The orbit

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Orbital plate of frontal bone
Orbital plate of ethmoid bone
Orbital plate of zygomatic bone
Lesser wing of sphenoid
Greater wing of sphenoid
Lacrimal bone
Frontal process of the maxilla
Orbital plate of maxilla
The orbits are bilateral structures below the anterior cranial fossa and anterior to middle cranial fossa.

The bony orbit is pyramidal in shape, with its base opening anteriorly onto the face and its apex extending in a posteromedial direction.

Has medial, lateral, superior (roof), inferior (floor) walls.

The apex of the pyramid is the **optic foramen**, whereas the base is the orbital rim.

Orbital
Ophthalmic
Ciliary
Optic
Contents of the orbit:
1. Eye ball
2. Extraocular muscles
3. Intraocular muscles
4. Nerves: Optic, branches of ophthalmic, branches from maxillary, divisions of oculomotor, trochlear, abducent, sympathetic fibers and ciliary ganglion
5. Ophthalmic artery and veins
6. Lacrimal apparatus
7. Fat

The apex of the pyramid is the optic foramen
Roof:
Formed by:

1- The orbital plate of the frontal bone, which separates the orbital cavity from the anterior cranial fossa and the frontal lobe of the cerebral hemisphere

2- The lesser wing of the sphenoid
Lateral wall:
Formed by:

1- The orbital plate of zygomatic bone
2- The greater wing of the sphenoid
Floor:
Formed by:

1- The orbital plate of the maxilla: separates the orbital cavity from the maxillary sinus

2- Palatine bone
Medial wall:
Formed from before backward by:

1. The frontal process of the maxilla
2. The lacrimal bone
3. The orbital plate of the ethmoid

1. The frontal process of the maxilla
The frontal process of maxilla and the lacrimal bones participate in the formation of the lacrimal groove which contains the lacrimal sac.

2. The lacrimal bone
The orbital plate of ethmoid separates the orbital cavity from the ethmoidal air sinuses.

It is a very thin wall.

3. The orbital plate of the ethmoid
1- Supraorbital notch (Foramen): transmits the supraorbital nerve and blood vessels
Openings Into the Orbital Cavity

2-Infraorbital groove and canal: Situated on the floor of the orbit. They transmit the infraorbital nerve (a continuation of the maxillary nerve) and blood vessels.
Openings Into the Orbital Cavity

3-Infraorbital foramen: transmits the infraorbital nerve (a continuation of the maxillary nerve) and blood vessels
Openings Into the Orbital Cavity

5- Anterior and posterior ethmoidal foramina: transmit anterior and posterior ethmoidal nerves and vessels

Note: Anterior and posterior ethmoidal foramina are located between the roof and the medial wall
Openings Into the Orbital Cavity

6-Inferior orbital fissure:
Located posteriorly between the maxilla and the greater wing of the sphenoid
it communicates with the infratemporal and pterygopalatine fossae.
It transmits
1- Maxillary nerve and its zygomatic branch
2- Infraorbital vessels
3- Inferior ophthalmic vein (or a vein communicating with pterygoid plexus of veins)

Note: inferior orbital fissure is located between the floor and the lateral wall
Openings Into the Orbital Cavity

7- **Superior orbital fissure:**
- Located between the greater and lesser wings of the sphenoid
- It communicates with the middle cranial fossa.
- It transmits
  - Lacrimal nerve
  - Frontal nerve
  - Trochlear nerve
  - Oculomotor nerve (upper and lower divisions)
  - Abducent nerve
  - Nasociliary nerve
  - Superior ophthalmic vein

**Note:** *superior orbital fissure* is located between the roof and the lateral wall
Note the **superior orbital fissure** opens anteriorly into orbit and posteriorly into middle cranial fossa.

Note the **inferior orbital fissure** opens anteriorly into orbit and posteriorly into two fossae: one big (infratemporal fossa) and one small (Pterygo-palatine fossa).

Use the wire within each of the skull fissures to determine precisely the communications of superior and inferior orbital fissures.
Openings Into the Orbital Cavity

8-Optic canal:
- Located in the lesser wing of the sphenoid
- It communicates with the middle cranial fossa.
- It transmits the optic nerve and the ophthalmic artery

9-Nasolacrimal canal:
Located anteriorly on the medial wall; it communicates with the nose.
It transmits the nasolacrimal duct.
Nasolacrimal canal
MUSCLES OF THE EYE
There are two groups of muscles within the orbit:

1- **Extrinsic muscles of eyeball** (extra-ocular muscles) involved in movements of the eyeball or raising upper eyelid
2- **Intrinsic muscles** within the eyeball, which control the shape of the lens and size of the pupil.

