

On behalf of Vision Expo, we sincerely thank you for being with us this year.

Vision Expo Has Gone Green!

We have eliminated all paper session evaluation forms. Please be sure to complete your electronic session evaluations online when you login to request your CE Letter for each course you attended! Your feedback is important to us as our Education Planning Committee considers content and speakers for future meetings to provide you with the best education possible.



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Seven horizontal lines for notes.

Current Trends in Keratoconus Management

Justin Schweitzer, OD, FAAO
Vance Thompson Vision, Sioux Falls, South Dakota
Optometric Externship Director
Associate Residency Director

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Seven horizontal lines for notes.

Financial Disclosure – Justin Schweitzer, OD, FAAO

- Aerle – C/L
- Alcon – C/L
- Allergan – C/L
- Bausch + Lomb – C/L
- Ocular Therapeutix – C
- EyePoint – C
- Sight Sciences – C/L
- Dompé – C
- Zetis – C/L
- Visus – C
- Science Based Health – C
- Kala – C
- RVL – C
- Tarsus – C/L
- Sun – C/L
- Equinox – I
- Reichert – C
- J&J – C/L
- Glaukos – C/L
- Horizon – C
- Guidel – C
- MedPrint – C
- LXC – C/L
- Avellino – C
- Novartis – C
- Iveric bio – C
- Occuphire – C

4

Seven horizontal lines for notes.

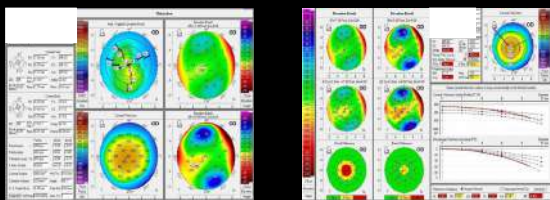
Case

"I have noticed a steady decline in my vision and glasses don't seem to fix it. I am also noticing some fluctuation in my vision"

- 29-year-old female w/reduced vision
- Refraction: OD: -0.75-2.25 x 34 20/15
OS: -1.75-0.75 x 15 20/15
- Ocular Allergies w/ eye-rubbing
- SLEx: Remarkable for conjunctival injection, otherwise unremarkable.

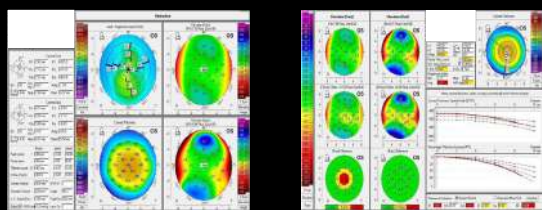
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Right Eye

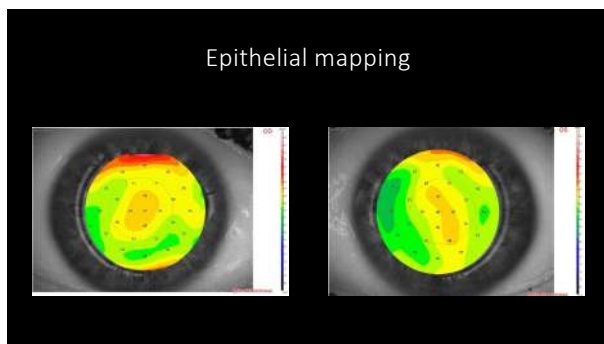


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Left Eye



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Keratoconus

- Keratoconus is a bilateral, asymmetric, progressive corneal ectasia resulting in irregular astigmatism and loss of visual function, with onset in teenage years¹
- Affects 1 in 2000 people (US)
 - More recent 1:375 (Netherlands)
- Alternative Treatment options include:
 - Rigid or Specialty Contact Lens
 - Intra-corneal ring segments
 - Corneal Transplant
- Eye Bank Association of America noted >6,900 transplants/year in patients with keratoconus (16% total penetrating keratoplasty in U.S.)²

¹Colvard J, Guemter JG, Bittelsohn JH. Keratoconus: age of onset and natural history. Optom Vis Sci 1997;74:147-151.
²Eye Bank Association of America Statistical Report, 2014

