The ministry of health of the Republic of Belarus

Educational institution «Gomel State Medical University»

Department of Otorhinolaryngology with a course of ophthalmology

Discussed at the meeting
department
Document № 9 dated 03.06.2025

MANUALS

for 5th year students of faculty of foreign students on ophthalmology

TOPIC №1. Ophthalmology and a history of its development. Anatomy, physiology, and functions of the components of the eye and adnexa.

The time 6 hours

Gomel, 2025

MOTIVATION FOR LEARNING TOPICS, TRAINING AND EDUCATIONAL PURPOSES, THE REQUIREMENTS TO THE ORIGINAL LEVEL OF KNOWLEDGE

Ophthalmology as a distinct medical discipline has emerged 200 years ago, and withdrew it from the bowels general surgery. To date, ophthalmology has become a vast specialities, which include elements of both surgical and therapeutic disciplines. In the textbooks and lectures-eye has long been known as a window into the body. Indeed, its structure it is legitimate and is characterized by responding to a number of common pathological condition. There are more than 870 diseases, syndromes and condition to which eye manifestations are typical. This includes many autoimmune diseases, systems inflammation, genetic origin, cancer, toxic lesion, AIDS, and many more. The relationship between eyes and common systems organism is very diversified. Most of all, it is via vascular and nervous system.

Our eyes is very clearly responds to the many changes in the external environment and can be considered to be "environmentally sensitive body". In the modern world is the growing tendency toward visual disorders in connection with the growing visual stress (for example, when working with your computer, alarm systems, displays).The number of blind people in the country - there is the best indicator of its culture and to care for the health of the people. It is a set of structures, wich emission of light (electromagnetic waves length of 390-760 nm) and forming even visual sensations. This is sensitive channel, which links organizm with the outside world. Eye gives more than 90 % of the information about the external world. Thanks to blind we see surrounding us world in the colors, we read, watch television.

The purpose of the class: To define ophthalmology, as a medical specialty. To determine its content and tasks. Show the place of ophthalmology in the medical science. Acquaint with latest achievements in world and domestic ophthalmology, show their importance in reducing eye disease and in the fight against blindness. To acquaint with history of ophthalmology in the Republic of Belarus. Introduction with clinic, contingent patients, clinical study anatomy, physiology and function parts of eye.

Objectives of the lesson:

Student should know:

1. The history of ophthalmology.
2. The latest achievements of world and domestic ophthalmology, their importance in reducing eye disease and in the fight against blindness.
3. Evolution of the organ of vision. Stage of eye development in the embryogenesis and the fetus.
4. Age dynamics, gross weight, form eyeballs.
5. Structure and function of external eye cover (fibrous tunica) (cornea and sclera), uveal tract (the iris, ciliary body and choroid), retina, lens, vitreous, anterior and posterior chamber of the eye.

6. Anatomy of the visual sensory system: the retina, topography anatomy optic nerves, optic chiasm, optic tracts, lateral geniculate nuclei, geniculostriate radiations, striate cortex, visual association areas, and related interhemispheral connections.
7. Anatomy and functions of the eyelid. Anatomy and functions of the conjuctiva.
8. Anatomy of the lacrimal system. Secretory lacrimal system. Excretory lacrimal system.
9. Functional anatomy of the extraocular muscles.
10. The orbit: topography anatomy, structure, content and function.
11. Vascular supply and nerves of the eye and eye appendix.

***Student must be able to*:**

1. Guided accurately in topography anatomy of the orbit.
2. To determine way and position of the cranial nerves in superior orbital fissure.
3. To perform differential diagnosis pathology of visual pathway.

The student must perform the following practical skills:

1. to study motility of the eyeballs;
2. to determine existence in lacrimal sac.

