DRY EYE IN CL PRACTICE

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Because dry eye is so prevalent among contact lens wearers, eyecare practitioners must stay up to date with the latest research and the newest products.
DRY EYE AND THE TEAR FILM

Complete tear film is essential to:

1. Ocular health
2. Optical performance of the eye
3. Successful Contact Lens Wear
But Doc, I am an eagle: I can't be seen wearing glasses... Can't you prescribe contact lenses?
PURPOSE OF TALK

- Overview of Tear Film
- Impact of CL Related Dry Eye
- Definition & Classification of Dry Eye
- Neurophysiology of Tear Secretion
- Mechanisms of Ocular Surface Disease
- Diagnosing Dry Eye
- Issues of Comfort
  - Tear Film & Contact Lenses
  - Effect of CL Materials
  - Lens Care Systems
- Treatment
NORMAL TEARFILM
An epithelial cell is like a goldfish...
You must maintain a delicate balance in the surrounding environment for it to survive

- Amino acids
- Temperature
- Oxygenation
- Glucose
- pH
- Shearing forces
- Nutrients
- Osmolarity
- Hydration

Mark B Abelson
2005
DYSFUNCTIONAL TEAR FILM

TEAR FILM

Aqueous diffuses away from corneal surface

Damaged corneal surface

Damaged corneal cells show up as dry spots during corneal staining
The Impact of CL Related Dry Eye
What is the Impact of CL-Related Dry Eye?

- Approximately 50% of CL wearers report to experience dry eye symptoms (Nichols 2005)
- CL wearers experience dry eye symptoms
  - $12 \times >$ than clinical emmetropes
  - $5 \times >$ than spectacle wearers (Nichols 2005)
What is the Impact of CL-Related Dry Eye?

- 24% of all subjects who had some experience with contact lenses had *permanently* discontinued contact lens wear.
- 26% of current wearers were dissatisfied with contact lens wear.
- Dissatisfied lens wearers tend to be female while those who discontinued tend to be male.
- Age when starting cl wear NB determinant of future satisfaction and continuation with lens wear.
- Symptoms of *dryness and discomfort* are leading causes of decreased contact lens wear time or cl discontinuation. (Nichols 2005)
Dry Eye

Definition & Classification
Definition (DEWS 2007)

- Dry eye is a disorder of the tear film due to tear deficiency or excessive evaporation which causes damage to the interpalpebral ocular surface and is associated with symptoms of ocular discomfort (NEI 1995).
- Dry eye is a multifactorial disease of the tears and ocular surface that results in symptoms of discomfort, visual disturbance, tear film instability with potential damage to ocular surface. It is accompanied by increased osmolarity of the tear film and inflammation of the ocular surface (DEWS 2007).
OSD – Classification
DEWS 2007

DRY EYE

AQUEOUS DEFICIENT
- Sjörgen Syndrome
  - Primary
  - Secondary
- Non-Sjörgen Syndrome
  - Lacrimal Deficiency
  - Lacrimal Gland Duct Obstruction
  - Reflex Block
  - Systemic Drugs

EVAPORATIVE
OSD – Classification
DEWS 2007

**Dry Eye**
- **Aqueous Deficient**
- **Evaporative**
  - **Intrinsic**
    - Meibomian Gland Deficiency
    - Disorders of Lid Aperture
    - Low Blink Rate
    - Drug Action
      - Accutane
  - **Extrinsic**
    - Vit A Deficiency
    - Topical Drug Preservative
    - Contact Lens Wear
    - Ocular Surface Disease
      - EG Allergy
OSD – Classification

Effect of the Environment

Milieu Interior
- Low Blink Rate
  - VTU
  - Wide lid aperture
- Aging
- Low androgen pool
- Systemic Drugs
  - Antihistamines
  - Beta-blockers
  - Anti-spasmodics
  - Psychotropic drugs