**The extrinsic muscles** include:

1. SUPERIOR RECTUS
2. INFERIOR RECTUS
3. MEDIAL RECTUS
4. LATERAL RECTUS
5. SUPERIOR OBLIQUE
6. INFERIOR OBLIQUE
7. LEVATOR PALPEBRAE SUPERIORIS

**The intrinsic muscles** include:

1. Ciliary muscle
2. Sphincter pupillae
3. Dilator pupillae
Movements of the eyeball

**Elevation** - moving the pupil/cornea superiorly

**Depression** - moving the pupil/cornea inferiorly

**Abduction** - moving the pupil/cornea laterally

**Adduction** - moving the pupil/cornea medially

**Internal rotation** - rotating the upper part of the pupil/cornea medially (or towards the nose)

**Intorsion**

**External rotation** - rotating the upper part of the pupil/cornea laterally (or towards the temple)

**Extorsion**
**Common tendinous ring** is a fibrous ring which surrounds the optic canal and part of the superior orbital fissure at the apex of the orbit. It is the common origin of the four recti muscles.
1-Superior rectus

**Origin:** Superior part of common tendinous ring  
**Insertion:** Anterior half of eyeball superiorly  
**Nerve supply:** Oculomotor nerve/superior division  
**Action:** Elevation, adduction (Raises cornea upward and medially)

2-Inferior rectus

**Origin:** Inferior part of common tendinous ring  
**Insertion:** Anterior half of eyeball inferiorly  
**Nerve supply:** Oculomotor nerve/inferior division  
**Action:** Depression, adduction (Depresses cornea downward and medially)
3-Medial rectus

**Origin:** Medial part of common tendinous ring  
**Insertion:** Anterior half of eyeball medially  
**Nerve supply:** Oculomotor nerve/ inferior division  
**Action:** Adduction (Rotates eyeball so that cornea looks medially)

4-Lateral rectus

**Origin:** Lateral part of common tendinous ring  
**Insertion:** Anterior half of eyeball laterally  
**Nerve supply:** Abducent nerve [VI]  
**Action:** Abduction (Rotates eyeball so that cornea looks laterally)
5-Superior oblique

**Origin:** Posterior part of the roof

**Insertion:** Passes through pulley (trochlea) and is attached to lateral posterior half of eyeball (*behind the equator*)

**Nerve supply:** Trochlear nerve

**Action:** Depression, abduction, intorsion (Rotates eyeball so that cornea looks downward and laterally)
5-Superior oblique

(Rotates eyeball so that cornea looks downward and laterally) **AS IF YOU ARE LOOKING TO YOUR SHOULDER**
**6-Inferior oblique**

**Origin:** medial part of the floor (anteriorly)

**Insertion:** lateral posterior half of eyeball (*behind the equator*)

**Nerve supply:** Oculomotor nerve/ inferior division

**Action:** Elevation, abduction, extorsion

(Rotates eyeball so that cornea looks upward and laterally)
Medial rectus

Lateral rectus
Inferior oblique

Superior oblique
The extraocular muscles do not act in isolation. They work as teams of muscles in the coordinated movement of the eyeball to position the pupil as needed.

*For example, although the lateral rectus is the muscle primarily responsible for moving the eyeball laterally, it is assisted in this action by the superior and inferior oblique muscles.*
The origins of the superior and inferior recti are situated about 23° medial to their insertions, and, therefore, when the patient is asked to turn the cornea laterally, these muscles are placed in the optimum position to raise (superior rectus) or lower (inferior rectus) the cornea.

The superior and inferior oblique muscles can be tested. The pulley (trochlea) of the superior oblique and the origin of the inferior oblique muscles lie medial and anterior to their insertions. The physician tests the action of these muscles by asking the patient first to look medially, thus placing these muscles in the optimum position to lower (superior oblique) or raise (inferior oblique) the cornea.

