Neurology of Lacrimation

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Relevant Cranial Nerves

- Trigeminal nerve (CN V) - sensory afferent and parasympathetic efferent
- Facial nerve (CN VII) - parasympathetic efferent
- Abducens nerve (CN VI), Glossopharangeal nerve (CN IX) - proximity to pathway
Trigeminal Nerve and Lacrimation

- Sensory afferent from cornea (esp. cold receptors in trigeminal axons of corneal epithelium) to trigeminal ganglion (adjacent to petrous temporal bone lateral to cavernous sinus near middle ear)

- Terminal branches distributes sympathetic and parasympathetic efferent to eye and adnexa
Parasympathetic Cranial Nerves

- **Oculomotor nerve (III)**
  - narrows pupil and focuses lens

- **Facial nerve (VII)**
  - tear, nasal and salivary glands

- **Glossopharyngeal nerve (IX)**
  - parotid salivary gland

- **Vagus nerve (X)**
Parasympathetic Efferent to Lacrimal Gland

- **Facial Nerve (CN V II) parasympathetic nuclei**
  - ⇒ Greater Petrosal nerve (petrous temporal bone)
  - ⇒ Nerve of Pterygoid Canal (with post ganglionic sympathetics)
  - ⇒ synapse in Pterygopalatine Ganglion (ventral periorbital region, near apex of orbit)
  - ⇒ Zygomatic nerve (CN V, maxillary division), and branches to Lacrimal nerve (CN V, ophthalmic division)
  - ⇒ Zygomaticotemporal nerve and Lacrimal nerve
  - ⇒ acinar cells of lacrimal gland

*postganglionic parasympathetics to nictitans gland undefined but presumably through zygomatic and infraorbital nn. which carry sympathetics to nictitans*
Parasympathetic nuclei
Caudal nasal nerve

Greater petrosal nerve and n. of pterygoid canal

Parasympathetic nuclei of CN VII

Zygomatic n.

Pterygopalatine ganglion
Efferent Arm of Lacrimation

Zygomaticotemporal n.

N. of pterygoid canal

Branches to periorbita

Lacrimal gland

Caudal nasal n.

Pterygopalantine ganglion

Lacrimal gland
Efferent Arm of Lacrimation and Nasal Secretion

- CN VII parasympathetic nuclei $\Rightarrow$ major petrosal nerve $\Rightarrow$ nerve of pterygoid canal (with sympathetic fibers) $\Rightarrow$ synapse on pterygopalatine ganglion $\Rightarrow$ caudal nasal nerve (maxillary division of CNV) to lateral nasal gland
Neurogenic KCS

- lesions along efferent arm of lacrimation pathway:
  - parasympathetic nucleus of facial nerve
  - main trunk of facial nerve
  - near geniculate ganglion
  - major petrosal nerve
  - nerve of the pterygoid canal
  - pterygopalatine ganglion
  - postganglionic parasympathetic fibers

- xeromycteria (dry nasal mucosa) common finding
Neurogenic KCS: Lesions in Petrous Temporal Bone

- Most commonly from otitis:
  - KCS
  - xeromyceteria

Parts of the Temporal Bone

- External auditory meatus
- Squamous portion
- Mastoid process (Petrour portion)
May have concurrent:
- neurotropic keratitis (CN V)
- anesthesia to eyelids (CN V)
- Horner syndrome
- facial n. paralysis (CN VII)
Neurogenic KCS: Lesions in Floor of Middle Fossa and Greater Petrosal Nerve (Cranial to Geniculate Ganglion)

- E.g. erosive or neoplastic lesions
- Similar findings to petrous temporal bone lesion (effects on CN V, Horner syndrome), but no facial nerve paresis/paralysis
Neurogenic KCS: Lesions in Extraperiobital Sheath and Pterygopalatine Ganglion

