

20/20 Refractive Update: Advances in Presbyopic and Corneal Procedures

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2022 Vision Expo East

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Disclosures for Josh Johnston, O.D., F.A.A.O.

- Allergan- Consultant, speaker, research
- Astareal- consultant
- Avellino- consultant
- Azura- consultant, speaker
- BioTissue- consultant
- Bruder- consultant
- Dompe- consultant
- Glaukos- consultant, speaker
- Horizon Therapeutics- consultant
- Kala- consultant
- LacriSciences- share holder
- Legrande Health
- Sight Sciences- consultant
- Maxi Vision- consultant
- Novartis- consultant
- Sun- consultant, speaker
- Tarsus- consultant, researcher
- Visus- consultant
- Quidel- consultant, speaker
- Zeiss- consultant

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Disclosures - Walter O. Whitley, OD, MBA, FAAO has received consulting fees, honorarium or research funding from:

- Aerie: C, L
- Alcon: C, L
- Allergan: C, L
- Astareal: C
- Azura: C
- Bausch and Lomb: C, L
- Biotissue: C, L
- Bruder: C
- Carl Zeiss Meditec: C
- CollaborativeEye – Co-Chief Medical Editor
- Dompe: Consultant
- Dry Eye Coach – Medical Editor
- EyeVance: C, L
- Glaukos: C
- Horizon: C
- J&J Vision: C, L
- Kala: C
- Mediprint Pharma: C
- Novartis: C, L
- Ocusoft: C, L
- Ocular Therapeutix: C
- Oyster Point: C
- Quidel: C
- Regener-Eyes: C
- Review of Optometry – Contributing Editor
- Science Based Health: C, L
- Sight Sciences: C
- Sun Pharmaceuticals: C, L
- Tarsus Pharmaceuticals: C
- TearLab Corporation: C
- Vertical Pharmaceuticals: C
- Visus Pharmaceuticals: C

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Optometric Comanagement

- High quality eye care
- Benefits to patient care
 - Patient comfort
 - Patient convenience
 - Efficiency
 - Cost effective
- Utilize skills and expertise of each practitioner

4

Today's Optometrists

“To be on the cutting edge of optometry, you need to be on the cutting edge of science and technology.”

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Why Is This Important For Optometry?

- 4 out of 5 patients diagnosed with a cataract are done so by an optometrist
- Optometrists are the “gatekeepers” to cataract referrals and ATIOLs
- Referring O.D.'s must discuss all IOL options and educate patients about cataract and treatment options

6

Patient Education

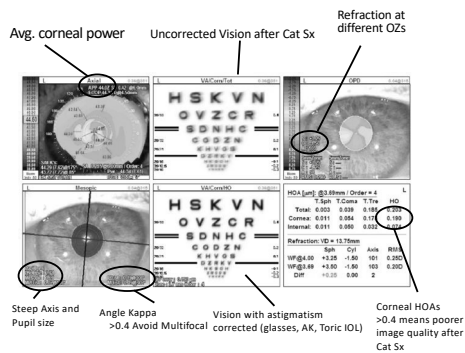
- Elements of effective education
- Explain the condition
 - Cataract
 - Astigmatism
 - Presbyopia
- Four presbyopic IOL classifications
 - Diffractive
 - Accommodating IOLs
 - Extended Depth of Focus IOLs (EDOF)
 - Trifocal

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Expect (Avoid) the Unexpected!

- Pre-op for Lifestyle IOLs
 - Topography, ocular surface testing
 - Macular OCT
 - Reliable biometry, reproducible astigmatism measurements
- Under promise and over deliver for ATIOLs
 - Emphasize need for +1.00 readers for near tasks ***
 - Discuss starbursts around lights at night

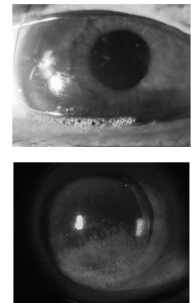
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Preparation for Ocular Surgery

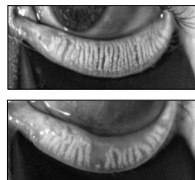
- Optimize the Ocular Surface
- Normalize the Lids
- Prepare the Cornea
- Eliminate Intra-ocular Inflammation
- Control Glaucoma
- Satisfy the Macula
- Evaluate the Retinal Periphery
- **Patient Education**



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Dry Eye Disease

- Chair time: blurred vision from cataracts versus DED
- Cataract sx can worsen DED for months after surgery
- Quality of vision may require chronic DED therapies



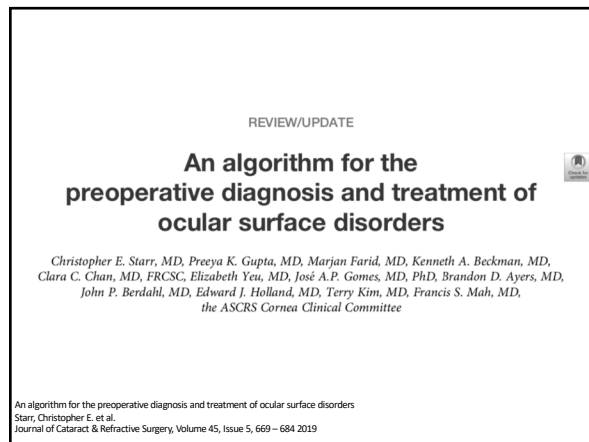
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Prevalence of ocular surface dysfunction in patients presenting for cataract surgery evaluation

Preedy, n, BS, Results: There were 120 patients (69% women), mean age 69.5 years \pm 8.4 (SD). Abnormal osmolarity was found in 68 patients (56.7%), and abnormal MMP-9 in 76 patients (63.3%). Clinical findings showed that 47 patients (39.2%) had positive corneal staining on presentation, 9 patients (7.5%) had epithelial basement membrane dystrophy, and 2 patients (1.6%) had Salzmann nodules. Questionnaire data showed 54 (54.0%) of 100 patients reported symptoms suggestive of ocular surface dysfunction. In the asymptomatic group of 46 patients, 39 (85%) had at least 1 abnormal tear test (osmolarity or MMP-9) and 22 (48%) had both tests abnormal. Overall, 96 (80%) of 120 patients had at least 1 abnormal tear test result suggestive of ocular surface dysfunction and 48 patients (40%) had 2 abnormal results.