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23 years

83%

Archives of Ophthalmology
2011 Jun; 129 (6): 691-697
Epub 2011 Feb

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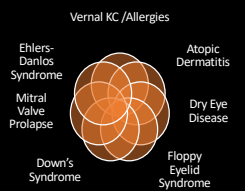
The Collaborative Longitudinal Evaluation of Keratoconus Study (CLEK)

8 year  1209 subjects

14% reported a family history
20% had corneal scarring
50% were eye rubbers

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Keratoconus – Disease Associations




The Collaborative Longitudinal Evaluation of Keratoconus Study
50% Eye Rubbing

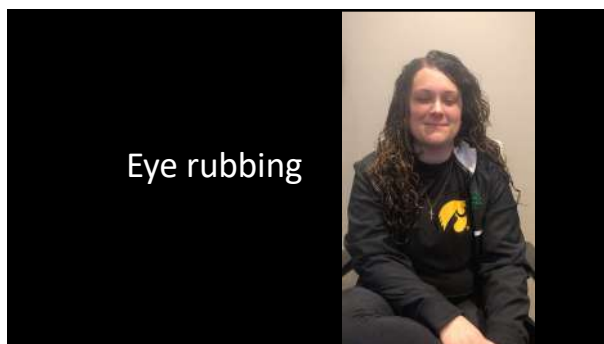
Other Published Data
50-70% of diagnosed KCN admit to eye rubbing
90% pediatric population
(Hawkes et al., Sheor et al, Leoni-Masip et al)

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Eye Rubbing




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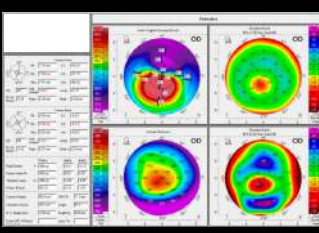


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Early Diagnosis



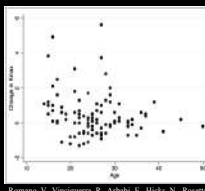
- Preserve spectacle corrected visual acuity
- Stabilize (cross link) prior to anterior corneal changes
- Delay/eliminate need for corneal transplantation
- Identify patients at risk of ectasia after corneal refractive surgery



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Early Diagnosis is Important

- Prospective study 104 patients
- Progressive KCN Age 14-50
- 53% were eye rubbers
- Mean time to CXL 85 days+/-69 days



| Measurement | Patients = 44 Mean (st. dev.) | Patients = 18 to 20 Mean (st. dev.) | Patients = 20 to 30 Mean (st. dev.) | P |
|--------------------|-------------------------------|-------------------------------------|-------------------------------------|-------|
| Age (yr) | 83.00 ± 12.00 | 23.00 ± 1.00 | 32.00 ± 12.00 | — |
| Meaning (mm steps) | 83.00 ± 20.00 | 10.00 ± 10.21 | 103.00 ± 10.00 | <.001 |
| SPHmax (D) | 1.18 ± 1.07 | 0.00 ± 0.00 | 0.40 ± 1.24 | .002 |
| Δ SPHmax (D) | 0.58 ± 1.02 | 0.00 ± 0.00 | 0.23 ± 1.06 | .10 |
| Δ SPHmax (D) | 0.38 ± 0.90 | 0.00 ± 0.00 | 0.09 ± 1.04 | .11 |
| Δ PVD (µm) | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | .00 |

Romana V, Vinciguerra R, Arshahi E, Hicks N, Rosetta P, Vinciguerra P, & Kaye S. (2018). Progression of Keratoconus in Patients While Awaiting Corneal Cross-Linking: A Prospective Clinical Study. *Journal of Refractive Surgery*, 34(3), 177-180.

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How Do We Diagnose?

SLE findings include:

- Central corneal thinning,
- Fleischer's ring,
- Corneal scarring
- Vertical striae (Vogt's lines).

• Common refractive or topographic effects include:

- irregular astigmatism and
- poor best-corrected visual acuity with specs
- "Oil droplet" reflex (Charleux sign)

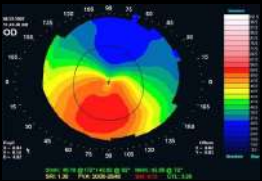


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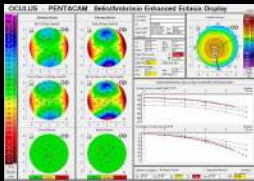
How Do We Diagnose?

