

THE “ANATOMY” OF DRY EYE DISEASE; A CLINICAL INTRODUCTION TO THE ATTENDEES AT DRY EYE UNIVERSITY

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Dry eye disease sounds like a simple problem for our patients. But we all know that it isn't as simple as it seems. Not even close. The pathophysiology of dry eye disease is just as complex as any other chronic disease. The causes are multifactorial and usually somewhat unique to each patient.¹ This means each patient's treatment plan needs to be tailored to their individual needs. This creates, at best, different ideas between physicians as to how to treat the disease, and at worst confusion and misconceptions about treatment and even proper diagnosis.

Our goal at Dry Eye University is to help in creating a more unified approach in treating this complex disease in a real-world setting. Many, most notably The Tear Film and Ocular Surface Society (TFOS), has produced tremendous work on explaining this disease and has made recommendations on how to treat it. Their famous Dry Eye Work Shop part II Report (DEWS II Report) has been their most recent offering in this effort. But even with theirs and others efforts; misconceptions, confusion and even disbelieving in dry eye disease among eye care providers remains. We at DEU want to help to minimize that.

At our practice, Bowden Eye & Associates in Jacksonville, FL; we have developed our own longstanding standard of care in diagnosing, treating and educating about dry eye disease. This has been developed over

time using all of the evidence-based information that TOFS and others have produced, as well as using our real-world clinical experiences. Dry Eye University is a cumulation of all of those years of knowledge. The purpose of this discussion about the “Anatomy” of dry eye disease is not necessarily just about ocular anatomy involved in DED. It is more to orient our attendees to our ideals and understanding of what dry eye disease is and our way of thinking about it in our clinics. This understanding is the foundation that we build on as we educate throughout the program. Dry Eye University (DEU) is open to not only eye care providers, but we also have strong attendance from administrations, marketing specialists, technicians, scribes, councilors, and others. Dry Eye Disease is so big that a physician can not do it alone. The doctors need a strong staff support team to help educate that patients, answer questions, schedule treatments and reinforce the same consistent message, to be successful. This segment is designed to orient all attendees (doctors and staff) to the same level of understanding.

The following are a list of ideas about dry eye disease that I keep in mind while treating patients:

- **Dry Eye Disease is a chronic and progressive condition that requires consistent and complete treatment with regular follow-ups for monitoring and control**

- Dry Eye Disease **requires diagnostic testing** to identify, quantify and follow its progression and/or control ... **especially to catch it early**
- The diagnostic tests can give us, and the patients **“hard evidence”** to validate our diagnosis and reinforce our treatment plans
- **The diagnostic tests are better** at finding early disease and identifying subtle changes, than our slit lamp exams alone allow us to see
- We use **complex medical treatment strategies** that can require multiple components to address the disease
- There are additional procedures that can/*should* be used in conjunction with the medical treatments to gain better control

If you took all of these statements and removed “Dry Eye Disease” from them and inserted “Glaucoma” in its place, each statement would remain valid. This is a key concept in understanding dry eye disease. It is not as foreign as it may seem. If you treat dry eye as intently as you treat glaucoma, with diagnostics, regular follow-ups and conviction, then you will be well on your way to being successful.

The following is a review of the working definition of dry eye disease according to TFOS DEWS II REPORT.²

“Dry eye is a **multifactorial disease** of the ocular surface characterized by a **loss of homeostasis** of the tear film, and accompanied by ocular symptoms, in which tear film instability and **hyperosmolarity**, ocular surface **inflammation** and damage, and neurosensory abnormalities play etiological roles.”

The words I have highlighted are “buzz words” that you will hear repeated regularly when discussing dry eye. We have to really understand how complex this disease is. Look at the mechanism of action² (Figure 1) and how cyclical it is. It can feed itself and start at any point. And due to its cyclical nature, it is more successful in treating it via multiple modalities to better interrupt the cycle. This diagram also leads us to (Figure 2) Mechanism of Dry Eye; International Dry Eye WorkShop (2007). *The Ocular Surface*, 5(2), see how dry eye is not only about the Lacrimal Gland, the Goblet Cells, and the Meibomian Glands. It is a disease that involves the entire Lacrimal Functional Unit (LFU), and the chemical reactions working around it.

