
THE FUTURE OF KERATOCONUS
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CORNEA, CATARACT, AND REFRACTIVE SURGEON
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Financial Disclosures

- None

Let's Time Travel To The Future…

- Every case of keratoconus is screened and treated **early**
- A diagnosis of keratoconus **does not mean poor vision**
- ZERO cases of acute hydrops
- ZERO cases of cornea transplants for keratoconus

Let’s talk about…

History of Keratoconus and Treatment

Current Screening Tools and Tips

Corneal Cross-linking

Co-management: Working Together

“Refractive-Plus” Procedures

Proposed Screening Protocols

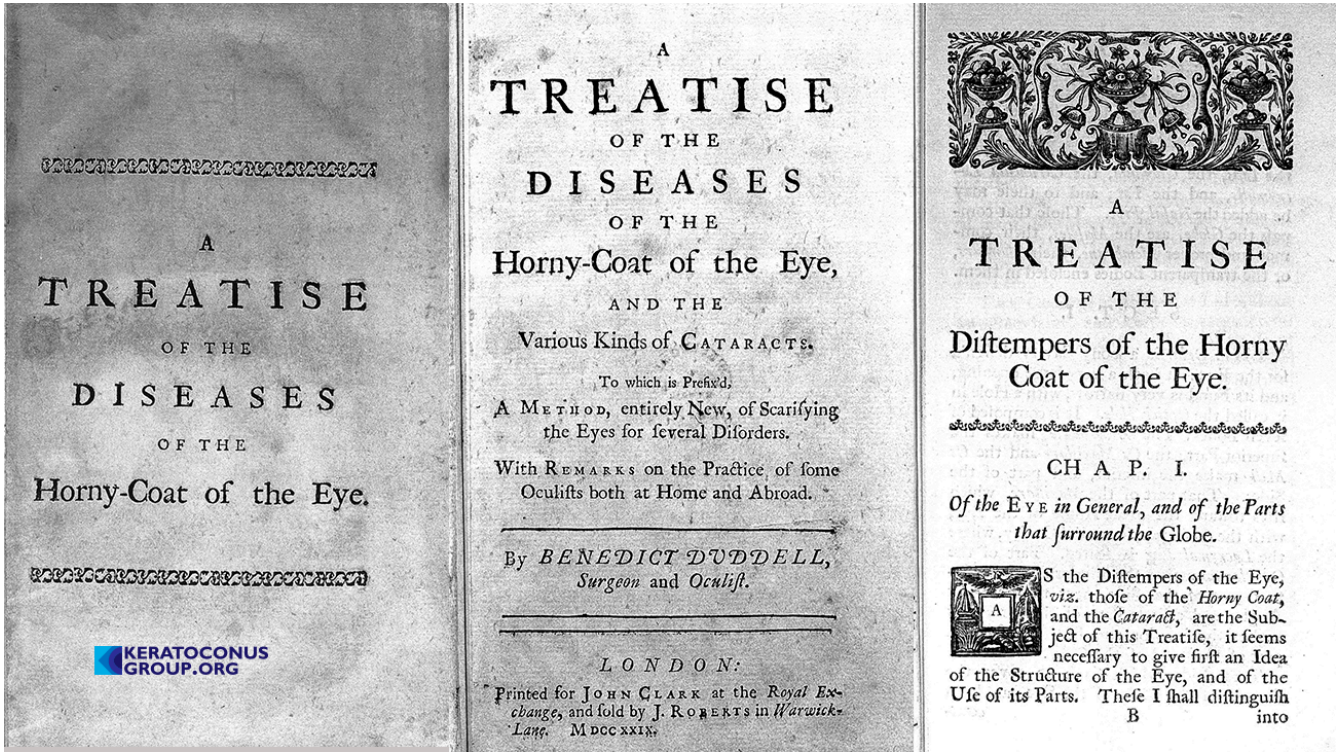
Let’s Start From The Beginning…

What is Keratoconus?
Signs & Symptoms
Historical Treatment Options

Keratoconus (kĕrʾə-tō-kōˈnəs)

kéras = Cornea
cōnus = Cone

First Description of Keratoconus: Benedict Duddell in 1736
“Diseases of the Horny-coat of The Eye”



A
TREATISE
OF THE
DISEASES
OF THE
Horny-Coat of the Eye.

KERATOCONUS GROUP.ORG

A
TREATISE
OF THE
DISEASES
OF THE
Horny-Coat of the Eye,
AND THE
Various Kinds of CATARACTS.

To which is Prefix'd,
A METHOD, entirely New, of Scarifying the Eyes for ſeveral Diſorders.