Topography/Tomography

Topography
Keratoconus cornea



Tomography
Keratoconus cornea
Irregular/thin pachymetry, posterior float changes



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SIRVA, Astoria

Global Consensus on Keratoconus and Ectatic Diseases

Andri A. P. Gomes, MD, PhD, FRCOphth, Donald Tan, MD, PhD, FRCOphth, Christopher J. Rapin, MD, FRCOphth, R. Bruce, MD, FRCOphth, Nicholas A. Mills, PhD, FRCOphth, and E. Gault, MD, FRCOphth, MD, PhD, FRCOphth, MD, FRCOphth, and FRCOphth, MD, FRCOphth, the Group of Experts for the Global Digital Panel of Keratoconus and Ectatic Diseases

Define:

- Abnormal posterior ectasia
- Abnormal corneal thickness distribution
- Noninflammatory corneal thinning


Diagnose:

- ✓ Tomography (Scheimpflug or OCT)
- ✓ Anterior curvature map
- ✓ Corneal thickness map
- ✓ Slit lamp exam
- ✓ Central pachymetry
- ✓ Biomechanics

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When to Consider Tomography

- Increasing astigmatism
- Central K value > 47.2 Plattner et al. MedView
- Astigmatism >2.0 D (~8% of the population)
- Unable to correct to 20/15 to 20/20
- Asymmetry between eyes
- Scissoring with retinoscope




<https://www.aao.org/education/1-minute-video/retinoscopy-findings-in-keratoconus>

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Genetic Testing for at Risk Patients

- Non-invasive cheek swab test
- Examines over 1,000 variants across 75 genes for keratoconus
- 0 to 100 green-yellow-red scale based on research done by Avellino and study populations




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Polygenic risk score for keratoconus and diagnosis of corneal dystrophy

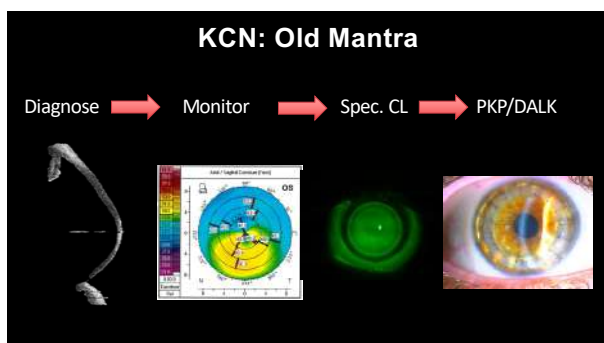
Summary of keratoconus risk and corneal dystrophy diagnosis **A**

Keratoconus risk assessment, explanation of polygenic risk score, and interpretation of risk score **B**

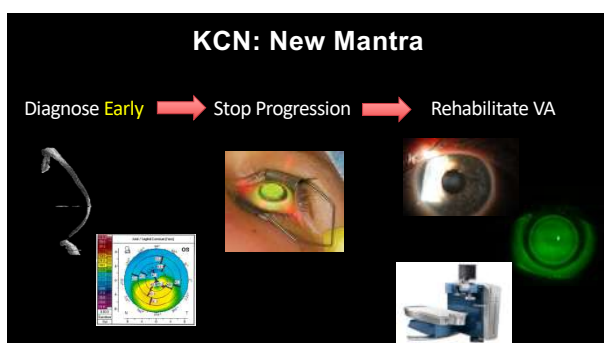
Corneal dystrophy detection with a YES / NO answer **C**



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What Do You Need?

Riboflavin 5' Phosphate
Active Pharmaceutical Ingredient

UV Light
Photoactivator

Oxygen
Reaction Catalyst

FDA approval:
April 2016 – Progressive KCN
July 2016 – Corneal ectasia following refractive surgery

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Use in Specific Populations: Label

No contraindications

Safety and effectiveness not established in pediatric patients below the age of 14 or over the age of 65

Cross-linking should not be performed on pregnant women.