J Cataract and Refractive Surgery 2018

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Premium IOLs: 5 Pearls ("P's") for Success

1. Plano Outcome
2. Proactive Tx of Ocular Surface Disease
3. Pre Op Counseling – Setting Realistic Expectations
4. Properly Screen Candidates
5. Pick the Right IOL

Other:

6. Pick the Right Surgeon
7. Posterior Capsular Opacification
8. Poor IOL Centration

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ATIOLs Provide The Opportunity to Treat More Than Just the Cataract

What are your patient's post-op visual goals?

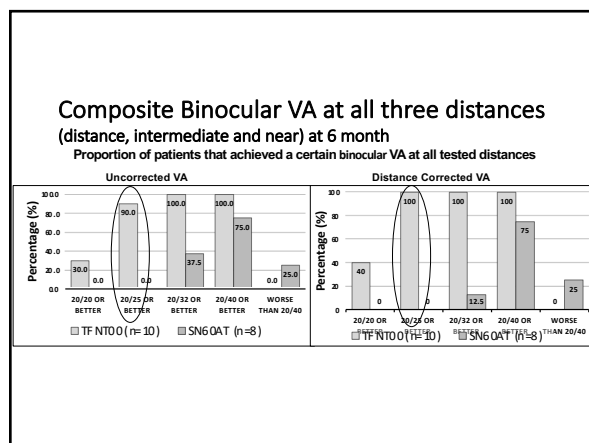
Accommodating IOLs Previous Generation of Multifocals Diffractive EDOF Unique Multifocal Design

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TRIFOCAL IOL

- SUPERPOSITION OF FOCAL POINTS
- LIGHT REDIRECTION - 120 cm intermediate focal point redirected to distance
- 3 FOCI – Trifocal with 40cm, 60 cm and distance
- 88% LIGHT UTILIZATION - at 3.0 mm pupil
- LIGHT ALLOCATION - 50% of available light to distance, 25% to intermediate and 25% to near

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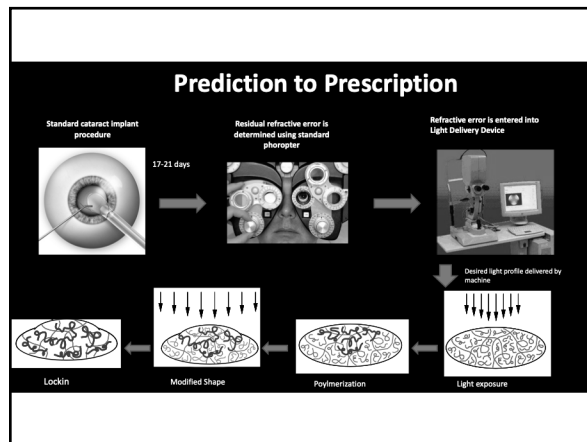


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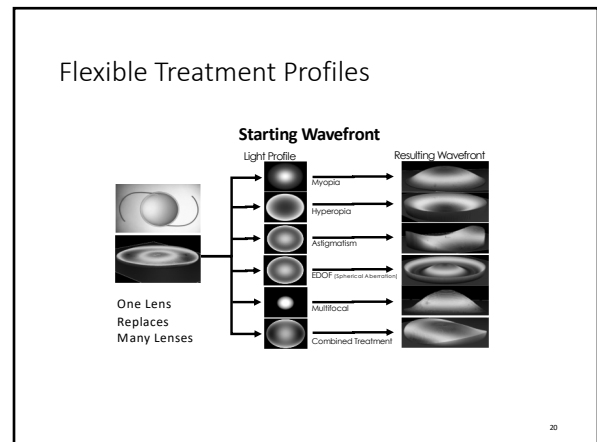
Light Adjustable Lens (LAL)

- FDA Approved 11/17 for pts with pre-existing astigmatism of $\geq 0.75D$ undergoing cat sx
 - Spherical and cylindrical errors up to 2D
- First and only lens designed to be **adjusted** after implantation by UV light
- 3 piece IOL design
- 6.0mm biconvex optic; 13.0mm overall length
- UV absorbing back layer: 50-100 μm

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Will Expand Monovision Use

- **Monovision used 3-4x more than PC-IOLs.**
 - Usual target: 0.75D-1.00D anisometropia
 - W/ average 0.5D SD, hard to hit target
 - If miss first eye, acuity degradation/ binocular fusion
- **Will increase binocular accuracy**
 - Standard deviation reduced to 0.2D
 - Patient ability to test-drive/adjust final outcome
 - LASIK-like outcomes
- **Creates new premium channel opportunity**

| IOL Type | Refractive Error (Standard Deviation) |
|----------------|---------------------------------------|
| Non-Adjustable | 0.5D |
| RxLAL | 0.2D |

1. 2020/2021 NEDS Survey 2. Postoperative at 12 to 13 Days/12-13 Day Study

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FDA Clinical Results

- **91.8% within 0.50 D of target manifest refraction spherical equivalent**
- **Results showed that 100% of study eyes had a best corrected visual acuity of 20/40 or better at the 6 month po visit.**

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What's Next in IOL Technology?

- **Modular IOL Systems**
- **Accommodating**
- **Multifocal / trifocal**
- **Extended Depth of Focus**

The slide features images of the 'ClarVista HARMONI Modular IOL' and a diagram showing an IOL implanted in an eye.

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Accommodating IOL

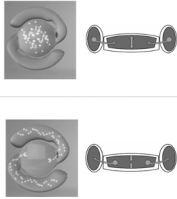
The diagram shows two views of an Accommodating IOL: 'DISTANCE' and 'INTERMEDIATE AND NEAR'.