CHECKLIST OF QUESTIONS FROM RELATED SUBJECTS

1. Embryology of the eye.
2. Histology of the cornea, sclera, chorioidea, lens and retina.

CHECKLIST OF CONTROL QUESTIONS FOR THE LESSON

1. The history of ophthalmology
2. Prenatal development of the eye and its adnexa. Stage of eye development in the embryogenesis and the fetus.
3. Eyeball. Its age dynamic, gross weight and form of eyeballs.
4. Structure and function external eye cover (cornea and sclera).
5. Structure and function uveal tract (the iris, ciliary body and choroid).
6. Structure and function retina.
7. Lens, vitreous, anterior and posterior chamber of the eye.
8. Anatomy of the visual sensory system.
9. Anatomy optic nerves, optic chiasm, optic tracts, lateral geniculate nuclei, geniculostriate radiations, striate cortex, visual association areas, and related interhemispheral connections.
10. Anatomy and functions of the eyelid. Anatomy and functions of the conjunctiva.
11. Anatomy of the lacrimal system. Secretory lacrimal system. Excretory lacrimal system.
12. Functional anatomy of the extraocular muscles. The orbit: topography anatomy, structure, content and functions.
13. Vascular supply and nerves of the eye and eye appendix.

PRACTICAL PART OF THE LESSON

Work of students is carried out in the ophthalmology department in the presence of the teacher of the department in order to develop and consolidate practical skills. The acquired skills are consolidated in the training room when examining patients or at a seminar. In the classroom, students independently study modern clinical protocols for examination and treatment, methodological recommendations of the ministry of health of the Republic of Belarus.

The control of the final level of knowledge is carried out at a seminar or in the clinical analysis of a patient, an outpatient card or a medical card.

1. Analysis of the thematic patient.
2. Clinical analysis of outpatient cards, medical records.
3. Answers to questions of a computer test program in ophthalmology on the topic “A brief description of the history and development of ophthalmology. Anatomy, physiology and function of eyes and its adnexa".

QUESTIONS FOR SELF STUDY AND ADDITIONAL RESEARCH TASKS

1. The history of ophthalmology.
2. Eye embryogenesis.
3. Anatomy of the eye.

DEVELOPMENT OF THE EYE

The eye develops from both neural and surface ectoderm and from mesoderm. Surface ectoderm forms the lens and the epithelium of the cornea and conjunctiva and contributes, together with the neural ectoderm, to the vitreous body and zonule. Neural ectoderm forms the retina, ciliary epithelium, iris epithelium and its sphincter and dilator muscles, and the neural part of the optic nerve. Mesoderm gives rise to the corneal stroma and endothelium, the iris stroma, the choroid and the sclera.

In the formation of the embryo from the embryonic plate of ectoderm and endoderm, at the area of contact of the amnion and the yolk sac a midline primitive groove appears in the dorsal ectoderm and anteriorly at each side an optic groove appears which is the primordium of the retina. This is best followed diagrammatically. At the five week (7 mm) stage the spherical optic vesicle has by differential growth changed to a structure like an egg cup with part of the lower side missing. Through this foetal fissure the hyaloid artery enters the concavity of the cup. By the end of the sixth week (15 mm) the fissure has closed.

The lens forms by an ingrowth of surface ectoderm in front of the optic vesicle. The hyaloids artery ramifies on the back of the lens at the beginning of the sixth week (10 mm). Meanwhile on the outer surface of the optic vesicle a network of vessels appears in the mesoderm which will eventually develop into the choroid at the end of the sixth week (15 mm). Outside this the mesoderm forms the sclera and the extraocular muscles, which are differentiated and receive their nerve supply as early as five weeks (7 mm).The lens becomes enclosed by the edge of the developing optic cup. Its anterior cells form the lens epithelium while the posterior cells elongate. Later new lens fibers formed at the equator

so that they comprise the nucleus engulf the posterior cells of the lens. The hyaline capsule of the lens is formed as a secretion of the lens cells.

The inner neural layer and the outer pigmentary layer of the optic vesicle form the retina, the ciliary epithelium and the iris epithelium which extends on the posterior surface of the iris to the pupil margin. The vitreous is originally the primitive tissue between the lens and the inner layer of the optic cup. This is invaded by the hyaloid vessels. Secondary vitreous then forms from the retina which displaces the primary vitreous forwards to the ciliary region and inwards to occupy a tubular space around the hyaloid vessels. The hyaloid system regresses leaving only its retinal branches. The hyaloid artery proximal to these branches becomes the central retinal artery. Tertiary vitreous which forms the lens zonule is partly made up of tissue from the primary vitreous and partly from fibres which develop in conjunction with the basement membrane of the ciliary body.

