The Final Front Tear
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Objectives
1. Terminology related to dry eyes
2. Anatomy of the eye
3. Anatomy of the tear and impact on vision
4. Clinical evaluation of the ocular surface
5. Causes of dry eyes
6. Tear testing
7. Dry eye treatment

Terms
- Dry Eye
- Inflammatory Dry Eye
- Aqueous Insufficiency
- Evaporative Dry Eye
- Sjogrens Disease
- Keratitis Sicca
- Osmolarity

Terms
- AD Aqueous Deficiency
- DED – Dry Eye Disease
- DES – Dry Eye Syndrome
- DEWS – Dry Eye Work Shop
- DTS – Dysfunctional Tear System
- Lipid Insufficiency
- MDG – Meibomian Gland Dysfunction
- NLDO – Nasal Lacrimal Duct Obstruction
- OS – Ocular Surface
- OSD – Ocular Surface Disease
- OSDI – Ocular Surface Disease Index
- POTF – Pre-Ocular Tear Film
- SPEED – Standard Patient Evaluation of Eye Dryness

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

Industry Issues
- If left undiagnosed, this can cause complications with eye surgery
- Systemic diseases can exacerbate the issue
- Medications can cause a significant decline in the condition

Tech Evals in Pre-Screening

Terms

Anatomy
What function does the punctum have?

Terms

Punctum
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

- Corneal sensitivity
- Lacrimal gland

Innovation

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

- Faucet
- Action
- Drain

Obstruction 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

Tear Anatomy

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

Tear Anatomy

A complex mixture of proteins, mucins, and electrolytes coated by a lipid layer

The Impact Of Tears On Vision

- Refractive Status
- Health of the Cornea, the most refractive surface of the eye
- Visual Acuity
- Fluctuating vision

Lacrical System: Tear Film Layers

What functions does each layer of the tear perform?

What are functions of tears?

Lacrical System: Tear Film Layers

Dry Eye Exposed

Discover the Truth Behind Dry Eye
A Healthy Tear Film

A healthy tear film is comprised of 3 layers: Mucin, Aqueous, and Lipid.

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.

The Tear Film Structure in Our Eyes

The aqueous (water) layer provides natural lubrication and is produced by the lacrimal glands.

The Meibomian Glands

The Meibomian glands are located in the eyelids. Meibomian Glands & Blinking

When we blink the meibomian glands express the necessary protective oils; blinking stimulates the meibomian glands to secrete oils and spread a protective oil layer across the tear film. Blockages in the meibomian glands result in insufficient oil to coat the tear film. Blinking partially blinks the eyelids do not touch, so no pressure is applied on the meibomian glands to release these oils. Over time the oils harden in the glands and blockages develop.

LipiView II: Interferometer

LipiView II: Partial Blink Analysis

LipiView II: Dynamic Meibomian Imaging

Meibomian gland structure is assessed with Dynamic Meibomian Imaging (DMI). DMI produces three images: surface illumination, transillumination, and merged images to capture a comprehensive view of meibomian gland structure. If left untreated, the glands can shrivel, deteriorate, and the loss of glands is unlikely to be reversible. Failure to treat blocked glands is likely to lead to further structural compromise.
Current model of treatment is INTERVENTIONAL.
Future of MGD treatment must be PREVENTIVE.

Meibomian Gland Evaluator

Meibomian gland function is evaluated by assessing how glands respond to gentle force, imitating that of a deliberate blink.

- CLEAR OIL SECRETION: Glands are functioning using the MGE
- NO OIL SECRETION (BLOCKED): No oil is expressed using the MGE
- OPAQUE SOLID SECRETION: Glands not functional; requires more force than the MGE

Meiboma Grade

LipiFlow: Cross Section

Gentle pressure applied to outer eyelids.
Meibomian gland therapeutic heat directed towards inner eyelids.
Cornea shield protects surface of the eye.

While there are multiple choices available for treating MGD, LipiFlow® is the only FDA-cleared device for removing gland blockages and restoring gland function.

Through advances in the application of Vectored Thermal Pulsation (VTP®) technology, the LipiFlow® treatment utilizes a patented algorithm of heat applied to the inner eyelid and massage to remove the obstructions in your meibomian glands.

