brighton and sussex medical school

BSMS MODULE: 202, NEUROSCIENCE AND BEHAVIOUR
THEME: BRAIN, SPINAL CORD AND NERVE CELLS

DR SESSION: 2. EXAMINATION OF THE ORBIT AND GLOBE OF EYE

LEARNING OUTCOMES

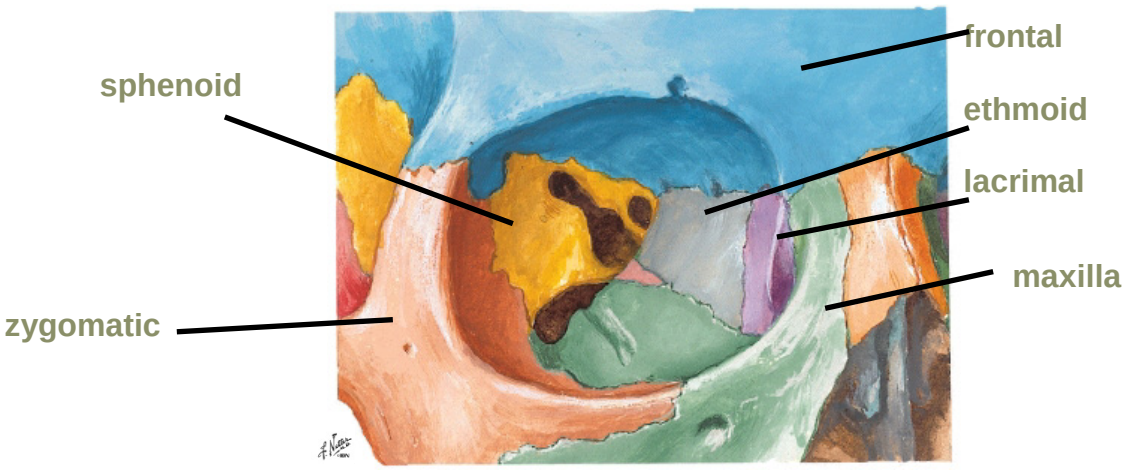
By the end of the practical session students should be able to:

1. Identify the bones of the orbit and understand the clinical relevance.
2. Identify the nervous supply to the orbit including motor, somatic sensory and special sensory (vision) supply.
3. Identify the extraocular muscles and explain their innervation, function and clinical testing.
4. Identify the ophthalmic artery and understand the structures that it supplies.
5. Appreciate the venous drainage of the orbit.
6. Appreciate the autonomic nerve supply to the lacrimal gland, pupil, and ciliary muscle.
7. Apply this anatomy knowledge to a range of clinical scenarios.

In this practical session you will study the anatomy of the **orbit** and the exterior of the globe of the eye including the **extraocular muscles**. You will be focussing on a number of different cranial nerves. For this session you will be performing much of the dissection and will start by making an opening in the superior aspect of the frontal bone to expose the orbit from a superior view. In addition you will be able to examine prosected specimens as well as the anatomical models available within the dissecting room. As with all your other practical sessions in the dissecting room make sure you work through this handout, answer the questions and complete the checklist.

Task 1. Examination of the orbit

Your first task is to examine the bones that make up the orbit using the available skulls. The orbit is a pyramidal-shaped cavity in the facial skeleton, with the apex lying medio-posteriorly and the base of the pyramid (orbital aperture) lying anteriorly. Pay particular attention to the roof, floor and walls of the orbit and the differences in their thickness. Now observe the foramina and fissures of the orbit: the **optic canal**, **superior orbital fissure**, **inferior orbital fissure**, **inferior orbital canal** and the **supraorbital foramen**.