Milieu Exterieur
- Low Relative Humidity
  - Natural environment
  - Airconditioning
  - Aircrafts
- High wind velocity
- Occupational environment

Pathological vs. Marginal
NEUROPHYSIOLOGY

Of

TEAR SECRETION
The Healthy Eye

Normal tearing depends on a neuronal feedback loop

Lacrimal Glands

Tears Support and Maintain Ocular Surface

Secretomotor Nerve Impulses

Ocular Surface Neural Stimulation
Lacrimal Gland Function Unit (Stern et al. 1998)

- LFU composed of the lacrimal glands (both main and accessory), the ocular surface and the interconnecting innervation.
- Stimulation of sensory fibers from cornea results in the generation of afferent nerve impulses through the ophthalmic branch of the Trigeminal Nerve (V).
- These impulses travel through the trigeminal ganglion and on to the mid-brain (pons) where they synapse and the signal is integrated with cortical and other neural input.
Lacrimal Gland Function Unit

- The efferent branch of the loop sends fibers through the pterygopalatine ganglion to the main and accessory (Wolfring and Krause) lacrimal glands (Stern et al., 1998).
- There is some belief that the nerve endings found around the meibomian glands and conjunctival goblet cells also travel this route (LeDoux et al., 2001 and Diebold et al., 2001).
- This lends credence to the concept that the three major tear film components (mucin, aqueous and lipid) are secreted to the ocular surface in a controlled and coordinated fashion.
Neurophysiology of Tear Secretion

- The *rate* of lacrimal gland fluid secretion is controlled primarily by the parasympathetic system, with modulation by sympathetic system.

(Mircheff (1989) and Lamberts (1994))
Neurophysiology of Tear Secretion

- Androgen & Estrogen receptors are present in acinar epithelial cell nuclei of LG & MG, regulate secretion
- Androgens anti-inflammatory, estrogens pro-inflammatory
- Blinking is main control of the release of meibum stored in MG

Neuro-hormonal control of secretion in LFU tissues
MECHANISMS OF OCULAR SURFACE DISEASE UNDERLYING PATHOPHYSIOLOGY
Unified Theory
Stern, et al. 1998

- Published 1998, based on Stern’s theory of tear secretion through LFU
- Proper functioning of the LFU is required to secrete tears of normal composition which helps to maintain a normal homeostatic environment for the epithelia of the ocular surface.
- In addition to maintaining normal lacrimal and meibomian glandular function, androgens also exert anti-inflammatory activity
Unified Theory
Stern, et al. 1998

- 2 major factors in helping to maintain the tissues and function of the LFU.
- 1\textsuperscript{st}: The presence of *circulating androgens* that help to maintain an anti-inflammatory umbrella over the tissues of the LFU (Sullivan and Edwards, 1997; Rocha et al., 1998; Sullivan et al., 2002).
2\textsuperscript{nd}: Immune system

- Immunovigilant T-cells migrate through the LG, MG in search of inflammation
- Normally T-cells undergo apoptosis while leaving the gland enroute to lymph nodes
- With inflammation, epithelial cells of LG, OS, MG express antigens which bind to T-cells
- T-cells activate & secrete cytokines leading to more inflammation (Pflufelder, Beuerman, Stern 2004)
Lacrimal Gland Function Unit
(Stern et al., 1998)

1. Neurogenic Inflammation
   Immune Activation

2. Role of Androgens
   Maintain Anti-inflammatory
   State of the Functional Unit
   Normalization of Meibomian
   Lipid Composition

3. Restoration of Ocular Surface
Dry Eye: An Inflammatory Cycle

Lacrimal Gland → T-cell Activation → Abnormal Tears Inflame Ocular Surface → Cytokines Delivered to Ocular Surface → Brain → Cytokines Disrupt Neural Arc
New approach for better comprehension of diseases of the ocular surface