The development of the three ocular vasculatures reviewed herein is perfectly synchronized to provide the nutritional and oxygen requirements of the forming human eye. The fetal vasculature of vitreous, which includes the hyaloid vasculature, vasa hyaloidea propria, and tunica vasculosa lentis, develops by hemo-vasculogenesis when the closure of the globe is nearing completion. This transient fetal vasculature remains until a retinal vasculature forms and then it regresses by apoptosis in mouse and man with the assistance of macrophages/hyalocytes. The human choroidal vasculature also develops by hemo-vasculogenesis and will supply nutrients and oxygen to outer retina. This lobular vasculature develops in a dense collagenous tissue juxtaposed with a cell constitutively making VEGF, the retinal pigment epithelium. The retinal vasculature is the last to develop. In human it develops by vasculogenesis, assembly of CXCR4+/CD39+ angioblasts or vascular progenitors perhaps using Muller cell Notch1 or axonal NRP1 for guidance of semaphorin 3A+ angioblasts. The mouse retinal vasculature develops by angiogenesis using astrocytes being in stalk endothelial cells and microglia. Fovea never has a retinal vasculature, which is probably because the fovel avascular zone area of retina has high levels of antiangiogenic factors [5].

The retinal neural layer of epithelial cells divides and an outer nuclear layer and an inner non-nuclear marginal layer can be distinguished. From about the sixth week (15mm) the ganglion cells are formed by nuclear zone cells invading the inner layer. Nerve fibers grow out from them and run to the optic stalk and then to the brain. By 9 weeks (40 mm) the chiasma has formed and the optic tracts develop. Medullation of the nerve fibers takes place from the brain distally and reaches the lamina cribrosa just before birth. The outer layer of the optic vesicle becomes pigmented at the beginning of the sixth week (10 mm) and becomes flattened to form the retinal pigment epithelium. Further differentiation of the retina takes place next in the central region. The outermost cells of the nuclear layer form the rod and cone cell bodies, they bear cilia projecting into the cavity of the optic vesicle which develop into the photoreceptors, the rods and cones. Other cells of the nuclear layer form the amacrine, the horizontal and the bipolar cells. Processes from all these cells and from the ganglion cells form the plexiform layers. The macular area forms at the 20th week (150 mm) as a thickening of the ganglion cell layer and the fovea appears in the center of this area in the 24th week (200 mm).

The development of other ocular structures:

Mesodermal cells grow in between the lens and the surface ectoderm to form the corneal endothelium which secretes Descemet's membrane at about the 16th week (100 mm). Other mesodermal cells form the stroma and the surface ectoderm becomes the epithelium of the cornea. The sclera and Tenon's capsule are condensations of mesoderm around the optic cup. This process commences anteriorly where it is associated with the developing extra ocular muscles. The anterior chamber appears as a slit in the mesoderm between the cornea and iris.

The canal of Schlemm is present at 12th weeks (70 mm). Cleavage of the structures in the angle of the anterior chamber takes place but some tissue remains to form the trabecular meshwork allowing communication between the anterior chamber and the canal of Schlemm.

The posterior part of the mesoderm between the surface ectoderm and the lens forms the iris stroma where it lies anterior to the rim of the optic cup, the central part being the pupillary membrane. The posterior ciliary arteries supply them both. There is no true iris up to the 12th week (70 mm) but then there is a forward growth of neural ectoderm at the rim of the optic cup which extends to the pupillary margin by the 16th week (100 mm) as the two layers of the iris. At about the 30th week (250 mm) the sphincter and dilator pupillae form from the pigment epithelium. The posterior layer of the iris epithelium becomes pigmented at this time and later the pupillary membrane regresses leaving a circular ring, the collarette, peripheral to the pupil. Incomplete regression may leave strands of persistent pupillary membrane arising from the collarette and crossing the pupillary aperture, sometimes still adherent to the front of the lens. The iris epithelium is continuous behind with the two layers of the ciliary epithelium and mesoderm forms the stroma of the ciliary body and the ciliary muscle. At about the time of the formation of the iris epithelium, vascularized ciliary processes appear and between 20 and 24weeks (150–200 mm) the main arterial circle of the iris, situated in the ciliary body, arises from the two long posterior ciliary and seven anterior ciliary arteries.

