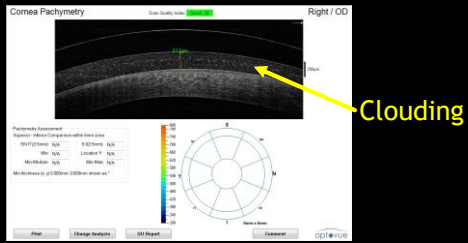
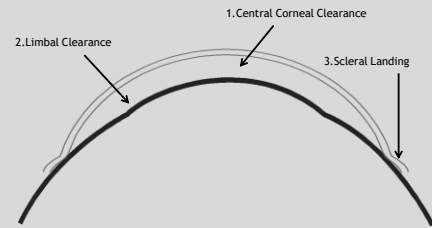


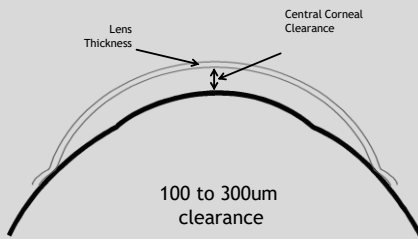
## Keratoconus



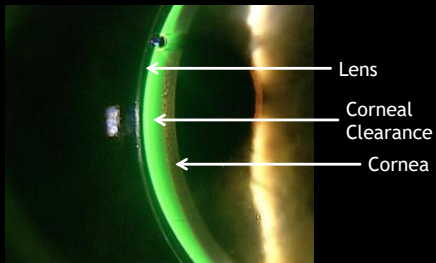
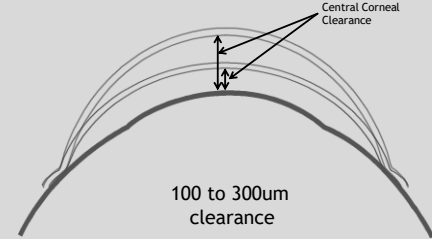
## The Fitting Philosophy



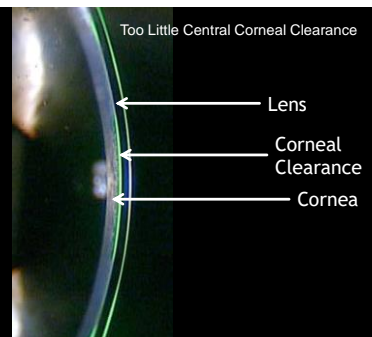
## The Fitting Philosophy (Optic Section)



## Too Much Central Clearance (Optic Section)

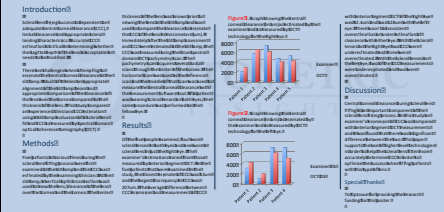


## Too Little Central Corneal Clearance

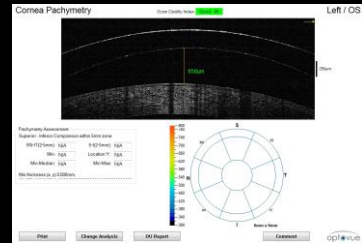


# Estimating Scleral Lens Clearance and Comparing it to OCT Measured Clearance

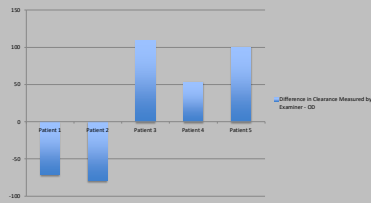
Mile Bruijic, DO, FAOD



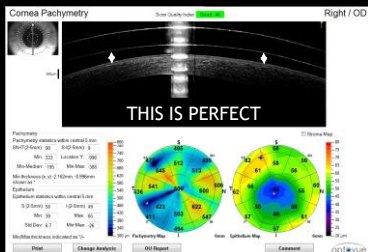
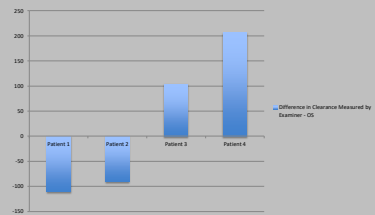
## Horizontal Cross Section



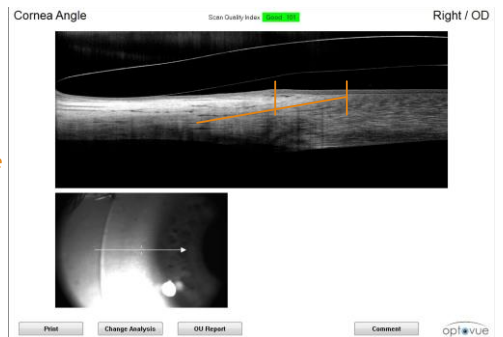
## Difference in Clearance Measured by Examiner - OD



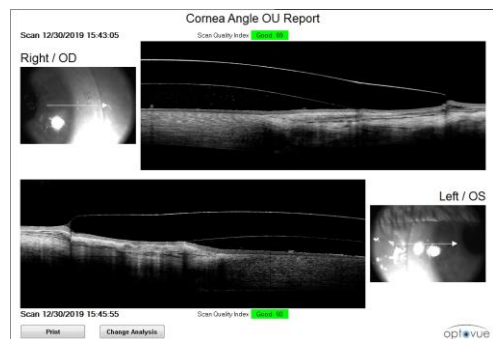
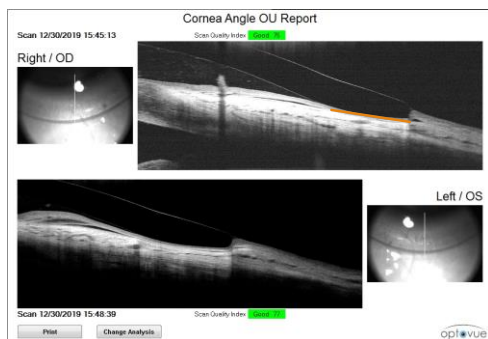
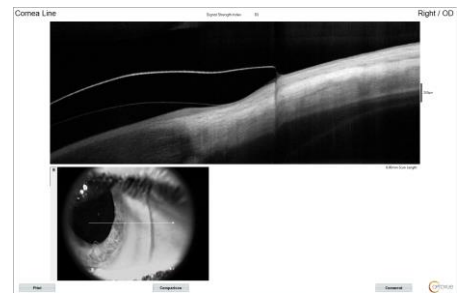
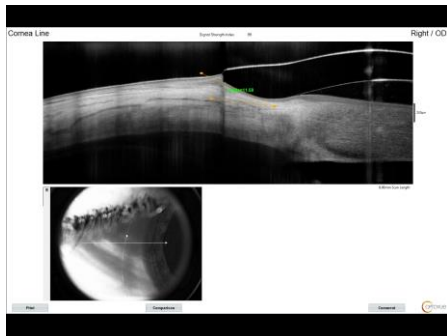
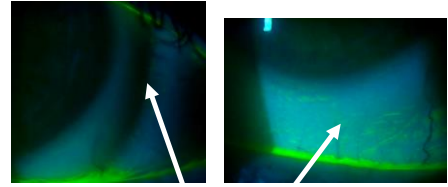
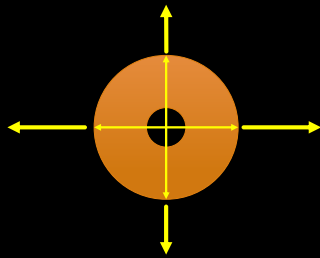
## Difference in Clearance Measured by Examiner - OS

