Unit 19: Orbit

Dissection Instructions:

The orbit is the bony cavity in the skull which contains the eyeball (bulb) and its muscles, nerves, blood vessels, glands and supporting connective tissues.

Demonstrate the following bony anatomy using a skull. The orbit (Plates 2; 7.36A) has four walls, an apex and a base, which opens on the face. The roof is formed by the orbital plate of the frontal bone and lesser wing of the sphenoid bone and also serves as the floor of the anterior cranial fossa. The floor is formed by the maxilla, zygomatic bone and orbital process of the palatine bone and also serves as the roof of the maxillary sinus. The medial wall is in a sagittal plane and is formed by the frontal process of the maxilla, lacrimal, orbital plate of the ethmoid and body of the sphenoid. The lateral wall is at a 45° angle from the medial wall and is formed by the greater wing of the sphenoid and frontal process of the zygomatic bone. The axis of the orbit is about 23° from the anterior-posterior axis of the eyeball, which is important when considering the function of the superior and inferior rectus muscles. The orbital rim or base is formed by three bones, the frontal, zygomatic and maxillary.

There are several apertures, fossae and grooves which are related to soft tissues in the orbit. The optic foramen is posterior and medial in position and transmits the optic nerve and ophthalmic artery. The superior orbital fissure is lateral to the optic foramen and transmits the oculomotor, trochlear, ophthalmic division of the trigeminal and abducens cranial nerves and the ophthalmic veins. The inferior orbital fissure is posterior, lateral and inferior, and transmits the infraorbital and zygomatic nerves and vessels. The lacrimal fossa is anterior, lateral and superior and relates to the lacrimal gland. The trochlear fossa is anterior, medial and superior and is for the attachment of the trochlea (pulley) for the superior oblique muscle. The infraorbital groove, canal and foramen are related to the floor of the orbit and are named for their location and for the nerves and vessels they contain. The groove for the lacrimal sac and the nasolacrimal canal for the nasolacrimal duct extend from the anteromedial aspect of the orbit to the inferior meatus of the nasal cavity. The groove for the lacrimal sac is between the anterior and posterior ethmoidal crests. In the medial wall above the ethmoid are the anterior and posterior ethmoidal foramina for nerves and vessels of the same name.

The orbit should be dissected from the anterior approach on one side and the superior approach on the other.

A. Anterior approach

Carefully remove any remaining skin from the eyelids (palpebrae) and review the orbicularis oculi muscle and its nerve supply (Plates 22; 7.7, 7.9A, Table 7.1 and figures-p. 603). The muscle closes the palpebral fissure (the opening between the upper and lower eyelids) and is innervated by zygomatic branches of the facial nerve. Review the lacrimal, supraorbital, supratrochlear, infra-trochlear and infraorbital nerves and vessels which supply the eyelids and surrounding tissues. All these nerves belong to the ophthalmic or maxillary divisions of the trigeminal nerve and have their cell bodies in the trigeminal ganglion. The vessels are branches of the ophthalmic vessels.

Locate the lacrimal papillae on the margins of the palpebral fissure adjacent to the medial canthus (medial angle of the eye). Each papilla has a small punctum (hole) at its tip. The puncta are the beginnings of the lacrimal canaliculi which carry tears from the lacus lacrimali (lacrimal lake) to the lacrimal sac. Attempt to demonstrate the canaliculi and lacrimal sac (Plates 77, 78; 7.37A-C).
Notice that the eyelashes exit the eyelids immediately anterior to the openings of the tarsal glands (Plates 77; 7.39B). Look at the deep surface of the tarsal plates to see the tarsal glands. The tarsal glands secrete an oily substance onto the rim of the palpebral fissure which seals the palpebral fissure when it is closed and repels tears from spilling over the palpebral rim. An infection of a tarsal gland is called a sty.

The conjunctival sac (Plates 78; 7.37) is the space between the eyelids and the bulb. It is open at the palpebral fissure and is lined by the conjunctival membrane. That portion of the conjunctival membrane on the eyelid is the palpebral conjunctiva and that part on the bulb is the bulbar conjunctiva. In the medial angle (canthus) of the eye are the lacrimal caruncle and the semilunar fold.

The skeleton of the eyelids attaches to the orbital rim and consists of the tarsal plates, medial and lateral palpebral ligaments and orbital septum (Plates 77, 81; 7.10, 7.39). They form a septum which closes the orbit anteriorly except for the palpebral fissure. The tarsal plates consist of dense connective tissue, the inferior one being about half the size of the superior one. They should now be cleaned but do not destroy the lacrimal canaliculi.

