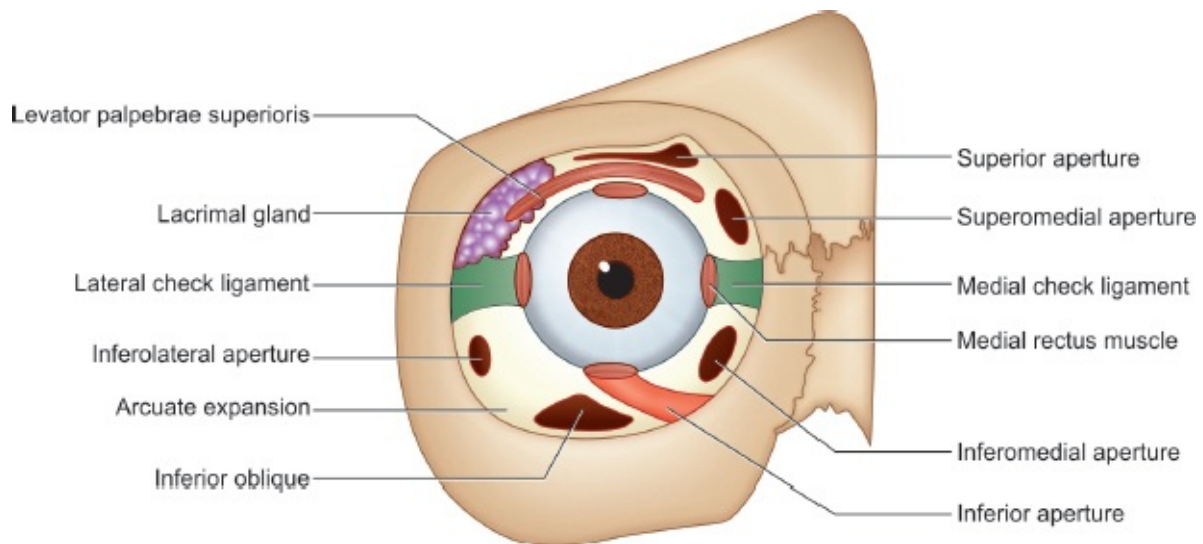
The orbital fat is divided into central and peripheral parts by the intermuscular septa. Posteriorly, where there is no intermuscular septa, the peripheral and central fat pads are continuous with each other. *The peripheral orbital fat* consists of four lobules namely superomedial, superolateral, inferomedial and inferolateral. If surgical spaces of orbit are considered five, then the orbital fat can be divided into three parts: Peripheral, central and apical.

Benign encapsulated tumours do not alter the normal structure of reticular tissue and fat, except that these structures are under great pressure and when the periorbita has been opened, bulge more persistently into the operative field. However, in case of malignant tumours and infiltrative lesions like pseudotumours and endocrine exophthalmos this basic matrix may alter depending on the nature and duration of the lesion.

The orbital fat and its reticular tissue are not as inert as is commonly assumed. At times, they may become very reactive. Therefore, lesser the disturbance of these structures during orbitotomy, the better the functional and cosmetic results.

## APERTURES AT THE BASE OF ORBIT

The base of orbit is closed partially by the globe and extraocular muscles with their fascial expansions. These expansions and two oblique muscles bound about five orifices between the orbital margin and globe (Fig. 14.13). Through these orifices, fat may herniate from the orbit to come into contact with the septum orbitale. Further, these apertures form a communication between the orbital cavity and deep portions of eyelids. It is through them that blood and pus pass out of the orbit from the space between periorbita and peripheral fat. Their further spread in the lids is stopped by septum orbitale. These apertures are described below.



**Fig. 14.13.** Fascial expansions from extraocular muscle sheaths and apertures at the base of orbit.

**1. Superior aperture.** This is a comma-shaped orifice and lies between the roof of the orbit and the upper surface of the levator palpebrae superioris muscle. The head of the comma lies near the trochlea and the tail reaches the lacrimal gland. Fat from the superomedial lobe may herniate through this aperture to form a retroseptal roll, which serves as an important landmark during levator resection surgery for ptosis.

**2. Superomedial aperture.** This vertically oval aperture lies between the reflected tendon of the superior oblique muscle and the medial check ligament. The infratrochlear nerve, dorsal nasal artery and angular vein pass through this aperture. Herniation of fat through this aperture is a common cause of lobulated

prominence in old people.

**3. *Inferomedial aperture.*** This is vertically oval in shape and lies between the medial check ligament, origin of inferior oblique muscle and the lacrimal sac.

**4. *Inferior aperture.*** This is triangular in shape and is bounded by the inferior oblique muscle, arcuate expansion of inferior oblique and floor of the orbit.

**5. *Inferolateral aperture.*** This is a small oval aperture situated between the arcuate expansion of the inferior oblique muscle and the lateral check ligament.