The eye lies in the front half of the orbit surrounded by fat and connective tissue and is supported by a fascial hammock. The optic nerve, which connects the eye with the brain, leaves the orbit at its apex through the optic foramen in which it lies close to the ophthalmic artery. Attached to the eye are six extraocular muscles, four rectus and two oblique. They take origin posteriorly from the orbital walls or from a tendinous ring which bridges the superior orbital fissure and includes the optic foramen. They are innervated by the 3^{rd},4^{th} and 6^{th} cranial nerves which enter the orbit at its apex through the superior orbital fissure. The branches of the ophthalmic division of the 5^{th} cranial nerve also pass through the superior orbital fissure to convey sensory impulses from the eye and the upper part of the face.

The exposed front of the eye consists of a central transparent convex portion, the cornea, surrounded at the corneo-scleral limbus by opaque white sclera which is covered by the loose bulbar conjunctiva continuous at the fornixes with the more adherent palpebral conjunctiva which linesthe eyelids.

The lacrimal gland is situated just behind the upper outer angle of the bony orbit and its ducts discharge tears into the upper fornix. The front of the eye isprotected by the eyelids which form an elliptical opening, the palpebral aperture. The area of the outer and

inner angles of the palpebral aperture are known as the lateral and medial canthi. The free margin of each lid bears the eye lashes and the mouths of sebaceous glands and, near the medial end of the upper and lower lids, on a small eminence will be found the openings of the upper and lower lacrimal canaliculi. Each upper lid is raised by the levator palpebrae superioris muscle supplied by the 3rd cranial nerve and the sympathetically innervated palpebral muscle of Muller. The lids are closed by the orbicularis oculi muscle supplied by the 7th cranial nerve.

The axial length of the normally sighted eye is approximately 24 mm (22–27 mm). Measuring posteriorly along the surface from the limbus, the anterior termination of the sensory retina lies at 8 mm, the equator at 16 mm and the posterior pole at 32 mm. The globe has three main layers. The outer **fibrous** supporting coat in front is the clear cornea which is continuous with the white opaque sclera behind. The middle **vascular** coat or uvea consists of the choroid, the ciliary body and the iris which has a central opening or pupil. The inner sensory coat, **the retina**, has a many cell layered neural membrane and a single celled outer membrane, the pigment epithelium. A fenestrated opening in the sclera 1.5 mm in diameter and 3 mm medial to the posterior pole transmits the fibres of the optic nerve, mainly the axons of the ganglion cells of the retina. The lens is a transparent structure, suspended immediately behind the iris by fine fibres, forming the zonule or suspensory ligament, which runs from the surface of the ciliary body to the periphery of the lens. The anatomy of all these structures is considered in more detail in the relevant sections.

ORBITAL CAVITY

The eyes rest in two bony cavities, the orbits, on either side of the nose.

The orbital cavity is the protective bony socket for the globe together with the optic nerve, ocular muscles, nerves, blood vessels, and lacrimal gland. These structures are surrounded by orbital fatty tissue. The orbital cavity is shaped like a funnel that opens anteriorly and inferiorly. The six ocular muscles originate at the apex of the funnel around the optic nerve and insert into the globe. The globe moves with in the orbital cavity as in a joint socket.

Bony socket. This consists of seven bones (figure 1):

1. Frontal.
2. Ethmoid.
3. Lacrimal.
4. Sphenoid.
5. Maxillary.
6. Palatine.
7. Zygomatic.

The bony rim of the orbital cavity forms a strong ring. Its other bony surfaces include very thin plates of bone.