Need three volunteers

TEST TIME

Artificial Tears

- Artificial tears contain electrolytes – But they lack the complex mixture of proteins, mucins & other factors found in normal healthy tears
**Tear Components Review**

- **Lipid Layer** – prevents evaporation
- **Aqueous Layer** - hydration
- **Mucus Layer** – sticks tear to the eye (goblet cells)
- **Other components**

**Lipid Secretion: Meibomian Glands**

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

**Mucin Secretion: Goblet Cells**

- Soluble mucins – lower surface tension allowing tear film to spread over surface

**With Every Blink**

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

**Hypersecretion = Pump Failure**

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

**Eyelid Positions**

**Disease:**
- Trichiasis
- Entropion
- Ectropion
- Tear deficiency / instability
- Trigeminal nerve (5th CN) irritation

**Lacrimal Pump**

- Pump Action
  - Lids
  - Lacrimal gland
  - Muscle
  - Duct
t
- Canaliculi
- Lacrimal Sac
- Nasolacrimal Duct
- Facial Nerve Palsy (7th CN)

**What is in a blink?**

- Normal blink rate is 24k a day
- 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

**Partial blinking presents a significant problem**
Eye Anatomy

- Eye anatomy is critical for the eye to sustain its ability to remain properly saturated
- The anatomical structure of the iris is vital for proper tear production and drainage

Pinguecula vs Pterygium

Abnormal Corneal Endothelium

Primary Corneal Endotheliopathies

- Corneal guttata
- Fuch's endothelial dystrophy
- Posterior polymorphous dystrophy
- Iridocorneal endothelial syndrome
- Age-related changes in endothelial cell morphology

Specular Photomicrograph

- Normal corneal endothelium in a 21-year-old woman
- Normal endothelial cell density
- Normal rate of polymegathism
- No pleomorphism
- No corneal guttata

Clinical Evaluation

Stage 2 Fuch's Endothelial Dystrophy

Contact Lens-Induced Endotheliopathy

35-year-old woman with 20 years of full-time soft contact lens wear

Meibomian Gland Dysfunction
MiBo Thermoflo / LidPro

- Supplies continuous controlled heat to the outer skin of the eyelid using ultrasound gel for conduction of heat to the posterior lid where the Meibomian glands reside
- Clearing the scurf (staph) is important

LipiView/LipiFlow

Causes of Tearing

- Punctal agenesis
- Poor/blocked drainage
- Trichiasis
- Superficial foreign bodies
- Poor pump action
  - Eyelid mal-positions
  - Eyelid disease MGD is only one of them
- Tear deficiency or instability
- 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)
- Epiphora
- Lacrimal pump failure
- Lacrimal drainage obstruction
- S/P Surgery

Environmental Factors

- Clean house
- Bedding
- Wood floors
- Pollen
- Animal dander
- Dust mites
- Ceiling fans
- Air conditioner vents
- Yard work
- Iphones
- Computers
- TVs
- Reading
- Video games
- Sports

Causes

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

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 you eyes uncomfortable or hurt?
- Do your eyes feel dry ever? In the morning or late evening?
- Do you sleep under a ceiling fan or work/ sit under a ceiling fan?
- Do your eyes ever feel uncomfortable?
- Do you ever find yourself rubbing your eyes
Is this possible? You be the judge

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

Conjunctivitis
- The "infamous" pink-eye
- Numerous causes:
  - Bacteria
  - Viruses
  - Allergies
  - Toxic Reactions (chemicals)
  - Often difficult to diagnose exact etiology

Call it

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

What is the most accurate measure of intraocular pressure?

Eyelid Positions
- Trichiasis
- Entropion ... drain
- Ectropion ... drain
- Tear deficiency / instability
- Trigeminal nerve (Vth CN) irritation
- Lagophthalmos

What is a normal tear lake measurement?

Lacrimal Pump
- Pump Action
  - Lids
  - Lacrimal/nasal
  - Muscles
  - Disease
- Punctum
  - Caruncula
- Lacrimal Sac
- Nasolacrimal Duct
- Facial Nerve Palsy (Vth CN)

Anatomical Functional Issues
- Entropion
- Ectropion
- Punctal Stenosis
- NLDO
- Floppy Eyelid Syndrome
- Lid Trauma
- Nerve Innervations
- Lid Disease
Demodex

- 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
- Children have Demodex too
- Mites are more active at night, medicate BID

New Treatments

- Ocular Lid Scrubs
  - Hypochlorous acid has a killing capacity
  - Everyday lid care
  - Removes germs and bacteria
  - Stable for 3 years in glass bottle

