18th edition

Vaughan & Asbury's GENERAL OPHTHALMOLOGY

Paul Riordan-Eva • Emmett T. Cunningham Jr.

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Vaughan & Asbury's General Ophthalmology

EIGHTEENTH EDITION

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. . . Now do you not see that the eye embraces the beauty of the whole world? It is the lord of astronomy and the maker of cosmography; it counsels and corrects all the arts of mankind; it leads men to the different parts of the world; it is the prince of mathematics, and the sciences founded on it are absolutely certain. It has measured the distances and sizes of the stars; it has found the elements and their locations; it . . . has given birth to architecture, and to perspective, and to the divine art of painting. Oh excellent thing, superior to all others created by God! . . . What peoples, what tongues will fully describe your true function? The eye is the window of the human body through which it feels its way and enjoys the beauty of the world. Owing to the eye the soul is content to stay in its bodily prison, for without it such bodily prison is torture.

Leonardo da Vinci (1452–1519)

This edition of
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Preface

For five decades, *General Ophthalmology* has served as the most concise, current, and authoritative review of the subject for medical students, ophthalmology residents, practicing ophthalmologists, nurses, optometrists, and colleagues in other fields of medicine and surgery, as well as health-related professionals. The eighteenth edition has been revised and updated in keeping with that goal. It contains the following changes from the seventeenth edition:

- Increased number of color illustrations, more available in the online version at accessmedicine.com
- New chapters on Ophthalmic Emergencies (3), Vision Rehabilitation (25), and Functional Vision Score (Appendix)
- Major revision of the tumors sections of Chapters 4 (Lids and Lacrimal Apparatus), 5 (Conjunctiva & Tears), 7 (Uveal Tract & Sclera), and 10 (Retina), of the sclera section of Chapter 7, and of Chapters 12 (Strabismus), 18 (Ophthalmic Genetics), 19 (Ophthalmic Trauma) and 24 (Low Vision)
- Reorganization of causes and prevention of vision loss into a single chapter (20).

As in past revisions, we have relied on the assistance of many authorities in special fields who have given us the benefit of their advice. We particularly thank David Albiani, Robert Campbell, William Edward, Debra Shetlar, Dhanes Thomas, Constance West and Jack Whitcher for their contributions to previous editions. We warmly welcome our new authors, Toby Chan, August Colenbrander, Zélia Corrêa, Walker Motley, Lisa Nijm, Carlos Pavesio, Adnan Pirbhai, Edward Pringle, Shefalee Shukla Kent, Gwen Sterns, and Reza Vagefi.

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Contents

Color plates follow page 466

Anatomy & Embryology of the Eye

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A thorough understanding of the anatomy of the eye, orbit, visual pathways, upper cranial nerves, and central pathways for the control of eye movements is a prerequisite for proper interpretation of diseases having ocular manifestations. Furthermore, such anatomic knowledge is essential to the proper planning and safe execution of ocular and orbital surgery. Whereas most knowledge of these matters is based on anatomic dissections, either postmortem or during surgery, noninvasive techniques—particularly magnetic resonance imaging (MRI), ultrasonography, and optical coherence tomography (OCT)—are increasingly providing additional information. Investigating the embryology of the eye is clearly a more difficult area because of the relative scarcity of suitable human material, and thus there is still great reliance on animal studies, with the inherent difficulties in inferring parallels in human development. Nevertheless, a great deal is known about the embryology of the human eye, and—together with the recent expansion in molecular genetics—this has led to a much deeper understanding of developmental anomalies of the eye.

I. NORMAL ANATOMY

THE ORBIT (FIGURES 1–1 AND 1–2)

The orbital cavity is schematically represented as a pyramid of four walls that converge posteriorly. The medial walls of the right and left orbit are parallel and are separated by the nose. In each orbit, the lateral and medial walls form an angle of 45°, which results in a right angle between the two lateral walls. The orbit is compared to the shape of a pear, with the optic nerve representing its stem. The anterior circumference is somewhat smaller in diameter than the region just within the rim, which makes a sturdy protective margin.

The volume of the adult orbit is approximately 30 mL, and the eyeball occupies only about one-fifth of the space. Fat and muscle account for the bulk of the remainder.