FIG. 1 The mechanism of dry eye disease.²

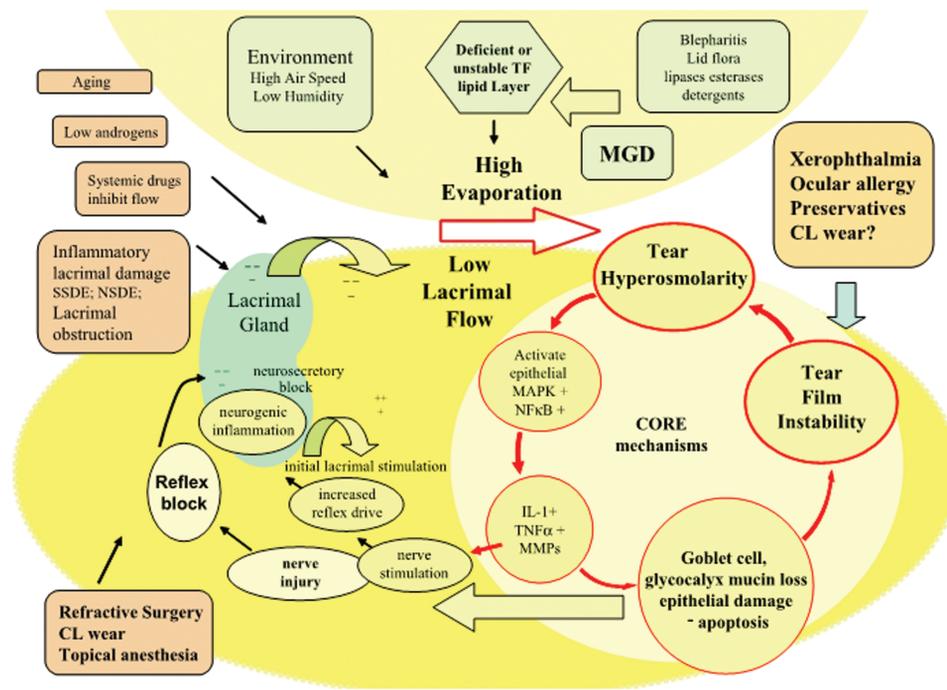
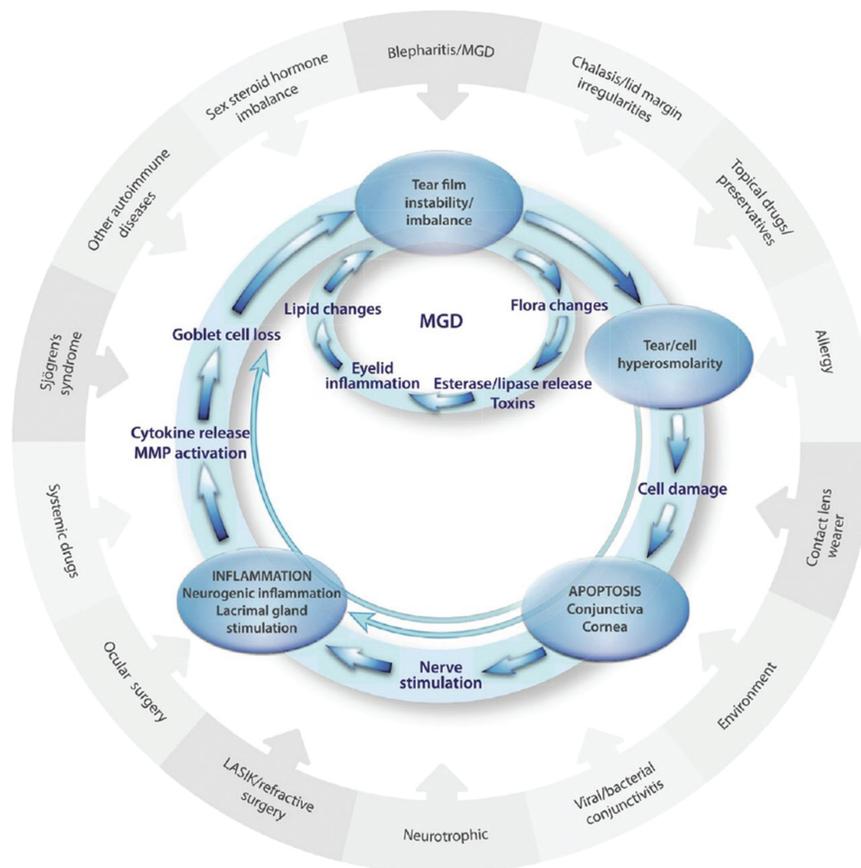