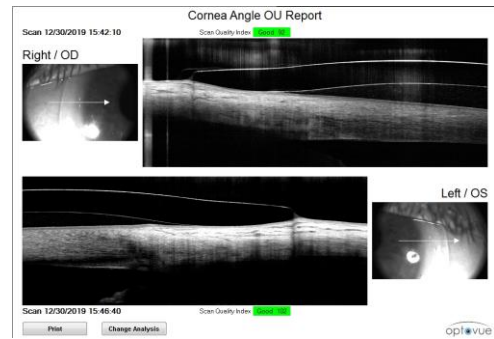
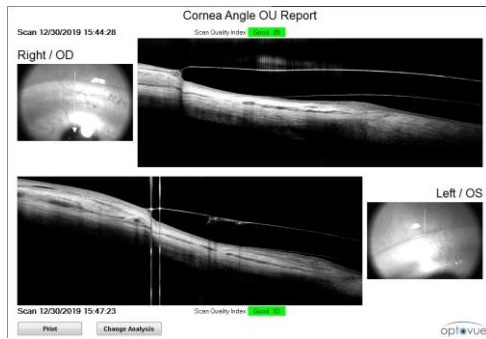


Limbal Clearance Zone

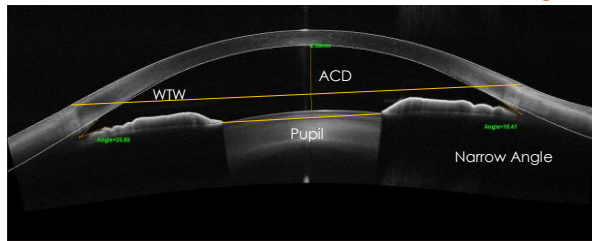


## The Measurements

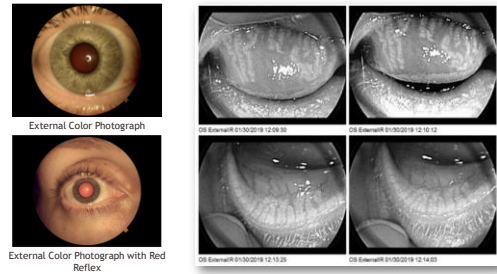




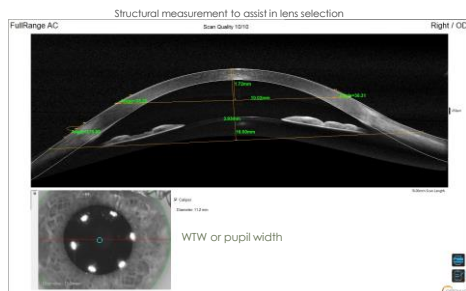
### Measurements for Anterior chamber and Scleral lens fitting



### External color photography & IR imaging

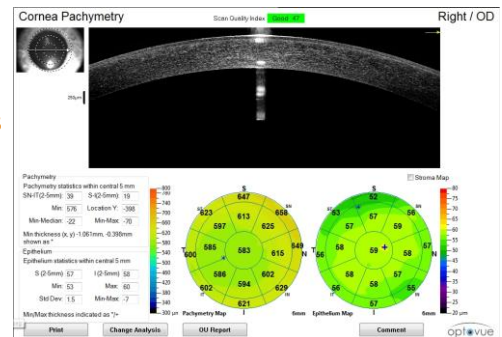


### Structural measurement 16mm Chord

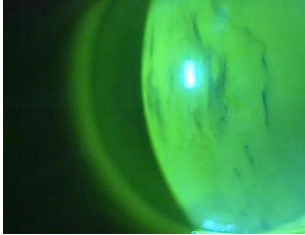


10mm Chord, 16 mm Chord with Sagittal depths 1.72mm 3.93mm

What is ETM?



# Dry Eye



## ORIGINAL ARTICLE

### Assessment of Corneal Epithelial Thickness in Dry Eye Patients

Xinhan Cui\*, Jiaxu Hong<sup>1</sup>, Fei Wang<sup>2</sup>, Sophie X. Deng<sup>3</sup>, Yujing Yang<sup>4</sup>, Xiaoyu Zhu<sup>5</sup>, Dan Wu<sup>6</sup>, Yujin Zhao<sup>7</sup>, and Jianjiang Xu<sup>8</sup>

#### ABSTRACT

**Purpose:** To investigate the features of corneal epithelial thickness topography with Fourier-domain optical coherence tomography (OCT) in dry eye patients.

**Methods:** In this cross-sectional study, 100 symptomatic dry eye patients and 35 normal subjects were enrolled. All participants answered the ocular surface disease index questionnaire and were subjected to OCT, corneal fluorescein staining, tear breakup time, Schirmer 1 test without anesthetic (S1t), and meibomian morphology. Several epithelium statistics for each eye, including central, superior, inferior, minimum, maximum, minimum – maximum, and map standard deviation, were averaged. Correlations of epithelial thickness with the symptoms of dry eye were calculated.

**Results:** The mean (±SD) central, superior, and inferior corneal epithelial thickness was 53.57 (±3.31)  $\mu\text{m}$ , 52.00 (±3.39)  $\mu\text{m}$ , and 53.03 (±3.67)  $\mu\text{m}$  in normal eyes and 52.71 (±2.83)  $\mu\text{m}$ , 50.58 (±3.44)  $\mu\text{m}$ , and 52.53 (±3.36)  $\mu\text{m}$  in dry eyes, respectively. The superior corneal epithelium was thinner in dry eye patients compared with normal subjects ( $p=0.037$ ), whereas central and inferior epithelium were not statistically different. In the dry eye group, patients with higher severity grades had thinner superior ( $p=0.017$ ) and minimum ( $p<0.001$ ) epithelial thickness, more wide range ( $p=0.032$ ), and greater deviation ( $p=0.003$ ). The average central epithelial thickness had no correlation with tear breakup time, S1t, or the severity of meibomian glands, whereas average superior epithelial thickness positively correlated with S1t ( $r=0.238$ ,  $p=0.017$ ).