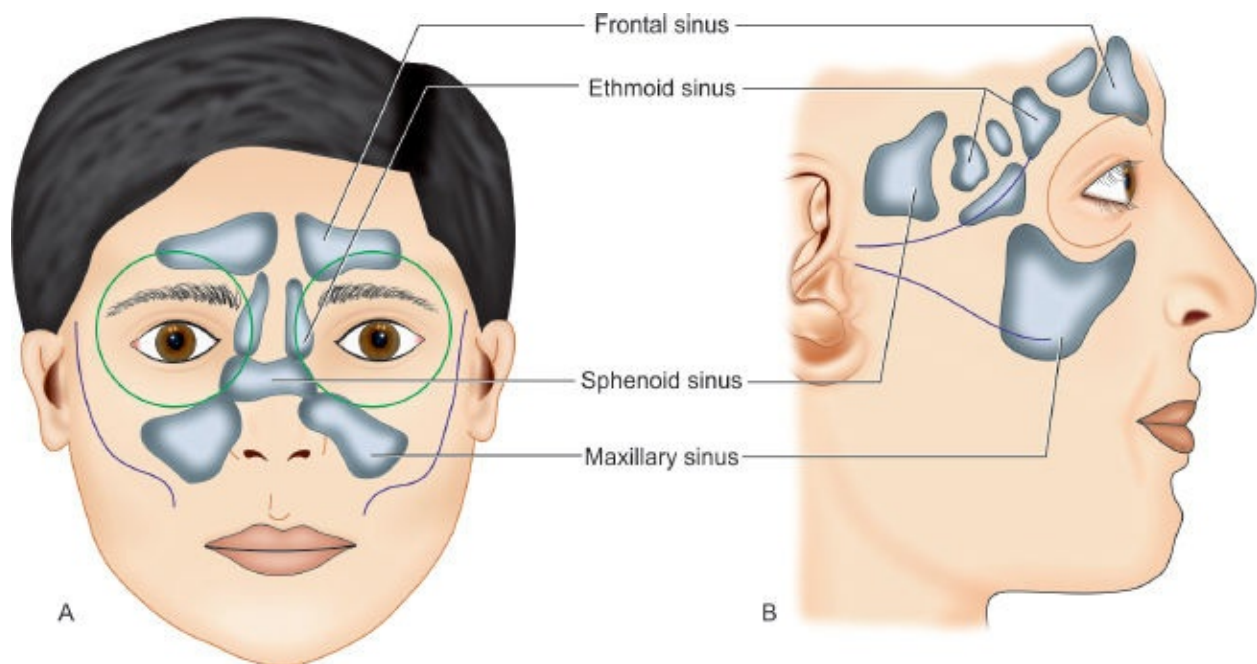
## CONTENTS OF THE ORBIT

- *Eyeball* occupies about one-fifth of the total orbital volume.
- *Muscles* include superior rectus, inferior rectus, medial rectus, lateral rectus, superior oblique, inferior oblique, levator palpebrae superioris, and Muller's muscles of the orbit. The *orbital muscle of Midler* (musculus orbitalis) is an aggregation of non-striated muscle fibres associated with the periorbita near the inferior orbital fissure. It spans the fissure and also extends back, deep to the annular tendon as far as cavernous sinus. Anteriorly, this muscle fades away in the periorbita. It is supplied by a branch from the pterygopalatine ganglion (sympathetic fibres). In the humans, its action is doubtful and thus it is more or less a vestigial structure.
- *Nerves*. These include optic nerve, oculomotor nerve, trochlear nerve, abducent nerve, branches of ophthalmic division of Vth nerve (lacrimal, frontal, nasociliary) and branches of maxillary division of Vth nerve (infraorbital, zygomatic).
- *Vessels*. Ophthalmic artery and its branches, infraorbital vessels, orbital branch of middle meningeal artery and superior and inferior ophthalmic veins.
- *Orbital fat, reticular tissue and orbital fascia.*
- *Lacrimal gland and lacrimal sac.*

## PARANASAL SINUSES

Anatomically, the orbital cavity is bounded on three sides by the air containing cavities—the paranasal sinuses also called paraorbital sinuses (Figs 14.3, 14.4 and 14.14). The intimate topographical relationship of the orbit to the paranasal sinuses indicates that the former may be involved in majority of expanding or bone eroding lesions originating in the sinuses and in the nasopharynx.

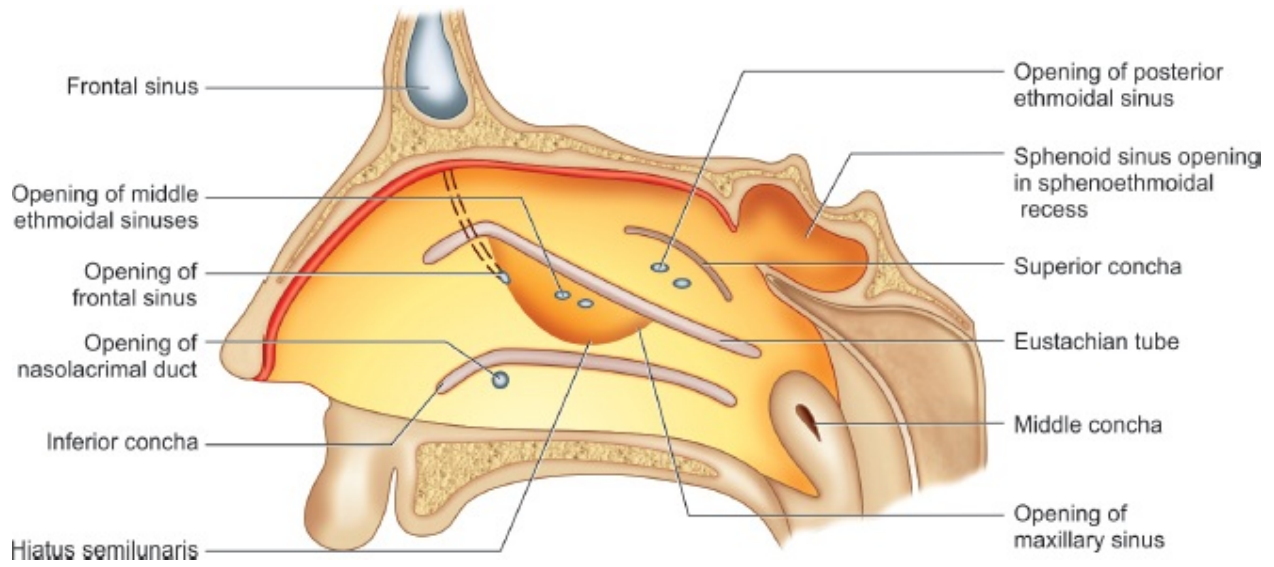
The paranasal sinuses are four on each side and from clinical point of view can be divided into two groups: anterior, in relation to anterior half of the orbit and the eyeball; and posterior, in relation to the orbital apex and the optic nerve (Fig. 14.14).



