The Lacrimal System

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Terms

• Etiology – the cause of a disease or abnormal condition

• Dacryocystitis – inflammation of the lacrimal sac

• Epiphora – watering of eyes due to excess secretion of tears or obstruction of the lacrimal passage
Tear Film Layers

What functions does each layer of the tear perform?

Lacrimal System: Tear Film Layers

What functions does each layer of the tear perform?

What are functions of tears?
Tear Components

- Lipid Layer – prevents evaporation
- Aqueous Layer - hydration
- Mucus Layer – sticks tear to the eye
- Other components

Lacrimal Apparatus

- Sometimes a person cannot produce natural tears they might need punctal plugs to prevent the tears from draining off the eye.
- Faucet
- Action
- Drain

Obstructive – vs. non-obstructive
Tear Production – Secretory

- Lacrimal gland
  - Reflex tearing
  - Too much tearing...epiphora
- Gland of Krause
  - Superior fornix
- Gland of Wolfring
  - Superior tarsal plate

Two Primary Forms of Dry Eye

The two primary forms of dry eye are Evaporative Dry Eye, also known as Meibomian Gland Dysfunction or MGD and Aqueous Dry Eye. The majority of dry eye sufferers have MGD.
Remember science class? Oil floats.

Oil does not mix with water, but rather sits on top of water.

Oil is what keeps water from evaporating.

### Table 1: Available over-the-counter lipid drops

<table>
<thead>
<tr>
<th>Lipid-based Eye Drop</th>
<th>Manufacturer</th>
<th>Active Ingredients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soothe XP</td>
<td>Bausch + Lomb</td>
<td>Light mineral oil (1.5%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mineral oil (4.5%)</td>
</tr>
<tr>
<td>Systane Balance</td>
<td>Alcon</td>
<td>Propylene glycol (0.6%)</td>
</tr>
<tr>
<td>Retaine</td>
<td>OCuSOFT</td>
<td>Light mineral oil (0.5%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mineral oil (0.5%)</td>
</tr>
<tr>
<td>Refresh Optive Advanced</td>
<td>Allergan</td>
<td>Carboxymethylcellulose sodium (0.5%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Glycerin (1%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Polysorbate 80 (0.5%)</td>
</tr>
</tbody>
</table>

**Need three volunteers**

**TEST TIME**

Lipid Secretion: Meibomian Glands

Left: Transillumination of eyelid showing meibomian glands

Right: Secretion of lipid at lid margin

- The lipid layer restricts evaporation to 5-10% of tear flow
  - Also helps lubricate

Mucin Secretion: Goblet Cells

Superficial layer of bulbar conjunctiva. Goblet cells violet, epithelial cells blue.

- Soluble mucins
  - Lower surface tension allowing tear film to spread over surface
Healthy Tears

- Antimicrobial proteins
- Growth factors & suppressors of inflammation
- Soluble mucin helps stabilize tear film
- Electrolytes for proper osmolarity (295-300)
  - pH slightly alkaline (7.4)

Anatomy

What function does the punctum have?
Anatomy and Physiology of the ocular adnexa

• Eyelids
• Eyebrows
• Eyelashes
• Accessory glands
• Lacrimal Apparatus

What is the opening between the upper and lower lid called?

Lacrimal Apparatus

• Lacrimal Apparatus
  – Lacrimal gland - located under the frontal bone at upper-outer angle of the orbit
  – Lacrimal canals/ducts (6-12)
  – Conjunctival sac
  – Puncta (um)...drainage ports (2 ea eye)
  – Canaliculi (us)
  – Lacrimal sac
  – Nasolacrimal duct - drains into the nose
Lacrimal Apparatus

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Causes of Tearing

- Punctal agenesis/stenosis
- Poor/blocked drainage
- Trichiasis...minor entropion
- Superficial foreign bodies
- Poor pump action
  - Eyelid mal-positions
  - Lid distraction/punctal laxity
  - Eyelid disease
- Tear deficiency /instability
  - Aqueous deficiency
  - Lipid deficiency
- Trigeminal nerve irritation

Causes of Tearing Cont...

- Foreign body sensation
- Hypersecretion
  - Lacrimal secretion and drainage imbalance
  - Primary or reflex tearing (reflex tearing is more common with ocular surface irritation)
- Lacrimal pump failure
- Lacrimal drainage obstruction
- Punctum location
- S/P Surgery (nasal too)
- Broke nose
Fluid Pools and Connections

• Pools
  – Eye
    • Lacrimal lake
  – Lacrimal Sac
  – Nose

A tear lake higher than 2mm indicative of obstruction

The Connections

• Connections
  – Lacrimal gland to the eye
  – From the eye to the lacrimal sac
  – From the lacrimal sac to the nose

Caniculitis can cause the blockage
What is in a blink?