With REMARKS on the Practice of ſome Oculiſts both at Home and Abroad.

By *BENEDICT DUDDELL*,
Surgeon and *Oculiſt*.

LONDON:
Printed for JOHN CLARK at the *Royal Exchange*, and ſold by J. ROBERTS in *Warwick-Lane*. MDCCXXIX.

A
TREATISE
OF THE
Diſtempers of the Horny Coat of the Eye.

CHAP. I.

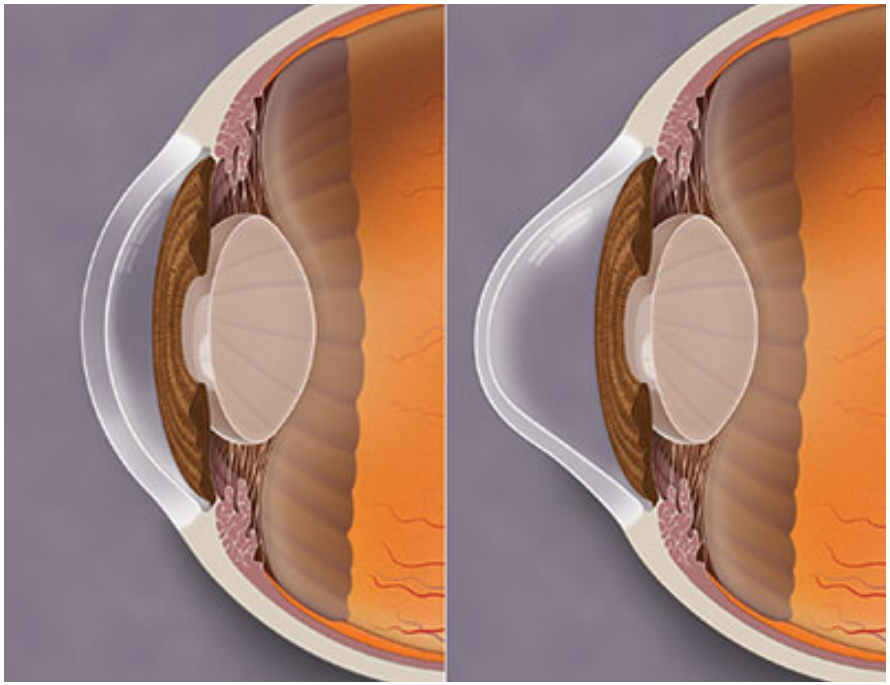
Of the EYE *in General, and of the Parts that ſurround the* Globe.

AS the Diſtempers of the Eye, *viz.* thoſe of the *Horny Coat*, and the *Cataract*, are the Subject of this Treatiſe, it ſeems neceſſary to give firſt an Idea of the Structure of the Eye, and of the Uſe of its Parts. Theſe I ſhall diſtinguiſh into

Early Descriptions of Keratoconus

- 1748: Burchard Mauchart described a case of keratoconus and called it “staphyloma diaphanous”
- 1854: John Nottingham described the conical cornea in “Practical observations on conical cornea”
- 1869: Johann Horner gave Keratoconus its name in his thesis “On the treatment of keratoconus”

What Is Keratoconus?



Signs:

- Thinning cornea
- Cone-like bulging
- Frequently changing glasses prescriptions

Symptoms:

- Blurry and/or distorted vision
- Sensitivity to light
- Contact lens intolerance

Keratoconus:

A sight-threatening disease

Previously estimated 1:2000 (1986 US), more recent estimate 1:375 (2017 Netherlands)

1 out of 5 people with keratoconus will need a corneal transplant

Survey of Ophthalmology - 1998

Awareness is growing

TODAY

"He was getting worse, we kept going to the doctor and saying 'Hey, he is really struggling with this'"

April 5, 2019

"For all his career, his life even, Steph Curry has had issues with his eyes. He said he has a condition called Keratoconus"

The Athletic - April 5, 2019

Keratoconus usually begins in the teenage years

CLINICAL SIGNS OF KERATOCONUS

Vogt's Striae

- Vertical fine white folds in the posterior stroma

Fleisher's Ring

- Iron ring deposit within epithelium around base of cone (brown in color and best visualized with cobalt blue filter)