FIG. 2 Revisiting the vicious circle of dry eye disease: A focus on the pathophysiology of meibomian gland dysfunction.³



This diagram (Figure 2) also shows the complexity of the disease as a “double vicious circle”³ fueling itself. Also, this figure displays the outer circle of numerous factors that can be causing and continuing the dry eye cycles to continue to churn and worsen. These diagrams are excellent at illustrating just how complex and multifactorial this disease is.

There are many different types and subtypes of dry eye disease. At DEU, we will cover the most frequently encountered types of this disease, and as the program progresses we will illustrate the nuance between the treatments for each. But there are 3 main concepts to treatment that we always want to keep in mind.

1. Address the inflammation that is at the core of the disease, monitor it and adjust treatment as needed
2. Address the ocular surface breakdown, repair it and try to preserve it

3. Address the obstruction to the meibomian glands, keep them clear and try to address what is contributing to their obstruction

These are very broad concepts, and it is very easy to drill down much further into each point. But the idea is to start with these ideas and then advance as we go.

Like any chronic disease, our goal is to identify patients with it as soon as possible and treat them appropriately. The meibomian glands can be the key to identifying the disease earlier. As we all know, the majority of dry eye disease patients have MGD. Learning to exam the meibomian glands is paramount to learning to exam a patient for dry eye disease. The meibomian glands are 20–30 lipid secreting glands along the lid margin. Every time you blink, 0.3 psi of pressure is put on the glands and that pumps out some oil as well as smooth muscle contraction helping the excretion.⁴ We recommend to make an area in

your exam slit lamp section to document your assessment of the glands. We do this on every patient just as we exam the lids, cornea or lens. Using the Korb Meibomian Gland Evaluator from TearScience, J&J Vision, we can document the meibomian gland score. The Korb MGE is designed to exert 0.3 psi on to the lid margin to mimic the force of a deliberate blink⁴. This is done in 3 regions along the lid margin (nasal, central and temporal). In each region, the closes 5 glands to the evaluator are examined. We are looking out of the 5, how many express and what the grade of the meibum is. The meibomian gland score is the product of the number of glands out of 15 (5 per each region) multiplied by the grade of the meibum (3 = clear “olive oil” consistency, 2 = turbid gel, 1 = opaque paste). The higher the score the better the gland function. This is a repeatable metric that can be just as important as other metrics to help determine the status of meibomian gland obstruction and function. Another useful meibomian gland metric, that can be obtained at the slit lamp, is the functional gland count (FGC). Using a simple cotton-tip applicator or even a finger, we can determine this count by pressing along the lid margin and simply viewing how many total glands are open and what the meibum grade is. This method likely results in exerting more than the 0.3 psi, that the Korb MGE does. We advise that the MGE is done first and the FGC is done after. Using these numbers can help us develop treatment plans with options like Lipiflow (J&J Vision), iLux (Alcon) or TearCare (Sight Sciences) or help us to determine if a patient would benefit from meibomian gland probing before these types of interventions. As mentioned above, the meibum secreted *Should* be a clear liquid of an “olive oil” like consistency. Frequently we see that the Meibum is thicker in consistency with a “Gel” or even thicker “Paste” appearance. It can even take on a thicker “Wax” like appearance and consistency. As the glands progress, we will so no expression, indicating that the gland is either scared shut or atrophied. Meibography is invaluable to be compared to the functional gland count to establish treatment plans. A pearl that we use involving all of this information is that if there is a lower functional gland count (FGC) then the visible glands seen on meibography, then the patient may be a candidate

for meibomian gland probing along with thermal pulsation treatment.