**Conclusions:** Fourier domain OCT demonstrated that the thickness map of the dry eye corneal epithelium was thinner than normal eyes in the superior region. In more severe dry eye disease patients, the superior and minimum epithelium was much thinner, with a greater range of map standard deviation.

(Optom Vis Sci 2014;91:1446–1454)

#### In Vivo 3-Dimensional Corneal Epithelial Thickness Mapping as an Indicator of Dry Eye: Preliminary Clinical Assessment

• **CONCLUSIONS:** This study, based on very user-friendly, novel AS-OCT imaging, indicates increased epithelial thickness in dry eyes. The ease of use and the improved predictability offered by AS-OCT epithelial imaging may be a significant clinical advantage. Augmented epithelial thickness in the suspect cases may be employed as an objective clinical indicator of dry eye. (Am J Ophthalmol 2013;■:■–■. © 2013 by Elsevier Inc. All rights reserved.)

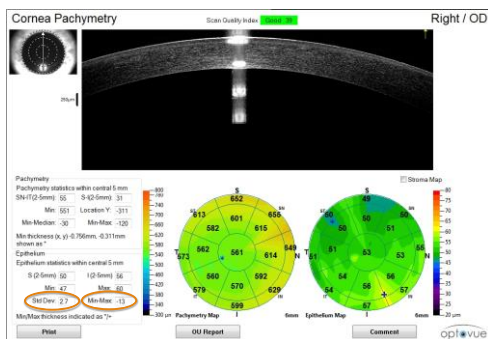


#### NIH Public Access

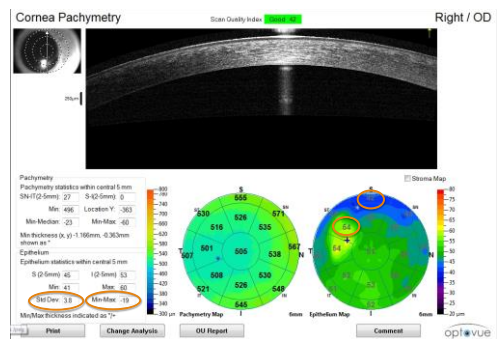
**Results—**The mean (±SD) central, superior, and inferior corneal epithelial thickness was 53.57 (±3.31)  $\mu\text{m}$ , 52.00 (±3.39)  $\mu\text{m}$ , and 53.03 (±3.67)  $\mu\text{m}$  in normal eyes and 52.71 (±2.83)  $\mu\text{m}$ , 50.58 (±3.44)  $\mu\text{m}$ , and 52.53 (±3.36)  $\mu\text{m}$  in dry eyes, respectively. The superior corneal epithelium was thinner in dry eye patients compared with normal subjects ( $p=0.037$ ), whereas central and inferior epithelium were not statistically different. In the dry eye group, patients with higher severity grades had thinner superior ( $p=0.017$ ) and minimum ( $p<0.001$ ) epithelial thickness, more wide range ( $p=0.032$ ), and greater deviation ( $p=0.003$ ). The average central epithelial thickness had no correlation with tear breakup time, S1t, or the severity of meibomian glands, whereas average superior epithelial thickness positively correlated with S1t ( $r=0.238$ ,  $p=0.017$ ).

Downloaded from ascelibrary.org by Seattle University, on 08/28/14. For personal use only.