- Lateral side higher than medial side
- Starts laterally and moves towards the medial and goes down the punctum
- The lid continues to close depressing the lacrimal sac and pushing tears towards the nasal duct
- This action also causes a suction for new tears

With Every Blink

- Cleansing
- Removal of old flora
- New fresh flora
- Draining of a tear
- Use of the lacrimal system
- Eye, nose, and throat
Meibomian Gland Dysfunction

#1 cause of Dry Eyes

Eyelid Disease

- Anterior blepharitis - lids
- Posterior blepharitis - glands
- Entropion
- Ectropion
- Droopy Eyelid Syndrome
- Cancer of the lids
- Cyst or lesions
- NLDO
Hypersecretion = Pump Failure

- Crocodile-tears Syndrome
- Gustatory
  Hyperlacrimation or Gustatory epiphora or Gustolacrimal reflex (could be congenital)
- Ocular Surface Irritation

Eyelid Positions

Disease:
- Trichiasis
- Entropion ... drain
- Ectropion ... drain
- Tear deficiency / instability
- Trigeminal nerve (5th CN) irritation
DEMODEX
Demodex = Parasitic Infection

- Can be found in adults and children
- Translucent sleeve around cilia
- Demodex can be found on the base of the eye lash and can be seen by using a microscope
- They live on the lash approximately for 4-6 weeks, so treatment has to last for 8 weeks to destroy the mites and their eggs. Eliminate the food source and mites die.
- Bolo for patient’s with Rosacea
- Mites are more active a night, medicate BID

Demodex mites are microscopic ectoparasites found in human skin. They are extremely common, and their rate of infestation increases with age. The life span of demodex outside the living body is very limited. Direct contact is thought to be required for transmission of the mites. The lifecycle of demodex from egg/molt to an adult is quite short and no longer than two to three weeks. The adult stage is less than a week, and this is when mating occurs.

http://optometrytimes.modernmedicine.com/optometrytimes/news/what-s-all-craze-about-demodex?utm_campaign=Sponsored+Resource+Center&utm_source=hs_email&utm_medium=email&utm_content=27975804&_hsenc=p2ANqtz-8RtgbCofC6qARW9k6ewHk5/PSW9_hGFvItzPR7Vsrnu2AogW9S5bq3r-20_X9FhLwJBAh9czpT-VtAoXgRqJKRKKx5_9djtnUw6_hsmn=27975804
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- Children have Demodex too
- Mites are more active a night, medicate BID

http://www.reviewofophthalmology.com/content/c/36411#.dpuf

Pinguecula  vs Pterygium

Little Penguin  Big Pterodactyl
Lacrimal Pump

- Pump Action
  - Lids
    - Lateral/medial
    - Muscles
    - Disease
  - Punctum
  - Canniculi
- Lacrimal Sac
- Nasolacrimal Duct
- Facial Nerve Palsy (7th CN)

Nasolacrimal Obstruction

- Primary Acquired Nasolacrimal Duct Obstruction (PANDO)
- Nasolacrimal examination
- Office testing
Stones

Chief Complaint Cont...

- Distinguish welling of tears from epiphora

- HPI = Onset, severity, consistency, frequency, nature of discharge, morning mucus, environmental factors, aggravating or alleviating factors

- Ask about punctal plugs

- Hx of broken nose, sinus surgery, and location of tears
Causes

- Anatomy
- Insufficient tear production
- Ocular surface disease
  - Demodex
- Meibomian Gland Dysfunction
- Improper blink rate
- Smoking
- Ceiling fans
- Medications (OTCs too)
- Chronic Diseases (thyroid, diabetes, etc...)
- Contact Lens Wear
- Ocular Surgery (CRS)

Clinical Presentation

- Chief Complaint
- History of present illness
- Past medical history
- Clinical examination
- Nasal Examination
Screening Questions

- Do activities like watching TV, looking at computers, reading a book make your eyes uncomfortable or hurt?
- Do you sleep under a ceiling fan or work/sit under a ceiling fan?
- Dry your eyes feel dry ever? In the morning or late evening?
- Do your eyes ever feel uncomfortable?
- Do you ever find yourself rubbing your eyes?