The meibomian gland grading scale that we use is as follows:

- Grade 3 = clear “Olive Oil” like consistency
- Grade 2 = turbid “Gel” like consistency
- Grade 1 = opaque “Paste” like consistency
- Grade 0 = almost solid “Wax” like consistency

If we review again the definition of dry eye from TFOS we can see some additional explanations that are added from the previous working versions. The last statement of the definition “neurosensory abnormalities play etiological roles”. This opens the discussion about neuroanatomy and physiology and dry eye. Again this confirms the complexity of the disease and now the complexity of our understanding of it.

Below is a review of the neuroanatomy of the Lacrimal Functional Unit:

- The Trigeminal Nerve (Figure 3) (CN V) is responsible for innervation of the LFU
 - 3 Divisions of CN V
 - Ophthalmic Nerve (V1)
 - Maxillary Nerve (V2)
 - Mandibular Nerve (V3)
 - Ophthalmic Nerve (V1)

FIG. 3 Trigeminal Nerve branches and zones, V1, V2 and V3.5

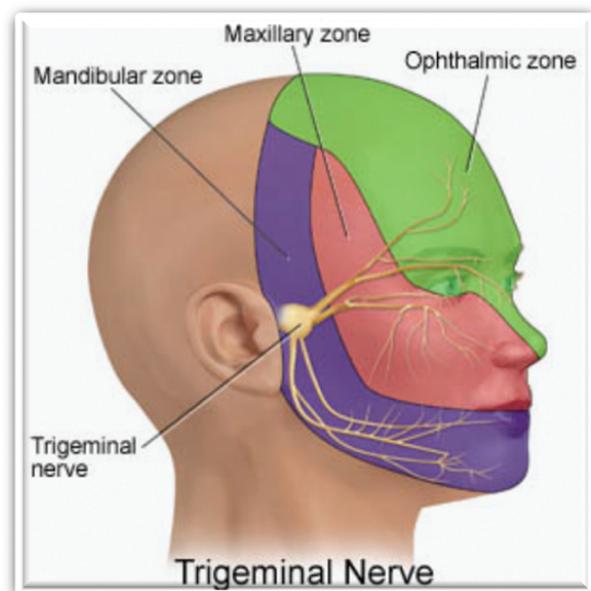
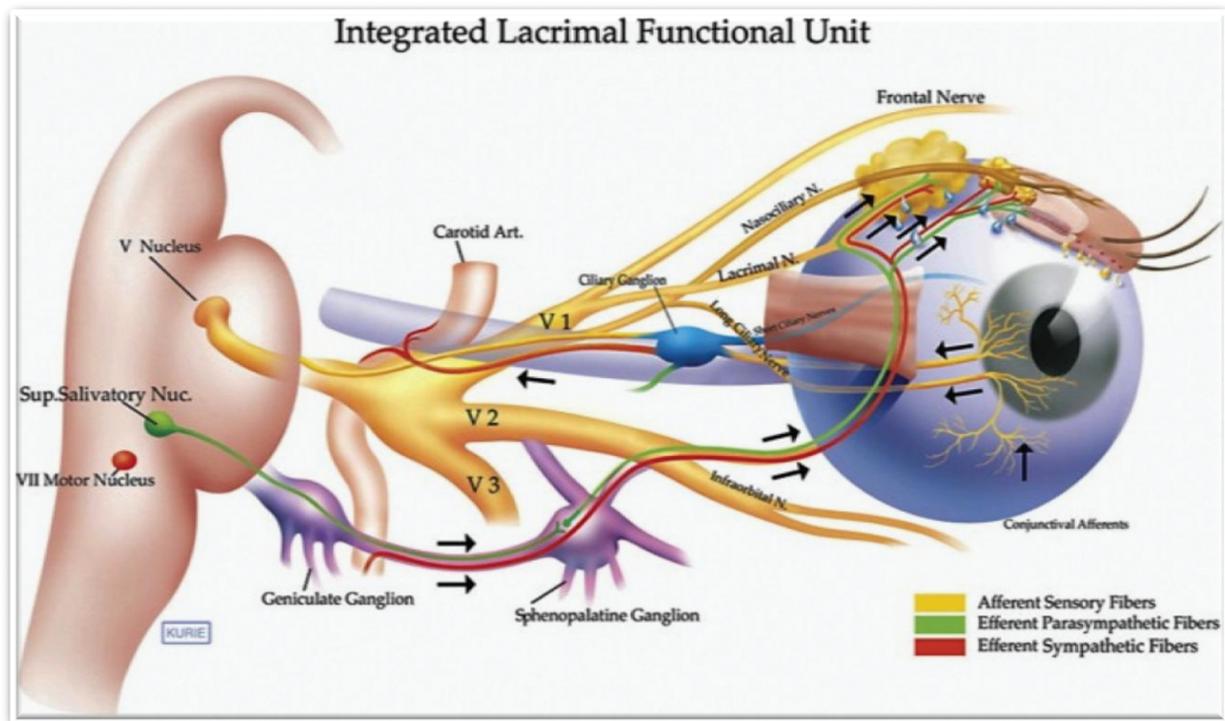