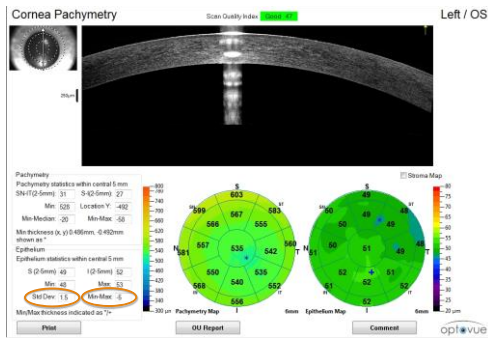
Dry Eye



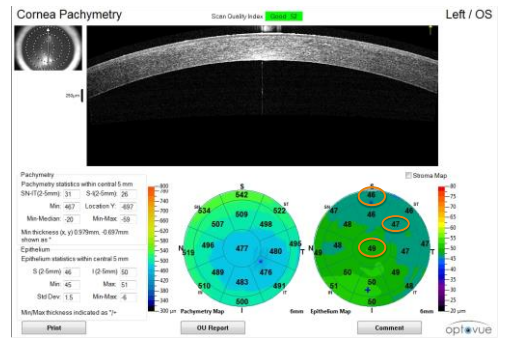
Dry Eye



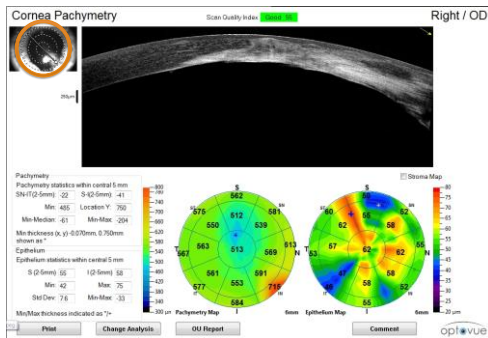
Dry Eye



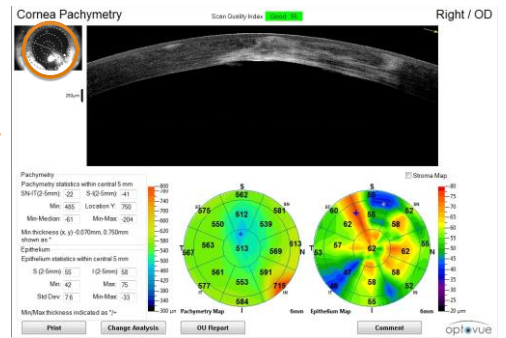
Dry Eye



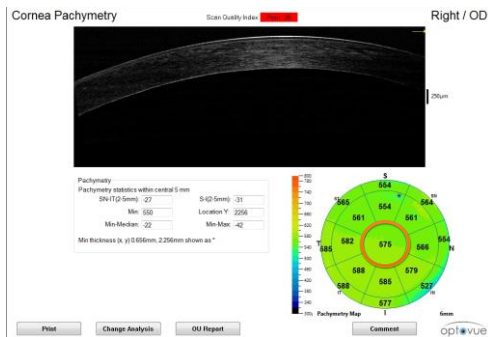
Corneal Injury



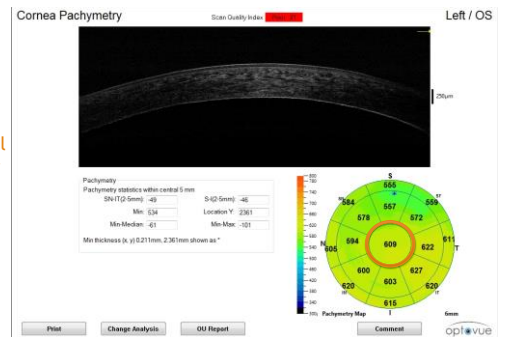
Corneal Injury



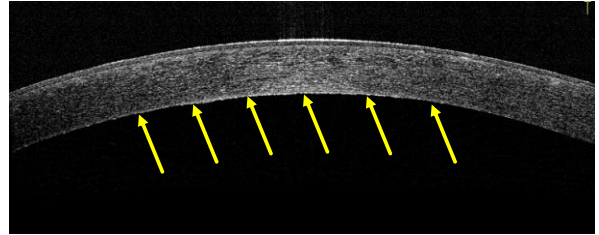
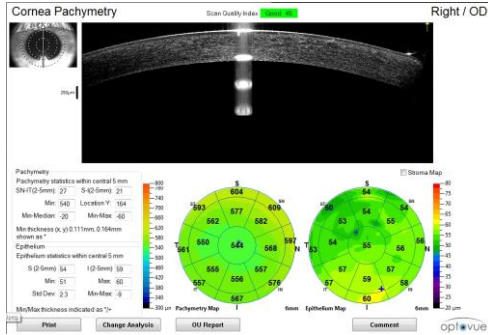
Fuch's Endothelial Dystrophy



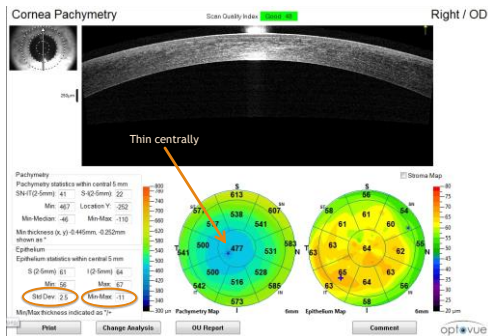
Fuch's Endothelial Dystrophy



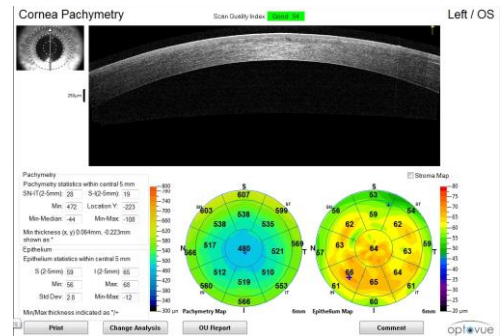
Fuch's  
Endothelial  
Dystrophy



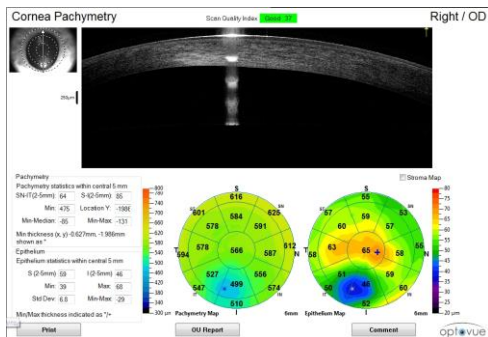
Post  
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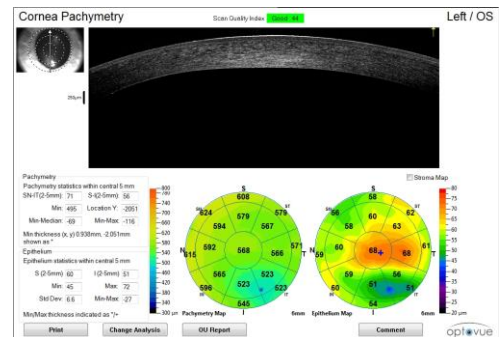
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LASIK



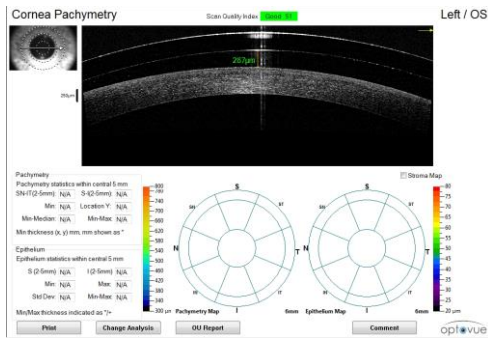
Post  
LASIK  
ectasia



Post  
LASIK  
ectasia



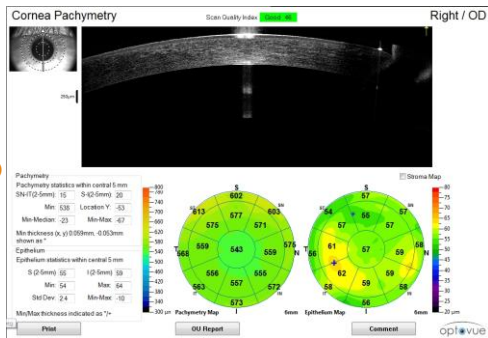
Post  
LASIK  
CCC



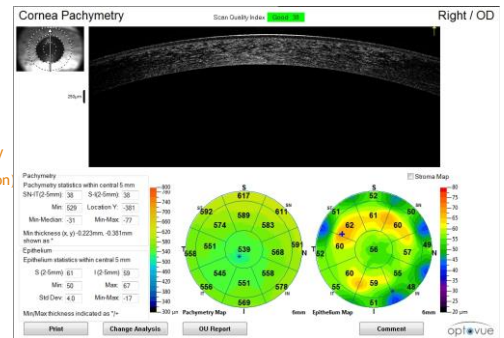
Radial Keratotomy



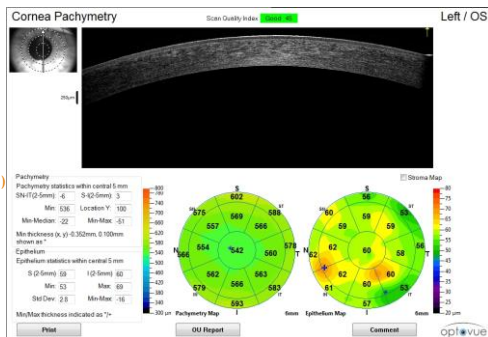
Radial  
Keratotomy  
(Good vision)



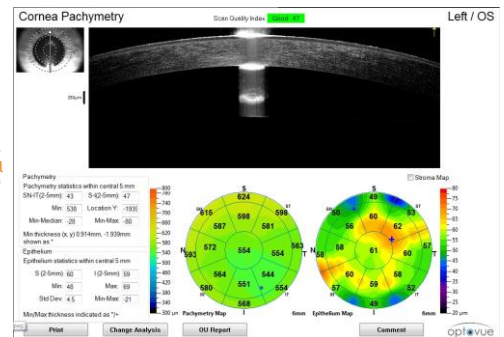
Radial  
Keratotomy  
(Slightly  
reduced vision)