Current Studies/Data

Evidence based medicine

DEWS Report

- Sponsored by The Tear Film & Ocular Surface Society
- The Ocular Surface, April 2007
- Dry eye grading scale: Levels 1 – 4
- Based on Ocular Surface Disease Index (OSDI)
- Level 1 dry eye recommendations: Education and environmental/dietary modifications, Elimination of offending systemic medications, Artificial tear substitutes, gels/ointments, Eye lid therapy
- Level 2 dry eye recommendations: If Level 1 treatments are inadequate, add: Anti-inflammatory agents, Tetacyclines (for meibomitis, rosacea), Pencical plugs, Secretagogues, Moisture chamber spectacles
- Level 3 dry eye recommendations: If Level 2 treatments are inadequate, add: Anti-inflammatory agents, Pencical plugs, Secretagogues, Serum, Contact lenses, Systemic immunosuppressives

DEWS Report

Table 3. Dry eye menu of treatments

- Artificial tear substitutes
- Gels/Ointments
- Moisture chamber spectacles
- Anti-inflammatory agents (topical CsA and corticonsteroide, omega-3 fatty acids)
- Tetacyclines
- Flap
- Secretagogues
- Serum
- Contact lenses
- Systemic immunosuppressives
- Surgery (AMT, MIG surgery transscleraphy, MM & SG transplant)

MGD Workshop

- Tear Film & Ocular Surface Society: Dr. Kelly Nichols, chairperson
- International Workshop - 50 dry eye experts
- Published in IOVS – 2011, volume 52, #4
- Dry eye grading scale: Stages 1 – 4
- Level 1 dry eye recommendations: Inform patient about MGD, the potential impact of diet and the effect of work/home environments on tear evaporation, and the possible drying effect of certain systemic medications.
- Level 2 dry eye recommendations: Advise patient on improving ambient humidity; optimizing workstations and increasing dietary omega-3 fatty acid intake.
Ocular Surface Disease Index (OSDI)

BOLO Non-Ocular Diseases

• RA-rheumatoid Arthritis
• HTN (high blood pressure)
• Thyroid
• Diabetes
• Fuch’s Disease
• Lupus
• Sjogren’s
• Leukemia
• Vitamin A deficiency
• Accutane

Risk Factors

• Age is #1
• Gender (Women)
• Chronic Systemic Disease
• Medications
• Environmental
• Anatomical
• CPAP Machines
• Contacts (CLIDE)

Medications BOLO

• Antihistamines
• Blood pressure meds
• Thyroid meds
• More...

*ask patients if they have recently started any new medication

Common Complaints

• Though is present, pt may not present with a chief complaint
• It is best to ask the question about dry eyes even if the patient does not volunteer
• Fluctuating vision
• Redness
• Painful
• Gritty
• Foreign body sensation
• Discharge
• Eyelid sticks
• Hard-to-open eyes
• Early in the a.m., or late in the evening, extra stress

Symptoms

• Redness
• Burning
• Watering eyes — Reflex tearing
• Itchy
• Foreign body sensation
• Discharge
• Excessive blinking
• Eye fatigue

Tear Balance

• Osmolarity and osmolality are units of solute concentration that are often used in reference to biochemistry and body fluids. Learn what osmolarity and osmolality are and how to express them.

• Both osmolarity and osmolality are defined in terms of osmoles. An osmole is a unit of measurement that describes the number of moles of a compound that contribute to the osmotic pressure of a chemical solution.

Dry Eye Syndrome/Disease

• Approximately 25% of all visits to Eye Care Professionals
• Up to 40 million Americans have symptoms or risk
• Dry eye increases with age
• 5.7% of women under age 50 (3.2 million)
• 14.6% of patients age 65 and older (post menopausal)
• 9.8% of women age 75 and older
• Despite prevalence, dry eye remains under-diagnosed

Meibomian Gland Dysfunction

• Chronic, diffuse abnormality of the meibomian glands characterized by terminal duct obstruction and/or quality or quantity changes in glandular secretions.
• May result in alteration of the tear film, symptoms of eye irritation, clinically apparent inflammation, and ocular surface disease.
• Approximately 75% of dry eye is MGD related
Contact Lens Wearers and Dry Eye

- Recent studies estimate that the frequency of contact lens related dry eye is about 50%.[1]
- Approximately 77% of patients discontinue contact lens wear at one time or another due to discomfort.[2]
- 16% of contact lens wearers stop wearing contact lenses, representing an annual revenue loss of $275 per patient, $45,000 per year for the typical practice.[3]

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

- Schirmer Tear Quantity tests (paper in 1901)
- Lissimine Green (conjunctival staining)
- TBUT (tear quality test)
- Tear Lab
- Lipi-flow
- RPS
- "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’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, decongestants, sleeping pills, etc.)