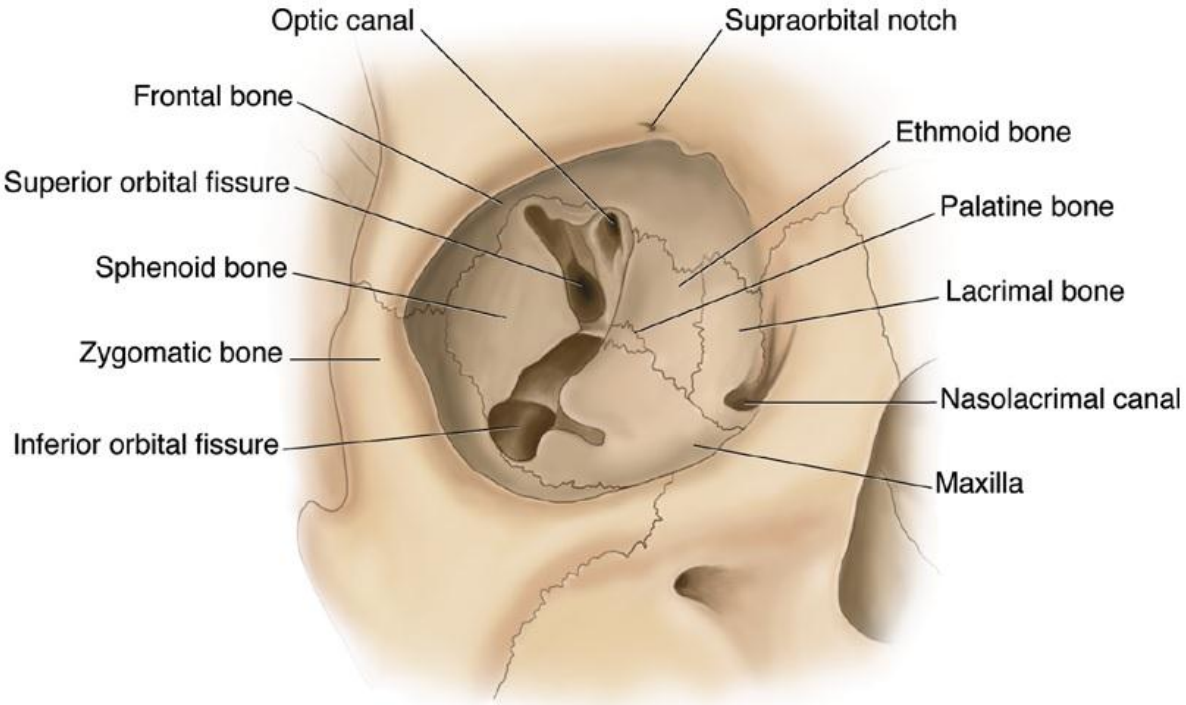


Fig. 1 The seven bones that comprise the bony orbit. [6]

The bones of the anterior margin of the orbit are thick and strong but may be fractured by severe direct blows. Because the rest of the walls are thin 'blow out' fractures occur when the intraorbital pressure is suddenly increased as the result of a blow from the front by a rounded object such as a small stone or a squash racquets ball. Usually the fracture occurs in the floor or medial wall with prolapse of the orbital contents.

There are three main conduits into and out of the bony orbit (Fig. 2): (1) the optic canal, which transmits the optic nerve; the superior orbital fissure, which transmits the lacrimal, frontal, trochlear, oculomotor, nasociliary, and abducens nerves as well as the superior ophthalmic vein; and the inferior orbital fissure, through which the maxillary nerve, the inferior ophthalmic vein, and sympathetic nerves traverse [5].