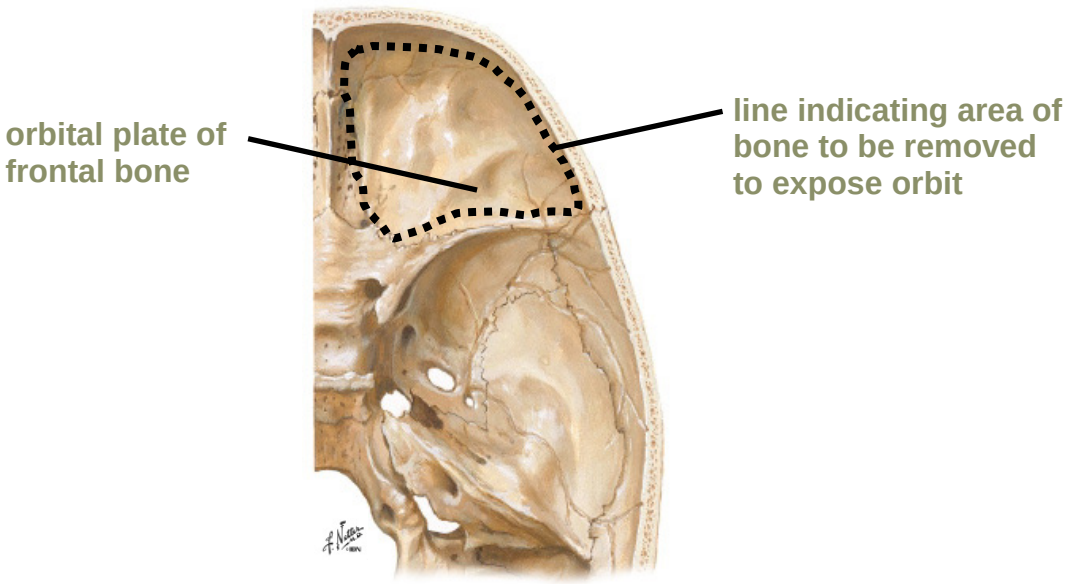


Question 1. What structure passes through the notch in the frontal bone?

Task 2. Contents of the orbit

Working on both the right and left sides of your cadaver in two sub groups.

To expose the orbit you will need to remove the thin orbital plate of the frontal bone by careful use of the chisel and forceps (you should seek the advice of your demonstrator at this point). The wider (laterally) you make the exposure the easier it will be to identify the various orbital contents. As your dissection moves towards the midline you may reveal part of the mucous membrane of the **ethmoidal air sinuses** lateral to the cribriform plate, which you should NOT remove or damage. In most cases the contents of the orbit are embedded in lobular fat bounded by a connective tissue membrane. You should gently remove this layer and the fat using forceps. This procedure should be repeated for the other orbit thereby allowing for both a superficial and deep dissection of the orbit. Both dissections can be carried out simultaneously.



Question 2. What nerve would you find medial to the frontal bone traveling through the cribriform plate?

Task 3. Superficial contents of the orbit

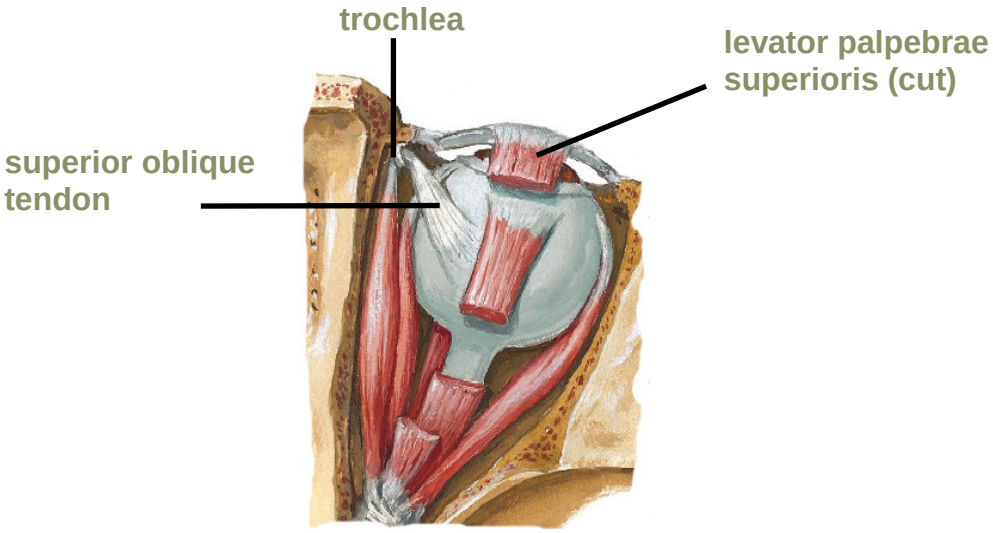
The **trigeminal nerve** (CNV) has three branches that divide intracranially. The first branch is the **ophthalmic nerve**. This nerve provides somatic sensory (touch, pain, temperature e) innervation to the eye, lacrimal gland, orbit and the skin around the orbit and forehead. It enters the orbit via the superior orbital fissure and has three main branches – **frontal, lacrimal and nasociliary**.