Because the lateral and medial recti are simply placed relative to the eyeball, asking the patient to turn his or her cornea directly laterally tests the lateral rectus and turning the cornea directly medially tests the medial rectus.
A

**Muscle tested** | **Direction to move eye when testing muscle**
--- | ---
Superior rectus | Look laterally and **upward**
Inferior rectus | Look laterally and **downward**
Lateral rectus | Look **laterally**
Medial rectus | Look **medially**
Inferior oblique | Look medially and **upward**
Superior oblique | Look medially and **downward**

B
Figure 11-24 The cardinal positions of the right and left eyes and the actions of the recti and oblique muscles principally responsible for the movements of the eyes. A. Right eye, superior rectus muscle; left eye, inferior oblique muscle. B. Both eyes, superior recti and inferior oblique muscles. C. Right eye, inferior oblique muscle; left eye, superior rectus muscle. D. Right eye, lateral rectus muscle; left eye, medial rectus muscle. E. Primary position, with the eyes fixed on a distant fixation point. F. Right eye, medial rectus muscle; left eye, lateral rectus muscle. G. Right eye, inferior rectus muscle; left eye, superior oblique muscle. H. Both eyes, inferior recti and superior oblique muscles. I. Right eye, superior oblique muscle; left eye, inferior rectus muscle.
Inferior muscles---------------Extorsion
Superior muscles------------Intorsion
Origin: Posterior part of the roof
Insertion: Anterior surface and upper margin of superior tarsal plate, skin of upper eyelid
Nerve supply: Oculomotor nerve/superior branch
Action: Elevation of upper eyelid
Nerves of orbit

Motor
1. Oculomotor
2. Trochlear
3. Abducent

Sensory
1. Ophthalmic (General sensations)
2. Optic (Special sensations)

SO4LR6

Lacrimal
Frontal
Nasociliary

Optic canal
superior orbital fissure
The tendinous ring surrounds the optic canal and the medial margin of superior orbital fissure.
Nerves of orbit

Live
Free
To
See
No
Insult
At All

Lacrimal nerve
Frontal nerve
Trochlear nerve
Superior division of the oculomotor
Nasociliary nerve
Inferior division of the oculomotor
Abducens nerve
Optic nerve
Ophthalmic artery
enter the orbit via the optic canal, and so lie within the common tendinous ring.

Superior and inferior divisions of the oculomotor nerve
Nasociliary branch of the ophthalmic nerve
Abducens nerve
also enter the orbit within the common tendinous ring, but they do so via the superior orbital fissure.
Lie outside the common tendinous ring

Trochlear nerve
Frontal branch of ophthalmic nerve
Lacrimal branch of ophthalmic nerve
Superior ophthalmic vein

all enter the orbit through the **superior orbital fissure** but lie **outside** the common tendinous ring
Structures which enter the orbit through the *inferior orbital fissure* lie outside the common tendinous ring.

The close anatomical relationship of the optic nerve and other cranial nerves at the orbital apex means that lesions in this region may lead to a combination of visual loss from optic neuropathy and ophthalmoplegia from multiple cranial nerve involvement.
The **intrinsic** muscles include

- **CILIARY MUSCLE**
- **SPHINCTER PUPILLAE**
- **DILATOR PUPILLAE**

**Ciliary muscle**: Controls shape of lens; in accommodation, makes lens more globular

Supplied by Parasympathetic via oculomotor nerve

- **Sphincter pupillae**: Constricts pupil
- **Iris** (two muscles)
  - Sphincter pupillae
  - Dilator pupillae
- **Dilator pupillae**: Dilates pupil
Intrinsic Eye Muscles and their response to light

- **Bright light**: Circular muscles contract.
- **Normal light**: Pupil.
- **Dim light**: Radial muscles contract.

Anterior views
At the apex of petrous bone, the free border crosses over the attached border.

At this point, the third and fourth cranial nerves pass forward to enter the lateral wall of the cavernous sinus.
Epidural Hemorrhage May Cause Temporal Lobe Herniation
Remember that the dura is a tough structure and its tentorium as well, thus one should think about it as a real septa.

Any intracranial mass inside the skull (tumor, bleeding…) may force its neighboring structures to herniate.