The anterior limit of the orbital cavity is the **orbital septum**, which acts as a barrier between the eyelids and orbit (see Eyelids later in this chapter).

The orbits are related to the frontal sinus above, the maxillary sinus below, and the ethmoid and sphenoid sinuses medially. The thin orbital floor is easily damaged by direct trauma to the globe, resulting in a "blowout" fracture with herniation of orbital contents into the maxillary antrum. Infection within the sphenoid and ethmoid sinuses can erode the paper-thin medial wall (lamina papyracea) and involve the contents of the orbit. Defects in the roof (eg, neurofibromatosis) may result in visible pulsations of the globe transmitted from the brain.

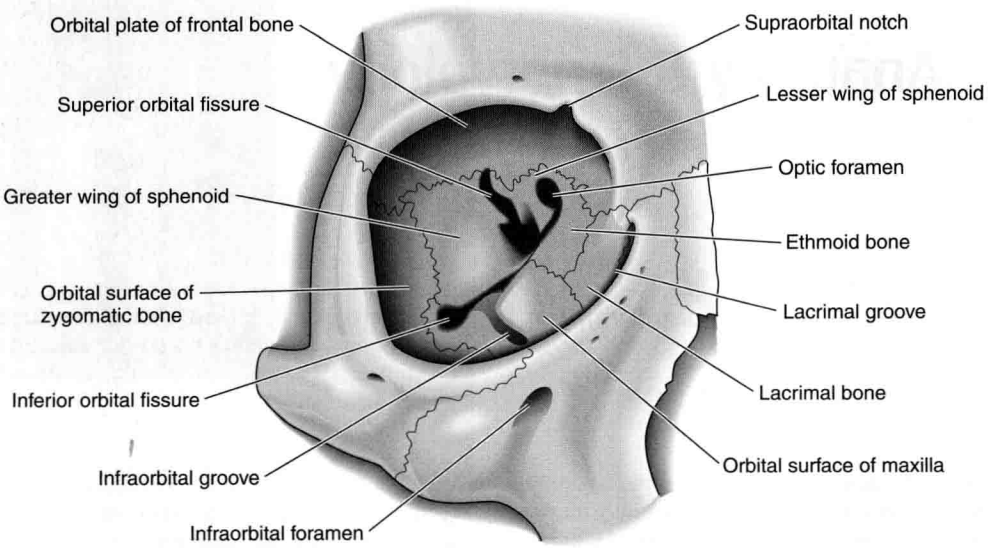
Orbital Walls

The roof of the orbit is composed principally of the orbital plate of the **frontal bone**. The lacrimal gland is located in the lacrimal fossa in the anterior lateral aspect of the roof. Posteriorly, the lesser wing of the **sphenoid bone** containing the optic canal completes the roof.