**Fig. 14.14.** Relations of paranasal sinuses to the orbits: A, Frontal view; B, Lateral view.

The *anterior group* includes frontal sinuses related to the orbital roof, the anterior and middle ethmoidal sinuses related to its medial wall and the maxillary antrum related to its floor. They all open into the middle meatus (Fig. 14.15).

The *posterior group* includes the posterior ethmoidal sinuses which open in the superior meatus and the sphenoid sinus which opens in the sphenoidal recess (Fig. 14.15). These are in relation to the medial aspect of orbital apex.



**Fig. 14.15.** *The lateral wall of nasal cavity with turbinates removed showing openings of various paranasal sinuses.*

## MAXILLARY SINUS

Maxillary sinus, also called as the antrum of highmore, is the largest of paranasal sinuses and occupies the body of maxilla (Figs 14.3 and 14.16).

On an average, maxillary sinus has a capacity of 15 ml in adults. It is pyramidal in shape with following features:

**Base** of the maxillary sinus forms part of the lateral wall of the nose.

**Apex** of this pyramidal cavity is directed laterally into the zygomatic process.

**Anterolateral wall** is formed by facial surface of the maxilla and is related to soft tissue of cheek.

**Posterior wall** is related to infratemporal and pterygopalatine fossae.

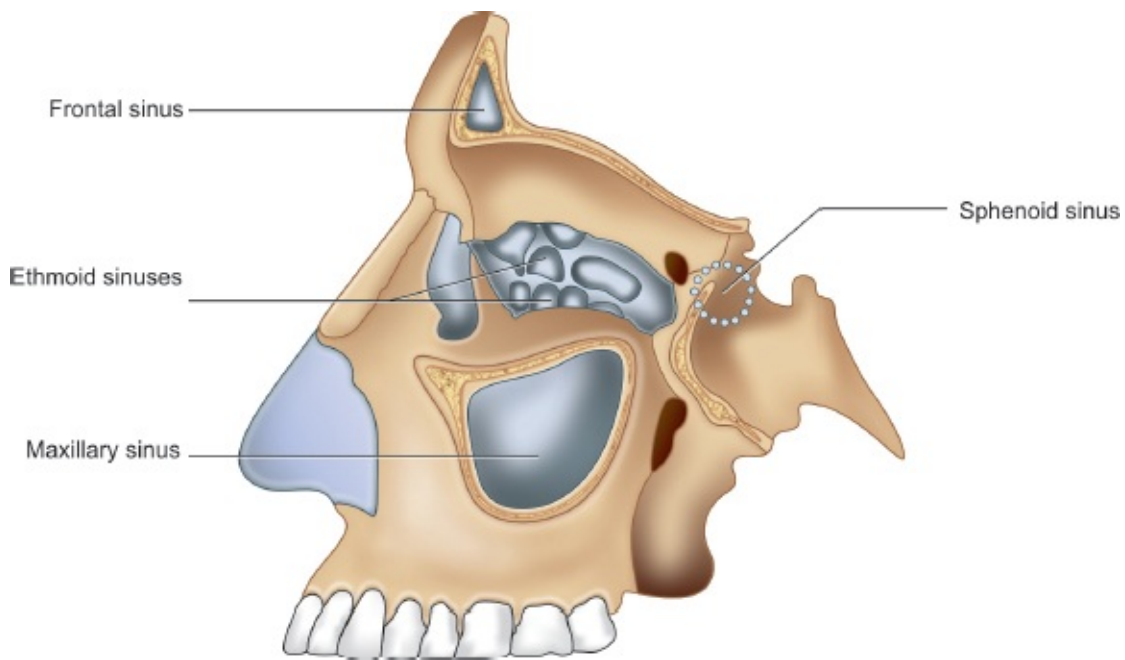
**Floor** is formed by maxillary alveolar process and is situated about 1.25 cm below the floor of the nose. Roots of the molars and premolars are in close relation to the floor separated from it by a thin lamina of bone. With advancing age, the floor undergoes absorption, which may expose the roots, especially of the first molar. Oro-dental fistulae can result from extraction of teeth.

**Roof** of the maxillary sinus is formed by the orbital plate of the maxilla, which also forms the floor of the orbit. Growths of the maxillary sinus may push the roof upwards causing proptosis with upward displacement of the eyeball.

**Ostium** of the maxillary sinus is situated high up in its medial wall and opens in the posterior part of ethmoidal infundibulum into the middle meatus. It is unfavourably situated for natural drainage.

## FRONTAL SINUSES

Frontal sinuses (Fig. 14.16) are situated between the inner and outer tables of frontal bone and are separated by a thin septum, which is usually deviated to one side making the two sinuses asymmetric. Frontal sinus may be absent on one or both sides or it may be very large extending into the orbital plate in the roof of the orbit. However, on an average, the height of the frontal sinus is 3 cm, the breadth 2.5 cm and depth 2 cm. Its anatomical features are as follows:



**Fig. 14.16.** *The left paranasal sinuses.*

**Anterior wall** of the sinus is related to the skin over the forehead.

**Inferior wall** or floor of the sinus is related to the orbit and its contents.

**Posterior wall** of the sinus is related to meninges and frontal lobe of the brain.

**Opening** of the frontal sinus is situated in its floor and leads into the middle meatus directly or through a canal **called frontonasal duct** (Fig. 14.15).