Compression of oculomotor nerve (III) is the first clinical sign of ipsilateral pupil dilation since the parasympathetic fibers that supply the constrictor pupil are located on the outside of the nerve and are inactivated first by compression.
Note: venous communication (via the ophthalmic veins) between the **facial vein** and the **cavernous sinus**.
**Cavernous sinus syndrome**

- Sepsis from the central portion of the face or paranasal sinuses

Clinical manifestations:
- Ophthalmoplegia with diminished pupillary light reflexes
- Venous congestion leading to periorbital edema
- Exophthalmos
- Pain or numbness of the face

Subsequent infection or inflammation in the cavernous sinus can result in damage to any of the cranial nerves that pass through it
Exophthalmos is a bulging of the eye anteriorly out of the orbit.

Ophthalmoplegia is the paralysis or weakness of the eye muscles.
Eyelids

- The eyelids (act like the curtains) protect the eye from injury and excessive light by their closure.

- The upper eyelid is larger and more mobile than the lower because of its attachment to the levator palpebrae superioris.

- The upper and lower eyelids meet each other at the medial and lateral angles.

- The palpebral fissure is the space between the eyelids when they are open.

  - The palpebral fissure is the entrance into the conjunctival sac.
The layers of the eyelids: (from anterior to posterior)

1. Skin
2. Subcutaneous tissue
3. Voluntary muscle
4. The orbital septum (tarsus)
5. Conjunctiva
1-Skin and subcutaneous tissue:
   - Thin
   - Only a thin layer of connective tissue (can be easily become oedematous (with fluid or blood))

Contains:
- The **sebaceous glands (glands of Zeis)** open directly into the eyelash follicles
- The **ciliary glands (glands of Moll)** are modified **sweat glands** that open separately between adjacent lashes
2- Voluntary muscle
Palpebral part of orbicularis oculi
4- Orbital septum (Palpebral fascia)
An extension of periosteum into both the upper and lower eyelids from the orbital margin

The orbital septum is thickened at the margins of the lids to form **the superior and inferior tarsal plates**

The lateral ends of the tarsal plates are attached by a band, **the lateral palpebral ligament**, to the orbital margin

The medial ends of the plates are attached by a band, **the medial palpebral ligament**, to the orbital margin.

Tarsus provides major support for each eyelid
The **tarsal glands** are long, modified sebaceous glands that pour their oily secretion onto the free margin of the lid; their openings lie behind the eyelashes.

- This oily material prevents the overflow of tears and helps make the closed eyelids airtight.

(Meibomian gland)
5-The conjunctiva
Is a thin mucous membrane that lines the eyelids

- It is reflected at the superior and inferior fornices onto the outer surface of the eyeball (sclera)
The eyelids are closed by:
1-The contraction of the orbicularis oculi and
2-The relaxation of the levator palpebrae superioris muscles in the upper eyelids

The upper eyelid is elevated by:
THE LEVATOR PALPEBRAE SUPERIORIS
Levator palpebrae superioris

**Origin:** posterior part of the roof of the orbit

**Insertion:** anterior surface of superior tarsus with some fibers attaching to the skin of upper eyelid

**Nerve supply:** oculomotor nerve/ superior division
There is a collection of smooth muscle fibers insert into the upper edge of the superior tarsus (superior tarsal muscle).

**Superior tarsal muscle** which is part of the levator palpebrae superioris, helps maintain upper eyelid elevation and are innervated by postganglionic sympathetic fibers from the superior cervical ganglion.

Loss of oculomotor nerve [III] function results in **complete ptosis or drooping of the upper eyelid**, whereas loss of sympathetic innervation to the superior tarsal muscle results in **partial ptosis**.
Horner's syndrome is caused by a lesion in the sympathetic trunk in the neck that results in sympathetic dysfunction. It is characterized by three typical features:

1-**Pupillary constriction** due to paralysis of the dilator pupillae muscle

2- **Partial ptosis** (drooping of the upper eyelid) due to paralysis of the superior tarsal muscle of the levator palpebrae superioris

3- **Absence of sweating** on the ipsilaterial side of the face and the neck due to absence of innervation of the sweat glands
The spaces between the main structures of the orbit are occupied by fat. The fat helps to stabilize the position of the eyeball and also acts as a socket within which the eye can rotate.