- **Modular, curvature-changing, fluid-optic IOL**
- **Two-part IOL - Base and Modular**
- **Advantages**
 - Doesn't split light
 - Up to 3D of continuous range vision
 - No change in ELP
 - No PCO up to 4 years
- **Astigmatism?? Drug Delivery?? Exchangeable 2nd implant??**

****Not FDA Approved**

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Accommodating IOL

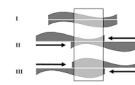


- Entire lens is hollow and filled with liquid silicone
- Fluid changes changes in optic
- Avg. accommodation range 2D
- Dr. Nichamin ESCRS 2018
- 29 eyes
- Distance 20/20
- Intermediate 20/20-20/25
- Near 20/22-20/27

**Not FDA Approved

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Accommodative IOL



- Two piece sulcus IOL
 - Fixed and variable
 - Hydrophilic acrylate
- Shifting optics
 - Can provide 3-4 D focal range when shifted
- Dr. Alio - 59 eyes of 43 pts
 - Accommodative range of 3.1D

**Not FDA Approved

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EDOF

| Confounders | Alcon AcrySulc IOL | | | MBA | | | Alcon AcrySulc IOL | | |
|----------------------|--------------------|--------------------|-------|-------|--------------------|-------|--------------------|--------------------|-------|
| | Mean | Standard Deviation | Range | Mean | Standard Deviation | Range | Mean | Standard Deviation | Range |
| Contrast | 14.2% | 12.2% | 3.8% | 14.0% | 11.8% | 3.7% | 14.2% | 12.2% | 3.8% |
| Glare | 11.2% | 8.2% | 1.2% | 11.2% | 8.2% | 1.2% | 11.2% | 8.2% | 1.2% |
| Chromatic Aberration | 1.1% | 0.8% | 0.1% | 1.1% | 0.8% | 0.1% | 1.1% | 0.8% | 0.1% |
| Chromatic Dispersion | 7.1% | 0.1% | 0.1% | 7.1% | 0.1% | 0.1% | 7.1% | 0.1% | 0.1% |
| Chromatic Aberration | 0.1% | 0.1% | 0.1% | 0.1% | 0.1% | 0.1% | 0.1% | 0.1% | 0.1% |
| Chromatic Dispersion | 2.1% | 0.1% | 0.1% | 2.1% | 0.1% | 0.1% | 2.1% | 0.1% | 0.1% |

Source: Alcon AcrySulc IOL Clinical Trial

- Non-diffractive IOL
- Novel X-Wave shaping technology creates an extended focal range by stretching and shifting the wavefront
- Low incidence of visual disturbances
- Possible for AMD?? Glaucoma??



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Enhanced Monofocal IOL

- First lens^[1] in the monofocal IOL category in Europe to deliver improved intermediate vision and 20/20" distance vision
- Offers the same well-established low incidence of halo, glare, or starburst 1-piece IOLs
- FDA approved 2/2/21

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Combined EDOF/Multifocal

- Gives broad range of continuous vision covering from distance to 33 cm**4-6
- Eliminates the visual gaps present in trifocal and other multifocal technology
- Continues to deliver superior performance in low-light conditions***2
- Violet-filtering technology demonstrates reduction in halo intensity for tasks like night driving⁷



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Trifocal IOL

- Aspheric diffractive trifocal
- 2 diffractive structures that give +3.5D add for N and +1.75D for intermediate
- Less glare and halos
- Designed to reduce the loss of light energy resulting from any diffractive system
- Diffractive anterior surface entirely convoluted
- Height of the diffractive step varied
- Distributes light to near, intermediate and distant foci adjusted according to the pupil aperture



**Not FDA Approved

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"Pinhole" IOL Design

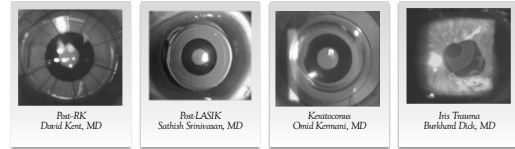
- IOL Material
 - Single-piece hydrophobic acrylic
- Mask
 - PVDF & nanoparticles of carbon
 - 1.36mm aperture
 - 3.23mm total diameter
 - 3200 microperforations
 - 5 microns thick



**Not FDA Approved

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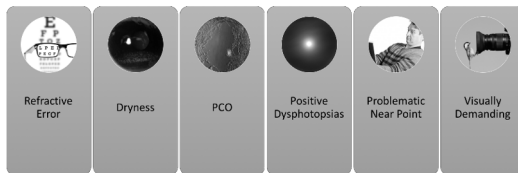
Presbyopia Correction No Longer Only for the Perfect Cornea!



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20/Unhappy

Causes of unhappiness



Woodward MA, Randleman JB, Stulting RD. Dissatisfaction after multifocal intraocular lens implantation. *Journal of cataract and refractive surgery*. 2006;32(6):992-997. doi:10.1016/j.jcrs.2006.01.031.

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Neuroadaptation of Multifocal IOLs

- Patients' expectations of time frame needed to adapt needs to be managed
 - These patients require more counseling post-op
 - Neuroadaptation can take as long as 6-12 months
 - About 10% never neuroadapt (will need IOL exchange)
 - No way of testing before surgery which patients will be able to adapt vs not
- Multifocal IOLs will induce more aberrations than monofocal IOLs

Take away: no YLC to be performed until rule out that IOL exchange is necessary

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Refractive Enhancement: Laser Vision Correction (LVC)

- **Timing is everything!**
- Wait at least 2-3 months after cataract surgery for wounds and LRIs to settle
- Nd:YAG posterior capsulotomy BEFORE LVC
 - No YAG in multifocal IOL that was never happy



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Managing the Unexpected Outcome: Have an Algorithm to Identify the Issue

- Develop communication with your staff regarding dissatisfied patients
 - Encourage clinic techs to communicate patient satisfaction to you
 - Have work-up done before you see the patient
 - MRx BCVA/Topo/OCT/Ocular surface testing
 - Have a plan to fix the problem before you enter the room!