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Post-operative course:
What's normal?

Day 1-5:

- Discomfort as epithelium heals
 - (BCL in place)
- Sensitivity to light
- Tearing
- A reduction and fluctuation in vision

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Post-operative course:
What's normal?

Day 5-30:

- Comfortable, sensitivity decreasing
- Hazy but improving vision back to baseline
- Typically relying on spectacles for correction
- No eye rubbing



Day 30 to month 3:

- Corneal remodeling (fluctuation!)
- +/- Progressive improvement in vision
- Ability to wear previous CL correction
- @ 3 months, consider refit for contact lens

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Preop

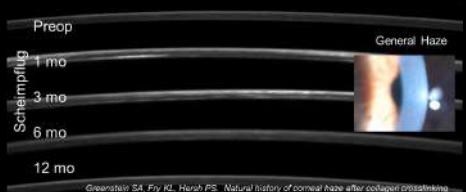
1 mo

3 mo

6 mo

12 mo

General Haze

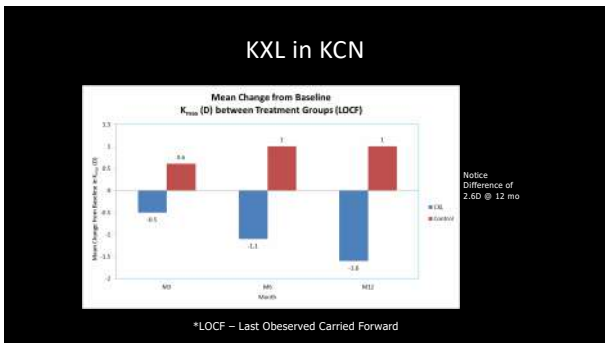


Greenstein SA, Fry KL, Herish PS. Natural history of corneal haze after collagen crosslinking for keratoconus and corneal ectasia. J Clin Refract Surg 2010;37:2109-2114

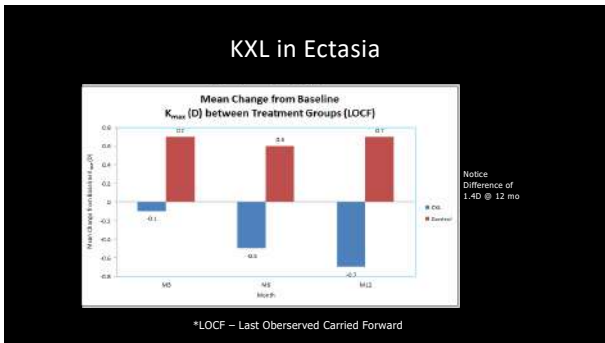
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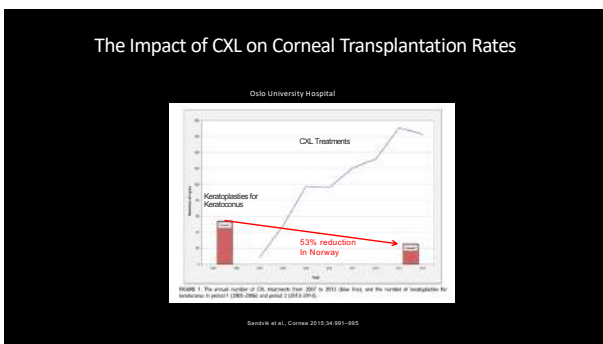
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Intacs® + CXL

| | |
|---|--|
| <p>Advantages</p> <ul style="list-style-type: none"> - Less invasive - Reversible - Recovery time | <p>Disadvantages</p> <ul style="list-style-type: none"> - Variable Response - Can Erode |
|---|--|

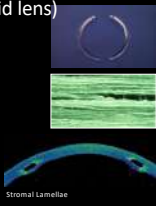


Approved for the treatment of Myopia in 1999
 Approved as a treatment for keratoconus in 2004
 Approved expanded range of sizes in 2010

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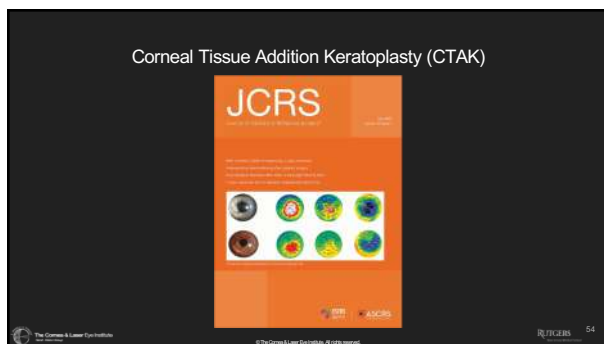
What are Intacs?