Treatments

- Artificial tears
- Medications (Restasis, doxycycline, ... pregnant!!!)
- Cyclosporine
- Azithromycin (Azasite) $55
- Punctal Plugs
- Amniotic grafts (Bio-Tissue)
- Lipi-flow
- Supplements (start early)
- Humidifiers
- Lid scrubs

Options: Drops, Gels, Ung, Sprays
EyePromise EZ Tears Formulation

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
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<tbody>
<tr>
<td>Vitamin A (as retinal palmitate)</td>
<td>1,000 IU</td>
</tr>
<tr>
<td>Fish Oil EE 70%</td>
<td>1,480 mg</td>
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<tr>
<td>Total Omega 3s</td>
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<td>EPA</td>
<td>560 mg</td>
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<tr>
<td>DHA</td>
<td>440 mg</td>
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<tr>
<td>Proprietary Blend</td>
<td>220 mg</td>
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<tr>
<td>Evening Primrose Oil</td>
<td>100 mg</td>
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<tr>
<td>Turmeric Extract</td>
<td>50 mg</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>
</tr>
</tbody>
</table>

What Are Omega-3 Fatty Acids?

- Considered essential fatty acids
- We need them in our body for it to work
- They are not made naturally in our body so we need to get it from our diet
- All omega-3s are not the same

Health benefits:
Reducing inflammation in blood vessels and joints

Vitamin A

A fat soluble vitamin that is essential for corneal surface health, as well as mucosal, conjunctival, Meibomian, and lacrimal gland health. It is needed in genes and cells that express mucin (a polysaccharide) of major importance in one of the three tear layers.

Vitamin D3

A fat soluble vitamin, aka cholecalciferol, which is the from of vitamin D that our bodies make from exposure to sunlight (UVB), it also usually comes from meat and fish. Vitamin D3 aids in building up your immune system and aids in systemic inflammation.

Vitamin E (d-alpha tocopheral)

A fat soluble vitamin that is essential for reduction of systemic and ocular inflammation, also important in stabilizing omega-3 fatty acids.

Supplements For The Eyes

Dry Eye Patient Study

- 56 Subjects
  - 96% described symptoms as moderate to severe

Results:
- 86% reported symptomatic relief at 4 weeks
- 93% reported no after taste
- 89% reported little or no GI side effects
- All patients were able to take the softgels

EZ Tears Contact Lens Comfort Study

- 95 Patients
  - 89% of patients reported improved contact lens comfort in 4 weeks
  - 32% saw improvement in hours per day of comfort (avg. 2.2 hours)
  - 45% reduction in contact lens removal
  - 11-13 day average onset of improved contact lens comfort
  - 85% of patients said they would likely continue taking EZ Tears
  - 91% said they would recommend EZ Tears to others

Results:
- Significant improvement in comfortable wear
- Extended hours of comfortable wear
- Reduced artificial tear usage

EZ Tears Contact Lens Comfort Study

- 75% wear 2 weeks
- 82% wear 3 weeks
- 89% wear 4 weeks
ONIT Clinical Study
Ocular Nutrition Impact on Tear Film
- IRB reviewed & approved
- FDA registered trial (clinicaltrials.gov)
- Study Investigators
  - Dr. Bruce Koffler (Ophthalmologist)
  - Dr. Rob Davis (Optometrist)
  - Dr. Sean Mulqueeny (OD: Principal Investigator)
- Currently enrolling patients

ONIT Clinical Study
Ocular Nutrition Impact on Tear Film
- 80 patients
- Objective: To determine whether EyePromise EZ Tears benefits patients with dry eye.
- Baseline, 1, 4, 8 week follow-up
- Patient Inclusion Criteria (Must Meet 4 of 7 criteria)
  - Tear Osmolarity
  - OSDI Survey
  - Tear breakup time
  - Corneal Staining
  - Conjunctival Staining
  - Tear Meniscus Height
  - Phenol red thread

Start-up Kit
- Free to ECP’s
  - Coupons
  - Product Samples
  - Brochure holders
  - Staff Training
  - Patient Education materials
  - Print & web

Patient Brochures
- Dry Eye
- AMD
- Visual Performance
- Brand Specific Brochures

Identify Patients With Dry Eye
OSDI Survey Form
Key Reminder:
Up to 50% of Contact Lens Wearers experience Contact Lens Induced Dry Eye (CLIDE)

Benefit To The Practice
- $700-$800 per pt per year
- Potential $200,000 per year
- Ophthalmology treating

Reference Material
- ZeaVision
- Allergan
- Wikipedia

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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