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Innovative Technologies in Refractive Surgery and Presbyopia

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Large and Growing Global Myopia Market

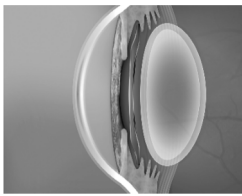
By 2050* . . .

- Myopia is projected to affect almost half of the world's population
- 5 billion with myopia
- 1 billion with high myopia (>-6D)
- In the United States and Canada, myopia to increase to 260 million, or close to half of the population, up from 89 million in 2000

*Holden BA, et al. Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050. *Ophthalmology*. 2016 May;123(5):1036-42.

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ICL: 20+ Years of global experience



- Sharp and clear vision, including at night¹
- Removable and biocompatible lens
- Can be used for myopes with thin corneas^{2,3}
- Flexibility for future procedures
- Long term history and over 1 million implants
- Does not contribute to dry eye syndrome⁴
- UV Protection

1. Parthasarathy S. *Clinical Ophthalmology* 2013; 5: 1228-1232.
2. Parthasarathy S, Pruthi NK, Gargan J. *J Refract Surg*. 2012;27(7):433-440.
3. Gargan J, Howard V, et al. *Journal of Cataract & Refractive Surgery*. Volume 38, Issue 7, 883-886.
4. Brown, L.S., Campt, G., Chhaba, S., et al. Presented at American Society of Cataract and Refractive Surgery (ASCRS), 2012.

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Toric ICL – US FDA approval in 2018

- Correction of myopic astigmatism with spherical equivalent ranging from -3.0 D to -15.0 D (in the spectacle plane) with cylinder (spectacle plane) of 1.0 D to 4.0 D in the spectacle plane.
- Reduction of myopic astigmatism with spherical equivalent ranging from greater than -15.0 D to -20.0 D (in the spectacle plane) with cylinder (spectacle plane) 1.0 D to 4.0 D in the spectacle plane.

- The US FDA clinical study data of [redacted] was submitted to the FDA in April 2021.



Not approved in the US

Not approved in the US

STAAR Vision Toric Implantable Collamer Lens (ICL) for Myopia (TICL). Directions for Use.

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PRESBYOPIA

by the numbers



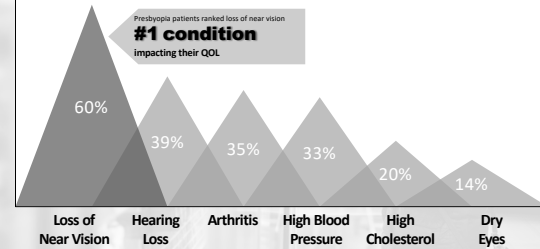
1. Ficker TS, et al. *Ophthalmology*. 2016;125:1485-1489. 2. Chang DH. *Ophthalmology Times*. Accessed November 4, 2021. 3. *Statista*. <https://www.statista.com/statistics/1000000/presbyopia-in-the-us/>. 4. *Statista*. <https://www.statista.com/statistics/1000000/presbyopia-in-the-us/>. 5. *Statista*. <https://www.statista.com/statistics/1000000/presbyopia-in-the-us/>.
Allergan Vision Council Member Report. September 2020/2021 FINAL. p. 5. NDI.
Accessed September 20, 2021. <https://www.allergan.com/press-releases/2021/09/20/ndi-vision-council-member-report-september-2020-2021-final.aspx>



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Presbyopia Has a Significant Impact on Quality of Life

% ranking conditions as top-2 most impactful on QOL

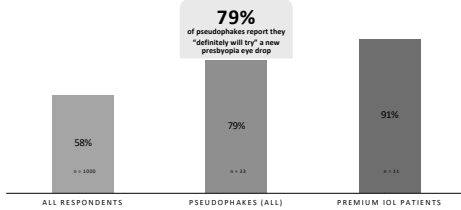


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Pseudophakes Very Interested in Trying a Presbyopia Drop – a Highly Motivated Patient Segment

If your eye doctor recommended it, how likely would you be to try this new eye drop to temporarily restore your near vision?

% OF PSEUDOPHAKES IN COMPARISON TO ALL RESPONDENTS WHO RESPONDED "DEFINITELY WILL TRY"

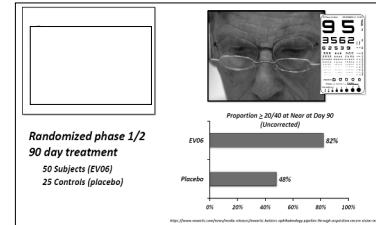


Burke Healthcare Research April 2020, n = 1,000 presbyopes ages 40-80 years old

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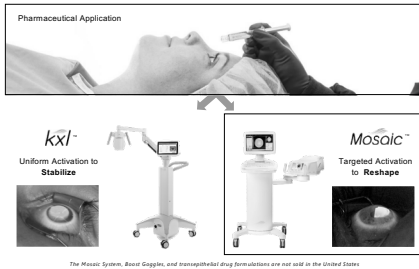
Presbyopia Prevention Drug?

Anti lens disulfide crosslinking
Improves natural lens elasticity



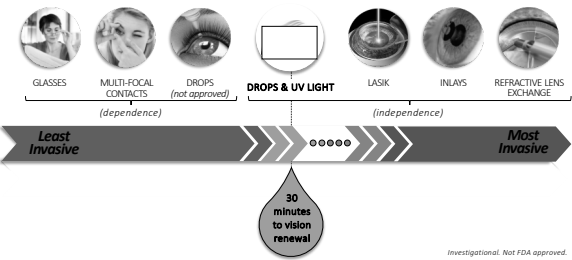
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Non-invasively Stabilizing and Reshaping the Cornea Corneal Remodeling Technology



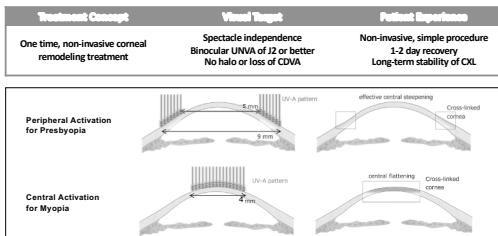
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Corneal remodeling for non-invasive reshaping the cornea without ablation or incision