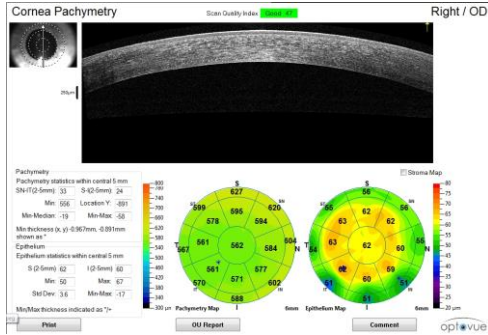
Radial  
Keratotomy  
(Slightly  
reduced vision)



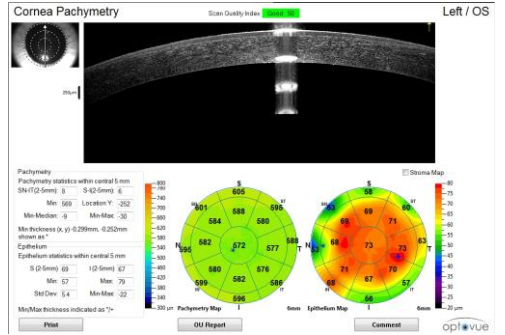
Radial  
Keratotomy  
(more visual  
complaints)



Radial  
Keratotomy  
(significant visual  
complaints)



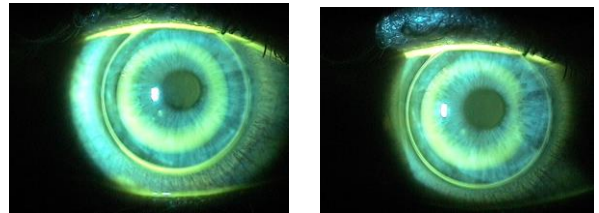
Radial  
Keratotomy  
(significant visual  
complaints)



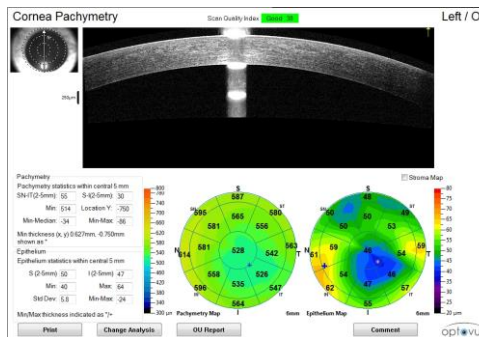
Pupil size



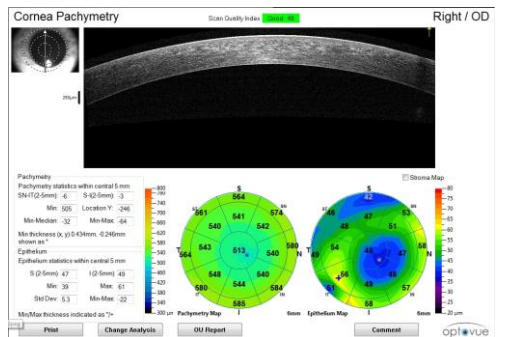
Orthokeratology



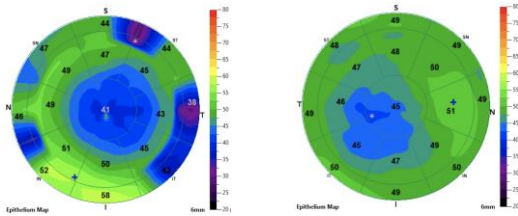
Ortho K



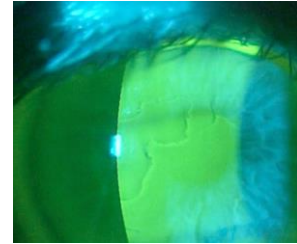
Ortho K



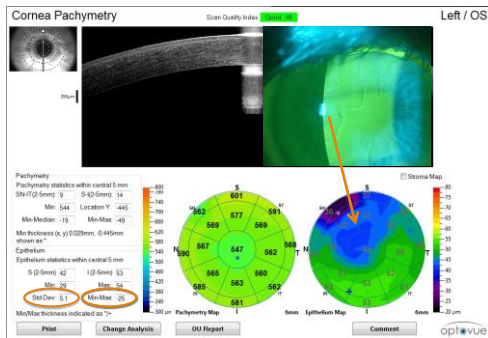
## Anterior Segment OCT for Orthokeratology



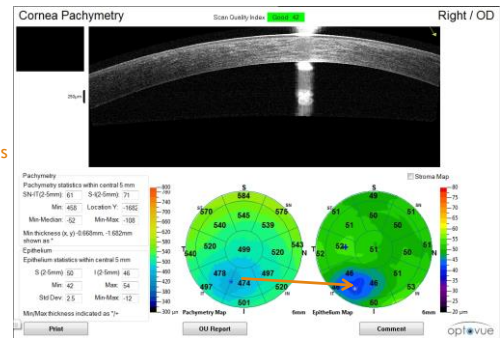
## Epithelial Basement Membrane Dystrophy



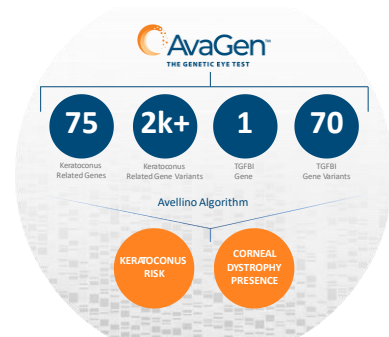
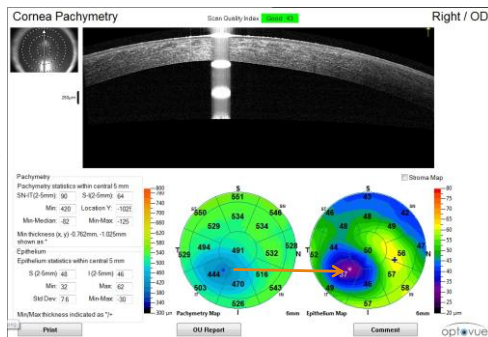
EBMD