## ETHMOIDAL SINUSES

Ethmoidal sinuses are thin-walled air cavities mostly situated in the lateral mass of the ethmoid. These are completed by the adjoining bones, viz. frontal, palatine, sphenoid, maxillary and lacrimal. Collectively, they form an *ethmoid labyrinth*.

The ethmoidal sinuses vary from 3–18 in number and occupy the space between upper third of lateral nasal wall and the medial wall of the orbit.

The sinuses are divided by irregular septa into anterior, middle and posterior groups (Figs 14.4 and 14.16). The **anterior and middle sinuses** open into the middle meatus and the posterior sinuses open into the superior meatus (Fig. 14.15).

Relations of ethmoid labyrinth are as follows:

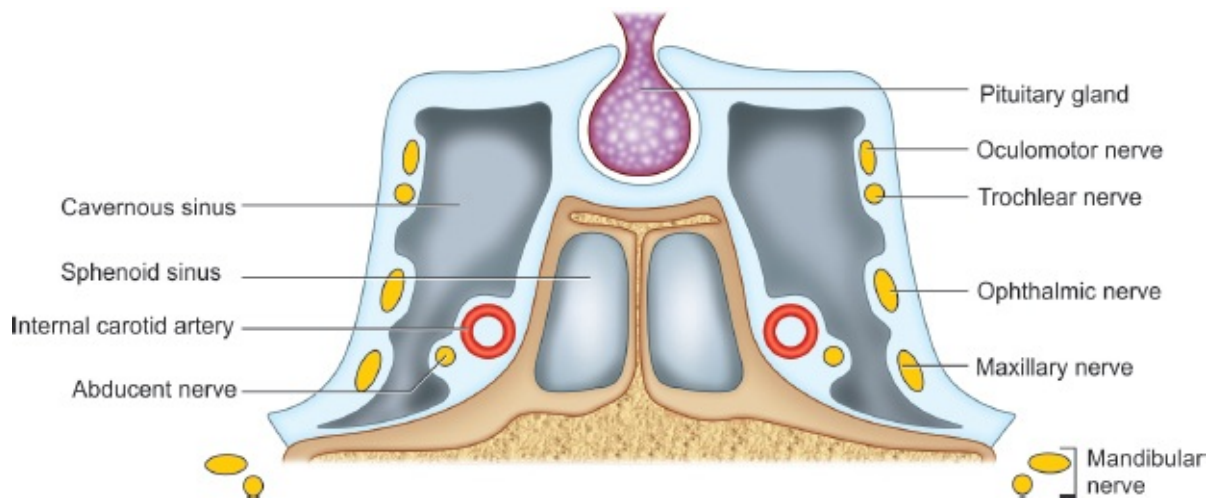
**Roof** of the ethmoidal sinuses is formed by anterior cranial fossa lateral to cribriform plate. Meninges of brain form important relations here.

**Lateral wall** of these sinuses is related to the orbit. The thin lamina of bone (**lamina papyracea**), separating air cells from the orbit favours spread of infection. For this reason, ethmoiditis is the most common cause of orbital cellulitis especially in children. Optic nerve forms close relationship with the posterior ethmoidal cells and is thus at risk during ethmoid surgery.

## SPHENOIDAL SINUSES

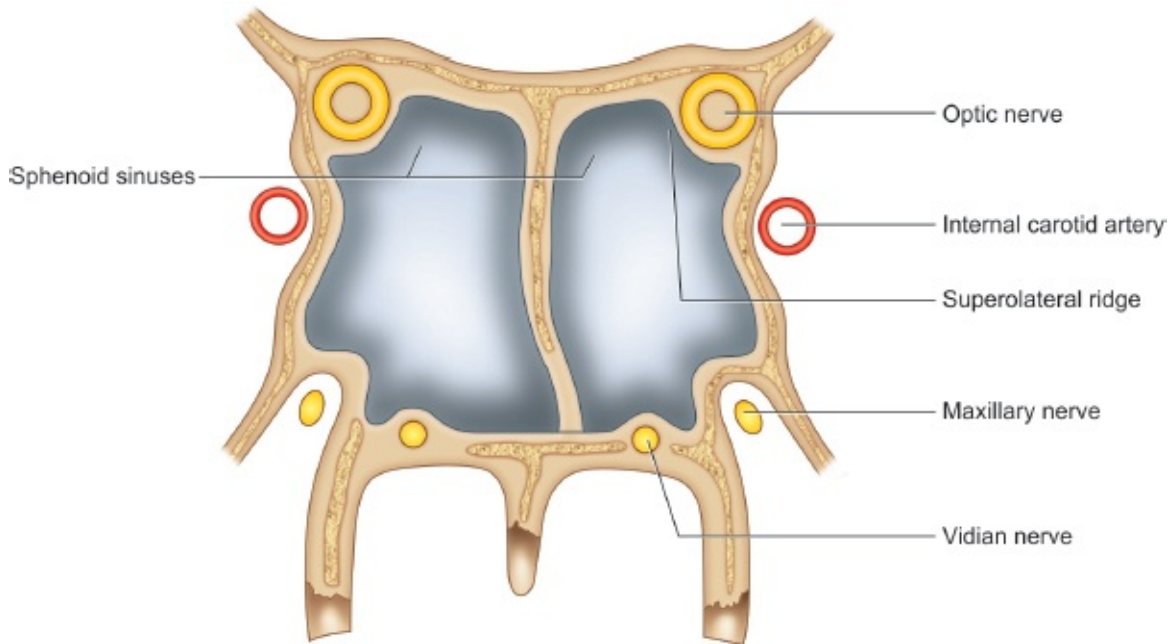
The sphenoidal sinuses situated in the body of sphenoid bones are separated by a thin bony septum which is often obliquely placed and thus the right and left sinuses are rarely symmetrical. Some important anatomical relations of the sphenoidal sinuses are as follows:

**Roof** of the sinus in anterior part is related to the olfactory tract, optic chiasma and frontal lobe. In the posterior part, roof is related to pituitary gland in the sella turcica (Fig. 14.17).