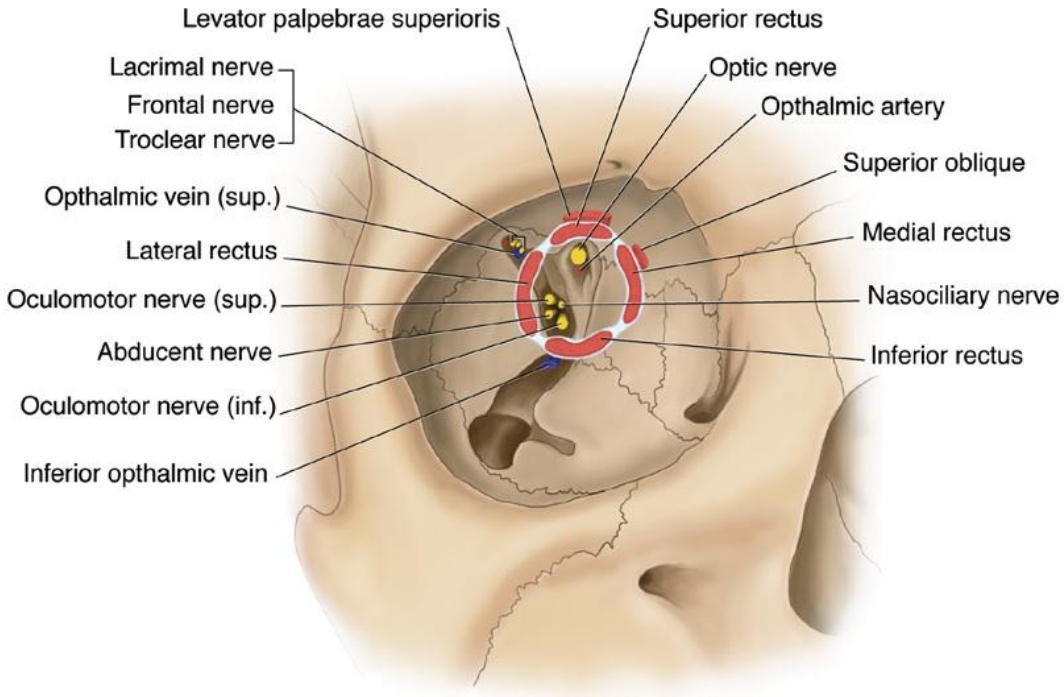


Fig 2 Foramina, fissures, and their neurovascular components [6].

Optic Canal

The optic canal is approximately 5 mm in diameter and runs in a superomedial direction to enter the cranial fossa. The bony canal itself is less than 1 cm in length and is in the medial portion of the orbital apex, lying entirely within the sphenoid bone. The extent of the sphenoid sinus pneumatization may lead to thinning of the canal or the optic nerve coursing through the lateral portion of the sinus. Lesions or fractures affecting the optic canal can cause orbital apex syndrome, which is characterized by ophthalmoplegia, hypoesthesia, and blindness.

Superior Orbital Fissure

The superior orbital fissure is superolateral to the optic canal and extends inferiorly to a point just medial to this canal. It is formed by the cleft between the greater and lesser wings of the sphenoid. Fractures, edema, or infection extending to the superior orbital fissure can result in superior orbital fissure syndrome, which is marked by ophthalmoplegia, ptosis, and pupillary dilatation.

Inferior Orbital Fissure

The inferior orbital fissure is the inferolateral continuation of superior orbital fissure. It is formed by the zygoma and greater wing of the sphenoid laterally and the zygoma and maxilla medially. The fissure connects the floor of the orbit with the pterygopalatine and infratemporal fossae. In the anterior portion of the fissure, a small canal runs forward through the floor of the orbit and exits the maxilla approximately 5 mm inferior to the rim. This canal carries the infraorbital nerve, which also gives off the anterior, superior alveolar, and middle superior alveolar nerves. The infraorbital nerve is accompanied by its artery, a terminal branch of the internal maxillary artery, and vein, which drains into the pterygoid plexus.

Anterior and Posterior Ethmoidal Foramina

The anterior and posterior ethmoidal foramina exit between the frontal and ethmoid bones at the frontoethmoidal suture. The anterior foramen is approximately 24 mm behind the anterior lacrimal crest, and the posterior foramen is 12 mm behind this. The anterior ethmoidal artery enters the anterior cranial fossa through the anterior ethmoidal canal and then the nasal cavity through the cribriform plate. It is accompanied by the anterior ethmoidal nerve, a sensory branch of the nasociliary nerve.

Cranio-Orbital Foramen

The cranio-orbital foramen is present in 55 to 70% of all orbits and is located anterior to the superior orbital fissure in the medial orbital wall. It carries within it a branch of the middle meningeal artery that forms an anastomosis with the lacrimal artery. During optic nerve decompression or orbital dissection, the surgeon must remain cognizant of this foramen and its potential for hemorrhage.

Nasolacrimal Canal

The nasolacrimal canal drains tears from the eye to the nasal cavity and is located in the medial wall of the orbit. The anterior portion of the canal is known as the anterior lacrimal crest and is formed by the maxilla. Posteriorly, the canal is formed by the lacrimal bone and is called the posterior lacrimal crest. The deeper fibers of the medial canthus and orbicularis oculi attach to the posterior lacrimal crest [5].

On the anterior margin of the lateral wall there is a thickening, the lateral orbital tubercle. This gives attachment to the hammock-like suspensory fascia of the eye (the ligament of Lockwood), which on the medial side is attached to the bone behind the lacrimal sac. Anteromedially in the roof of the orbit is the trochlea which forms the pulley for the tendon of the superior oblique muscle.

The orbital contents are supported by connective tissue which is thickened in places to form definite layers and compartments which are important in surgery and in the spread of hemorrhage and inflammation:

Periosteum of the orbit is continuous with the dura mater which also provides at the margin of the optic foramen the dural sheath of the optic nerve.

Orbital septum stretches from the bony margins of the orbit to the tarsalplates and prevents orbital fat from herniating into the lids.