Keratoconus



Keratoconus



## When To Order AvaGen™, The Genetic Eye Test...

### OCULAR DIAGNOSTIC ASSESSMENT

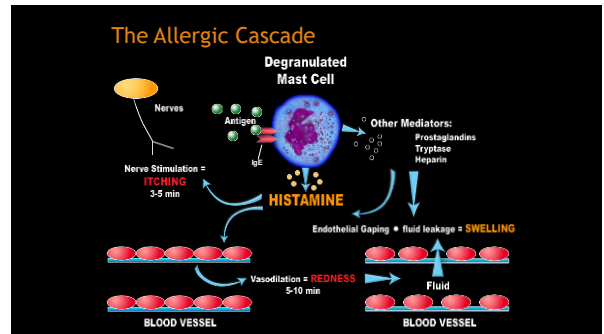
	1 Family History	2 Red Flags In Younger Patients	3 Refractive Concerns	4 Corneal Refractive Surgery Decisions
	Family Members suspected to be affected by a genetic diagnosis	Concerns in the cornea such as topography or astigmatism causing the patient to pause	Against the rule or oblique astigmatism in younger patients	Suspicious on stable astigmatism irregularity, such as when when location
		Pachymetry	Pachymetry	Pachymetry
		Unstable reflections such as progressive myopia or astigmatism	Unstable reflections such as progressive myopia or astigmatism	Unstable reflections such as progressive myopia or astigmatism
		Steep Corneal curvature	Steep Corneal curvature	Steep Corneal curvature
		Suspicious Pre refractive surgery patient or post LASIK ectasia	Suspicious Pre refractive surgery patient or post LASIK ectasia	Suspicious Pre refractive surgery patient or post LASIK ectasia
		Young when correction candidates	Young when correction candidates	Young when correction candidates
		RSE	RSE	RSE
		Corneal Dystrophy	Corneal Dystrophy	Corneal Dystrophy
		LASIK vs PRK	LASIK vs PRK	LASIK vs PRK
		When deciding between the two options	When deciding between the two options	When deciding between the two options
For Early Diagnosis & Management of Keratoconus (KC)				
For Corneal Crosslinking (CXL) Decisions				
For LASIK / PRK / Refractive Surgery Decisions				

### Key Clinical Findings to Consider for Test Candidates

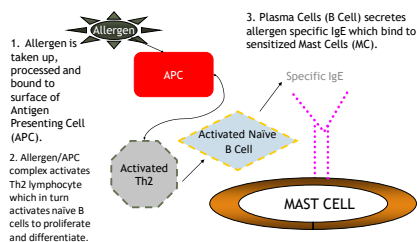
- ▶ Family History
- ▶ Young individual with reduced BCVA
- ▶ Progressing keratometry readings
- ▶ Against the rule or oblique astigmatism (initial measurement or progressing)
- ▶ Unstable refractive error
- ▶ Scissor reflex with retinoscopy
- ▶ Suspicious topography findings
- ▶ Suspicious tomography findings
- ▶ Suspicious pachymetry findings

### Why It's Important to Consider?

- ▶ Optimizing refractive surgery outcomes
- ▶ Earlier detection, earlier follow up, earlier treatment
- ▶ Helps categorize suspicious patients
- ▶ Helps direct or avoid certain treatments
- ▶ Orthokeratology
- ▶ Lens selection



## Allergic Response

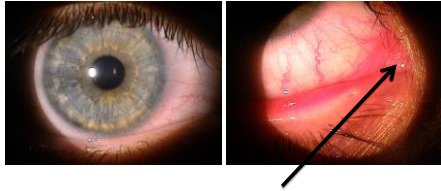


Thank you to Dr. Gil Pierce

## Types of Allergic Eye Disease

- ▶ Acute allergic conditions
  - Seasonal Allergic Conjunctivitis (Hay Fever) - SAC
  - Perennial Allergic Conjunctivitis - PAC
- ▶ Chronic allergic conditions
  - Vernal Conjunctivitis - VKC
  - Atopic Conjunctivitis - AKC
  - Giant Papillary Conjunctivitis - GPC

## Misunderstanding the Itchy Eye



## Allergic Conjunctivitis: Seasonal / Perennial

### Causes:

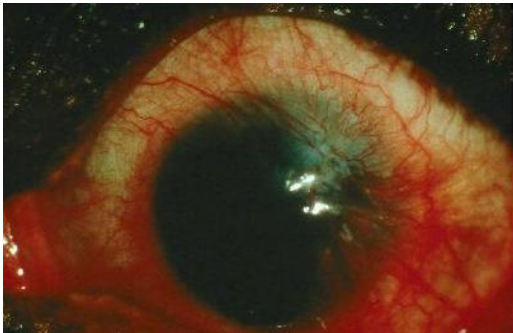
Environmental  
Genetic predisposition

### Findings:

Family history  
No eosinophils found in scrapings  
Spike in tear histamine  
Normal histaminase function

### Signs/Symptoms:

Itching  
Redness  
Chemosis  
Lid swelling  
Tearing



## Atopic Keratoconjunctivitis (AKC)

### Causes:

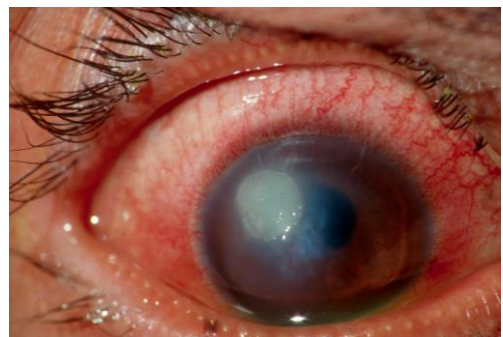
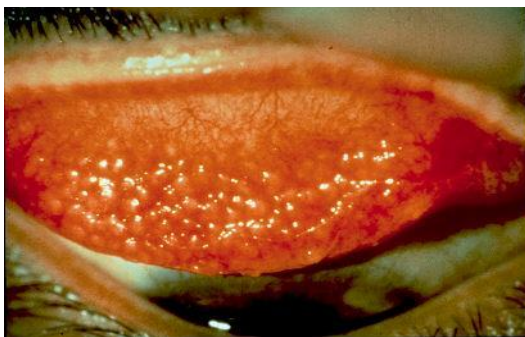
Associated with atopic dermatitis  
May be perennial  
Genetic predisposition  
Environmental antigens

### Clinical Findings:

Initiates between 20 and 50 years of age  
Elevated levels of eosinophils, TH<sub>2</sub>, lymphocytes, and mast cells

### Signs/Symptoms:

Itching  
Redness  
Photophobia  
Keratopathy  
SPK/Ulcers  
Keratoconus  
Anterior polar cataracts  
Mucous discharge  
Atopic blepharitis



## Vernal Keratoconjunctivitis (VKC)

### Causes:

Genetic predisposition, atopy  
Seasonal/perennial allergens (IgE)  
Nonspecific hypersensitivity

### Clinical Findings:

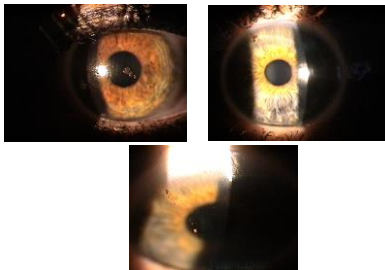
Most predominant in males from 3 to 20 years old  
Increased levels of superficial mast cells, eosinophils, and lymphocytes  
Decreased levels of histaminase