- Standard aetiologies (MGD, HRT, Allergies...) seen as risk factors to enter a self-stimulated biological process involving the ocular surface
- Chronicity, severity & presence of more than one risk factor may cause patient to enter self stimulated loop
- Tear film instability/imbalance key point of dry eye disease
Mechanistic view, sequelae

- Tear film impairment will cause hyperosmolarity of tears & superficial epithelial cells of cornea & conjunctiva
- Resident inflammatory T-cells stimulated
- Cell damage to cornea & conjunctiva by apoptosis, mechanical & osmotic stress
- Mucus, glycocalyx & adhesion forces destabilized
- LFU neuro-sensory reflex arc stimulated
- LG, MG neurogenic inflammation
- Cytokine release, MMP activation, inflammation of ocular surface
Sequalae continued

- Goblet cells are lost with further tear film instability
- With bacterial or viral disease present, endotoxins, lipopolysaccharides, and or lipase activation causing eyelid inflammation & MGD lead to tear film impairment
- Can participate in the vicious circle or be an independent or complementary loop
- Eventually stem cells are lost leading to epithelial and stromal damage
Mechanistic View

- Clinically this approach may explain examples of dry eye syndrome occurring after ocular surgery, contact lens wear, chronic allergy or systemic or topical drugs.
Dry Eye Cascade

- Meibomian gland disease
- Aqueous deficiency
- Mucin abnormalities
- Observable pathophysiology
- TBUT < blink rate

Abnormal tear film: causes & conditions
- Aging
- Dry environment
- Hormonal changes
- Medications
- Contact lens wear
- Blepharitis
- Autoimmune disease

Abnormal or insufficient tears

Tear film impairment

Increased osmolarity

Ocular irritation

Inflammation

Squamous metaplasia

Decreased goblet cell density

Increased cytokines

Healthy ocular surface
DIAGNOSING DRY EYE
Diagnosing Dry Eye – Not all look like this....
Diagnosis

- Symptomatically, dry eye fits the definition of a chronic pain syndrome.
- Although symptoms may vary during the day, the patients are in constant pain and are relegated to thinking about their eyes all day which makes many otherwise routine daily tasks more difficult.
- A large percentage of these patients become clinically depressed and require systemic anti-depressive therapy.
Diagnosis

- Poor correlation between signs & symptoms
  - 57% symptomatic had objective signs
  - Attributed to symptoms preceding signs (Tomlinson)
- In many cases ocular surface’s have been shown to be highly infiltrated with CD4 positive T-cells while still looking white under examination. (Not classical “red eye”)
- The key sign to look for in patients is chronicity.
  (Goa et al 1998, Brignole et al 2000)
Diagnosis

- Korb 1999 surveyed experts in dry eye
- Most used the following 4 tests to confirm dry eye
  - 1. Case history
  - 2. TBUT
  - 3. Rose Bengal or lissamine green stain
  - 4. Flourescein stain

Remember the tests only work after you have used your EARS
Symptomatology

- Clinical assessment must include thorough evaluation of **history and symptoms**
- Standardized questionnaire aids in consistency
- Several questionnaires have been developed, but most commonly used is designed by McMonnies 1996
  - Help predict presence of dry eye and/or monitor effects of therapy
  - [http://dryeyeni.com/dry-eye-questionnaire](http://dryeyeni.com/dry-eye-questionnaire)
Patients rated their severity worse than professionals 23% to 60% of the time

Robin L. Chalmers, O.D., F.A.A.O

- 19% of patients rated their condition "severe," while the doctors rated only 9% severe.
- 36% of patients rated their condition "moderate," while the doctors rated only 20% moderate.
- 23% of patients rated their condition "mild," while the doctors rated 47% mild.
"Whoa - watch where you're standing Brian - I've dropped a contact lens!"
Ocular Protection Index

Diagram showing the sequence of events during an ocular protection index test:
- Blink
- Tear Protected Ocular Surface
- Tear Break-Up Time (TBUT)
- Unprotected Ocular Surface
- Blink