**Fig. 14.17.** Coronal section through the sphenoid sinuses showing relations of the posterior part.

**Lateral wall** of the sinus in the anterior part is related to internal carotid artery, maxillary nerve and optic nerve anterosuperiorly (which often ridge each sinus) (Fig. 14.18). This close relationship explains involvement of the nerve in sinusitis, causing sudden loss of vision due to retrobulbar neuritis. In the posterior part, each lateral wall is related to cavernous sinus, internal carotid artery and cranial nerves—3<sup>rd</sup>, 4<sup>th</sup>, 6<sup>th</sup> and all the divisions of 5<sup>th</sup> (Fig. 14.17).



**Fig. 14.18.** Coronal section through the sphenoid sinuses showing relations of the anterior part of the sinuses.

**Floor of the sinus** lies above the nasal cavity and houses pterygoid canal, which may ridge it (Fig. 14.18).

**Anterior wall** of the sphenoidal sinus is related to the posterior ethmoidal sinus which may infact be bulging in it (Fig. 14.4).

**Osteum** of the sphenoidal sinus is situated in the upper part of its anterior wall and drains into sphenothmoidal recess (Fig. 14.15).



## Bony Anatomy of the Orbit

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**Article initiated by:** Susan Luo, MD

**All contributors:** Cameron Reinisch, Nina Boal, M.D., Michael T Yen, MD, Preeti Thyparampil, MD, Dr Akash Keshav Chaurewar, Susan Luo, MD

**Assigned editor:** Preeti Thyparampil, MD

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### Contents

- 1 Dimensions of the Orbit
- 2 Bones of the Orbital Rim
- 3 Bones of the Orbital Wall
  - 3.1 Orbital Roof
  - 3.2 Lateral Wall
  - 3.3 Orbital Floor
  - 3.4 Medial Wall
- 4 Orbital Foramina, Fissures, and Canals

### Dimensions of the Orbit

The orbit is a pyramidal shaped structure, with the base of the pyramid forming the orbital rim.<sup>[1]</sup> The walls of the orbit angle posteriorly towards the optic canal to form the orbital apex.

The average dimensions of the orbit are as follows:<sup>[2]</sup>

Average dimensions	
Volume	30ccs
Height	35mm
Width	40mm
Length of the medial orbital wall	45mm
Length of the lateral orbital wall	35mm

### Bones of the Orbital Rim

The orbital rim is formed by three bones: the **frontal**, **zygomatic**, and **maxillary bones**.<sup>[3]</sup> The orbital rim is strong compared to the relatively weak orbital walls and helps provide protection for the globe.

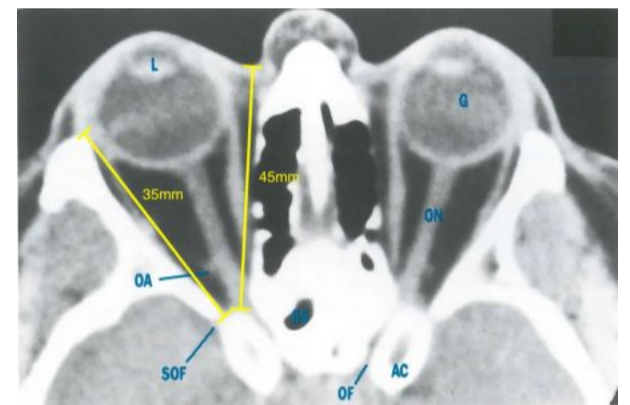
The **frontal bone** forms the superior rim and contains the **supraorbital foramen/notch**, through which the supraorbital nerve, artery, and vein pass.

The **zygomatic bone** contributes to the lateral, inferior, and medial rim and contains the zygomaticotemporal foramen and the zygomaticofacial foramen.

The **maxillary bone** forms the inferior rim and contains the infraorbital foramen, through which the infraorbital nerve, artery, and vein pass.

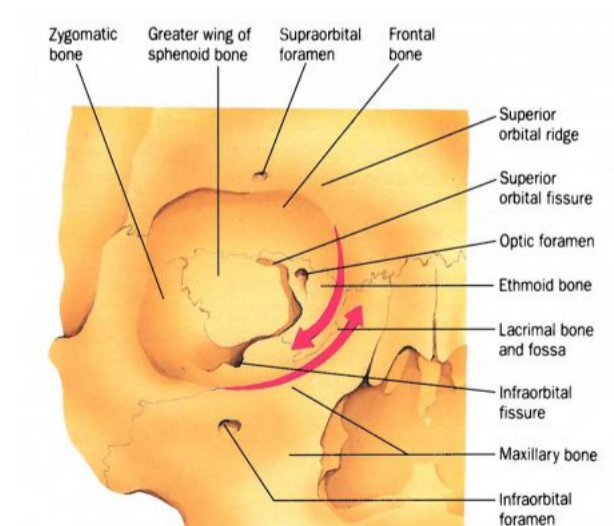
### Bones of the Orbital Wall

The orbit is made of four orbital walls, and a total of seven bones.<sup>[1][2][3]</sup>



