7.12.1. Lacrimal System: Anatomy, Development, and Physiology

Normal Anatomy

Secretory System

precorneal tear film has 3 layers

middle aqueous layer

sources

- main lacrimal gland
  - exocrine gland
  - superior lateral quadrant of the orbit
  - lacrimal gland fossa
  - lateral horn of levator aponeurosis divides lacrimal gland into 2 lobes
    - orbital lobe
    - palpebral lobe
  - superior transverse ligament (Whitnall ligament)
    - forms septa through the stroma of the gland
    - some fibers project onto the lateral orbital tubercle
  - major lacrimal ducts
    - 8–12
    - empty into the superior cul-de-sac
    - ≤ 5 mm above the lateral tarsal border
  - pass through the palpebral portion of the gland
    - removal of the palpebral lobe may reduce secretion from the entire gland
    - biopsy of the lacrimal gland is preferentially performed on the orbital lobe
- accessory lacrimal glands
  - exocrine glands
  - types
    - glands of Krause
      - deep within the superior fornix
    - glands of Wolfring
      - just above the superior border of the tarsus

types

- basal secretion
- reflex secretion
  - reflex tear arc
    - sensory (afferent) pathway
      - ophthalmic branch of the trigeminal nerve (CN V)
    - efferent pathway
      - superior salivatory nucleus of pons
        - parasympathetic fibers
        - exit brainstem with facial nerve (CN VII) (via nervus intermedius)
        - lacrimal fibers leave CN VII as the greater superficial petrosal nerve
          - pass to sphenopalatine ganglion
            - enter zygomaticotemporal nerve (branch of V2)
              - enter lacrimal nerve via an anastomosis (branch of V1)
                - enter lacrimal gland

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superficial oily layer

- produced by meibomian glands

deep mucin layer

- secreted by goblet cells within the conjunctiva

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Drainage System

puncta

- located medially on margin of both upper and lower eyelids
- lower puncta lie slightly farther lateral
- are slightly inverted and apposed to the globe within the tear lake
- ampulla
  - nasal mucosa is pseudostratified
  - lined with nonkeratinized, non–mucin-producing stratified squamous epithelium

lacrimal canaliculi

- run roughly 2 mm vertically from the punctum
  - turn 90°
    - continue 8–10 mm medially
      - join at the common canaliculus
        - valve of Rosenmüller
          - 10%
          - 1-way valve
          - prevent reflux of tears from the sac into the canaliculi
        - In some individuals there is a unique configuration in which 2 independent canaliculi lead to the lacrimal sac
        - bends from posterior to anterior behind medial canthal tendon before entering lacrimal sac at an acute angle

Figure 12-3 (© 2020 American Academy of Ophthalmology)

lacrimal sac

- bony lacrimal sac fossa
  - anterior medial orbit
  - anterior and posterior lacrimal crests
  - medial wall of the fossa
    - composed of the lacrimal bone posteriorly and the frontal process of the maxilla anteriorly
    - adjacent to middle meatus of the nose
      - sometimes with intervening ethmoid air cells
- medial canthal tendon
  - anterior and posterior crura
    - superficial head attaches to anterior lacrimal crest
    - deep head (with the Horner muscle), attaches to posterior lacrimal crest
    - wrap around the anterior and posterior aspects of the lacrimal sac
- dome of sac extends several millimeters above medial canthal tendon

angular artery and vein

- lie 7–8 mm medial to the medial canthal angle
- anastomose with vascular systems of face and orbit
- if cut during dacryocystorhinostomy, may cause troublesome bleeding

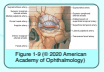
Figure 1-9 (© 2020 American Academy of Ophthalmology)

nasolacrimal duct (NLD)

- within the bony nasolacrimal canal
- 12–18 mm in length
  - intraosseous portion
    - 12 mm
  - meatal portion
    - 5–6 mm inferior to the bony ostium
- curves in an inferior and slightly lateral and posterior direction from the lacrimal sac
- opens into the nose under the inferior turbinate
  - inferior meatus
- mucosal ostium
  - partially covered by a mucosal fold (valve of Hasner)
  - located 30–35 mm from external nares

Physiology

tear evaporation

- 10% of tear elimination in young
- ≥20% in elderly

most of tear is actively pumped from tear lake by actions of the orbicularis oculi muscle

- blinking pushes the tears from lateral to nasal on the eyelid margin
- action of the orbicularis muscle on the canaliculi and the lacrimal sac also promotes drainage

Figure 12-4 (© 2020 American Academy of Ophthalmology)

- weakened blink interferes with normal pumping mechanism

Development

Secretory System

- lacrimal gland develops from multiple solid ectodermal buds (in anterior superolateral orbit)
- buds branch, canalize, and form ducts and alveoli
- lacrimal glands are small and do not function fully until approximately 6 weeks after birth
- newborn infants do not produce tears when crying

Drainage System

- end of fifth week of gestation
- forms as a furrow between nasal and maxillary prominence
- nasolacrimal groove
  - solid cord from ectoderm
    - cord canalizes, forming the NLD and the lacrimal sac
      - canalicular system is an outgrowth of the lacrimal sac
      - canalization of NLD is usually complete around time of birth
      - failure of opening of distal aspect of duct is the most common cause of congenital NLD obstruction
        - symptomatic in approximately 5% of infants at birth
          - excessive tearing may not occur until around age 6 weeks
          - patency usually occurs spontaneously within first few months of life
- lacrimation does not function normally until around age 6 weeks

Ophthalmology Mind Maps/Arman Mashayekhi, MD