NLDO Test: Lacrimal Irrigation

- Nose inspections
- S-Tubes 3-4 months
- Jones Tubes
Nasal Lacrimal Duct Obstruction

• Correct through surgery called a DCR

• Stones in the lacrimal sac

• Stenosis of the punctum

Treatments

• Medications/artificial tears...moisture/oil

• Punctal Plugs

• Botulinum Toxin Injections into the lacrimal gland (pg 979)

• Surgery...lids, DCR, tubes
Is this possible? You be the judge

Gee-Whiz Facts

- Children don’t start tearing until they are 6 weeks old
- 5% of children have NLDO
- Prognosis is decreased in children after 13 months
- Congenital glaucoma can cause reflex tearing due to photophobia
Testing

- Florescein staining
- Schirmer Tear Quantity Tests (paper in 1901)
- Lissimine Green (conjunctival staining)
- TBUT (tear quality test)
- “SJO” Test (Sjogrens test)
- Tear Lab
- Lipi-flow
- RPS

Testing

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- “SJO” Test (Sjogrens test)
- Rose Bengal
Schirmer Testing

• The human eye maintains a stable level of moisture and eliminates foreign particles by producing tears. When your eyes are too dry or too wet, you may be given Schirmer’s test. This test will show whether your eyes produce too few or too many tears to maintain optimal eye health. Schirmer’s test is primarily used to diagnose dry eye conditions.

Schirmer 1 – dry strip

Schirmer 2 – anesthetic

• Schirmer’s test is also known as a dry eye test, tear test, tearing test, or Basal secretion test.

Schirmer Test Results

• If your eyes are healthy, each test paper should contain more than 10 millimeters of moisture. Less than 10 millimeters of moisture indicates that your eyes are dry. The diagnosis of dry eyes could mean that you have other health issues, such as rheumatoid arthritis or a bacterial infection. More tests will likely be required to diagnose the specific cause of your dry eyes. If your eyes produce far more than 10 to 15mm of moisture, further tests may also be required to determine the cause of your watery eyes.
Lissimine Green

• Staining is a really great way to identify surface defects

Causes of Excess Tearing

• a strong emotional response (crying)
• climate (including cold and/or windy weather)
• allergies
• infections
• blocked tear ducts
• complications from dry eyes
• irritation of the eye (from stray eyelashes or other debris)
• ingrown eyelashes
• relaxation of eye muscles (limits the eye’s ability to drain)
• the common cold
• pink eye (conjunctivitis)
• reactions to certain medications (antihistamines, eye drops, diuretics, sleeping pills, etc.)
Treatments

- Artificial tears
- Medications (Restasis, doxycycline, ...) pregnant!!
- Cyclosporine
- Azithromycin (Azasite) $$$
- Punctal Plugs
- Ammino grafts (Bio-Tissue)
- Lipi-flow
- Supplements (start early)
- Humidifiers
- Lid scrubs

Options: Drops, Gels, Ung, Sprays
New Treatments

- This requires a doctor’s Rx
- Ocular Lid Scrubs
- Avenova with neutrox
  - Hypochlorous acid has a killing capacity
  - Everyday lid care
  - Removes germs and bacteria
  - Stable for 3 years in glass bottle

Contact: Rhonda Schultheis 225-397-1335 rschultheis@novabay.com
Supplements For The Eyes

EyePromise EZ Tears Formulation

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
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<tr>
<td>Vitamin A - Retinyl Palmitate</td>
<td>1,000 IU</td>
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<tr>
<td>Vitamin D3</td>
<td>2,000 IU</td>
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<tr>
<td>Fish Oil EE 70%</td>
<td>1,480 mg</td>
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<tr>
<td>Total Omega 3's</td>
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<td>EPA</td>
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<tr>
<td>DHA</td>
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<td>Proprietary Blend (ingredients below)</td>
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<td>Evening Primrose Oil</td>
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<tr>
<td>Turmeric Extract</td>
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<tr>
<td>Green Tea Extract</td>
<td>50 mg</td>
</tr>
<tr>
<td>Mixed Tocotrienols/Tocopherols</td>
<td>20 mg</td>
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Learn More In One Course
-Than You’ve Learned All Year-

• Increase Your Dry Eye Standard of Care While Improving Your Profitability
• Get Real World Experience, That is Proven and Works
• Great for Practices Just Entering the Dry Eye Arena or Those looking to Go To The Next Level
• Open To M.D.s, O.D.s, Ph.D’s and Their Staff
• Great for Networking

Featured in:
Product Demonstrations • Diagnosing Made Easy • Defined Treatment Plans Implementation Plans for Efficiency • Training & Patient Education Manuals

Reference


• Images from EyelImaginations
Reference

- Endoscopic Surgery of the Orbit and Lacrimal System 2006...
  Acquired Nasolacrimal Duct Obstruction David M. Mills M.D., Dale R. Meyer M.D. FACS

Thank you to:
- Images from Eye Imaginations
- Reports: from ZeaVision
- Images from TearScience

Thank You

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