Growth and Development of the Orbit

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KEYWORDS

• Development • Orbit • Aging

KEY POINTS

- The diagnosis and treatment of patients with orbital/periorbital abnormalities requires knowledge of congenital differences and awareness of the changes that occur as individuals age.
- Embryological development and migration of the eyes determines the formation of the surrounding orbital soft tissue and skeletal elements.
- Congenital anomalies of the orbit result from primary defects in the structural architecture of the bony orbit (eg, facial clefts and craniosynostosis) or as a result of defects in development of the eyeball (eg, anophthalmos) and surrounding soft tissues.
- The orbits complete half of postnatal development by age 2, and adult dimensions of the orbit are attained by age 7.
- The first signs of aging in the face become apparent in the late 20s and early 30s, and involve the skin and soft tissues of the face.
- Changes to the bony architecture have been recognized and described but no longitudinal studies using modern imaging technologies have been performed.

INTRODUCTION

Every surgeon operating on the face, and particularly around the eye, should possess a working knowledge of the critical details related to development of the human orbit and recognized changes that occur during the course of aging. The anatomy of the orbit and periorbital region is complex, and the diagnosis and treatment of patients with orbital/periorbital abnormalities requires expertise in congenital differences and awareness of the changes that occur as individuals age.

RELEVANT ANATOMY

Osseous Anatomy

The bones of the face are considered to hang from the skull, with attachments at the frontozygomatic, frontonasal, and frontoethmoidal sutures, and the sphenoid bone.

Seven bones contribute to the orbit:

1. Orbital process of the frontal bone
2. Lesser wing of the sphenoid bone
3. Orbital plate and frontal process of the maxilla
4. Zygoma
5. Orbital plate of the palatine bone
6. Lacrimal bone
7. Lamina papyracea of the ethmoid bone

Muscular Anatomy

The annulus of Zinn (**Fig. 1**) is a dense fibrous band of connective tissue with firm attachments to the periosteum of the orbital apex and the optic nerve sheath. The 4 rectus muscles of the eye arise from the annulus and insert 5.5 to 8 mm behind the limbus of the globe.[1] The inferior oblique muscle arises just lateral to the nasolacrimal duct ostium in the anterior orbit, whereas the superior oblique muscle arises just superior to the superior rectus

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http://dx.doi.org/10.1016/j.coms.2012.08.001
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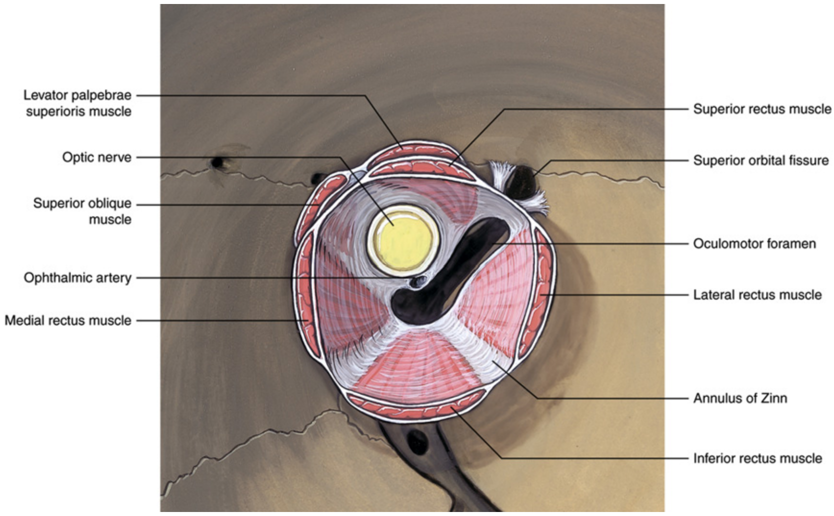

Fig. 1. Annulus of Zinn, anterior surface with origins of the extraocular muscles. (*From* Dutton JJ. Extraocular muscles. In: Dutton JJ, editor. Atlas of clinical and surgical orbital anatomy. 2nd edition. Elsevier; 2011. p. 29–49; with permission.)

muscle. The levator muscle arises from the lesser wing/body of the sphenoid bone.

DEVELOPMENT OF THE ORBIT

Influence of Eye Growth and Migration

Any discussion of orbit development would be incomplete without mention of the importance of the eye and ocular development. The development of the eyes determines the formation of the surrounding orbital soft tissue contents and the bony orbital walls. The growth and migration of the eyes play an important role in the shape and position of the orbits. Growth of the eyes, in particular, provides an expanding force that separates the neural and facial skeletons at the frontomaxillary and frontozygomatic sutures.

The eyeball is derived from surface ectoderm, neural ectoderm, neural crest tissue, and mesoderm. The retina is a direct outgrowth from the forebrain, projecting bilaterally as the optic vesicles. The neuroectodermal optic vesicles induce the overlying surface ectoderm to form the lens placodes. Meningeal ectomesenchyme, of neural crest origin, becomes the sclera, choroid, ciliary bodies, and cornea. Mesoderm invades the structure to form the vitreous body. The extrinsic muscles of the eye are derived from the prechordal somitomeres. Cutaneous ectoderm overlying the cornea form the conjunctiva. Ectodermal folds above and below the cornea become the eyelids.[2]

The eyeballs grow rapidly, and the orbits complete half of their postnatal growth during the first 2 years of life. The adult dimensions of the orbital cavities are usually attained by 7 years of age.[2] Dimensions of the adult orbit include an approximate volume of 30 mL, a lid skin to orbital apex depth of 5 cm, and an overall quadrangular pear shape sweeping toward the medially situated apex.[1] If the globe is absent or microphthalmic (seen in cases of radiation therapy for retinoblastoma), the orbit will fail to reach its normal volume.

FETAL DEVELOPMENT OF THE ORBIT

The scaffolding of the orbital bones is established within the first 2 months of embryogenesis.[3] Migration of neural crest cells over the face follows 2 routes, which meet in the area of the orbit (**Fig. 2**). The frontonasal anlage migrates over the prosencephalon, approaching the orbit from

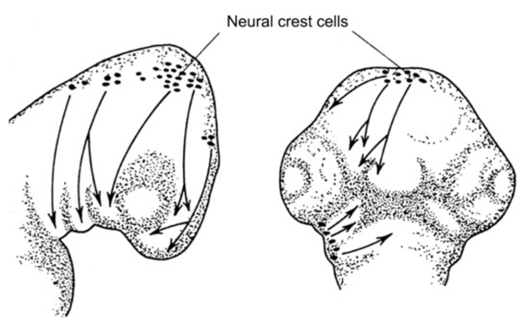

Fig. 2. Neural crest cells arise along the dorsolateral part of the neural tube and migrate ventrally to fill in the upper facial process in 2 waves. The frontonasal anlage migrates over the prosencephalon, whereas the maxillary wave migrates from caudal to cranial. (*From* Johnston MC. A radioautographic study of the migration and fate of cranial neural crest cells in the chick embryo. Anat Rec 1966;156:147; with permission.)