The first two of these can be found in the superficial dissection, by carefully removing the lobular fat. The **frontal nerve** runs just under the roof of the orbit and is easily visible. Remove as much of the lobular fat around this nerve and identify its two terminal branches. The larger more lateral branch is the **supraorbital nerve** that will exit the orbit through the supraorbital foramen that you should have previously observed.

Question 3. What innervation do you think these branches provide?

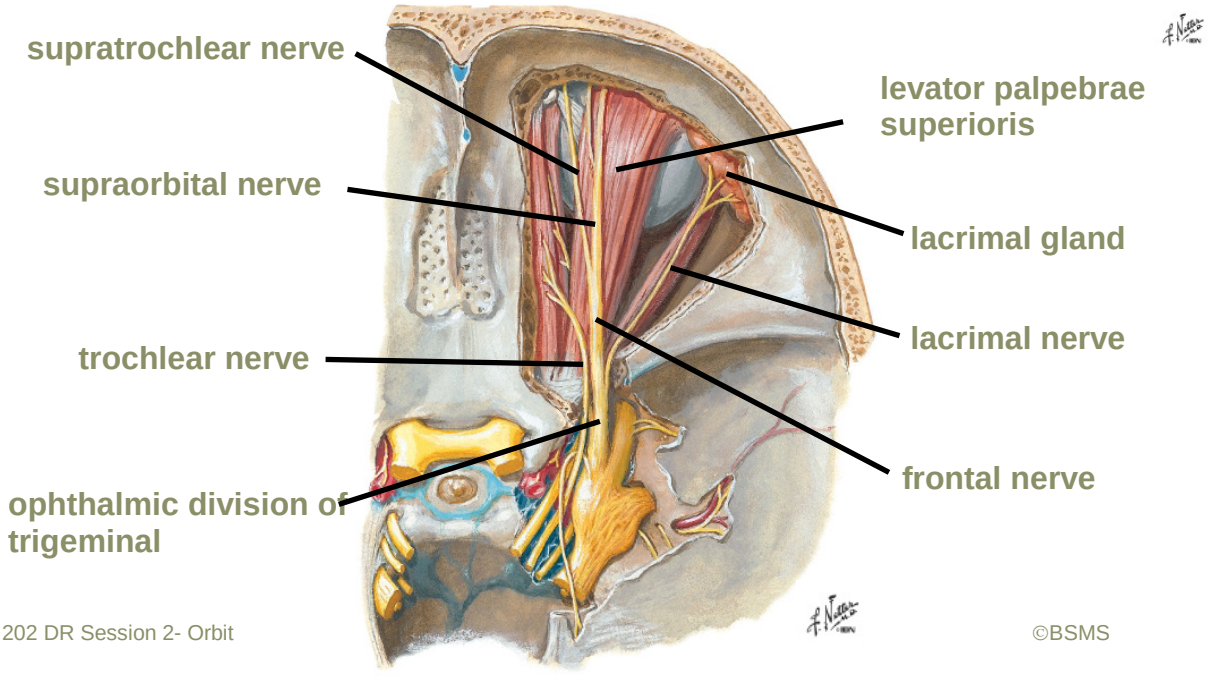
Now by removing as much of the lobular fat as you can, locate the **lacrimal gland** in the supero-lateral aspect of the orbital aperture. Carefully locate the **lacrimal branch** of the ophthalmic nerve as it runs from the apex of the orbit to this gland. This nerve carries somatic sensory information from the lacrimal gland, lateral conjunctiva, and also from a small area of skin over the lateral portion of the eyelids. Parasympathetic nerve innervation to the lacrimal gland (for tear production) will be discussed later.