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PiXL for Vision Improvement Non-invasive corneal remodeling

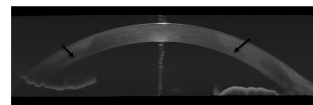


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PiXL for Presbyopia

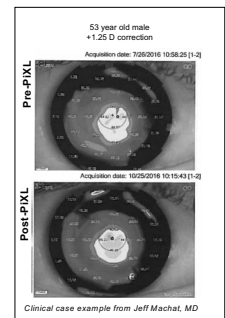
Spatially targeted, epithelium-on, accelerated cross-linking

More than 200 eyes treated internationally with PiXL to date



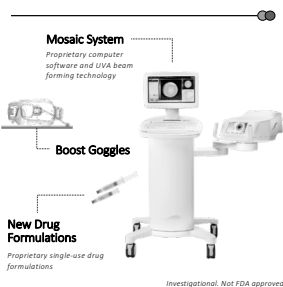
- Midperipheral cross-linking, no UVA applied to central cornea
- Image above: High resolution OCT image showing mid peripheral corneal stromal demarcation line after epi-ON PiXL with oxygen

Investigational. Not FDA approved.



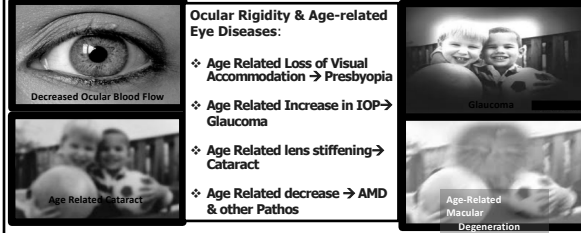
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- A potential non-invasive solution for presbyopia
- Filling a gap in refractive treatment options
- Drops, UV light and O₂
- Targeted corneal reshaping with long-term durability of cross-linking
- Likely advantageous for post operative cornea adjustability
- Early clinical results are promising
- **Multicenter Phase II Study in 2019**



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Ocular Rigidity Correlation Age-Related Eye Diseases

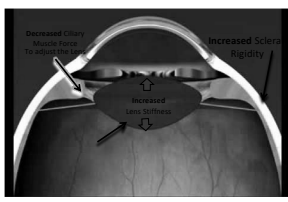



Ocular Rigidity & Age-related Eye Diseases:

- ❖ Age Related Loss of Visual Accommodation → Presbyopia
- ❖ Age Related Increase in IOP → Glaucoma
- ❖ Age Related lens stiffening → Cataract
- ❖ Age Related decrease → AMD & other Pathos

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Ocular Rigidity: Leads to **Loss of Visual Accommodation**

Detorakis ET, Pallikaris, IG. Ocular rigidity: bio-mechanical role, in vivo measurements and clinical significance. Clin Experiment Ophthalmol 2012 May 18.

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Solution: Laser Scleral Microporation "Uncrosslinking" Scleral Microfibrils to Rejuvenate BioDynamics

Problem

- ↑ Ocular/ Scleral rigidity
- ↓ Efficiency Ciliary Muscle Forces
- ↓ Lens shape changes during accommodation
- ↑ Positive Spherical Aberration (SA)/undesirable monochromatic aberrations

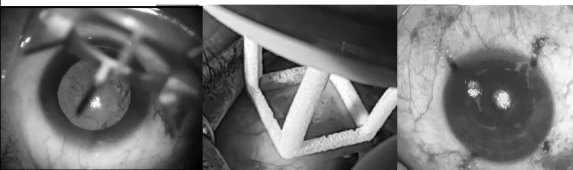
LSM Solution

- ↓ Scleral biomechanical Stiffness
- ↑ Ciliary Muscle forces on the Lens
- ↑ Lens shape changes during accommodation
- ↓ Positive Spherical Aberration SA/undesirable monochromatic aberrations



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Laser Scleral Microporation: LSM Procedure

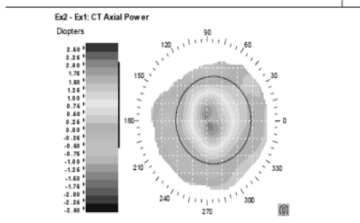
Courtesy Dr. Mitch Jackson

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Allogenic Corneal Inlay

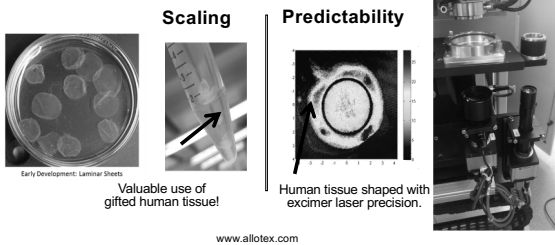
PEARL: PrEsbyopic ALlogenic Refractive Lenticule

- Increasing central corneal power to improve near vision



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Excimer laser shaped corneal inlays



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European Multicenter Study: Interim data analysis (20 eyes)

| | Preoperative | Post-op (last visit) |
|-------------------------------------|------------------------------|----------------------|
| UCVA of 20/40 or better (monocular) | 0% | 95% |
| Near Vision (binocular) | Gain: +17 letters (mean) | |
| Intermediate Vision (binocular) | Unchanged: +2 letters (mean) | |
| Distance Vision (binocular) | Unchanged: -2 letters (mean) | |

*** last visit was 1 or 3 months after surgery

c/o Aylin Kylic, MD

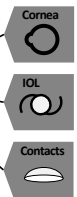
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The LIRIC Platform: Laser Induced Refractive Index Change for Refractive Error Correction

LIRIC: *a disruptive technology*

Poised to revolutionize:

- refractive surgery
- cataract surgery
- contact lenses

A revolutionary way to
refine the optics of the eye

- Cornea**
 - Minimally invasive
 - No flap, epi on, no doping
 - No nerve damage
- IOL**
 - Post-implantation optical touch-up
 - Monofocal to multifocal & vice-versa
 - Correct residual refractive error
- Contacts**
 - Enables diffractive multifocals for better presbyopia correction
 - Thin lenses for all prescriptions
 - Better oxygen transmissibility

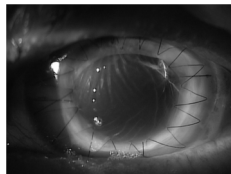
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Updates on Modern Day Corneal Surgery

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Common Corneal Procedures

- Corneal crosslinking
- Penetrating keratoplasty
- Descemet's stripping endothelial keratoplasty
- Pterygium surgery
- Superficial keratectomy



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Watch Out for Keratoconus!