- 150° Arcs of PMMA (same as rigid lens)
- Placed between stromal layers
- Inner Diameter = 6.8 mm
- Outer Diameter = 8.1 mm
- Hexagonal-Shaped
- Intacs® are:
 - Replaceable
 - Removable
 - Upgradable

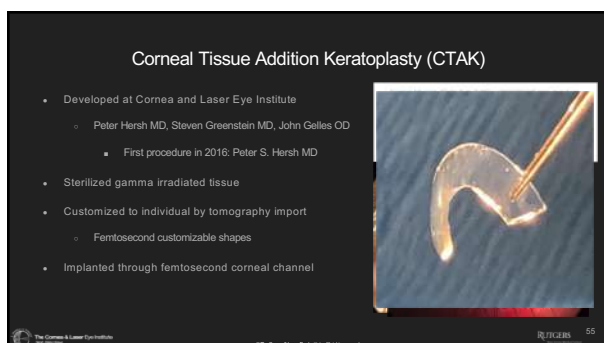


Stromal Lamellae

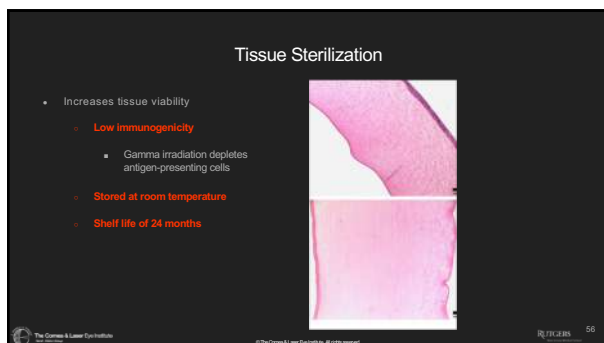
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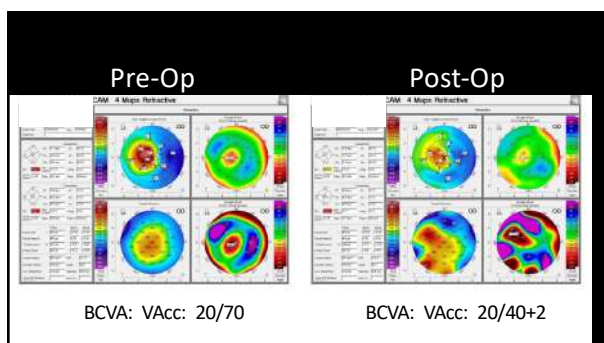
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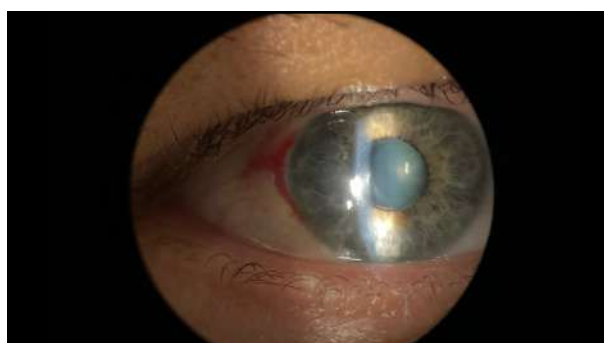
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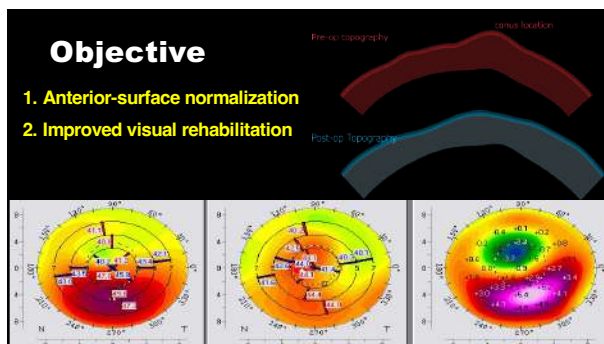
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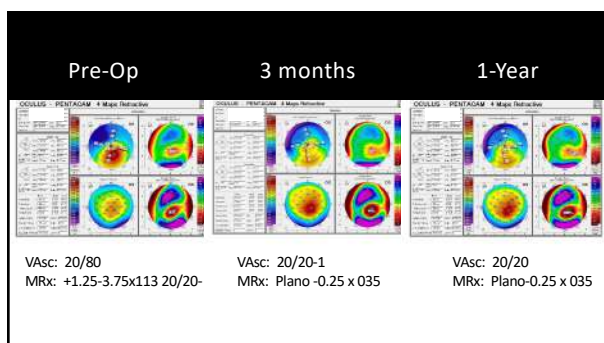
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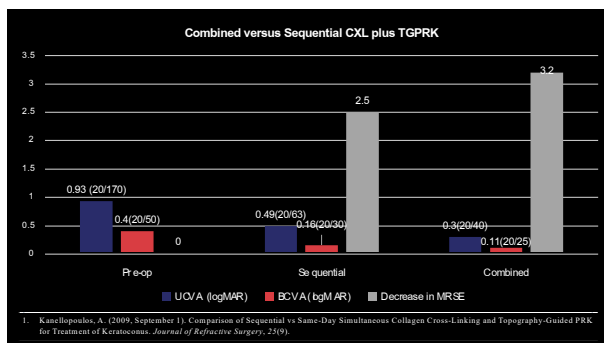
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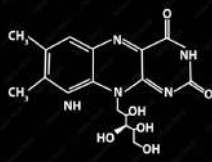
Additional/Future Applications