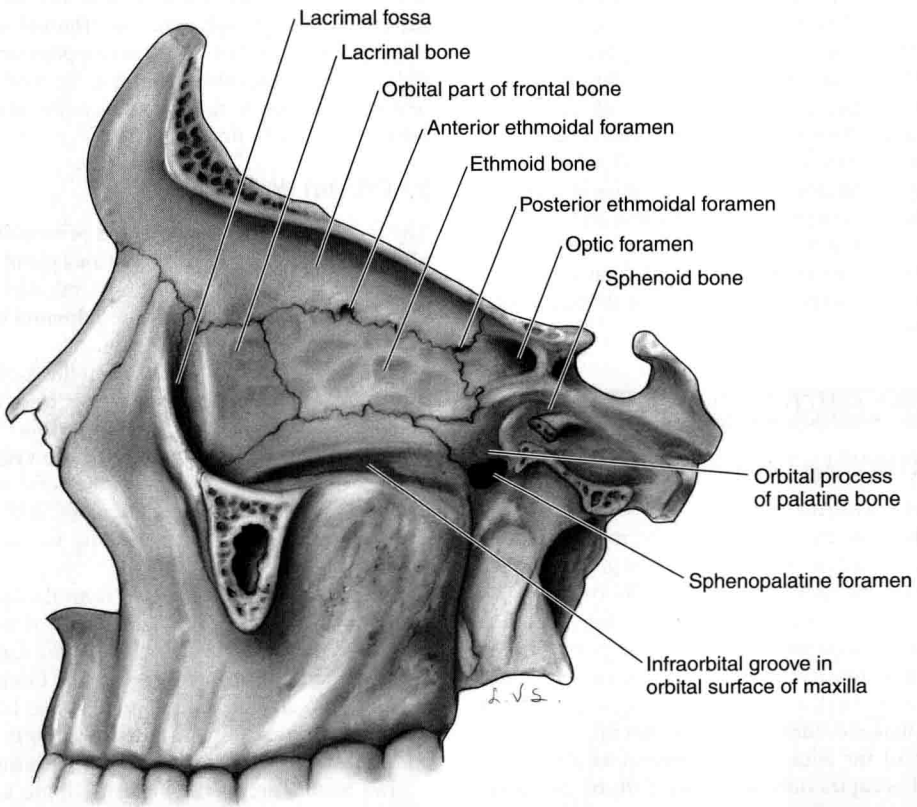
The lateral wall is separated from the roof by the superior orbital fissure, which divides the lesser from the greater wing of the sphenoid bone. The anterior portion of the lateral wall is formed by the orbital surface of the **zygomatic (malar) bone**. This is the strongest part of the bony orbit. Suspensory ligaments, the lateral palpebral tendon, and check ligaments have connective tissue attachments to the lateral orbital tubercle.

The orbital floor is separated from the lateral wall by the inferior orbital fissure. The orbital plate of the maxilla forms the large central area of the floor and is the region where blowout fractures most frequently occur. The frontal process of the **maxilla** medially and the zygomatic bone laterally complete the inferior orbital rim. The orbital process of the **palatine** bone forms a small triangular area in the posterior floor.

The boundaries of the medial wall are less distinct. The **ethmoid bone** is paper-thin but thickens anteriorly as it meets



▲ **Figure 1–1.** Anterior view of bones of right orbit.