### Signs/Symptoms:

**Ptosis**  
**Ropy mucous discharge**  
**Photophobia**  
**Large, nonuniform cobblestone papillae**  
**Trantas dots**  
**Limbal nodules**  
**Neovascularization**  
**Shield ulcers**  
**Itching**



## Contact Lenses



## Giant Papillary Conjunctivitis (GPC)

### Causes:

**Repeated mechanical irritation caused by:**

Contact lens edge  
Exposed sutures  
Extruded scleral buckle  
Ocular foreign bodies

**Aggravated by concomitant allergy**

**Can also aggravate ocular allergy**

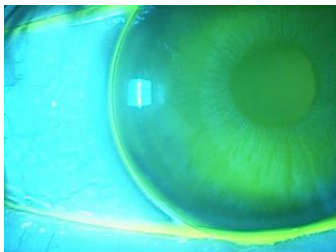
### Clinical Findings:

**Increased chronic inflammatory cells**

### Signs/Symptoms:

**Decreased CL tolerance**  
**Blurred vision**  
**Foreign body sensation**  
**Small, uniform papillae on upper tarsal plate**  
**Thick mucous build-up**

## RGP's



## Treatment Options

### ► Topical Medications

#### ► Antihistamine/ Mast Cell Stabilizer Combinations

► Blocks Histamine receptors on blood vessels, nerve endings, etc

► Inhibits histamine degranulation from sensitized mast cells so that when these cells are challenged with antigen, they do not degranulate

► Patanol, Pataday, Elestat, Zaditor, Lastacaft, Bepreve

## Ketotifen



## Alcaftadine 0.25%



## Zerviate

- ▶ Cetirizine ophthalmic solution 0.24%
- ▶ Available as oral agent (Zyrtec)
- ▶ Distributed through Santen
- ▶ First topical ophthalmic formulation of cetirizine
- ▶ Approved as bid dosing regimen



## Treatment Options



## RASP Inhibitors

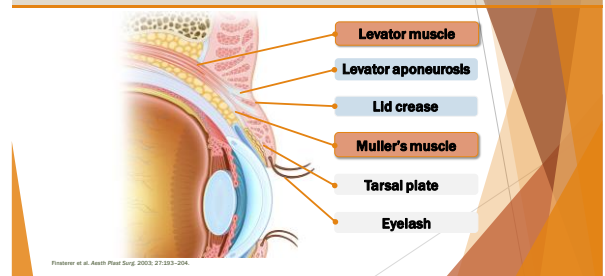
- ▶ [www.aldeyra.com](http://www.aldeyra.com)
- ▶ Aldehyde is a product of metabolism
- ▶ Normally rapidly broken down
- ▶ With inflammation, is produced in quantities that are difficult to breakdown efficiently
- ▶ RASP - Reactive aldehyde species
- ▶ Reproxalap - Is a RASP inhibitor



## Non-Surgical Lid Lifting



## Lid Anatomy: Two Muscles Lift the Eyelid



## Oxymetazoline Acts at Müller's Muscle to Lift the Upper Eyelid

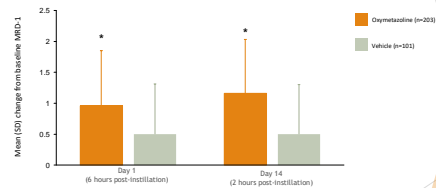


- Oxymetazoline is a potent, direct-acting  $\alpha$ -adrenergic receptor agonist<sup>1,2</sup>
  - $\approx$ 5-fold greater affinity for  $\alpha_2$  receptors<sup>3\*</sup>
- Selectively activates  $\alpha$ -adrenergic receptors in Müller's muscle<sup>4</sup>

\*Receptor binding affinity is defined via in vitro binding assays

1. Neumeier R, et al. *Frontiers Clin Pharmacol*. 2020;24(1):729-739. 2. Sogister D, et al. *Br J Pharmacol*. 2006;148(1):1246-1252. 3. Hooper LG, et al. *Clin Otolaryngol*. 2020;45(1):105-115. 4. Upneeq™ (oxymetazoline hydrochloride ophthalmic solution, 0.1%, Prescribing Information). JPR Pharmaceuticals, Inc. 2020.

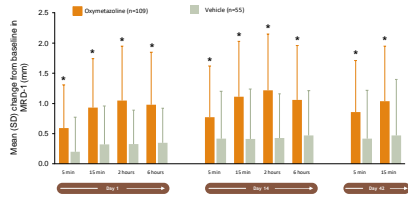
## Oxymetazoline Significantly Increased Upper Eyelid Lift In Two Clinical Studies



Printed data from two 6-week, randomized, double-masked, placebo-controlled clinical trials (p<0.0001 vs. vehicle, from an ANCOVA model with study site, treatment, sex, race, and baseline score as a covariate). Patients with congenital ptosis, Turner syndrome, myasthenia gravis, mechanical ptosis, pseudoptosis or submyotic ptosis were excluded. Eyelid skin occurring within 3 mm of the upper eyelid margin, or visual field loss from any cause other than ptosis were excluded from both trials.

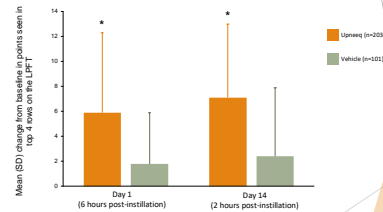
Sorenson CB, et al. *JAMA Ophthalmol*. 2020;138(11):1168-1175.

### Oxymetazoline Provided a Rapid and Sustained Effect Over 42 Days



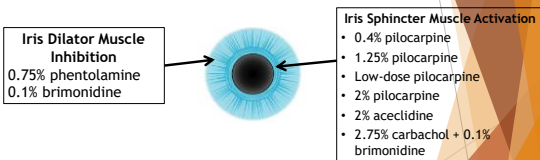
Data from 6-week, randomized, double-masked, placebo-controlled clinical trial (PVL-1201-202);  $p < 0.05$  vs. vehicle, from an ANCOVA model with timepoint as a fixed factor and baseline score as a covariate.  
Becharach A, et al. Clin Ophthalmol. 2021;15:2743-2751

### Oxymetazoline Significantly Improved Superior Visual Field Deficits



Postulated data from two 6-week, randomized, double-masked, placebo-controlled clinical trials;  $p < 0.0001$  vs. vehicle, from an ANCOVA model with timepoint and treatment as fixed factors and baseline score as a covariate.  
Storres CE, Foster S, Javitt N, et al. JAMA Ophthalmol. 2020;138(11):1168-1175.