The lateral and medial palpebral ligaments (Plates 77; 7.10B) anchor the tarsal plates to the orbital rim. Note that the medial palpebral ligament attaches to the anterior lacrimal crest and thus is anterior to the lacrimal sac. Note also that some of the fibers of theorbicularis oculi muscle pass deep to the medial palpebral ligament, attaching to the fascia covering the lacrimal sac and also to the posterior lacrimal crest. The muscle can therefore pull on the fascia, decreasing the pressure in the lacrimal sac, and aid in the flow of tears. The orbital septum extends from the orbital rim to the tarsal plates. It is relatively delicate and is perforated by nerves and blood vessels.

Incise the orbital septum at its superior lateral aspect and clean the lacrimal gland (Plates 77, 78, 80, 81; 7.45, 7.46a&b, 7.50 7.55). The gland is divided into superior (orbital) and inferior (palpebral) parts by the aponeurosis of the levator palpebrae superioris muscle. Ducts draining both parts of the lacrimal gland pass through the inferior part to empty into the superior fornix of the conjunctival sac. Blinking distributes the tears over the cornea, preventing it from drying. Tears accumulate in the lacus lacrimale until they are drained through the canaliculi to the lacrimal sac. The tears then drain into the inferior meatus of the nasal cavity through the nasolacrimal duct. The lacrimal gland is stimulated by postganglionic parasympathetic fibers whose cell bodies are in the pterygopalatine ganglion.

Incise the lower medial aspect of the orbital septum and locate the inferior oblique muscle (Plates 79, 80; 7.37 and 7.38 B). It arises near the medial inferior part of the orbital rim and passes inferior to the inferior rectus muscle to insert into the lateral aspect of the posterior hemisphere of the bulb. It elevates and abducts the pupil.

B. Superior approach

Strike the center of the orbital roof with a bone forceps and crack the bone. Carefully remove the bony roof, leaving the periorbita (periosteum lining the orbit) intact. Identify the frontal branch of the ophthalmic nerve through the periorbita so that it is not destroyed when the periorbita is removed (Plates 83; 7.38). Locate the frontal nerve, trochlear nerve, superior oblique muscle, levator palpebrae superioris muscle and lacrimal nerve. Clean the frontal nerve and notice that it branches into the supraorbital and supratrochlear nerves. As you clean the trochlear nerve, note that it travels superior to the levator palpebrae superioris muscle to reach the superior oblique muscle. Clean the superior oblique muscle and locate the trochlea (pulley) through which it passes (Plates 80-82; 7.37A, 7.38A-B, Tables 7.7 and 7.8 and figures-pp. 648 & 649). Do not clean its tendon at this time. It depresses and abducts the pupil.
Clean the **levator palpebrae superioris muscle**. It arises from the sphenoid bone and inserts into the upper eyelid, primarily to the upper border of the superior tarsal plate (Plates 77, 80, 82; 7.38, 7.39A-B, 7.74A). The levator palpebrae superioris muscle is also attached to the tarsal plate by the *tarsal muscle* (Plate 76; 7.52), which consists of smooth muscle and is innervated by sympathetic nerves. *Loss of sympathetic supply to the head causes ptosis (drooping of the upper eyelid).* As its name states, the levator palpebrae superioris elevates the upper eyelid. Transect the levator palpebrae superioris muscle at its mid-point and carefully lift its posterior half while looking for its nerve supply entering its deep surface. Clean the **superior rectus muscle** (Plates 80, 82; 7.38A, 7.39A&B). Its origin is from a common tendinous ring which serves all the rectus muscles. It inserts on the anterior superior area of the bulb and acts to elevate and adduct the pupil. Transect the superior rectus muscle at its mid-point after it has been cleaned. Elevate its posterior part to locate its nerve supply. Both the levator palpebrae superioris and superior rectus muscles are innervated by the **superior division of the oculomotor nerve** (Plates 115; 7.38A). Clean the tendon of the **superior oblique muscle** and note its insertion on the posterior, superior, lateral quadrant of the bulb. Follow the *lacrimal nerve* (Plates 82, 116; 7.38A-B, 7.39) to the lacrimal gland, looking for a communicating branch from the zygomatic nerve which contains the parasympathetic nerve fibers to the lacrimal gland.