Munson's Sign

- V-shaped indentation observed in the lower eyelid when patients gaze downwards

Apical Scarring

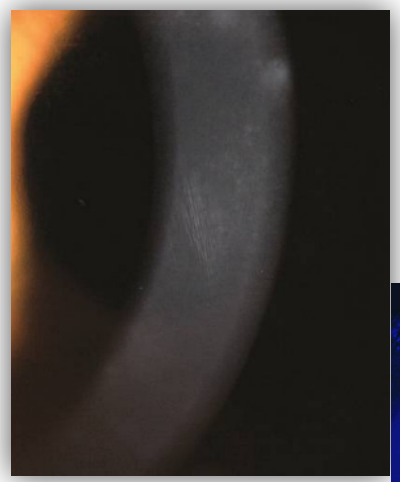
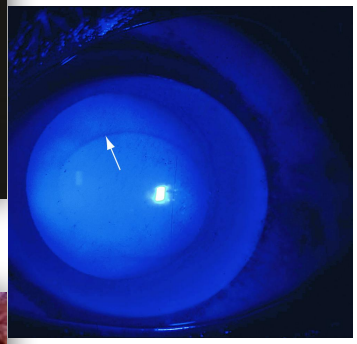


Fig (a) Vogt's Striae



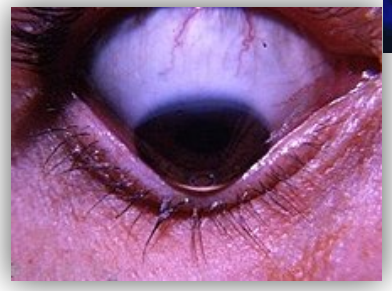


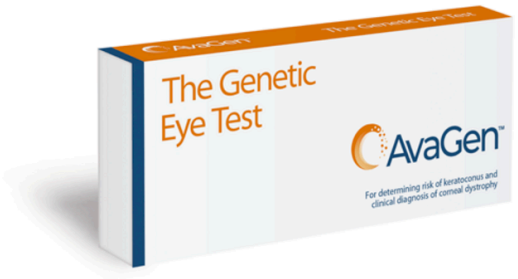
Fig (c) *Munson's sign*

Fig (a). Feizi et al *J Ophthalmic Vis. Res. 2012 Oct; 7(4): 328–331*
Fig (b) *https://en.wikipedia.org/wiki/Kayser%E2%80%93Fleischer_ring*
Fig (c) *https://en.wikipedia.org/wiki/Munson%27s_sign*

Causes of Keratoconus

- Genetic component
- Excessive eye rubbing
  - Vernal conjunctivitis
  - Allergic conjunctivitis
  - Atopy
  - Down Syndrome
- Connective tissue disorders
  - Marfan Syndrome
  - Ehlers-Danlos Syndrome

Genetic Testing for Keratoconus



- AvaGen, The Genetic Eye Test (Avellino)
- Buccal swab (non-invasive)
- Multiple genes may affect development and progression of keratoconus
- Tests for 75 known genes related to KC risk
- Gives a risk score

FINAL RESULTS

CONDITION TESTED	RESULT	DETAIL	EXPLANATION
Keratoconus (KC)	LOW genetic risk	22 polygenic risk score	Tested for variants within 75 genes found to be associated with keratoconus.
TGFBI Corneal Dystrophies (CD)	Negative for TGFBI Corneal Dystrophies	No pathogenic variants detected	Tested Negative for 70 known variants associated with TGFBI corneal dystrophies.

This AvaGen Genetic Test result should be considered with other clinical criteria, the patient's family history and communicated in a setting that includes appropriate genetic counseling.