Tenon's Capsule Tenon's capsule, or the fascia bulbi, is a layer of delicate connective tissue that completely envelops the globe from the limbus to the optic nerve, forming a potential space free of any tissue attachments that might restrict globe rotation. Posteriorly, extremely fine connective tissue filaments to the sclera loosely attach it. This episcleral space contains no fluid or endothelium and is not a full-fledged ball-and-socket joint in function. The globe can rotate some within the capsule; however, beyond small rotations, the globe and capsule move together, deflecting the orbital fat attached behind. This is to be expected, since the capsule is attached firmly to the eye at the limbus and to the muscles at their points of entrance.

The optic nerve, the extraocular muscles, and the blood vessels and nerves serving the globe penetrate tenon’s capsule. About the optic nerve the capsule is penetrated and broken up by multiple posterior ciliary arteries and nerves, and some have considered it to cease a few millimeters away from the optic nerve. There is no sheath continuing backward around the optic nerve.

There are four rectus and two oblique’s muscles in the eyeball (Figure 3).

The four rectus muscles arise from the annulus of Zinn at the apex of the orbit. The medial rectus inserts onto the medial side of the globe at approximately 5.3 (B ± 0.7) mm from the corneoscleral limbus, whereas the lateral rectus inserts onto the lateral side of the globe at approximately 6.9 (B ± 0.7) mm from the limbus. Because the origins and insertions of the horizontal rectus muscles are symmetric and lie in the horizontal meridian of the globe, their functions are relatively simple and are antagonistic; contraction of the medial rectus adducts the globe, whereas contraction of the lateral rectus abducts the globe.

The superior and inferior recti also originate from the annulus of Zinn. The superior rectus inserts onto the globe superiorly at approximately 7.9 (B ± 0.6) mm from the limbus, and the inferior rectus inserts inferiorly at approximately 6.8 (B ± 0.8) mm from the limbus.

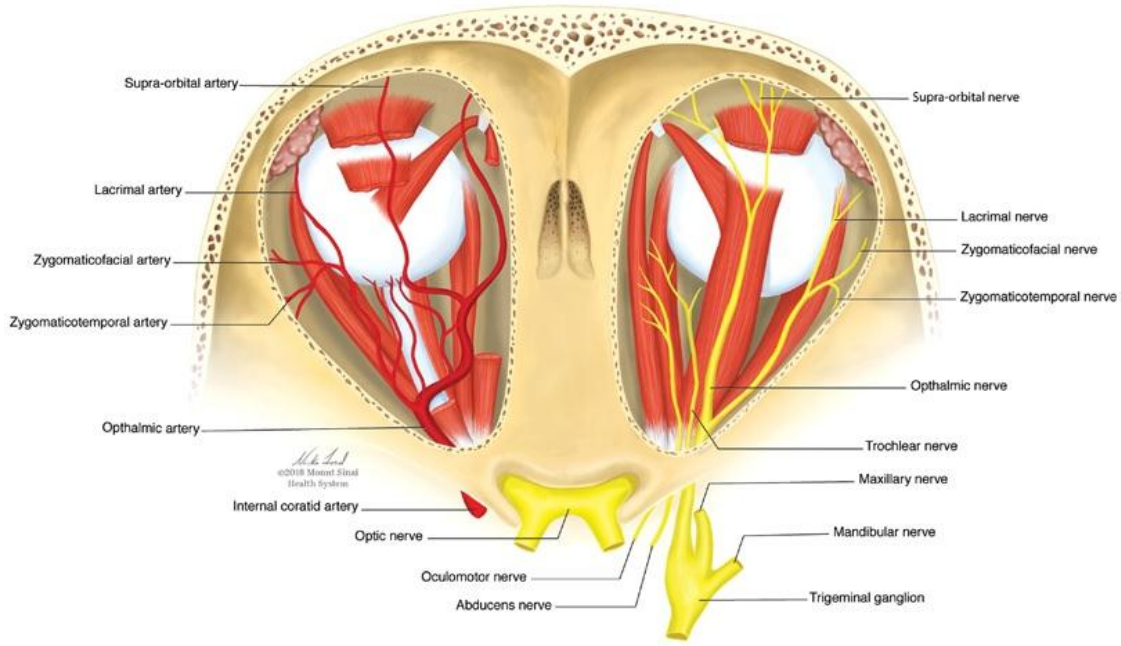


Fig. 3 Extraocular muscles and neurovascular supply of the orbit [6].