The third branch of the ophthalmic nerve is the nasociliary nerve. This supplies the structures of the eye itself (as well as the ethmoid sinus and the skin over the nose) and so will be encountered shortly as part of the deep dissection.



Before completing the superficial dissection, you should move your attention to the medial aspect of the orbit and find the **superior oblique eye muscle**. This muscle extends forward from its origin at the apex, becomes tendinous and passes through a fibrous ring of tissue called the **trochlea** (which acts as a pulley). Here it changes direction and inserts into the sclera in the posterior part of the globe.

Carefully remove the fat around this muscle in its posterior third in order to find the **trochlear nerve** (CNIV) entering this muscle. Ocular movements will be covered in more depth later.



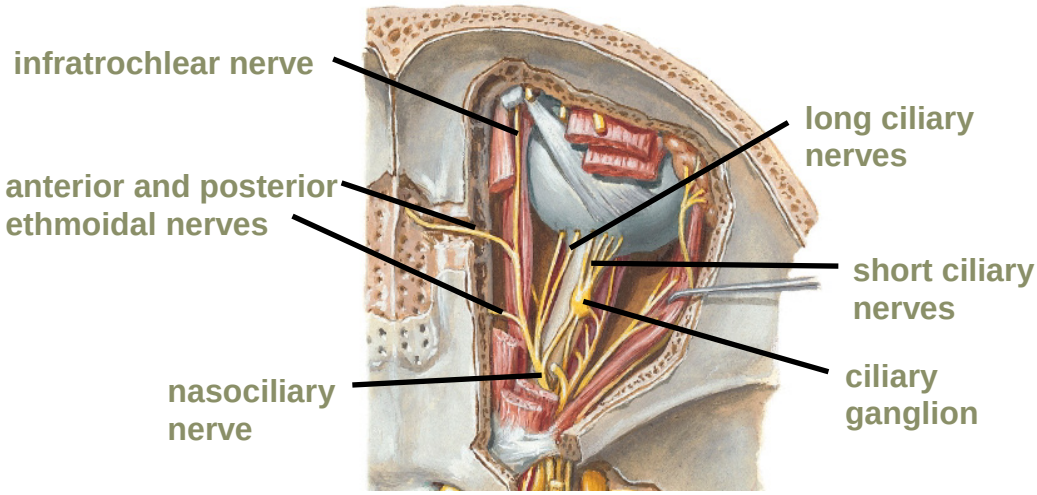
Task 4. Deep contents of the orbit

Following the removal of the fat, observe the **levator palpebrae superioris muscle**. As its name suggests, this lifts the upper eyelid. Cut this muscle, along with the frontal nerve midway along their length and reflect to expose the first of the recti muscles of the eye, the **superior rectus**. Following a brief examination of the course of the muscle, cut and reflect it in the mid-belly region. As you reflect both muscles you should look for branches of the **oculomotor nerve** (CNIII) entering both of these muscles.

The four recti muscles will be covered in depth later but you should appreciate that along with their surrounding fat and fascia, they form a 'cone' extending from the apex to the eye. Carefully remove as much fat as you can from this 'intraconal space'. There are a number of delicate structures to be found.