FIG. 4 The Integrated Lacrimal Functional Unit. Image adapted from Beuerman et al.⁶



- 3 Divisions of V1
 - Lacrimal Nerve
 - Nasociliary Nerve
 - Frontal Nerve
- **Ophthalmic Nerve (V1) is the division of CN V that innervates the LFU**
 - Lacrimal Gland
 - Meibomian Glands
 - Goblet Cells

SUMMARY POINTS

- Dry eye disease is real and is caused by many factors!
- It will continue to become more prevalent
- You see these people every day whether you or they know it or not
- It is a chronic and progressive disease and therefore: early detection and treatment is the key
- You don't ignore early-onset glaucoma, high blood pressure or diabetes, why is it ok to ignore early dry eye disease? IT'S NOT!

- Like glaucoma, ocular surface disease requires diagnostic testing and complex treatment plans to address totally, more on this later...
- If your patients are symptomatic, or they have signs of DED, then they have a significant disease and need aggressive treatment!
- The Meibomian glands are the key to diagnosis and treatment, an especially early diagnosis!
- Getting good at the treatment can be very profitable and rewarding!!

REFERENCES

1. Craig JP, Nichols KK, Akpek EK, et al. TFOS DEWS II Definition and Classification Report. *Ocul Surf* 2017;15(3):276–83. doi:10.1016/j.jtos.2017.05.008
2. Rapuano CJ; credit to DEWS Report. Research in dry eye: report of the Research Subcommittee of the International Dry Eye WorkShop. *Ocul Surf* 2007;5:179–93.
3. Baudouin C, Messmer EM, Aragona P, et al. Revisiting the vicious circle of dry eye disease: A focus on the pathophysiology of meibomian gland dysfunction.

- Br J Ophthalmol 2016;100(3):300–306. doi:10.1136/bjophthalmol-2015-307415
4. Korb DR, Blackie CA, Meibomian gland diagnostic expressibility: correlation with dry eye symptoms and gland location. *Cornea* 2008 Dec;27(10):1142–7.
 5. <http://www.intelligentdental.com/wp-content/uploads/2012/05/en2626521.jpg>
 6. Beuerman et al. Plugfelder et al, eds. *Dry Eye and Ocular Surface Disorders*. 2014.