Orbit & Lacrimal Apparatus

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Atlas of Human Anatomy
By Frank Netter

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By Richard Drake, Wayne Vogl & Adam Mitchell

Essential of Human Anatomy & Physiology
By Elaine Marieb and Suzanne Keller
Topics

1. ORBIT
2. MUSCLES OF ORBIT
3. LACRIMAL APPARATUS
ORBIT
The bony orbits (Sometimes called eye sockets) are bilateral and symmetrical cavities in the head.

- They enclose the eyeball and its associated structures.
- The orbit can be thought of as a pyramidal structure, with the **apex** pointing posteriorly and the **base** situated anteriorly.
- The boundaries of the orbit are formed by six bones.
- **Roof (superior wall)**: Formed by the frontal bone and the lesser wing of the sphenoid. The frontal bone separates the orbit from the anterior cranial fossa.
- **Floor (inferior wall)**: Formed by the maxilla, palatine and zygomatic bones. The maxilla separates the orbit from the underlying maxillary sinus.
- **Medial wall**: Formed by the ethmoid, maxilla, lacrimal and sphenoid bones. The ethmoid bone separates the orbit from the ethmoid sinus.
- **Lateral wall**: Formed by the zygomatic bone and greater wing of the sphenoid.
- **Apex**: Located at the opening to the optic canal, the optic foramen.
- **Base**: Opens out into the face and is bounded by the eyelids. It is also known as the o
- **Eyeball** and related structures.
- **Extraocular muscles**: These muscles are separate from the eye. They are responsible for the movement of the eyeball and superior eyelid.
- **Eyelids**: These cover the orbits anteriorly.
- **Nerve**: Several cranial nerves supply the eye and its structures. Those are optic, oculomotor, trochlear, trigeminal and abducens nerves.
- **Blood vessels**: The eye receives blood primarily from the ophthalmic artery. Venous drainage is via the superior and inferior ophthalmic veins.
- **Orbital fat**: it fill any space within the orbit that is not occupied. This tissue cushions the eye and stabilizes the extraocular muscles.
There are **three** main pathways by which structures can enter and leave the orbit:

- **Optic canal** transmits the optic nerve and ophthalmic artery.
- **Superior orbital fissure** transmits the lacrimal, frontal, trochlear (CN IV), oculomotor (CN III), nasociliary and abducens (CN VI) nerves. It also carries the superior ophthalmic vein.
- **Inferior orbital fissure** transmits the maxillary nerve (a branch of CN V), the inferior ophthalmic vein, and sympathetic nerves.

There are **other** minor openings into the orbital cavity.

- **Nasolacrimal canal** which drains tears from the eye to the nasal cavity, is located on the medial wall of the orbit.
- **Other small openings** include the supraorbital foramen and infraorbital canal which carry small neurovascular structures.
Bony orbit fractures

- It is a fracture of the bones forming the outer rim of the bony orbit.
- It usually occurs at the sutures joining the three bones of the orbital rim – the maxilla, zygomatic and frontal.
- Any fracture of the orbit will result in infraorbital pressure, raising the pressure in the orbit, causing exophthalmos (protrusion of the eye).
- There may also be involvement of surrounding structures.
  - Example: hemorrhage into one of the neighboring sinuses.
Eyelids

- The eyelids are thin, mobile folds that cover the eyeball anteriorly.
- They offer protection from excessive light or injury and maintain lubrication by distributing tears over the surface of the eyeball.
- The eyelids are split into upper and lower portions, which meet at the medial and lateral canthi of the eye.
- The opening between the two eyelids is called the palpebral opening.
Eyelids layers

- The skin and subcutaneous tissue form the most superficial layer of the eyelid.
- The layer of skin is among the thinnest in the human body.
- In the subcutaneous layer, there is loose connective tissue but no subcutaneous fat.
- The eyelashes are attached here with their accompanying modified sweat glands.
- The eyelid consists of five main layers (superficial to deep):
  - Skin and subcutaneous tissue
  - Orbicularis oculi
  - Tarsal plates
  - Levator apparatus
  - Conjunctiva
The eyelid has a rich arterial supply from numerous vessels:

- **Ophthalmic artery**: lacrimal, medial palpebral, supraorbital and supratrochlear arteries.
- **Facial artery**: angular branch.
- **Superficial temporal artery**: transverse facial artery branch.

Venous drainage is provided by a rich network around the eyelid:

- Medially, medial palpebral vein into the **angular and ophthalmic veins**.
- Laterally, blood drains into the **superficial temporal vein from the lateral palpebral vein**.