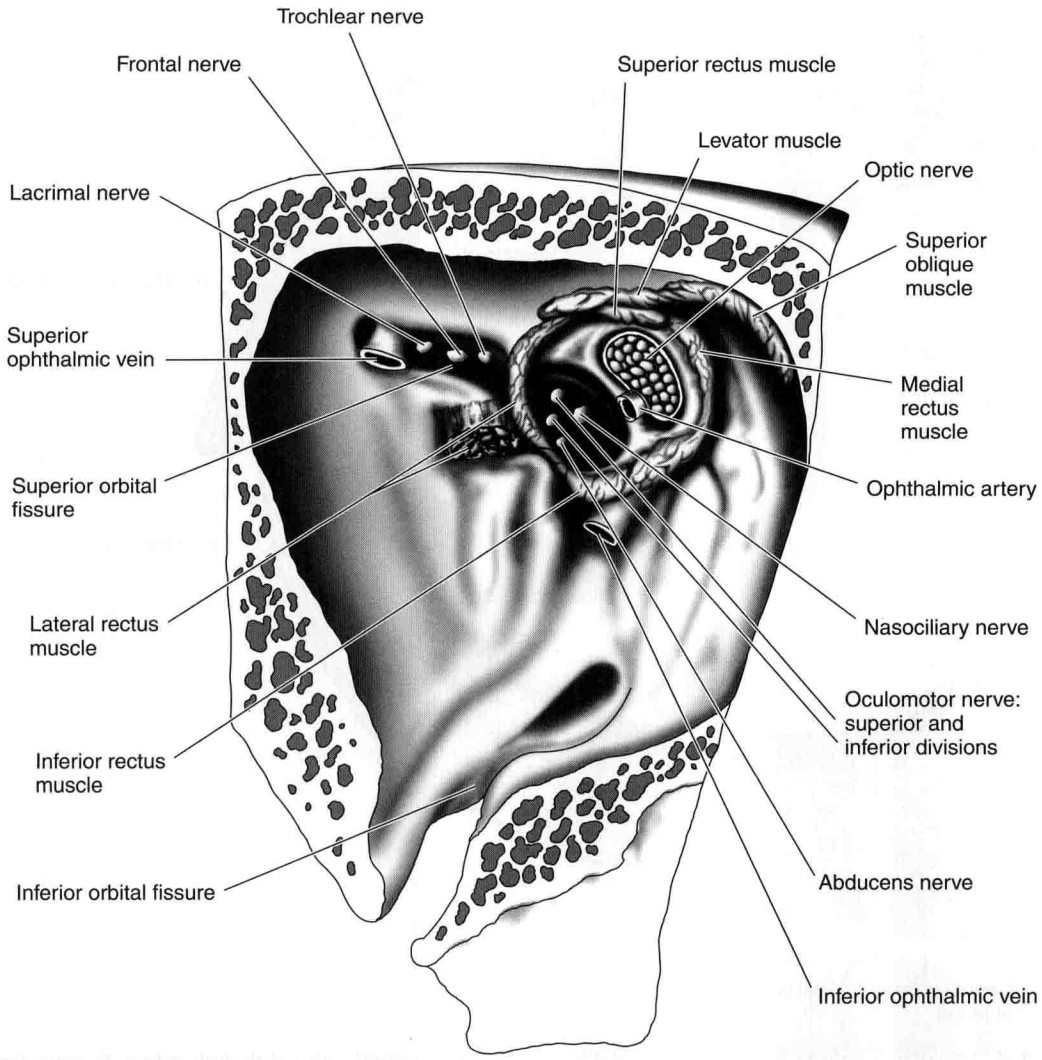


▲ **Figure 1–2.** Medial view of bony wall of left orbit.

the **lacrimal bone**. The body of the sphenoid forms the most posterior aspect of the medial wall, and the angular process of the frontal bone forms the upper part of the posterior lacrimal crest. The lower portion of the posterior lacrimal crest is made up of the lacrimal bone. The anterior lacrimal crest is easily palpated through the lid and is composed of the frontal process of the maxilla. The lacrimal groove lies between the two crests and contains the lacrimal sac.

Orbital Apex (Figure 1–3)

The apex of the orbit is the main portal for all nerves and vessels to the eye and the site of origin of all extraocular muscles except the inferior oblique. The **superior orbital fissure** lies between the body and the greater and lesser wings of the sphenoid bone. The superior ophthalmic vein and the lacrimal, frontal, and trochlear nerves pass through the lateral portion of the fissure that lies outside the annulus of Zinn. The superior and inferior divisions of the oculomotor nerve and the abducens and nasociliary nerves pass through the medial portion of the fissure within the annulus of Zinn. The optic nerve and ophthalmic artery pass through the optic canal, which also lies within the annulus of Zinn. The inferior ophthalmic vein frequently joins the superior ophthalmic vein before exiting the orbit. Otherwise, it may pass through any part of the superior orbital fissure, including the portion adjacent to the body