Conditions resulting in an increased overall volume of orbital fat, e.g. hyperthyroidism ( Graves’ disease), may lead to forward protrusion of the eyeball, exophthalmos.
Sensory nerve supply of upper eyelid:

- Infratrochlear nerve
- Supratrochlear nerve
- Supra-orbital nerve
- Lacrimal nerve
- Infra-orbital nerve
Lacrimal apparatus

- Tendon of levator palpebrae superioris muscle
- Lacrimal gland
- Lacrimal canaliculi
- Lacrimal sac
- Puncta
- Nasolacrimal duct
Sensory: The lacrimal nerve (ophthalmic nerve)
Parasympathetic: The greater petrosal nerve (facial nerve)
Sympathetic (postganglionic fibers): originate from the superior cervical ganglion
Foramen lacerum

Has an anterior opening for the pterygoid canal
And a posterior opening for the carotid canal
Lacrimal nerve is joined by a branch of the zygomaticotemporal nerve (parasympathetic to lacrimal gland)
The parasympathetic secretomotor nerve supply is derived from the facial nerve.

1. Greater petrosal nerve (a branch of the facial nerve) which carries the preganglionic parasympathetic fibers.

2. Greater petrosal nerve joins the deep petrosal nerve to form the nerve of the pterygoid canal (vidian nerve) (at foramen Lacerum).

3. Nerve to pterygoid canal passes through the pterygoid canal to the pterygopalatine ganglion.

4. Postganglionic parasympathetic fibers join the maxillary nerve.

5. They then pass into its zygomatic branch and the zygomaticotemporal nerve.

6. Finally the lacrimal nerve.
The sympathetic postganglionic fibers are derived from the internal carotid plexus.

6- Finally the lacrimal nerve

5- They then pass into its zygomatic branch and the zygomaticotemporal nerve.

4- Postganglionic sympathetic fibers join the maxillary nerve.

3- Nerve to pterygoid canal passes through the pterygoid canal to the pterygopalatine ganglion.

1- Deep petrosal nerve contains postganglionic sympathetic fibers from the internal carotid plexus (superior cervical ganglion).

2- Deep petrosal nerve joins the Greater petrosal nerve to form the nerve of the pterygoid canal (vidian nerve) (at foramen Lacerum).
**Optic Nerve**
- The optic nerve enters the orbit from the middle cranial fossa by passing through the **optic canal**
- It is accompanied by the **ophthalmic artery**
- The nerve is surrounded by sheaths of pia mater, arachnoid mater, and dura mater
- It pierces the sclera at the posterior pole of the eyeball (optic disc)

Remember that the meninges fuse with the sclera so that the subarachnoid space with its contained cerebrospinal fluid extends forward from the middle cranial fossa, around the optic nerve, and through the optic canal, as far as the eyeball. Thus, the subarachnoid space extends around the optic nerve as far as the eyeball. A rise in pressure of the cerebrospinal fluid within the cranial cavity therefore is transmitted to the back of the eyeball.
Papilledema

A swollen optic disc caused by increased intracranial pressure

Can be seen when retina is examined using an Ophthalmoscope

Any increase in intracranial pressure results in increased pressure in the subarachnoid space surrounding the optic nerve

Optic disc: the point of exit of the optic nerve, lacking visual receptors (blind spot)
Lacrimal Nerve

The lacrimal nerve arises from the ophthalmic division of the trigeminal nerve.

It enters the orbit through **the superior orbital fissure**.

It is joined by a branch of the zygomaticotemporal nerve (parasympathetic to lacrimal gland).
Frontal Nerve

The frontal nerve arises from the ophthalmic division of the trigeminal nerve.

It enters the orbit through the **superior orbital fissure**.

It divides into the supratrochlear and supraorbital nerves that wind around the upper margin of the orbital cavity to supply the skin of the forehead.
The nasociliary nerve arises from the ophthalmic division of the trigeminal nerve. It enters the orbit through the **superior orbital fissure**.
Branches of the Nasociliary Nerve

1- **The communicating branch to the ciliary ganglion** is a sensory nerve. The sensory fibers from the eyeball pass to the ciliary ganglion via the short ciliary nerves without interruption, and then join the nasociliary nerve by means of the communicating branch.

2- **The long ciliary nerves**, two or three in number, arise from the nasociliary nerve as it crosses the optic nerve. They contain sympathetic fibers for the dilator pupillae muscle. The nerves pass forward with the short ciliary nerves and pierce the sclera of the eyeball. They continue forward between the sclera and the choroid to reach the iris.