Key points:
- Time in seconds: 0, 1, 2, 3, 4, 5, 6, 7
- Ocular Discomfort
- Staining

Cycle repeats.
Diagnosis

**DRY EYE**

**OCULAR SURFACE DAMAGE**

Usually demonstrated by vital staining:

- **Rose Bengal**
  - *rating system exists (van Bijsterveld, 1969)*

- **More recently, Lissamine Green used**
  - *better tolerated*

- **Sodium fluorescein also has a role**
  - *observe with yellow barrier filter (W12, OG515)*
Dry Eye Signs
Diagnosis
Diagnosis
CCLRU GRADING SCALES
http://www.siliconehydrogels.org/grading_scales/DATA/front_page.htm
CCLRU GRADING SCALES
http://www.siliconehydrogels.org/grading_scales/DATA/front_page.htm

**LID REDNESS (area 2)**
- 1. VERY SLIGHT
- 2. SLIGHT
- 3. MODERATE
- 4. SEVERE

**LID ROUGHNESS: WHITE LIGHT REFLEX (areas 1,2)**
- 1. VERY SLIGHT
- 2. SLIGHT
- 3. MODERATE
- 4. SEVERE

**LID ROUGHNESS: FLUORESCEIN (area 2)**
- 1. VERY SLIGHT
- 2. SLIGHT
- 3. MODERATE
- 4. SEVERE
The palpebral conjunctiva is divided into five areas to grade redness and roughness.

- Areas 1, 2 and 3 are most relevant in contact lens wear.
The cornea is divided into five areas. The type, extent and depth of staining are graded in each area.

**Type**
- 1 Micropunctate
- 2 Macropunctate
- 3 Coalescent macropunctate
- 4 Patch

**Extent:**
- **Surface Area**
  - 1: 1 - 15%
  - 2: 16 - 30%
  - 3: 31 - 45%
  - 4: > 45%

**Depth**
- 1 Superficial epithelium
- 2 Deep epithelium, delayed stromal glow
- 3 Immediate localized stromal glow
- 4 Immediate diffuse stromal glow

*Based on penetration of fluorescein and slit lamp optic section*
Test Correlation

Dry eye tests have low result correlation to each other. (Alan Thomlinson)

- **Schirmer & Rose Bengal**
  - 25% sensitivity
  - 90% of normal’s diagnosed
  - 31% positive predictive value

- **Osmolarity**
  - 70% sensitivity
  - 92% specificity
  - 60% positive predictive value
Tearlab Osmolarity System

- New technology now available to test tear osmolarity
- Normal 312mOsm/L
- Abnormal > 329 mOsm/L
- Expensive
- Gold standard for dry eye testing
Tear Film & Contact Lenses

ISSUE WITH COMFORT
Clinical & Tear composition
Characteristics of Intolerant wearers

- Intolerant patients have more degraded lipid compounds. Glasson et al (2002, 2003)
- Greater levels of tear cholesterol esters associated with increased discomfort & unstable lipid layer. Guillon et al (2002)
- Tear volume (Zone Quick), NITBUT significantly reduced in intolerant wearers. Glasson et al (2002)
- TBUT < 10 seconds in 85% of intolerant wearers. Andres et al (1987)
Contact Lenses And Tear Film

- Very little tear exchange occurs under a soft lens, so what happens to the different components of the tear film?
- What lies on top of the lens?
- Does mucus make its way to the surface or does the aqueous layer lie directly on the lens?
- Does the lipid layer cover the aqueous, or is it thinned or absent?
- Is blink rate affected by the lens, affecting the lipid layer?
Effects on the Tear Film: RGP’s

RGP’s dry more at the edges & front surface of the lens
May cause stagnation of post-lens TF
**Inferior Arcuate Staining**