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Epi-On Corneal Cross-Linking

Iontophoresis or penetration enhancers
Epithelium absorbs 20% of incoming UV and barrier to O2



Increase UV fluence results in reduction of O2
Pulse CXL
O2 Goggles
Getting Close!!
Penetration Enhancers
Optimized UV irradiation profiles
Atmospheric O2

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US FDA Phase III Oxygen + Transepithelial CXL

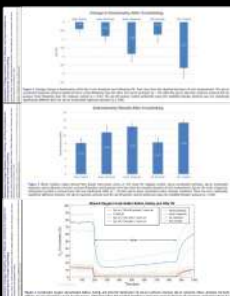
- Riboflavin formulations
 - Penetrate intact epi
- UV Delivery
 - Accelerated and Pulsed
 - ~1/3 procedure time
- Oxygen supplement
 - Aerobic cornea



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Oxygen + Transepi CXL

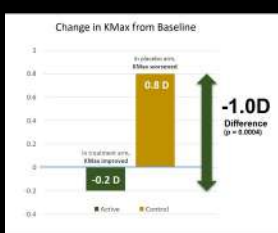
- Oxygen depleted in traditional CXL
- Oxygen supplementation:
 - Significantly greater stiffening ($p < .05$) than epi-on tissue crosslinked without additional oxygen
 - No statistical difference between the epi-on protocol with oxygen and epi-off Dresden protocol ($p \geq 0.05$)
 - No statistical difference between the negative control and the epi-on treatment without oxygen ($p \geq 0.05$)
 - The oxygen protocol produced more central flattening than the other epi-on protocols ($p < .05$)



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US Phase III Pivotal Trial Results

- Achieved primary efficacy outcome
- -1.0 D difference in Kmax at 6 months ($p=0.0004$).
- Well-tolerated
- 98% of placebo eyes elected to cross-over for Epi-on treatment



| Group | Change in KMax (D) |
|-------------------|--------------------------------|
| Active | 0.8 D |
| Control | -0.2 D |
| Difference | -1.0 D ($p = 0.0004$) |

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What is going to happen next

Predicting the Future is Easy.....

.....Being Right is Hard

-Yogi Berra

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