3- **The posterior ethmoidal nerve** supplies the ethmoidal and sphenoidal air sinuses

4- **The infratrochlear nerve** supplies the skin of the medial part of the upper eyelid and the adjacent part of the nose

5- **The anterior ethmoidal nerve** passes through the anterior ethmoidal foramen. After supplying an area of mucous membrane in the nasal cavity, it appears on the face as the external nasal nerve at the lower border of the nasal bone, and supplies the skin of the nose down as far as the tip
Branches of the Nasociliary Nerve

1- The communicating branch to the ciliary ganglion
2- Posterior ethmoidal nerve
3- Anterior ethmoidal nerve
4- Infracrochlear nerve
5- Long ciliary nerves
The trochlear nerve enters the orbit through the superior orbital fissure. It supplies the superior oblique muscle.
Abducent nerve

The abducent nerve enters the orbit through the superior orbital fissure. It supplies the lateral rectus muscle.
The superior division of the oculomotor nerve enters the orbit through the superior orbital fissure.
- It supplies **superior rectus** and **levator palpebrae superioris**.

The inferior division of the oculomotor nerve enters the orbit through the superior orbital fissure.
- It supplies **inferior rectus**, **medial rectus**, **and** **inferior oblique** muscles.
- The nerve to the inferior oblique gives off a branch that passes to the **ciliary ganglion** and carries parasympathetic fibers to the **sphincter pupillae** and the **ciliary muscle**.
Ciliary Ganglion

- Is a parasympathetic ganglion
- About the size of a pinhead and situated in the posterior part of the orbit.
- It receives its preganglionic parasympathetic fibers from the oculomotor nerve via the nerve to the inferior oblique muscle.

The postganglionic fibers leave the ganglion in the short ciliary nerves, which enter the back of the eyeball and supply the sphincter pupillae and the ciliary muscle.

It receives its postganglionic sympathetic fibers from the internal carotid sympathetic plexus (superior cervical ganglion) and run through the ganglion without interruption.
Parasympathetic ganglia in the head

- Ciliary ganglion
- Ophthalmic nerve [V₁]
- Oculomotor nerve [III]
- Trigeminal nerve [V]
- Mandibular nerve [V₃]
- Facial nerve [VII]
- Vagus nerve [X]
- Pterygopalatine ganglion
- Otic ganglion
- Glossopharyngeal nerve [IX]
- Submandibular ganglion

**Legend:**
- Preganglionic parasympathetic fibers
- Postganglionic parasympathetic fibers
Long ciliary nerve

Short ciliary nerve

1- Constrictor pupillary ms
2- Ciliary ms

Dilator pupillary ms

General sensation from eyeball

Brain stem

Oculomotor nerve

Postganglionic parasympathetic

Sympathetic plexus around ICA

Superior division

Inferior division

Preganglionic parasympathetic

Sensory communicating branch

Nasociliary

Long ciliary nerve

Frontal

Lacrimal

Brain stem

V1

V2

V3

Trigeminal nerve

V1

V2

V3
Ophthalmic Artery

- Is a branch of the internal carotid artery
- It enters the orbit through the optic canal with the optic nerve
- It gives off numerous branches, which accompany the nerves in the orbital cavity

Branches of the Ophthalmic Artery:

The central artery of the retina is a small branch that pierces the meningeal sheaths of the optic nerve to gain entrance to the nerve
- It runs in the substance of the optic nerve and enters the eyeball at the center of the optic disc. Here, it divides into branches, which may be studied in a patient through an ophthalmoscope.
The central artery of the retina
Occlusion of central artery of retina results in blindness

The central artery of the retina
**Ophthalmic Veins**

**Superior ophthalmic vein**
- Communicates in front with the facial vein
- Leaves the orbit through the superior orbital fissure and enters the cavernous sinus

**Inferior ophthalmic vein**
- Leaves the orbit by:
  1. Joining the superior ophthalmic vein
  2. Passing through the superior orbital fissure on its own to join the cavernous sinus
  3. Passing through the inferior orbital fissure to join with pterygoid venous plexus.
Pterygoid venous plexus

Facial vein

Superior ophthalmic vein

Cavernous sinus

Inferior ophthalmic vein

deep facial vein

Inferior ophthalmic vein