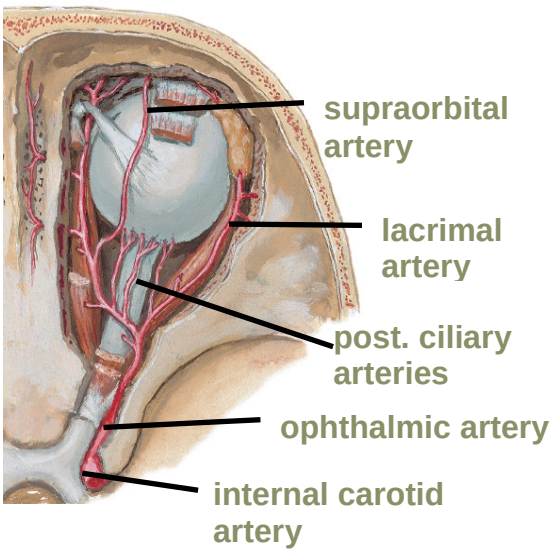
The largest structure is the **optic nerve** (3-4mm diameter) and will be the easiest to find. This carries nerve axons from the retina all the way to the thalamus of the brain and this pathway will be covered in more depth later.

Recall the two branches of the ophthalmic nerve (CNV_1) seen in the superficial dissection. The final branch (**nasociliary nerve**) should now be found crossing the optic nerve from lateral to medial along with the ophthalmic artery. The nasociliary nerve carries pain and touch sensation from the cornea via its long posterior ciliary branches. Its other branches are the anterior and posterior ethmoidal nerves that supply the mucous membranes of the paranasal sinuses and nasal cavity, and the terminal branch, the **infratrochlear nerve**, which supplies the medial portion of the eyelids and conjunctiva, as well as the skin of the nose. Carefully try to remove as much fat as you can and identify these branches.



The main artery supplying the orbit is the **ophthalmic artery**, the first branch of the internal carotid artery. As it branches from the internal carotid, it travels through the optic canal along with the optic nerve. After entering the orbit it gives a variety of branches that you should attempt to locate. These branches will supply the lacrimal gland, extraocular muscles, the ethmoid and sphenoid sinuses, eyelids, as well as the skin over the forehead and nose. Blood supply to the globe of the eye itself is two-fold:

the central retinal artery and the ciliary arteries. The former is the first branch of the ophthalmic artery and enters the optic nerve sheath to supply this nerve as well as the retina. This artery and its 4 terminal branches are what can be visualised by ophthalmoscopy (see image below). The long and short posterior ciliary arteries enter the back of the eye along with the ciliary nerves to supply the other structures within the eye.



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The orbit blood supply drains via the **superior** and **inferior ophthalmic veins**. You may have already come across the former. If not you should try to find it now. This vein passes through the superior orbital fissure into the cavernous sinus (part of the intracranial dural venous sinus network). The inferior vein may drain into the cavernous sinus or may pass through the inferior orbital fissure into the sphenopalatine fossa. Both of these have communications with veins of the face and sinuses, and so are important potential routes of entry for pathogens causing intracranial infections eg cavernous sinus thrombosis, meningitis, encephalitis.

Question 4. What would be the result of a blockage of the central retinal artery? (think back to your first year notes from Module 102!)

Task 5. Extraocular Muscles and Cranial Nerves III, IV, VI

You need to appreciate the six muscles that act on the eye in addition to the levator palpebrae superioris that lifts the upper eyelid. In particular, it is essential that you fully understand their innervation and function as this is the basis for identifying intracranial pathology as part of the neurological examination. This is life-saving anatomy!

The six muscles that act to move on the eye include the four recti (superior, inferior, medial and lateral) and the two oblique muscles.

The Rectus Muscles
Each of the rectus muscles arise from the apex of the orbit, and insert in the anterior hemisphere of the eye. Identify each of these on the prosections.