Carefully pick away orbital fat and locate the **superior ophthalmic vein** (Plates 81; 7.40C). The main trunk of the ophthalmic vein should be cleaned, but its tributaries may be cut. Next, clean the *nasociliary nerve* and *ophthalmic artery*. These structures should cross superior to the optic nerve from lateral to medial. The *nasociliary nerve* (Plates 82, 116; 7.38A&B, 7.39) enters the orbit through the *superior orbital fissure* and common tendinous ring lateral to the oculomotor nerve. The *nasociliary nerve* is a branch of the ophthalmic division of the trigeminal nerve and therefore contains sensory nerve fibers whose cell bodies are in the trigeminal ganglion. As the nasociliary nerve is cleaned, preserve its branches. The nasociliary nerve passes medially between the superior and inferior divisions of the oculomotor nerve and gives off the sensory root of the ciliary ganglion. On its medial aspect will be the posterior and anterior ethmoidal branches and on its lateral aspect will be the **long ciliary nerves** going to the bulb. By direction, the apparent continuation of the nasociliary nerve is the *infratrochlear nerve*.

Clean the **ophthalmic artery and optic nerve** (Plates 81; Table 7.6 and figures-p 647). The ophthalmic artery should have branches to accompany all nerves in the orbit. The important central artery of the retina enters the optic nerve before entering the eyeball.

The **ciliary ganglion** (Plates 82, 115; 7.38B, 9.5) lies on the lateral side of the optic nerve in the posterior third of the orbit. Its motor root comes from the *inferior division of the oculomotor nerve* and it gives off several tiny **short ciliary nerves** which supply the bulb. The cell bodies in the ciliary ganglion are postganglionic parasympathetic neurons which cause constriction of the pupil and serve accommodation (focusing on near objects) by taking tension off the lens and allowing it to thicken. As we get older, the lens loses its elasticity and fails to thicken, making us far-sighted. A sympathetic root may also be seen entering the ciliary ganglion from the *superior orbital fissure*. The sympathetic fibers have their cell bodies in the *superior cervical ganglion*. The sensory fibers from the nasociliary nerve and the sympathetic fibers pass through the ciliary ganglion without synapsing. The **short ciliary nerves** contain postganglionic parasympathetic fibers, postganglionic sympathetic fibers and sensory fibers.

The **medial and lateral rectus muscles** should next be cleaned (Plates 79, 80; 7.38A-B, 7.40A, 7.74, 7.76, Table 7.7 and figures-pp. 648 & 649. Table 9.4 and figures-pp. 804 & 805). The former is innervated by the *inferior division of the oculomotor nerve* and the latter is innervated by the abducens nerve, which enters the orbit through the superior orbital fissure and common tendinous ring. The **medial and lateral rectus muscles** arise from the common tendinous ring and insert anteriorly on the respective sides of the bulb. The **medial rectus** is an adductor and the **lateral rectus** is an abductor of the bulb.
Now clean the inferior division of the oculomotor nerve and inferior rectus muscle Plates 82; 7.38B, 7.39A, 7.40A, Table 7.7 and figures-pp. 648 & 649). The inferior rectus muscle is a depressor and adductor of the bulb.

Note the fascia surrounding the bulb (Plates 79; 7.39B). This is the bulbar fascia and it continues a short distance like a short sleeve around each muscle that inserts on the bulb. Behind the medial and lateral palpebral ligaments, the fascial sleeves of the medial and lateral rectus muscles attach to the palpebral ligaments and adjacent parts of the orbital wall as check ligaments. The bulbar fascia is thickened inferior to the bulb and is called the suspensory ligament. It has been likened to a hammock.

The neuroreceptors for receiving light and converting it to nerve impulses are in the retina within the bulb. Impulses pass through the optic nerve to the central nervous system where the sense of vision is located. The bulb and its retina are protected by a number of reflexes.

The blink reflex is a response to touching or pain at the front of the orbit. The reflex may occur through stimulation of several branches of the ophthalmic or maxillary branches of the trigeminal nerve. Touching the skin of the upper eyelid would cause impulses to travel through the lacrimal nerve, supraorbital and/or supratrochlear branches of the frontal nerve, and/or the infratrochlear branch of the nasociliary nerve to the ophthalmic division of the trigeminal nerve. All fibers belonging to the ophthalmic division pass through the superior orbital fissure, wall of the cavernous sinus, trigeminal ganglion and sensory root of the trigeminal nerve to reach the central nervous system (Plates 78, 81; 7.51, 9.7). Touching the cornea would cause impulses to travel in the palpebral branches of the infraorbital nerve to the maxillary division of the trigeminal nerve. The fibers of the infraorbital nerve join the maxillary division in the pterygopalatine fossa, then pass through the foramen rotundum and wall of the cavernous sinus to reach the trigeminal ganglion. Touching the cornea would cause impulses to travel in the long and short ciliary nerves to the nasociliary branch of the ophthalmic division of the trigeminal nerve. The cell bodies of all the afferent nerve fibers of the blink reflex are in the trigeminal ganglion.