The length of the medial orbital wall is 45mm on average, while the length of the lateral orbital wall is shorter at 35mm. Image Source from AAO Image Bank:

<https://www.aao.org/education/image/midglobe-through-optic-foramen>

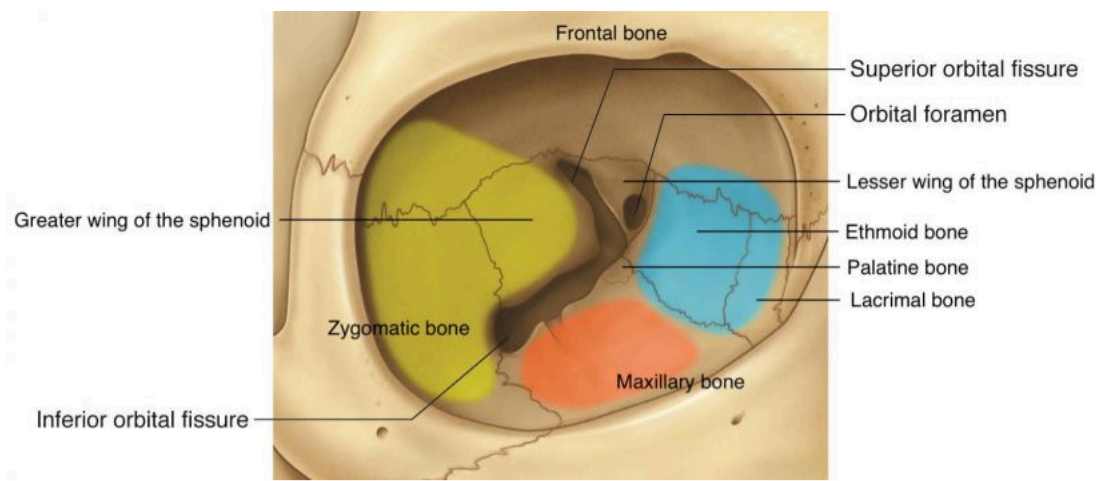


Bones of the orbital rim include the frontal bone (superior rim), zygomatic bone (lateral, medial, and inferior rim) and maxillary bone (inferior rim). Image Source from AAO Image Bank:

<https://www.aao.org/education/image/orbital-margin>

1.	Frontal bone
2.	Sphenoid bone (lesser and greater wing)
3.	Zygomatic bone
4.	Maxillary bone
5.	Palatine bone
6.	Ethmoid bone
7.	Lacrimal bone

Orbital Wall	Number of Bones	Bones
Orbital Roof	2	Frontal bone Lesser wing of the sphenoid
Lateral Wall	2	Zygomatic bone Greater wing of the sphenoid
Orbital Floor	3	Zygomatic bone Maxillary bone Palatine bone
Medial Wall	4	Maxillary bone Ethmoid bone Lacrimal bone Sphenoid bone



This anatomical illustration depicts the seven bones that make up the orbital cavity. The lateral wall is highlighted in yellow, the orbital floor is highlighted in orange, and the medial wall is highlighted in blue. Image Source from AAO Image Bank: <https://www.aao.org/education/image/orbital-decompression>

## Orbital Roof

The orbital roof is made of two bones: the **frontal bone** and the **lesser wing of the sphenoid**. The frontal bone separates the orbit from the anterior cranial fossa.

The frontal bone also contains three important foramen and fossa.<sup>[1]</sup>

- The **supraorbital notch or foramen** is located on the medial third of the portion of the frontal bone that comprises the superior orbital rim.
- The **fossa of the lacrimal gland** is located on the inferior surface of the frontal bone underneath the zygomatic process and houses the lacrimal gland in the superolateral orbit.
- Superomedially, a shallow depression creates the **trochlear fossa**, which houses the complex trochlear apparatus.

See Orbital Roof Fractures for more on orbital injuries associated with the orbital roof.

## Lateral Wall

Two bones comprise the lateral orbital wall: the **zygomatic bone** and the **greater wing of the sphenoid**.<sup>[1]</sup> The lateral orbital wall is the strongest wall of the orbit.

**Whitnall's tubercle**, also known as the lateral orbital tubercle, is a bony prominence on the zygomatic bone that serves as an important anatomic landmark on the lateral orbital wall.<sup>[4]</sup> The tubercle is located 11 mm inferior to the frontozygomatic suture and 4-5mm posterior to the lateral orbital rim.<sup>[4]</sup>

Whitnall's tubercle serves as the attachment site for several important structures including:<sup>[4][5][6]</sup>

Lockwood's ligament
Lateral canthal tendon
Lateral horn of the levator aponeurosis
Lateral rectus check ligament
Lacrimal gland fascia
Lateral extremities of the superior and inferior tarsal plates

Whitnall's tubercle is an important surgical anatomic landmark as it often serves as the location for reattachment during lateral canthal procedures, such as a lateral tarsal strip. Proper attachment at this site is indicated to prevent the development of eyelid malposition such as entropion or ectropion. In the absence of Whitnall's tubercle, the height of the lateral orbital wall (as determined by the maximum distance of the zygomaticofrontal suture to the jugal point) has been proposed to reliably localize the lateral canthal insertion site.<sup>[7]</sup>

Of note, **Whitnall's ligament** does not attach at Whitnall's tubercle. Rather, Whitnall's ligament forms septa through the lacrimal gland fascia with fibers inserted onto the lateral orbital wall several millimeters above Whitnall's tubercle.<sup>[8]</sup>

## Orbital Floor

Three bones make up the orbital floor: the **maxillary bone**, **zygomatic bone**, and **palatine bone**.<sup>[2][3]</sup> The orbital floor separates the orbit from the underlying maxillary sinus. Orbital floor fractures are the most common orbital fractures. The origin of the inferior oblique muscle also lies within the orbital floor posterior to the inferior medial orbital rim. Care must be taken to separate this muscle out during orbital floor fracture repairs to prevent iatrogenic damage.