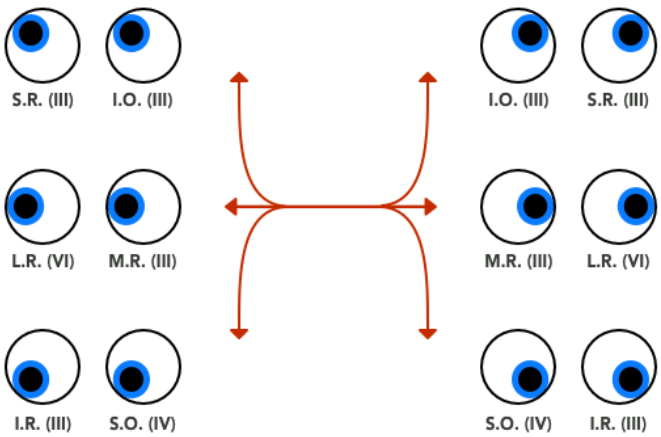
When considering the movements that these muscles make, you need to examine the prosections. Looking at the superior orbital prosection, observe how the rectus muscles are directed at an angle of about 20° antero-laterally. However, the visual axis is directed anteriorly in the primary gaze (looking straight ahead).

To test these muscles clinically you need to *isolate* the muscle. To isolate the superior or inferior recti muscles you must first align the muscle directions with the visual axis i.e. ask the patient to look laterally, and then to look up or down. The medial and lateral rectus muscles will move the eyes in the medial and lateral direction as expected.

The Oblique Muscles
The superior oblique was observed as part of the superficial orbital dissection. It runs from the apex along the supero-medial aspect of the orbit to the trochlea, where it turns backwards and medially to insert on the postero-lateral aspect of the globe.

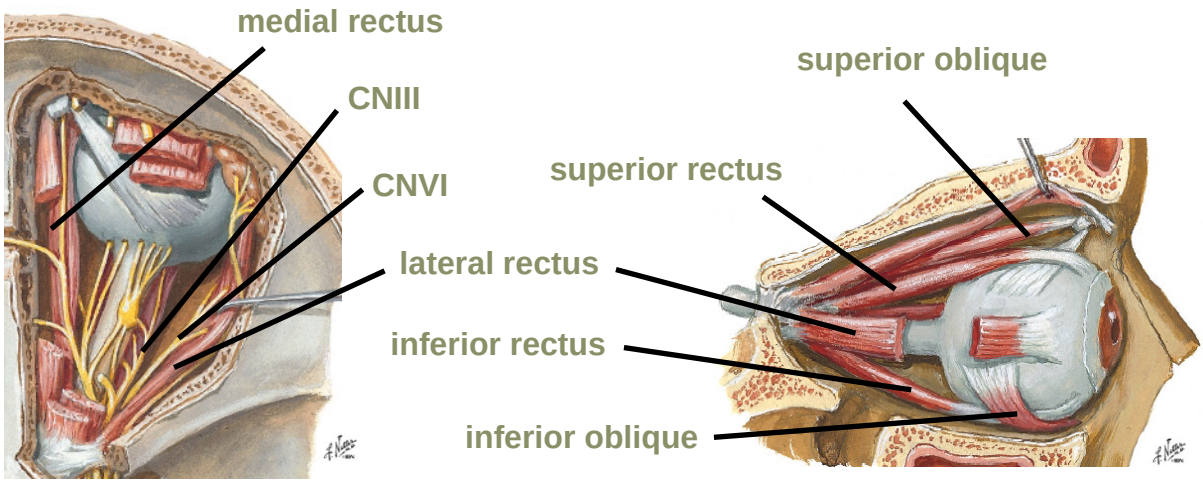
Now examine the inferior oblique. This is the only muscle not to originate from the apex. It arises from the maxillary bone in the infero-medial orbital margin. The muscle passes under the eye to insert into the postero-lateral aspect of the globe.

To test the function of these muscles clinically you must again test them in isolation. To do this, **always align the visual axis** with the direction of the muscle by asking the patient to turn the eye in question medially first. Then, if they are asked to look up or down, the oblique muscles will work in isolation to elevate (inf. oblique) or depress (sup. oblique) the eye.



Nerve supply to the extraocular muscles
The oculomotor nerve (CNIII) carries motor innervation to the levator palpebrae superioris and inferior oblique as well as the superior, medial and inferior recti muscles. It also carries parasympathetic supply to the ciliary muscle to adjust the lens for near vision (accommodation) and to the sphincter pupillae for pupil constriction. The trochlear nerve (CNIV) supplies the superior oblique muscle. The abducent nerve (CNVI) supplies the lateral rectus muscle.