**Blood vessels**

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Innervation

- Sensory innervation to the eyelids is supplied by branches of the trigeminal nerve:
  - **Ophthalmic nerve (V1)**: supraorbital, supratrochlear, infratrochlear and lacrimal branches.
  - **Maxillary nerve (V2)**: infraorbital branch.

- The motor innervation to the muscles of the eyelid is via:
  - **facial nerve** (orbicularis oculi)
  - **oculomotor nerve** (levator palpebrae superioris)
  - **sympathetic fibers** (superior tarsal muscle)
MUSCLES OF ORBIT
Muscles of orbit

- The extraocular muscles are located within the orbit but are extrinsic and separate from the eyeball itself.
- They act to control the movements of the eyeball and the superior eyelid.
- There are seven extraocular muscles:
  - levator palpebrae superioris
  - superior rectus
  - inferior rectus
  - medial rectus
  - lateral rectus
  - inferior oblique
  - superior oblique
- Functionally, they can be divided into two groups:
  - responsible for eye movement: Recti and oblique muscles.
  - responsible for superior eyelid: levator palpebrae superioris
The only muscle involved in raising the superior eyelid.

It has a small portion contains a collection of smooth muscle fibers called **superior tarsal muscle**.

It originates on the lesser wing of the sphenoid bone just above the optic foramen.

It broadens and decreases in thickness (becomes thinner) and then becomes the levator aponeurosis.

This portion inserts on the skin of the upper eyelid, as well as the superior tarsal plate.

**Action:** It elevates and retracts the upper eyelid.

**Innervation:** Oculomotor nerve.
There are four recti muscles:
- superior rectus
- inferior rectus
- medial rectus
- lateral rectus

These muscles originate from the common tendinous ring of fibrous tissue, which surrounds the optic canal at the back of the orbit.

From their origin, the muscles pass anteriorly to attach to the sclera of the eyeball.

The name recti is derived from the Latin for ‘straight’ – this represents the fact that the recti muscles have a direct path from origin to attachment.

This in contrast with oblique eye muscles which have an angular approach to the eyeball.

**Recti muscles**
**Superior rectus**

- **Attachments:** Originates from the superior part of the common tendinous ring and attaches to the superior and anterior aspect of the sclera.
- **Actions:** Main movement is elevation. Also contributes to adduction and medial rotation of the eyeball.
- **Innervation:** Oculomotor nerve.
**Inferior rectus**

- **Attachments**: Originates from the inferior part of the common tendinous ring and attaches to the inferior and anterior aspect of the sclera.
- **Actions**: Main movement is depression. Also contributes to adduction and lateral rotation of the eyeball.
- **Innervation**: Oculomotor nerve.
Medial rectus

- **Attachments:** Originates from the medial part of the common tendinous ring and attaches to the anterio-medial aspect of the sclera.
- **Actions:** Adducts the eyeball.
- **Innervation:** Oculomotor nerve.
**Lateral rectus**

- **Attachments:** Originates from the lateral part of the common tendinous ring and attaches to the anterio-lateral aspect of the sclera.
- **Actions:** Abducts the eyeball.
- **Innervation:** Abducens nerve.
There are two oblique muscles:
  - superior oblique.
  - inferior oblique.

Unlike the recti group of muscles, oblique muscles do not originate from the common tendinous ring.

From their origin, the oblique muscles take an angular approach to the eyeball (in contrast to the straight approach of the recti muscles).

They attach to the posterior surface of the sclera.

**Oblique muscles**
- **Attachments:** Originates from the body of the sphenoid bone. Its tendon passes through a trochlear, and then attaches to the sclera of the eye, posterior to the superior rectus.
- **Actions:** Depresses, abducts and medially rotates the eyeball.
- **Innervation:** Trochlear nerve

**Superior oblique**
- **Attachments:** Originates from the anterior aspect of the orbital floor. Attaches to the sclera of the eye, posterior to the lateral rectus.
- **Actions:** Elevates, abducts and laterally rotates the eyeball.
- **Innervation:** Oculomotor nerve
Cranial nerves palsies