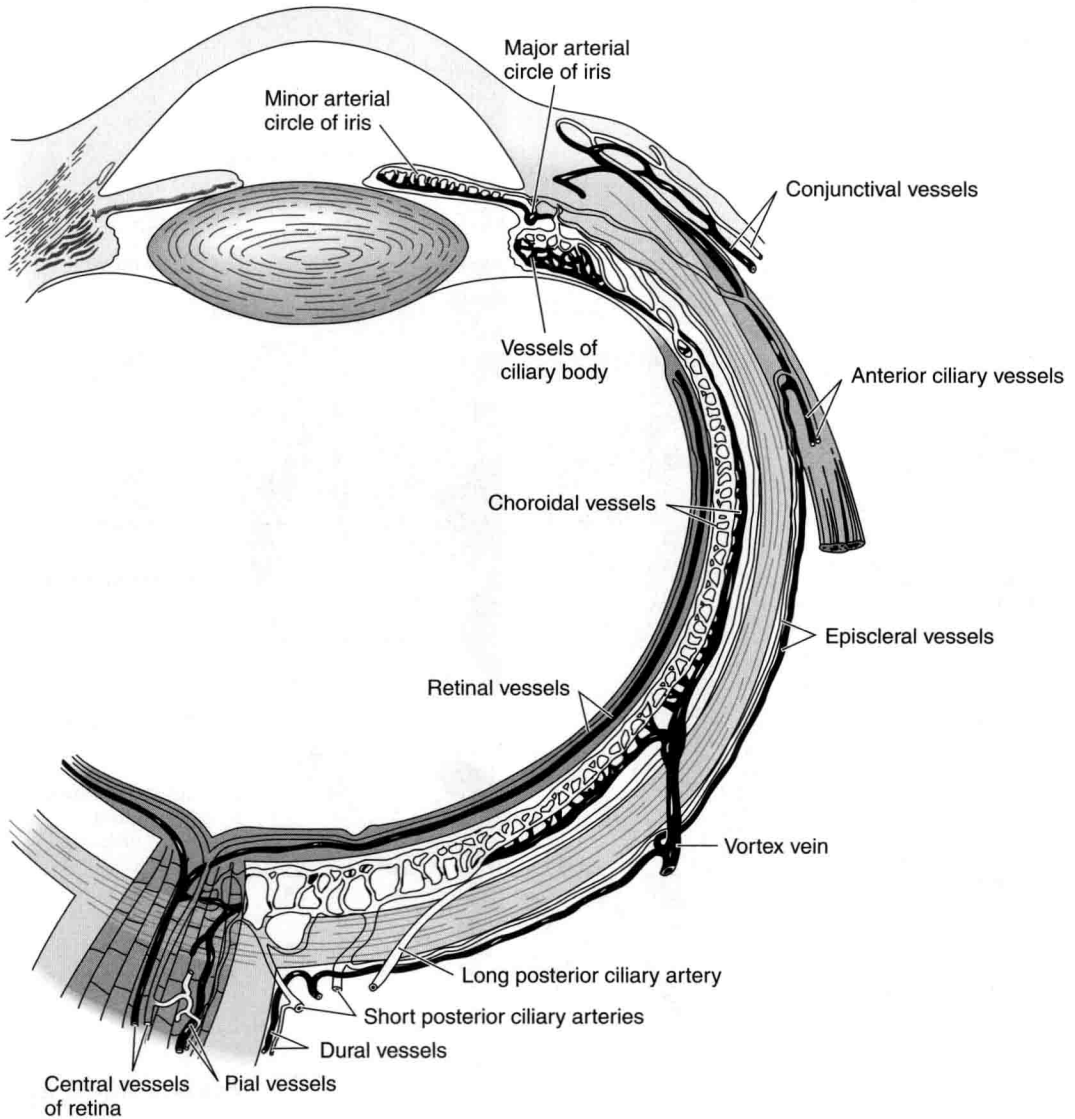


▲ **Figure 1–3.** Anterior view of apex of right orbit.

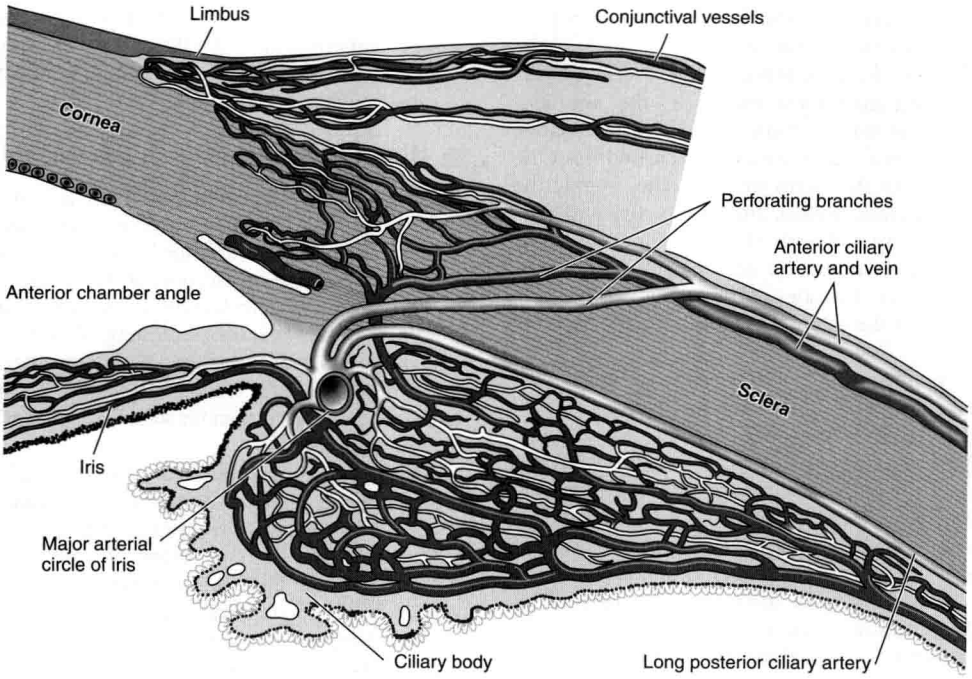
of the sphenoid that lies inferomedial to the annulus of Zinn, or through the inferior orbital fissure.