Although you do not need to describe the precise course of these nerves, you should be aware that these nerves exit the brainstem in close proximity to a number of arterial branches, where they may be compressed by an aneurysm. Before entering the orbit through the superior orbital fissure, all three of these nerves pass through the cavernous sinus, along with the ophthalmic branch of the trigeminal nerve. Use the prosections to appreciate these points.



It is important to note that all the extraocular muscles are continuously involved in the movement of the eye and as such actions made by individual muscles are not tested clinically.

Question 5. The action of which muscles of the left eye would you therefore be testing if you asked a patient to look up and to the right?

Task 6. Autonomic Supply

The autonomic nervous system is concerned with innervation to smooth muscles under involuntary control. In the eye and orbit this system acts predominantly on the pupil, the ciliary muscle (for lens adaptation) and the lacrimal gland.

The sympathetic nervous system is associated with “fight or flight responses” and the parasympathetic nervous system is associated with “rest and digest”. These systems will be discussed separately.

Sympathetic nervous system

Sympathetic innervation of the eye stimulates the dilator muscle of the pupil and also opens the eyelid to allow more light in and enable better vision in dark, scary situations (fight or flight). It also inhibits the parasympathetic supply to the ciliary muscle, relaxing this muscle and allowing the lens to focus in the distance.

The sympathetic nervous system exits the central nervous system in the spinal cord levels T1-L2 (thoracolumbar). In order to innervate the structures in the head, nerve fibres from these levels will travel up the sympathetic chain (recall your notes from your first year dissection) to the superior cervical ganglion where they synapse. This ganglion

lies in the neck (C2-C3) and is closely related to the internal carotid artery. Postganglionic fibres travel as a plexus (network) of nerves that travel with the arteries of the head and neck. To reach the eye they will travel with the branches of the nasociliary nerve (branch of CNVI) along with the sensory fibres.

Parasympathetic nervous system

When considering the parasympathetic supply, “rest and digest” is commonly used to remember the actions eg. in the gut.

In order to “rest” your eyes, your pupil constricts to let less light in, and when “digesting” your anatomy textbook, you need to stimulate the ciliary muscle to focus the lens on short distances (*accommodation*).

Parasympathetic nerves to these structures travel within the oculomotor nerve and synapse in the ciliary ganglion located within the orbit. Postganglionic fibres are carried in the short ciliary nerves into the eye.

On your dissection, you should locate the oculomotor nerve, the long and short ciliary nerves, and the small ciliary ganglion.

Additionally, as is the case in the gut and salivary glands, the parasympathetic nerve system promotes lacrimal gland secretion. Tears are secreted by this gland (you will recall is in the supero-lateral orbital margin) and wash across the eye as you blink. They nourish and protect the front of the eye. As they wash across, tears are drained into the lacrimal sac in the infero-medial orbital margin, and then drain into the nasal cavity via the nasolacrimal duct (When you cry lots, you sniff lots).

The parasympathetic nerve supply to the lacrimal gland is complex. You need to appreciate that preganglionic fibres originate from the lacrimal nucleus which is part of the facial (CNVII) nucleus in the brainstem and that they synapse in the sphenopalatine ganglion.

You should locate the sphenopalatine fossa and its communication with the orbit through the inferior orbital fissure. The postganglionic fibres “hitch-hike” with branches from the maxillary nerve (CNV_2) to reach the terminal part of the lacrimal nerve (branch of CNV_1). Although you do not need to know any more detail than this, you may find it useful to discuss this with one of the demonstrators.

Question 6. What action does sympathetic innervation have on the dilator muscle?

Checklist

Review all the structures you have examined today and ensure that your demonstrator is satisfied that you have completed the check list below before you leave the dissecting room:

Identified the skeleton that makes up the orbit
Distinguished the components of lacrimal apparatus and understood their function
Discriminated the branches of the ophthalmic division of CNV

Understood the structure, function and innervation of the extraocular muscles

Identified the main blood vessels of the orbit