- Soft lenses dry on the front surface – inferior arcuate staining
- Pervaporation staining – epithelial dessication if SCL
  - Too thin
  - High water content
Contacts & Tear Film

- Lens affects lid conformity & sensation; leads to poor mucus spreading, inflammation, MGD
- Lipid layer rupture, lipid layer is absent on RGP lenses
- TBUT reduced up to 58%, more with soiled surfaces
Contacts & Tear Film

- Can affect the glycocalyx, compromise epithelial health and affect corneal metabolism
- LFU is activated by inflammation, reduced tear production.....
- Most importantly, evaporation is increased & tear thinning time is decreased
- All the above contribute to osmolarity changes
Effect of Lens Materials

ISSUE WITH COMFORT
Dry Eye Symptoms
Effect of Lens Materials

- No correlation between lens dehydration and subjective symptoms of dryness or discomfort (Fonn et al.; 1999)
  - Dehydration of high water-content (low refractive index) is not the mechanism associated with symptoms
  - Polar head groups associated with tear film lipid molecules may be attracted to lenses of higher water content (or silicone expression), leaving their nonpolar tails extended away form the lens surface leading to evaporation and/or non-wetting (PLTT & TFBU)
- Leads to direct increase in osmolarity → inflammation
How do material compare?

- **Fonn et al. (1999, 2003)** examined comfort over 7 hour in symptomatic & non symptomatic wearers.
  - Materials included; omafilcon A, etafilcon A, nefilcon A & lotrafilcon A
  - Comfort decreased equally with all materials over time only for symptomatic wearers

- **Thai et al. (2004)** examined aspects of biocompatibility using measures of tear physiology
  - Materials included; polymacon, omafilcon A, phemfilcon A, balafilcon A, etafilcon A
  - No significant differences among lens materials, irrespective of surface treatments
  - Except improved pre-lens tear film structure for omafilcon A
Lens edge and fit
Lens Care Systems

ISSUE WITH COMFORT
Care Solution Considerations

- Solutions have NB role in disinfecting lenses
- Recent events with product recalls remind us that we should never take the care system for granted
- It is also necessary to consider the interaction between CL materials and care systems, as the long and/or short term effect of solution incompatibility on discomfort and dryness is still uncertain
- SICS – solution induced corneal staining
  - Controversial topic as some degree of corneal staining is somewhat common in general non-wearing population
Treatment
General Treatment

- Tears, gels and ointments
- Systemic medication, tetracycline's
- Nutrition
- Topical anti-inflammatories & antibiotics
- Immunomodulatory agents
- Punctal occlusion
- Lid hygiene
- Topical androgen therapy
- Mucolytic agents
Treatment, C/L related dry eye

- Try treat the underlying cause, not just the symptoms
  - Detailed Case Hx
  - Be anti-smoking advocate
  - Change in make-up/CL solution/Eyedrops?
  - Complete dry eye work-up
  - Treat ocular surface problems first
    - Lid scrubs
    - Warm compresses
Treatment, C/L related dry eye

- Tear supplements, unpreserved
- Punctal occlusion
- Newer materials designed for drier eyes
- Increase lens bulk, lower water content
- Reduce coefficient of friction, improve lubricity, lens design
- Eliminate surfactants & preservatives, hydrogen peroxide seems best, single use lenses
- **Daily Disposables**
  - Nutrition, Omega 3 +++
  - Increase humidity in environment
  - Midday soaks for rehydration
  - Optimize blink frequency & fullness
  - Cyclosporine bid
  - doxycycline
Join the
Dry Eye Book Club
http://www.dryeyebookclub.com

- I love a good cry when I read a terrific book. Who doesn't? As women, we often find emotional release in the tears we shed over books like those on our **list of tear-jerkers**.
The Future

- Wettability
- Lubricity (smoothness)
- Comfort
- Oxygen Flux (Breathability)
- Modulus (stiffness)
“It shows off your astigmatism very nicely”