- The extraocular muscles are innervated by three cranial nerves.
- Damage to one of the cranial nerves will cause paralysis of its respective muscles.
- This will alter the resting gaze of the affected eye.
- Thus, a lesion of each cranial nerve has its own characteristic appearance:
  - **Oculomotor nerve**: A lesion of this nerve affects most of the extraocular muscles. The affected eye is displaced laterally by the lateral rectus and inferiorly by the superior oblique. The eye adopts a position known as **down and out**.
  - **Trochlear nerve**: A lesion of this nerve will paralyze the superior oblique muscle. There is no obvious affect of the resting orientation of the eyeball. However, the patient will complain of diplopia (double vision) and may develop a head tilt away from the site of the lesion.
  - **Abducens nerve**: A lesion of this nerve will paralyze the lateral rectus muscle. The affected eye will be adducted by the resting tone of the medial rectus.
Intrinsic muscles

- **Iris Sphincter (Sphincter Pupillae)**
  - **Nerve supply:** Parasympathetic fibers from oculomotor nerve, via nerve to inferior oblique after relay in ciliary ganglion, postganglionic fibers pass to eyeball via short ciliary nerves.
  - **Action:** constricts the pupil in bright light and in accommodation.

- **Dilator Pupillae**
  - **Nerve supply:** Sympathetic fibers via long ciliary nerves.
  - **Action:** dilates the pupil in dim light and in excessive sympathetic activity as in fright.

- **Ciliary muscle**
  - Smooth muscle in the ciliary body.
  - **Nerve supply:** Parasympathetic from oculomotor.
  - **Action:** accommodation by making the lens more convex.
Blood supply of orbit

- The main arterial supply to the lacrimal gland is from the lacrimal artery, which is derived from the ophthalmic artery – a branch of the internal carotid.
- Venous drainage is via the superior ophthalmic vein, and ultimately empties into the cavernous sinus.
- Lymphatic drainage is to the superficial parotid lymph nodes. They empty into the superior deep cervical nodes.
- It is a branch of **internal carotid artery**.
- It passes through optic canal, below optic nerve & within the common tendinous ring.
- It lies below then lateral then superior to optic nerve.
- It runs close to medial wall of orbit close to its roof, where it divides into supratrochlear & dorsal nasal arteries.
- **Branches:**
  - Central artery of retina
  - Lacrimal artery.
  - Long post ciliary artery
  - Short post ciliary artery
  - Post ethmoidal artery
  - Ant ethmoidal artery
  - Supraorbital artery
  - Medial palpebral artery
Ophthalmic Vein

- It has two branches:
  - Superior Ophthalmic Vein
  - Inferior Ophthalmic Vein
- They pass through the superior orbital fissure to end in the cavernous sinus.
- They communicate with veins of the face & pterygoid plexus of veins through Inferior orbital fissure.
Innervation of orbit

- **Sensory Nerves**
  - Optic nerve
  - Branches from ophthalmic division of trigeminal nerve

- **Motor Nerves**
  - Occulomotor nerve
  - Trochlear nerve
  - Abducent nerve

- Please note that the **maxillary nerve** passes through the **inferior orbital fissure**, enters into the groove in floor of the orbit.

- Then continues as **infraorbital nerve**.

- Exits through **infraorbital foramen** and supplies the skin of the face.

- It does not supply any of the orbital contents though.
Optic nerve

- It located in the back of the eye.
- It is the 2\textsuperscript{nd} cranial nerve.
- It carries the transmission of special sensory information from the retina of the eye to the primary visual cortex of the brain.
- It arises from retina and pierces the posterior surface of the sclera.
- It passes through the optic canal.
- It accompanied by the ophthalmic artery that lies below it.
- It surrounded by meninges and subarachnoid space containing CSF.
- It runs forward & laterally within the cone of the recti muscles.
- It is the smallest of the three divisions of the *trigeminal nerve*.
- It runs in the lateral wall of the *cavernous sinus* and divides into:
  - Lacrimal nerve
  - Frontal nerve
  - Nasociliary nerve
- It enters the orbit through the *superior orbital fissure*.

**Ophthalmic nerve**
Lacrimal nerve

- One of the terminal branches of Ophthalmic nerve.
- It enters orbit through the **superior orbital fissure** outside the tendinous ring.
- It passes above lateral rectus to enter lacrimal gland.
- It provides sensory fibers to:
  - Lacrimal gland
  - Skin of the lateral part of the upper eyelid
- Please note that the **zygomatic nerve** of the maxillary is connected to the lacrimal nerve to carry autonomic fibers (sympathetic and parasympathetic) fibers to the lacrimal gland.
- One of the terminal branches of Ophthalmic nerve.
- It enters the orbit through the **superior orbital fissure**, outside the tendinous ring.
- It runs over the **levator palpebrae superioris**.
- It divides into:
  - **Supratrochlear Nerve**: supplies skin of forehead & scalp.
  - **Supraorbital Nerve**: supplies skin of forehead & scalp.
Nasociliary nerve