Blood Supply (Figures 1–4, 1–5, and 1–6)

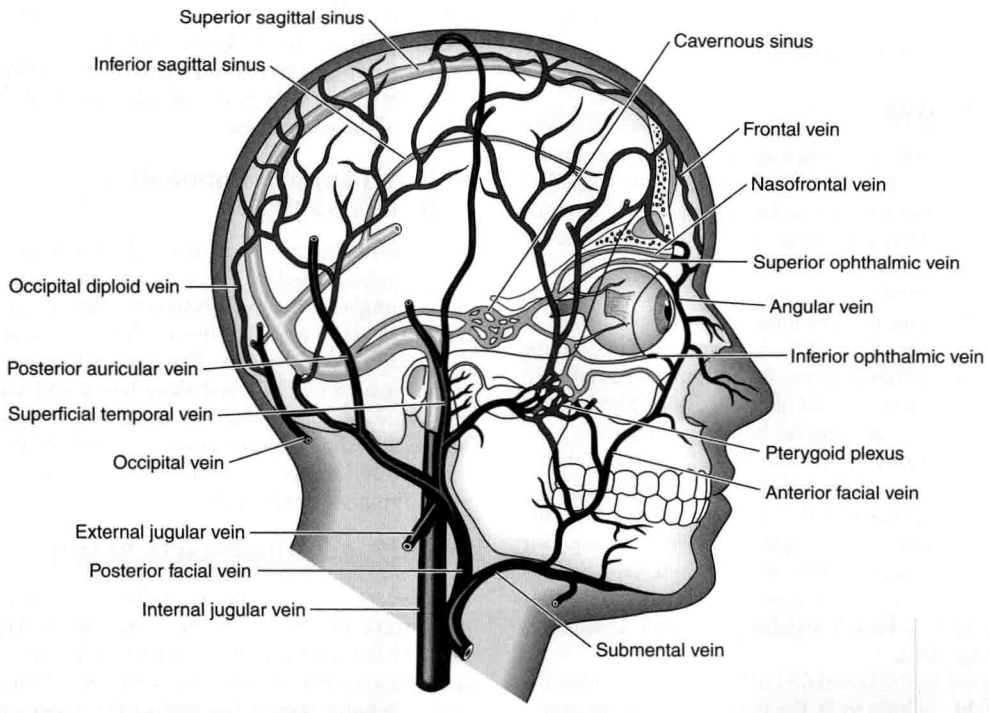
The principal arterial supply of the orbit and its structures derives from the ophthalmic artery, the first major branch of the intracranial portion of the internal carotid artery. This branch passes beneath the optic nerve and accompanies it through the optic canal into the orbit. The first intraorbital branch is the central retinal artery, which enters the optic nerve about 8–15 mm behind the globe. Other branches of the ophthalmic artery include the lacrimal artery, supplying the lacrimal gland and upper eyelid; muscular branches to the various muscles of the orbit; long and short posterior ciliary arteries; medial palpebral arteries to both eyelids; and



▲ **Figure 1–4.** Vascular supply to the eye. All arterial branches originate with the ophthalmic artery. Venous drainage is through the cavernous sinus and the pterygoid plexus.



▲ **Figure 1–5.** Vascular supply of the anterior segment.



▲ **Figure 1–6.** Venous drainage system of the eye.