8 Potential Signs & Symptoms

Typically onset occurs in teenage years or early twenties



- **Look out for warning signs in medical history**
 - History of eye rubbing
 - Family & genetic predispositions
- **Look out for visual complaints**
 - Blurred vision
 - Distortion of images
- **Look out for refractive anomalies**
 - Distortion of mires on keratometry
 - Error messages on autorefractors
 - Unsatisfactory attempts at vision correction & progressive loss of UCVA & BCVA
 - Increasing astigmatism

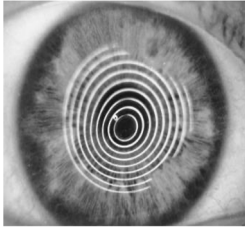
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Diagnostic Imaging

- Irregular Placido (egg-shaped) Topography

Early signs of keratoconus may include

- Skewed radial axis of astigmatism
- Asymmetric or truncated bow-tie

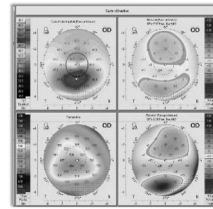


¹ F.S. Rahbarizadeh. Keratoconus. Survey of Ophthalmology Vol 62, No 4, Jan-Feb 2008.

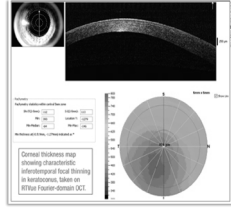
73

Diagnostic Imaging

Irregular Topography/Tomography



Focal thinning on OCTs¹



Additional signs of keratoconus may include

- Astigmatism variance between eyes
- Stromal and epithelial thickness changes
- Posterior elevation changes
- Wavefront aberrations
- Topographic changes
 - Inferior steepening
 - Irregularity indices

¹ <https://www.reviewofophthalmology.com/article/making-the-most-of-anterior-segment-oct>

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Corneal Crosslinking

- UV light and photosensitizer to strengthen chemical bonds in the cornea
 - Oxidative deamination reaction with ends chains of collagen
- FDA Approved in the US 2016
 - Epi-off
- Indicated to help slow progression of:
 - Keratoconus
 - PMD
 - Terrien Marginal Degeneration
 - Post-refractive surgery ectasia

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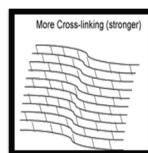
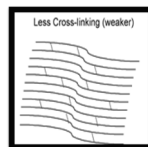
Contraindications

- Corneal thickness <400um (epi off)
- Prior herpetic infection
- Concurrent infection
- Severe corneal scarring or opacification
- History of poor epithelial wound healing
- Severe ocular surface disease
- Autoimmune disorders

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Mechanism of Action

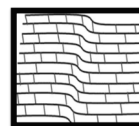
- Corneal collagen cross-linking combines the use of **ultra-violet (UV) light** and **riboflavin (vitamin B2) drops**
- The absorption of UVA by riboflavin generates radical riboflavin and singlet oxygen to form cross-links¹
- **Corneal Cross-Linking:**
 - Creates new corneal collagen cross-links
 - Results in a shortening and thickening of the collagen fibrils
 - Leads to the stiffening of the cornea²



¹ Farnsworth A, Friedman MW, Sherriff S, Walter D. Photochemical kinetics of corneal cross-linking with riboflavin. Invest Ophthalmol Vis Sci. 2012;53:2360-7.
² Ruestow M, O'Donnell C, Kucharski M. Biomechanical properties of corneal tissue after ultraviolet A-riboflavin crosslinking. J Cataract Refract Surg. 2013;39(5):651-62.

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Keys to Patient Counseling: Discuss Treatment Goals



Aim of CXL is to halt or slow disease progression



Cross-Linking is not a refractive procedure



Post-op evaluation for visual correction will be necessary

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Patient Case Study –
Refractive Evaluation

Patient Profile

- 29 year old AA male patient
- Unable to wear SCL
- Glasses Rx stable for past years
- PMHx: unremarkable
- MRX: OD: -3.00 + 0.50 x 164
OS: -3.00 + 0.25 x 178
- CCT: 535/551 microns

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Patient Case Study

OD

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Patient Case Study

OS

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What Does Genetic testing Tell Us

WITH Genetic testing...

- Understand the right treatment plan
- Patient demonstrated risk score of **99** indicating a **HIGH** risk for KC.

| CONDITION TESTED | RESULT | DETAIL | EXPLANATION |
|---------------------------------|-------------------|--------|---|
| Keratoconus (KC) | Genetic High risk | 99.00 | Based on the polygenic risk score, the patient is at a high risk for KC. |
| Highly myopic keratoconus (HMK) | Negative | None | Based on the polygenic risk score, the patient is not at a high risk for HMK. |

Keratoconus (KC) Risk Assessment

Based on the polygenic risk score of 99.00, this patient's risk for KC is **High**.