The efferent impulses of this reflex exit the pontomedullary junction of the central nervous system in the fibers of the facial nerve. The facial nerve passes through the internal acoustic meatus, facial canal, stylomastoid foramen, parotid gland, where the upper division and zygomatic branches carry impulses to the orbicularis oculi muscle. The cell bodies of these motor neurons are in a motor nucleus of the facial nerve inside the CNS.

Pain in the cornea, as from drying, causes lacrimation (formation of tears). The afferent limb of this reflex is the same as the blink reflex resulting from touching the cornea, but the efferent limb is different. Fibers of the preganglionic parasympathetic neurons, whose cell bodies are in the lacrimary portion of the superior salivatory nucleus of the facial nerve, leave the central nervous system through the nervous intermedius. The fibers enter the facial nerve in the internal acoustic meatus as it enters the facial canal. At the geniculate ganglion (no synapse), the fibers leave the facial nerve proper to form the greater petrosal nerve. This travels through the hiatus for the facial canal to the pterygoid canal. The deep petrosal and greater petrosal nerves form the nerve of the pterygoid canal. The preganglionic fibers synapse with the postganglionic fibers whose cell bodies are in the pterygopalatine ganglion in the pterygopalatine fossa. The impulses then travel in fibers which pass to the maxillary, zygomatic and lacrimal nerves to end in the lacrimal gland, causing it to increase secretion.

Bright light causes constriction of the pupil through the light reflex. When bright light reaches the retina, impulses travel in fibers which enter the optic nerve and pass through the optic foramen (canal) and optic chiasma to continue in the optic track to the back of the brainstem. The cell bodies of these fibers are in the retina.
The efferent limb of this reflex begins in preganglionic parasympathetic fibers whose cell bodies are in the Edinger-Westphal nucleus of the oculomotor nerve. They exit the mesencephalon and enter the wall of the cavernous sinus, pass through the superior orbital fissure and common tendinous ring in the inferior division of the oculomotor nerve and form the motor root of the ciliary ganglion. They synapse with the postganglionic neurons whose cell bodies make up the ciliary ganglion. The postganglionic fibers pass through short ciliary nerves to the eyeball and reach the sphincter of the pupil in the iris.

Dim light causes dilatation of the pupil by a reflex whose afferent limb is the same as above, but the efferent limb is through the sympathetic system rather than the parasympathetic system. The preganglionic sympathetic neurons are located in the intermediolateral gray matter in the upper thoracic spinal cord. The fibers exit through the ventral horn and pass through white communicating rami to the sympathetic chain where they travel up to the superior cervical ganglion to synapse with the postganglionic neurons. Postganglionic fibers pass through the carotid canal as the carotid plexus, then pass through the cavernous sinus, superior orbital fissure, ciliary ganglion (do not synapse), short ciliary nerves, and eyeball to reach the dilator muscle of the pupil in the iris. A recent report states that the sympathetic fibers may enter the orbit in the abducens nerve.

**Be sure to identify all of the following in this unit:**

- bones of orbit
- walls of orbit
- orbital rim
- optic foramen
- superior orbital fissure
- inferior orbital fissure
- lacrimal fossa
- trochlear fossa
- infraorbital groove, canal & foramen
- groove for lacrimal sac & nasolacrimal canal
- ant & post lacrimal crests
- ant & post ethmoidal foramina
- orbicularis oculi muscle
- palpebral fissure
- lacrimal papilla
- puncta
- conjunctival sac & parts
- med & lat palpebral ligaments
- orbital septum
- inferior oblique muscle
- periorbita
- frontal nerve
- trochlear nerve
- superior oblique muscle
- levator palpebrae superioris muscle

- lacrimal nerve
- supraorbital nerve
- supratrochlear nerve
- trochlea
- superior rectus muscle
- oculomotor nerve with divisions
- superior ophthalmic muscle
- superior ophthalmic vein
- nasociliary nerve
- ophthalmic artery
- ciliary ganglion
- common tendinous ring
- long ciliary nerves
- infratrochlear nerve
- optic nerve
- branches of ophthalmic artery
- central artery of retina
- inferior division of III nerve
- ciliary ganglion
- short ciliary nerves
- medial rectus muscle
- lateral rectus muscle
- inferior rectus muscle
- bulbar fascia