## Medial Wall

The medial wall is formed by four bones. Anteriorly to posteriorly, they are the **maxillary bone**, **lacrimal bone**, **ethmoid bone**, and the **sphenoid bone**.<sup>[3]</sup> The ethmoid bone contains the **lamina papyracea**, which makes up the bulk of the medial orbital wall and is often involved in medial wall fractures due to its paper-thin qualities. Interruption of the lamina papyracea can allow for the spread of infection from the ethmoid sinus.

## Orbital Foramina, Fissures, and Canals

The **optic foramen** is located in the lesser wing of the sphenoid bone. It extends into the orbit, traveling in an inferior, anterior, and lateral direction. The optic nerve, the ophthalmic artery, and the choroid plexus all pass through the optic foramen as they enter the orbit.<sup>[2]</sup>

The **supraorbital foramen** is a small opening at the superior and medial margin of the orbit in the frontal bone. It is called the supraorbital notch if the foramen is incomplete. It contains the supraorbital nerve, artery, and vein. The **supraorbital nerve** is a sensory branch of the frontal nerve, which branches from the ophthalmic division of the trigeminal nerve (CN V1), and provides sensory cutaneous innervation to the forehead, upper eyelid, and root of the nose.<sup>[9]</sup>

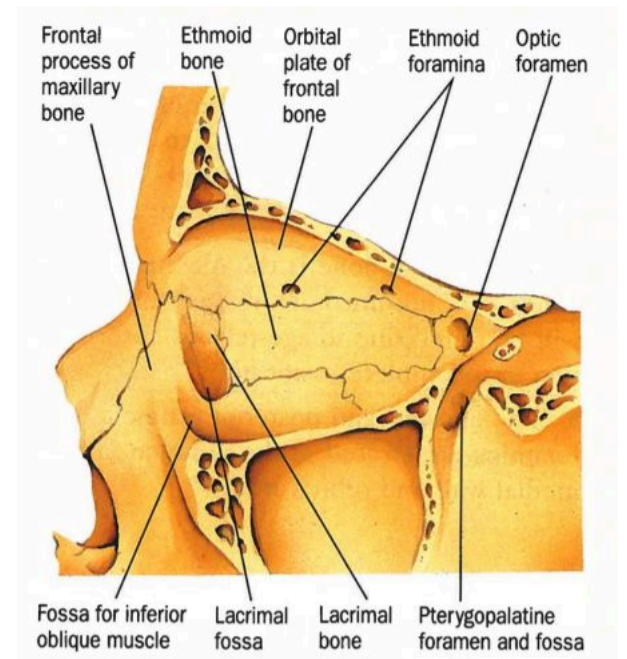
The **superior orbital fissure** is located between the greater and lesser wings of the sphenoid bone. Cranial nerves III, V, IV, and VI all travel within the superior orbital fissure. The common tendinous ring surrounds the optic canal and the lower half of the superior orbital fissure. It is also the origin of the four recti muscles.<sup>[3]</sup>

Above the common tendinous ring, the **superior orbital fissure** transmits the lacrimal and frontal branches of CN V1, CN IV, and the superior ophthalmic vein. The superior and inferior divisions of CN III, the nasociliary branch of CN V1, sympathetic fibers of CN V1, and sympathetic fibers to the ciliary ganglion all pass through this fissure.<sup>[1]</sup>