TREATMENT DECISION

- Deferred LASIK / PRK, patient can consider ICL surgery

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Corneal Transplant

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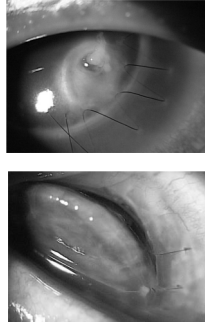
What to expect PK

- Day 1**
 - Moderate to severe stromal/corneal edema
 - AC 1-2+ cell and pigment
 - Poor vision and pain
- Week 1**
 - Moderate corneal edema may still be present
 - Vision is improved but still moderately decreased
 - AC some inflammation present (tr-1+ cell)
- Month 1**
 - Most corneal edema should be resolved at this time
 - Refraction/Pachymetry/Atlas to monitor
 - AC is quiet
- Month 6**
 - Stabilization
 - Select suture removal to decrease induced astigmatism

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Complications of Penetrating Keratoplasty

- Long-term complications
 - Glaucoma
 - Microbial keratitis
 - Suture-related problems
 - Wound dehiscence
 - Immunologic graft rejection
 - Late endothelial failure
 - Graft failure
- Refractive error, astigmatism



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Long-term maintenance

- Long term topical steroid to decrease rejection rate
- Some patients may require oral antivirals if corneal transplant is related to scarring from prior HSV
- Repeat PK may be needed after approximately 20 years

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Descemet's Stripping Endothelial Keratoplasty (DSEK)

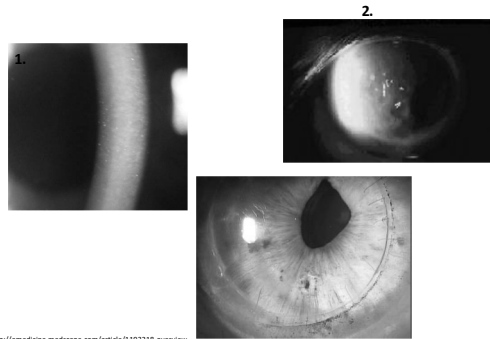
- Sutureless transplant of the posterior cornea
- Replaces diseased portion of cornea with donor graft
- Donor tissue obtained by
 - Manual dissection
 - Microkeratome dissection
 - Femtosecond laser



1. Photos accessed from <http://www.moria-surgical.com/> on 8/26/11
 2. Photos accessed from <http://www.alcon.com/en/alcon-products/refractive-surgery.aspx>

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Indications

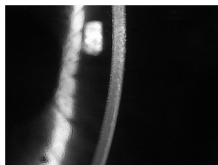


1. <http://emedicine.medicapedia.com/article/1192218-overview>
 2. <http://webeye.ophth.uiowa.edu/eyeforum/cases/case5.htm>

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DSEK/DSAEK Exclusion Criteria

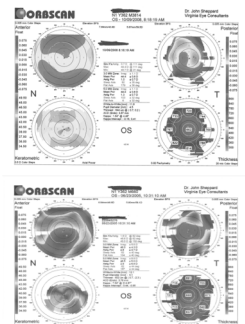
- Exclusion
 - Corneal scarring
 - Aphakic
 - Iris loss / atrophy



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Advantages of DSEK/DMEK vs. PK

- Sutures
- Visual recovery
- Astigmatism / ametropia
- Epithelial complications
- Corneal allograft rejection
- Wound strength
- Globe stability
- Length of surgery
- Intraoperative complications
- Post op visits



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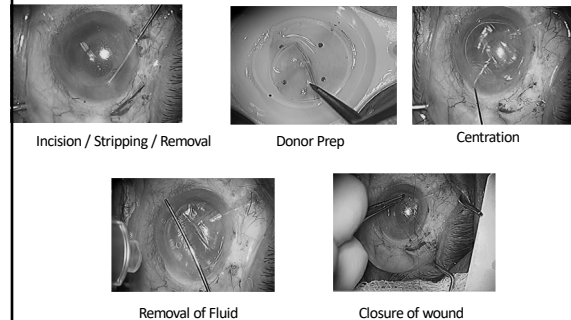
DSEK, PK Yield Similar Graft Survival

Price et al. Ophthalmology. 2011;118(4):725-729

- Retrospective, interventional case series
- DSEK graft survival rates
 - 95% for Fuchs
 - 76% for PBK/ABK
- PK graft survival rates
 - 93% for Fuchs
 - 73% for PBK/ABK
- Endothelial cell loss at 5 years
 - 53% in DSEK
 - 70% in PK

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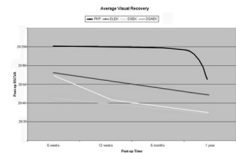
DSEK Procedure



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DSEK Average Visual Recovery

- 1 Day: 20/400
- 1 Week: 20/70
- 1 Month: 20/40
- 3 Months: 20/30
- 6 Months: 20/25
- 1 Year: 20/25-20/20



Dr. Gorovoy Study - Results presented during the AAO 2006 - Las Vegas

Terry and Shamie. Endothelial Keratoplasty. Retrieved from <http://www.dise-dise.com/dise/diseprocedure.htm> on 6/20/08.

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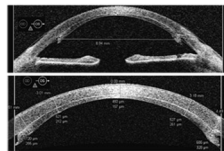
DMEK

- Graft of Descemet's membrane and endothelium only
- Better optical outcome of 20/25 or 20/20
- Difficult to manipulate
- Early graft dislocation risk
- Decreased risk of rejection

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DSEK/DMEK Complications

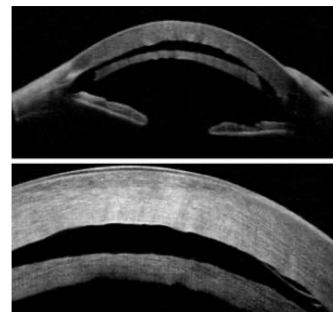
- Caused by any of the following
 - Graft-recipient interface
 - Fragile graft tissue
 - Graft location
 - Glaucoma
 - Infection
 - CME
 - Retinal detachment



Miller, J. Accessed from <http://www.revoptom.com/content/d/technology/c/16179/>

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DSEK Gone Wrong



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Long-term Maintenance DMEK and DSEK

- Long term topical steroid
 - Helps decrease rejection rate
 - Steroid Lotoprednol, prednisolone acetate, FML 1 gtt QD typically
- Unknown length of graft viability
 - No long term data since started approx 2003
 - In theory surpass PK ~20 years
- 5 year Graft survival similar at 93%¹

1. Price DA, Kelley M, Price FW Jr, Price MO. Five-Year Graft Survival of Descemet Membrane Endothelial Keratoplasty (EK) versus Descemet Stripping EK and the Effect of Donor-Sex Matching. *Ophthalmology*. 2018 Oct;125(10):1508-1514. doi: 10.1016/j.ophtha.2018.03.050. Epub 2018 May 3. PMID: 29733347.