### MOAs of Different Miotics In Development For Presbyopia



### Topical Presbyopia Treatment Approaches

#### FDA Approved

Allergan/AbbVie  
1.25% pilocarpine

#### Phase 3

Orasis  
low dose pilocarpine

Eyenovia  
microdose 1% or 2%  
pilocarpine

#### Phase 2

Visus  
brimonidine +  
carbachol

LENZ  
aceclidine

Ocuphire  
0.75% phenolamine  
+ 0.4% pilocarpine

Novartis  
1.5% lipoic acid  
choline ester

Glaukos  
transdermal delivery  
of pilocarpine

Charman WN. Ophthalmic Physiol Opt. 2019;39(1):1-10.

### Miosis and Depth of Focus



Employ the eye's own iris to create a pinhole effect, which extends the depth of focus without restricting peripheral vision.<sup>1</sup>

1. Charman WN. Ophthalmic Physiol Opt. 2017;37(6):655-660.

### The Red Eye



53 year old female  
cc: her left eye started bothering her a little last night; is a lot more red this morning. Some discharge and the eye is feeling more irritated  
VA - OS 10/20  
IOP - OS 16 mm Hg at 10:00 am



## Viral Conjunctivitis

- ▶ 20-70% of infectious conjunctivitis is thought to be of viral etiology
- ▶ Viral infections are less common in children under 12 years old and more common in those over 12 years old
- ▶ Between 65-90% are thought to be caused by adenovirus

## Viral vs. Bacterial

- ▶ Bacterial
  - ▶ More common in children less than 12 years old - redness, mucoid discharge, purulent discharge, eyelid matting
- ▶ Viral
  - ▶ More common in those greater than 12 years old - itching, burning, watery discharge, mucoid discharge, foreign body sensation, lymphadenopathy, hemorrhages

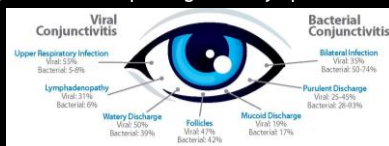
## Clinical Accuracy<sup>1-4</sup>

- Leibowitz et al.<sup>2</sup>
    - 31% of presumed bacterial conjunctivitis were culture positive
    - 52% with presumed viral conjunctivitis were culture positive for pathogenic bacteria
  - Cheung et al.<sup>3</sup>
    - 67% of Adenoviral cases presented unilaterally and the misdiagnosis rate was 42% in these patients
- During a clinical trial to evaluate cidofovir treatment at 16 academic centers, experts showed a clinical accuracy of about 48%

[1] O'Brien TP, Jiang BH, McDonald M, Rasmussen MB. Can Med Res Opin 2003;25(3):1953-1961. [2] Fish CP, Rappaport PA, Owens S. Ophthalmology 1993;96:1215-1223. [3] Gargioli P, Williams WT, Hayden FG. J Pediatr 1991;96:531-536.

## Misdiagnosis

- Misdiagnosis occurs in ~50% of conjunctivitis cases<sup>1</sup>
- Significant overlap of signs and symptoms<sup>1-3</sup>



[1] O'Brien TP, Jiang BH, McDonald M, Rasmussen MB. Can Med Res Opin 2003;25(3):1953-1961. [2] Fish CP, Rappaport PA, Owens S. Ophthalmology 1993;96:1215-1223. [3] Gargioli P, Williams WT, Hayden FG. J Pediatr 1991;96:531-536.

## Viral Conjunctivitis

- Nonspecific Follicular Conjunctivitis
  - Occurs more often in children, can be associated with a URI, unilateral or bilateral presentation, usually resolves in 14 days
- Pharyngeal Conjunctival Fever
  - More common in children and is usually associated with a pharyngitis and low grade fever
  - More commonly seen as a unilateral presentation
  - Typically 2 week resolution

## Viral Conjunctivitis

- Acute Hemorrhagic Conjunctivitis
  - Most common in developing countries
  - Large subconjunctival hemorrhages
  - Preauricular lymphadenopathy, keratitis
- Epidemic Keratoconjunctivitis
  - Highly contagious
  - Most commonly seen in those 20-40 years
  - Keratitis, foreign body sensation, blurred vision
  - Signs and symptoms may last for up to 4 weeks

## How to Use AdenoPlus



1. Use a "dab and drag" motion in 6-8 locations on the palpebral conjunctiva (lower eyelid) to collect a tear sample.
2. Snap the sample collector into the test cassette and press firmly where indicated.
3. Dip the test cassette into the provided buffer vial for 20 seconds. Replace the cap.
4. Read the results: 2 lines (1 red, 1 blue) = positive, 1 line (blue) = negative

## AdenoPlus Clinical Trials

A prospective, multicenter, masked, sequential, clinical trial was performed at a combination of private ophthalmology practices and academic centers.

The study enrolled 128 patients presenting with a clinical diagnosis of acute viral conjunctivitis.

Thirty-one patients were confirmed positive for Adenovirus by viral cell culture.

N = 128		Cell Culture	
		+	-
AdenoPlus	+	28	4
	-	3	93
Sensitivity		90% (28/31) 95% CI [74.2-98.0]	
Specificity		96% (93/97) 95% CI [89.8-98.9]	
Negative Predictive Value		97% (93/96) 95% CI [91.1-99.3]	
Positive Predictive Value		88% (28/32) 95% CI [71.0-96.5]	

## QuickVue Result



## Viral Conjunctivitis

- Treatment:
- Artificial tears
  - Cool compresses
  - Topical Antihistamines
  - Topical povidone iodine
  - Gancyclovir gel
  - Steroids – when there is significant light sensitivity or reduced visual acuity

## Off-Label Adenoviral Treatments<sup>1</sup>

### Gancyclovir .15% Gel vs Preservative Free Tears (N=18)

	Gancyclovir .15% gel N=9	Preservative free tears N=9
Recovery time [mean (range)]	7.7 (7-12) days	18.5 (7-30) days
SEIs	2 patients	7 patients

[1] Cohen J. Gancyclovir ophthalmic gel, 0.15%: a valuable tool for treating ocular herpes. Clin Ophthalmol. 2007;1:481-53.

### Off-Label Adenoviral Treatments<sup>1</sup>

Open-label, uncontrolled study with ganciclovir 0.15% gel in 36 patients with epidemic keratoconjunctivitis (EKC)

- ▶ GCV given QID at each EKC episode
- ▶ Ocular discomfort alleviated in 1 week and no patients developed keratitis

Sig: 1-2 gtts to affected eye qid for 1 week



Plan: return in 3-5 days for a follow up

### Treatment technique with Betadine 5% wash

- Instill 3 drops of tetracaine
- Instill 5 drops of Betadine 5%
- Instruct patient to close eye(s) and move side to side, up and down for 60 seconds; use gloved finger to spread Betadine over lid margin and lashes to eradicate any virus on external adnexa.
- After 60 seconds, thoroughly rinse eye
- Follow up: 2-3 days, 4-5 days, and 7-14 days



Betadine wash

Saline wash



**Thank You!**  
[mile@optometricinsights.com](mailto:mile@optometricinsights.com)