The conjunctiva is a thin vascularised mucous membrane consisting of a non keratinising, stratified, columno-squamous epithelium and a substantia propria. It leaves the posterior surface of the eyelids from which it is reflected forwards at the fornices, to cover the anterior sclera. The conjunctiva thus forms a potential space, the conjunctival sac, which is open at the palpebral fissure. The conjunctival epithelium is continuous with the corneal epithelium at the limbus and a muco-cutaneous junction is formed at the eyelid margins.

The uveal tract (also known as the vascular pigmented layer, vascular tunic, and uvea takes its name from the Latinas (grape) because the dark pigmentation and shape of the structure are reminiscent of a grape. The uveal tract consists of the following structures:

- Iris.
- Ciliarybody.
- Choroid.

The ciliary body consists of the anterior pars plicata (2 mm wide) and the posterior pars plana (4 mm wide). The pars plicata bears 70 radially orientated ciliary processes wich project into posterior chamber. Each ciliary process is lined by a pigment epithelial layer continuous with the retinal pigment epithelium and a non-pigment epithelial layer continuous with neuroretina. Each process also has a central arteriole ending in a rich capillary network. Tight junctions between adjacent non-pigment epithelial cells constitute the blood-aqueous barrier. Aqueous humor is a actively secreted by the non-pigment epithelium as a result of a metabolic process that depends on several enzyme systems, especially the Na/K ATPase pump, which secrets Na ions into the posterior chamber. Water follows passively along the osmotic gradient. Carbonic anhydrase also pays a role, but the precise mechanism is uncertain. Aqueous secretion is diminished by factors that inhibit active metabolism such as hypoxia and hypothermia but its idepend of the level of intraocular pressure.

The retina is the innermost of three successive layers of the globe. It consists of two parts:

I. A photoreceptive part (pars optica retinae), consisting of the first nine of the 11 layers listed below.

II. A non receptive part (pars ceca retinae) forming the epithelium of the ciliary body and iris.

The pars optica retina emerges with the pars ceca retinae at the ora serrata.

Layers of the retina. Moving inward along the path of incident light, the individual layers of the retina areas follows:

1. Internal limiting membrane (glial cell fibers separating the retina from the vitreous body).

2. Nerve fiber layer (axons of the third neuron).

3. Ganglion cell layer (cell nuclei of the multi polar ganglion cells of the third neuron; “data acquisition system”).

4. Inner plexiform layer (synapses between the axons of the second neuron. And dendrites of the third neuron).

5. Inner nuclear layer (cell nuclei of the bipolar nerve cells of the second neuron, horizontal cells, and amacrine cells).

6. Outer plexiform layer (synapses between the axons of the first neuron and dendrites of the second neuron).

7. Outer nuclear layer (cell nuclei of the rods and cones=first neuron).

8. Outer limiting membrane (sieve-like plate of processes of glial cells through which rods and cones project).

9. Layer of rods and cones (the actual photoreceptors).

10. Retinal pigment epithelium (a single cubic layer of heavily pigmented epithelial cells).

11. Bruch′s membrane (basal membrane of the choroid separating the retina from the choroid).

The retina is supplied by two vascular systems: The central retinal artery supplies the inner retina and the choriocapillaris supplies the retinal pigment epithelium and outer retina (consisting primarily of photoreceptors). The central retinal artery travels along the inferior margin of the optic nerve sheath and then enters the eye through the center of the optic nerve. The artery then branches in the inner retina to form three capillary layer. The retinal vessels provide blood to the inner retinal neurons. The avascular photoreceptor layer relies on the choriocapillaris lying beneath the retinal pigment epithelium to supply oxygen by diffusion. The choroid, a densely pigmented vascular sinusoidal plexus, originates from two ophthalmic artery branches: the short posterior ciliary arteries, which supply the posterior portion of the choroid, and the long posterior ciliary arteries, which supply the anterior choroid, ciliary body, and iris. The choroidal vasculature has three interconnected distinct layers: the innermost choriocapillaris, the intermediate Sattler’s layer, and the outermost Haller’s layer. It composes up to 85% of the blood volume in the eye [7, 8, 9].

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