- E.g. temporal mm. myositis, cellulitis, abscesses from foreign body in orbit, dental apical abscesses, iatrogenic
- if preganglionic = KCS, xeromyceteria, anesthesia of eyelids
- if postganglionic = more likely to have KCS and anesthesia of eyelids with no xeromyceteria or vice versa
Neurogenic KCS: Lesions in Periobita and Zygomaticotemporal Nerve

- E.g. with orbital trauma
- KCS, periocular anesthesia without xeromycteria
Neurogenic KCS: Associated Findings

- Xeromycteria
- Horner syndrome
- Facial nerve paralysis
- Eyelid anesthesia
- Corneal anesthesia (neurotropic keratitis)
Diagnostic Principles in Neurogenic KCS

- Consider neurogenic KCS first if xeromyceteria
- Otoscopy in all cases of unexplained or unilateral KCS
- Schirmer tear test in all cases of otitis media/interna, Horner syndrome
- Examine eyelids and cornea for anesthesia in all cases of unexplained or unilateral KCS
Denervation Hypersensitivity and Lacrimal Gland

- Oral pilocarpine to maximum tolerable level:
  - 2 drops/2%/2x day/10kg in increasing dose until toxicity, then decrease to previous dose

- Some clinicians use topical pilocarpine

- *Add 2.5% phenylephrine once lacrimation induced...smooth muscle fibers under adrenergic control in lacrimal gland that express aqueous tears into ductules*
Major petrosal n.
Trigeminal n.
Abducens n.
Facial n.
Vestibular n.
Cochlear n.
Glossopharyngeal n.
Petrus Temporal Bone

- Pass through:
  - CN V
  - CN VII
  - CN IX
  - sympathetic fibers
  - parasympathetic fibers

- Proximity to:
  - trigeminal ganglion (rostral PTB)
  - CN VI (rostral PTB)

- Possible effects on:
  - lacrimation
  - nasal secretion
  - blinking
  - third eyelid retraction
  - eyelid and corneal sensation
  - pupil
  - salivary secretion
Petrous Temporal Bone Lesions (e.g. otitis media/interna)

- xeromycteria (CN VII)
- xerostomia (CN VII, CN IX)
- facial palsy (CN VII)
- facial and nasal cavity anesthesia (CN V)
- loss of taste (CN VII, CN IX)
- Horner syndrome
  - some idiopathic Horner syndrome and neurogenic KCS may be subclinical otitis media
Metaherpetic Syndrome
(Dr. David Maggs)

- HSV-1 or FHV-1 virally induced damage to trigeminal nerve axons or ganglion

- Reduced corneal sensation → reduced reflex tearing

- Reduced Schirmer tear test (which measures reflex tearing in response to strip), but noxious olfactory stimuli elicits lacrimation
Key Points from Lacrimation

- Parasympathetic efferent pathway:
  - CN VII nuclei ➔ greater petrosal nerve / nerve of pterygoid canal ➔ pterygopalatine ganglion ➔ branches of CN V ➔ lacrimal gland and nasal gland

- KCS + xeromyteria = neurogenic KCS until proven otherwise

- Concurrent signs may relate to CN V, CN VI, CN VII, CN IX, sympathetic efferents

- Knowledge of cranial nerves and their functions can be incredibly localizing in neuro-ophthalmology
The Cranial Nerves

- Olfactory nerve fibers (I)
- Optic nerve (II)
- Oculomotor nerve (III)
- Trochlear nerve (IV)
- Trigeminal nerve (V)
- Abducens nerve (VI)
- Facial nerve (VII)
- Vestibulocochlear nerve (VIII)
- Glossopharyngeal nerve (IX)
- Vagus nerve (X)
- Accessory nerve (XI)
- Hypoglossal nerve (XII)

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reflex tearing (think onions) parasympathetics to parotid salivary gland, sympathetics to eye pass briefly through CN IX

oculo-cardiac reflex reflexive turning of head (and gaze) from peripheral visual field stimuli mediated through rostral colliculi

Okapi (relative of giraffe)

Olfactory nerve fibers (I)
Optic nerve (II)
Oculomotor nerve (III)
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