- One of the terminal branches of Ophthalmic nerve.
- It enters the orbit through the superior orbital fissure, within the tendinous ring.
- It crosses above the optic nerve with the ophthalmic artery, to reach the medial wall of the orbit.
- It runs along the upper margin of the medial rectus, and ends by dividing into:
  - anterior ethmoidal nerve
  - infratrochlear nerve
Oculomotor nerve

- It divides into superior and inferior divisions before entering the orbit.
- Both enter the orbit through the superior orbital fissure within the tendinous ring.
- Superior division supplies:
  - Superior rectus
  - Levator Palpebrae superioris
- Inferior division supplies:
  - Inferior rectus
  - Inferior oblique
  - Medial rectus
- Please note that the nerve to inferior oblique gives off preganglionic fibers to ciliary ganglion and carries parasympathetic fibers to the sphincter pupillae & ciliary muscles, via short ciliary nerves.
Trochlear nerve

- It enters orbit through the **superior orbital fissure** outside the tendinous ring.
- It supplies **superior oblique muscle**.
- Lesion of this nerve results in **diplopia** on looking down, and inability to look infero-laterally.
- Thus, the eye deviates; upward and slightly inward.
- The effected person will have difficulty in walking downstairs.
- It enters orbit through the **superior orbital fissure** within the tendinous ring.
- It runs forward on the deeper surface of the **lateral rectus muscle** to supplies it.
- Lesion of this nerve leads to **diplopia** & **medial squint**.

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**Abducent nerve**

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- A parasympathetic ganglion.
- Located in the upper part of the orbit, lateral to the optic nerve.
- Afferent (preganglionic) fibers: Carried by the oculomotor nerve, reach the ganglion via the nerve to the inferior oblique.
- Efferent (postganglionic) fibers: Carried by the short ciliary nerves to supply the constrictor pupillae and ciliary muscle.
Summary
LACRIMAL APPARATUS
The lacrimal apparatus is the system responsible for the drainage of lacrimal fluid from the orbit.

After secretion, lacrimal fluid circulates across the eye, and accumulates in the lacrimal lake – located in the medial canthus of the eye.

From here, it drains into the lacrimal sac via a series of canals.

The lacrimal sac is the dilated end of the nasolacrimal duct and is located in a groove formed by the lacrimal bone and frontal process of the maxilla.

Lacrimal fluid drains down the nasolacrimal duct and empties into the inferior meatus of the nasal cavity.
The lacrimal glands are serous type exocrine glands that secrete lacrimal fluid onto the surfaces of the conjunctiva and cornea of the eye.

- Lacrimal fluid acts to clean, nourish and lubricate the eyes.
- It forms tears when produced in excess.
- It is located anteriorly in the superolateral aspect of the orbit, within the lacrimal fossa – a depression in the orbital plate of the frontal bone.

Its anatomical relations include:

- Superior: zygomatic process of frontal bone
- Anterior: orbital septum
- Posterior: orbital fat
- Inferolateral: lateral rectus muscle
The lacrimal gland can be divided into two main parts:

- **Orbital**: larger and sits on the lateral margin of the levator palpebrae superioris muscle.
- **Palpebral**: smaller and is located along the inner surface of the eyelid.

- The lacrimal gland is a compound tubuloacinar gland, comprised of lobules – which are formed by multiple acini.

- The acini contain serous cells and produce a watery serous secretion (lacrimal fluid).

- The lacrimal fluid produced by the gland is secreted into excretory ducts, which empty into the superior conjunctival fornix.

- The fluid is then spread over the cornea by the process of blinking.
The sensory innervation to the lacrimal gland is via the lacrimal nerve, a branch of the ophthalmic nerve.

It also receives autonomic nerve fibers:

**Parasympathetic:**
- Preganglionic fibers are carried in the greater petrosal nerve (branch of the facial nerve) and then the nerve of pterygoid canal, before synapsing at the pterygopalatine ganglion.
- Postganglionic fibers travel with the maxillary nerve, and finally the zygomatic nerve.
- Stimulates fluid secretion from the lacrimal gland

**Sympathetic**
- Fibers originate from the superior cervical ganglion and are carried by the internal carotid plexus and deep petrosal nerve.
- They join with the parasympathetic fibers in the nerve of pterygoid canal and follow the same route to supply the gland.
- Inhibits fluid secretion from the lacrimal gland
Questions?

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