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
- 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

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
- OSD - Ocular Surface Disease
- OSDI - Ocular Surface Disease Index
- POTF – Pre-Ocular Tear Film
- SPEED – Standard Patient Evaluation of Eye Dryness
- Expression

Industry Issues
- Patients are leaving the office undiagnosed in too many cases
- If left undiagnosed, this can cause complications with eye surgery
- Patients are not volunteering the necessary information
- Systemic diseases can exacerbate the issue
- Staff members are not asking the necessary questions
- Medications can cause a significant decline in the condition
Anatomy

- Iris
- Pupil
- Sclera

What function does the punctum have?

Lacral Apparatus

- Corneal sensitivity
- Lacrimal gland innovation

5th Cranial Nerve - Trigeminal

Tech Evals in Pre-Screening

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?

Lacral 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

Light enters the eye through the pupil. The colored iris, which is made of muscle fibers, contracts or dilates (open or close) when light is brighter or dimmer. The lacrimal gland, located behind the upper lid, produces tears that keep the eye lubricated and clean.

Figure 1.
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

Lacrimal System: Tear Film Layers

What functions does each layer of the tear perform?
What are functions of tears?

Lacrimal System: Tear Film Layers

- Oil
- Aqueous
- Mucus

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.

Oil & Water

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 layer is protected by the lipid layer that is produced by the meibomian glands located in the eyelids.

The Meibomian Glands

The meibomian glands are located in the eyelids.

Meibomian Glands & Blinking

Blinking stimulates the meibomian glands to secrete oils and spread a protective oil layer across the tear film. When we partially blink the eyelids do not touch, so no pressure is applied at the meibomian glands to release these oils. Over time the oils harden in the glands and blockages develop.
LipiView II: Interferometer

**Avg LLT 25 nm**

- 50% chance of MGD

**Avg LLT 90 nm**

- 50% chance of MGD

**Figures are represented in nanometers (nm).**

**Avg LLT – Average Lipid Layer Thickness (LLT) in nanometers (nm). Number less than 90 indicates increased probability for MGD.**

LipiView II: Partial Blink Analysis

- A decrease in lipid layer thickness is associated with incomplete blinking.
- Increase in visual fatigue is associated with incomplete blinking.
- Presence of partial blinks greater than 40% of total blinks is considered contributory to dry eye condition.
- If partial blinking is present, patient education and blink training should be considered.

LipiView II: Dynamic Meibomian Imaging

Meibomian gland structure is observed with Dynamic Meibomian Imaging (DMI). DMI produces three images (surface illumination, transillumination, and merged) to capture a comprehensive view of meibomian gland structure.

If left untreated, the glands can shrink and deteriorate. The loss of glands is unlikely to be reversible. Failure to treat blocked glands is likely to lead to further structural compromise.

**Figures are shown below:**

- **Surface Illumination**
- **Transillumination**
- **Merged (Surface + Transillumination)**

Intervention & Prevention

**Upper Eyelid**

- **Meibomian Glands Over Time**

**Prevention**

**Intervention**

Current model of treatment is interventional.

Future of MGD treatment must be preventative.

Meibomian Gland Evaluator

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

**Figures are shown below:**

- **Clear Oil Secretion**
- **No Oil Secretion (Blocked)**
- **Opaque Solid Secretion**

MeiboGrade

**MGE Score**

- 1.0 mm: Normal Function
- 0.8 mm: Mild Dysfunction
- 0.6 mm: Moderate Dysfunction
- 0.4 mm: Severe Dysfunction

**Lipid Layer Thickness**

- Normal: 0.8 mm or thicker
- Abnormal: Less than 0.8 mm

**Gland Drop Out**

- Compromised gland structure indicates chronic MGD.

**Gland Duct Dilatation**

- Progressive dilatation of gland ducts indicates chronic MGD.
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 eyelids and massage to remove the obstructions in your meibomian glands.