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Limbal Stem Cell Deficiency

- When limbal stem cells begin to struggle and poorly function, the epithelial cell layer and its reproduction becomes compromised
- Loss or deficiency of stem cells in the limbus which are vital for re-population of the corneal epithelium and to the barrier function of the limbus
- Once limbal stem cells are damaged the epithelium will be replaced by conjunctival goblet cells

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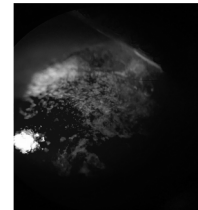
LSCD Causes

- | | |
|--|---|
| <ul style="list-style-type: none"> • Acquired <ul style="list-style-type: none"> • Trauma • Contact lenses | <ul style="list-style-type: none"> • Autoimmune <ul style="list-style-type: none"> • Sjogrens Syndrome • Stevens Johnson syndrome • Mucous membrane pemphigoid |
| <ul style="list-style-type: none"> • Inflammatory <ul style="list-style-type: none"> • DED • Allergy • Neurotrophic keratopathy | <ul style="list-style-type: none"> • Congenital <ul style="list-style-type: none"> • Aniridia • Autoimmune Polyglandular Syndrome • Keratitis, Ichthyosis, and Deafness Syndrome |

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Signs and Symptoms

- Varying degree of ocular signs depending on severity and level of corneal conjunctivalization
- Symptoms
 - Decreased vision
 - Photophobia
 - Tearing
 - Blepharospasm
 - Recurrent pain



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Severe LSCD

- Conjunctivalization
 - Corneal surface stains abnormally because the conjunctival epithelium is more permeable to the stain than true corneal epithelium
- More prone to recurrent or non-healing epithelial defects
- Stromal scarring or melting
 - Expect more pain and vision loss

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Non-Surgical Treatment

- Remove traumatic or toxic insults that may be the cause
- Discontinue contact lens wear
 - Possible refit in scleral
 - Bandage CL?
- Discontinue or switch topical medications
 - Glaucoma medications
 - Preservative sensitivity

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Non-Surgical Treatment

- Treating underlying systemic causes
 - Autoimmune control
- Improve tear film and control inflammation
 - Vitamin A ointment QHS
 - Topical steroids
 - Compounded Preservative Free option
 - Topical cyclosporine
 - Preservative free AT
 - Punctal Plugs

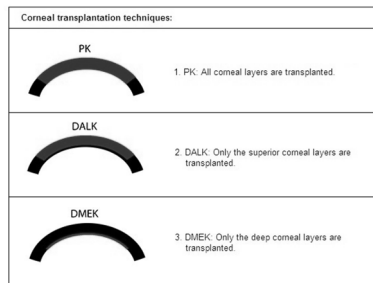
109

Non-Surgical Treatment

- Amniotic membrane
 - Dehydrated vs cryopreserved
- Amniotic membrane drops
 - Can be costly and not covered by insurance currently
- Serum Tears
 - Can be costly and inconvenient
- Cenegegermin
 - Neurotrophic keratitis

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DALK (deep anterior lamellar keratoplasty)



111

Post-Operative Care

- Moxifloxacin QID OD x 1 week and Difluprednate starting at QID OD and tapered down to Loteprednol QHS OD for maintenance
- Several corneal sutures removed after 6-9 months
- Cataract extraction OD
- Final BCVA 20/25 OD

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Pterygium

- “wing” like ocular surface lesion originating from limbal conjunctiva within the palpebral fissure progressing to the cornea
 - Nasal and temporal
- More common in people with history of increased UV exposure
 - Males > females
- Typically asymptomatic
 - Induced astigmatism

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Treatment

- Non Surgical
 - Treat the ocular inflammatory response
 - Cyclosporin
 - Lifitegrast
 - Topical steroids
 - Artificial tears
- Surgical
 - Encroaching on visual axis
 - Preparing for cataract surgery
 - Significant induced astigmatism

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What to expect after Sx

- Day 1
 - Epithelial defect
 - Conjunctival injection, check wound site
- Week 1
 - Epithelial defect healed with haze
 - Conjunctiva check for secure wound site
 - Monitor for wound dehiscence
- Month 1
 - Haze resolution
 - Conjunctival stabilization

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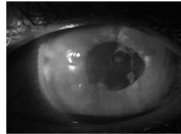
Long term treatment

- Control UV exposure
- Control dryness and inflammation
 - Cyclosporine
 - Lifitigrastr
 - Artificial tears
 - Topical steroids
 - Punctal plugs
- Will help to control reoccurrence

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Lamellar keratoplasty

- Indications:
 - ABMD
 - Salzmanns
 - Band Keratopathy
 - RCE
 - Corneal scars



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Lamellar Keratoplasty

- Corneal epithelium is removed down to Bowman's layer
- Can be performed in slit lamp or operating room using Weck-cel sponge or scarifier blade, and cleaned up with diamond burr
 - After removal surface is polished with cellulose sponge, antibiotics, and THBL placed

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Long Term Treatment

- After lam K for RCE
 - Maintain THBL for 3 months
 - Oral Doxycycline
 - Topical Antibiotics
 - Topical Steroids
 - Vitamin C
- Control of ocular surface disease

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Comanagement Pearls

- Opportunity to provide cutting edge technology
- Importance of your recommendation
- Patient education is critical!

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Comanagement Pearls

- Identify potential causes of surgical complications
- Educate your patients your role within medical eye care
- *We are all judged by the visual outcomes our patients. Comfort and quality of vision is the key!*

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Thank you!!

Questions?

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wowhitley@eyecareassociatesnv.com

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