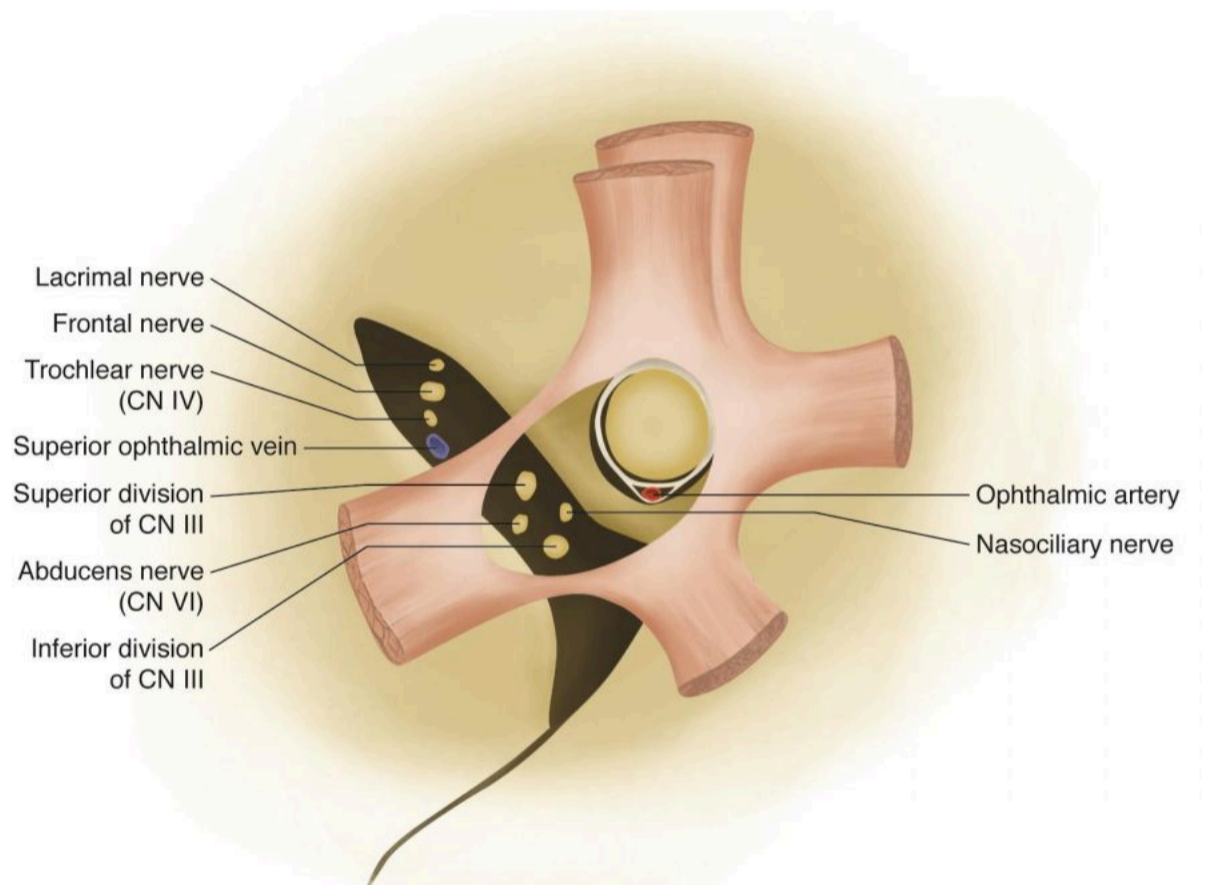
The **inferior orbital fissure** is located on the floor of the orbit. The infraorbital nerve, zygomatic nerve, and inferior ophthalmic vein traverse this fissure.

The **inferior orbital canal** is located within the maxilla and eventually leads anteriorly to the infraorbital foramen below the inferior orbital rim.<sup>[3]</sup> The **infraorbital foramen** transmits the infraorbital nerve, artery, and vein. The **infraorbital nerve** provides sensory cutaneous innervation to the lower eyelid, anterior cheek, side of the nose, and upper lip.<sup>[9]</sup>

The **zygomaticotemporal foramen** and the **zygomaticofacial foramen** are small openings located within the zygomatic bone on the orbital rim.<sup>[9][10][11]</sup> Both the zygomaticotemporal foramen and zygomaticofacial foramen contain their respective named nerves, which are terminal branches of the maxillary division of the trigeminal nerve (CN V2). The **zygomaticotemporal nerve** gives sensory innervation to the skin on the temporal forehead and parasympathetic innervation to the lacrimal gland. The zygomaticofacial nerve provides cutaneous sensory innervation to the prominence of the cheek.



This anatomical illustration depicts a sagittal view of the bony structures of the medial wall. Key landmarks include the frontal process of the maxillary bone, ethmoid bone, orbital plate of the frontal bone, and optic foramen. Image Source from AAO Image Bank: <https://www.aao.org/education/image/medial-orbital-wall>



This diagram illustrates the anatomical structures passing through the orbital apex and the superior orbital fissure. It includes key neurovascular components such as the lacrimal nerve, frontal nerve, trochlear nerve (CN IV), superior and inferior divisions of the oculomotor nerve (CN III), abducens nerve (CN VI), nasociliary nerve, ophthalmic artery, and superior ophthalmic vein. <https://www.aao.org/education/image/superior-orbital-fissure>

Structure	Location	Contents	Nerve	Supplies
Optic foramen	Lesser wing of the sphenoid	Optic nerve Ophthalmic artery Choroid plexus	Optic nerve	Retina
Supraorbital foramen	Frontal bone	Supraorbital nerve, artery, and vein	Supraorbital nerve	Sensory cutaneous innervation to the forehead, upper eyelid, and root of the nose
Zygomaticotemporal foramen	Zygomatic bone	Zygomaticotemporal nerve	Zygomaticotemporal nerve	Sensory cutaneous innervation to the temporal forehead Parasympathetic innervation to the lacrimal gland
Zygomaticofacial foramen	Zygomatic bone	Zygomaticofacial nerve	Zygomaticofacial nerve	Sensory cutaneous innervation to the prominence of the cheek
Superior orbital fissure	Between the greater and lesser wing of the sphenoid bone	Oculomotor nerve (CN III) Trochlear nerve (CN IV) Ophthalmic division of the trigeminal nerve (CN V1) Abducens nerve (CN VI) Superior ophthalmic vein (SOV)	Oculomotor nerve (CN III) Trochlear nerve (CN IV) Ophthalmic division of the trigeminal nerve (CN V1) Abducens nerve (CN VI) Superior ophthalmic vein (SOV)	
Inferior orbital fissure	Greater wing of the sphenoid, maxilla, palatine bone, and zygomatic bone	Infraorbital nerve Infraorbital artery Infraorbital vein Zygomatic nerve Inferior ophthalmic vein (IOV)	Infraorbital nerve Infraorbital artery Infraorbital vein Zygomatic nerve Inferior ophthalmic vein (IOV)	
Inferior orbital canal Infraorbital foramen	Maxillary bone	Infraorbital nerve, artery, and vein	Infraorbital nerve	Sensory cutaneous innervation to the lower eyelid, anterior cheek, side of the nose, and upper lip

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