**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**

**LipiFlow Treatment Cross Section**

Need three volunteers

**TEST TIME**

**Tear Components Review**

**LipiFlow Treatment Cross Section**

**Artificial Tears**

**Meibomian Gland Evaluator**

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

**Meibomian Gland Function**

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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

With Every Blink

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

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

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
• Ectropion
• Tear deficiency / instability
• Trigeminal nerve (5th CN) irritation

Lacrimal Pump

• Pump Action
  – Lids
    • Lateral/medial
  – Muscles
  – Disease
  – Punctum
  – Canniculli
• Lacrimal Sac
• Nasolacrimal Duct
• Facial Nerve Palsy (7th CN)
Eye Anatomy

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

Pinguecula vs Pterygium

Abnormal Corneal Endothelium

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

Primary Corneal Endotheliopathies

Specular Photomicrograph

- Normal corneal endothelium in a 21-year-old woman
- Normal endothelial cell density
- Normal rate of polymegethism
- 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

http://www.mibomedicalgroup.com/mibovideo/mibothermoflo_intro/mibothermoflo_intro.mp4

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
  - 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 you eyes uncomfortable or hurt?
- 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

**Hypersecretion = Pump Failure**

- Crocodile-tears Syndrome
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- Ocular Surface Irritation

**Eyelid Positions**

**Disease:**
- Trichiasis
- Entropion ... drain
- Ectropion ... drain
- Tear deficiency / instability
- Trigeminal nerve (5th CN) irritation
- Lagophthalmos
**Lacrimal Pump**

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

**Anatomical Functional Issues**

- **Entropion**
- **Ectropion**
- **Punctal Stenosis**
- **NLDO**
- **Floppy Eyelid Syndrome**
- **Lid Trauma**
- **Nerve Innervations**
- **Lid Disease**

**Demodex**

**New Treatments**

- **Ocular Lid Scrubs**
- **Avenova with neutrox**
  - Hypochlorus acid has a killing capacity
  - Everyday lid care
  - Removes germs and bacteria
  - Stable for 3 years in glass bottle

Contact: Rhonda Schuletes 225-397-1335

**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, Tetracyclines (for meibomianitis, rosacea), Punctal plugs, Secretagogues, Moisture chamber spectacles

Table 3. Dry eye menu of treatments

- Artificial tears substitutes
- Gels/Ointments
- Moisture chamber spectacles
- Anti-inflammatory agents (topical CsA and corticosteroids, omega-3 fatty acids)
- Tetracyclines
- Plugs
- Secretagogues
- Serum
- Contact lenses
- Systemic immunosuppressives
- Surgery (AMT, lid surgery, tarsorrhaphy, 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

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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 70% of dry eye is MGD related

Compliments of ZeaVision
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. (compliments of ZeaVision)

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

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, diuretics, sleeping pills, etc.)

Treatments

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

Options: Drops, Gels, Ung, Sprays

Supplements For The Eyes

EyePromise EZ Tears Formulation

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A Retinyl Palmitate</td>
<td>1,000 IU</td>
</tr>
<tr>
<td>Vitamin D3</td>
<td>2,000 IU</td>
</tr>
<tr>
<td>Fish Oil EE 70%</td>
<td>1,480 mg</td>
</tr>
<tr>
<td>Total Omega 3’s</td>
<td>1,100 mg</td>
</tr>
<tr>
<td>EPA</td>
<td>590 mg</td>
</tr>
<tr>
<td>DHA</td>
<td>440 mg</td>
</tr>
<tr>
<td>Proprietary Blend</td>
<td>220 mg</td>
</tr>
<tr>
<td>Evening Primrose Oil</td>
<td>100 mg</td>
</tr>
<tr>
<td>Turmeric Extract</td>
<td>50 mg</td>
</tr>
<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 (as retinal palmitate)

- 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 form 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.

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

- 90 Patients
  - Results:
    - 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 were likely to 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
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
  Tear breakup time
  Conjunctival Staining
  Corneal Staining
  Tear Meniscus Height
  Phenol red thread

EyePromise
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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