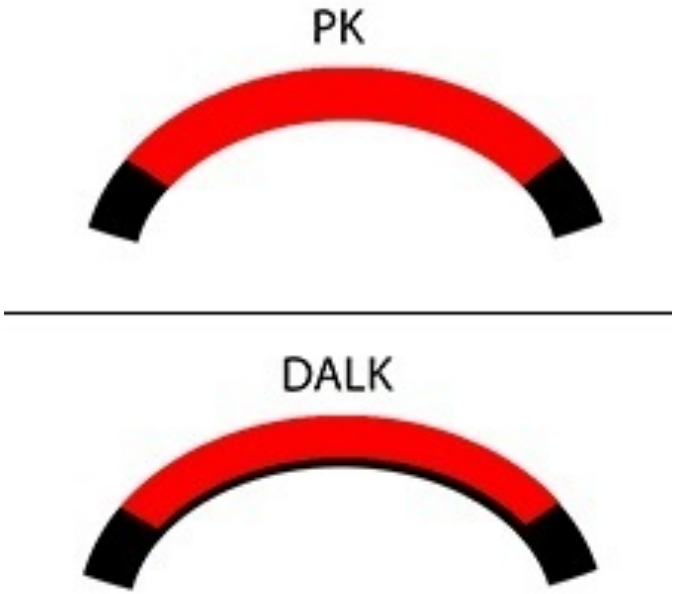
Keratoconus (KC) Risk Assessment

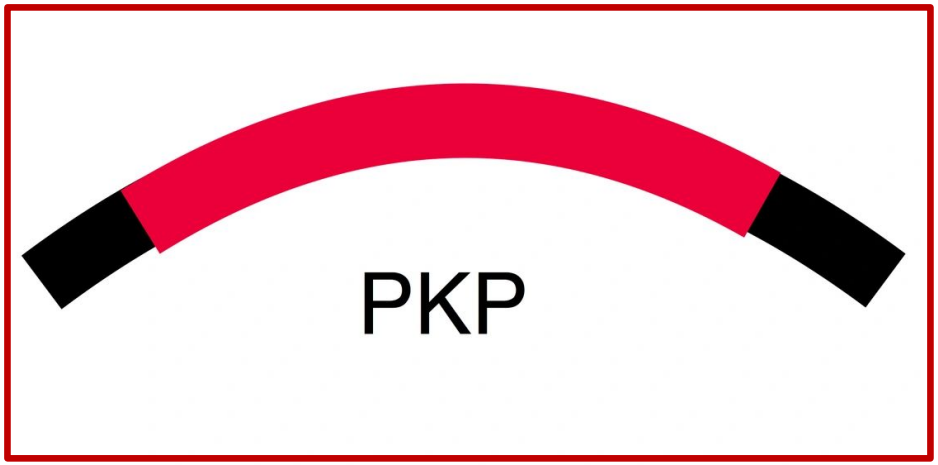
Based on the polygenic risk score of 22, this patient's risk for KC is LOW.

0	1 to 33	34 to 66	67 to 100
No genetic risk	Low genetic risk	Moderate genetic risk	High genetic risk

Historical Treatment of Keratoconus

- “Watch + Wait”
- Contact Lenses
- INTACS
- Cornea Transplant
  - Deep Anterior Lamellar Keratoplasty (DALK)
  - Penetrating Keratoplasty (PKP)




PKP

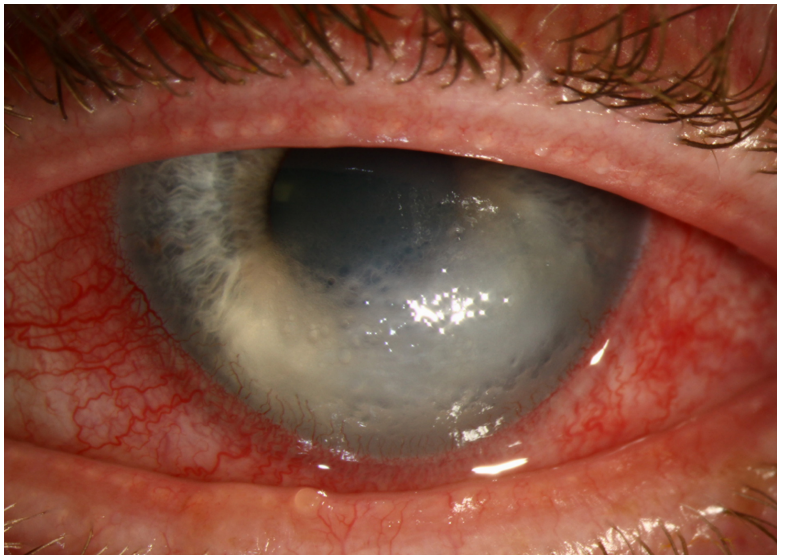

DALK


DSAEK


DMEK

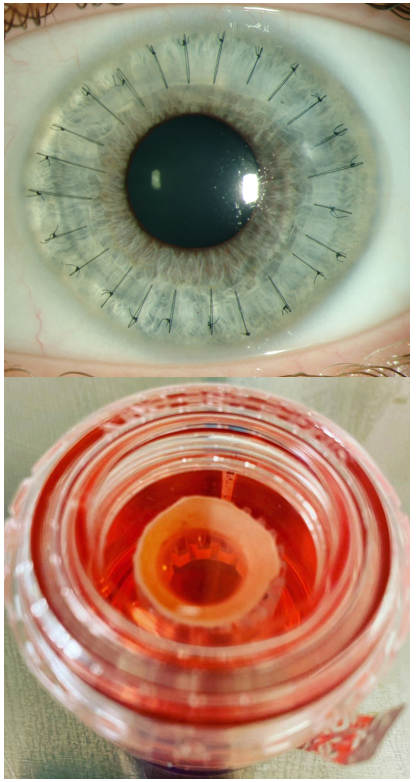
MOST COMMON INDICATIONS FOR PKP

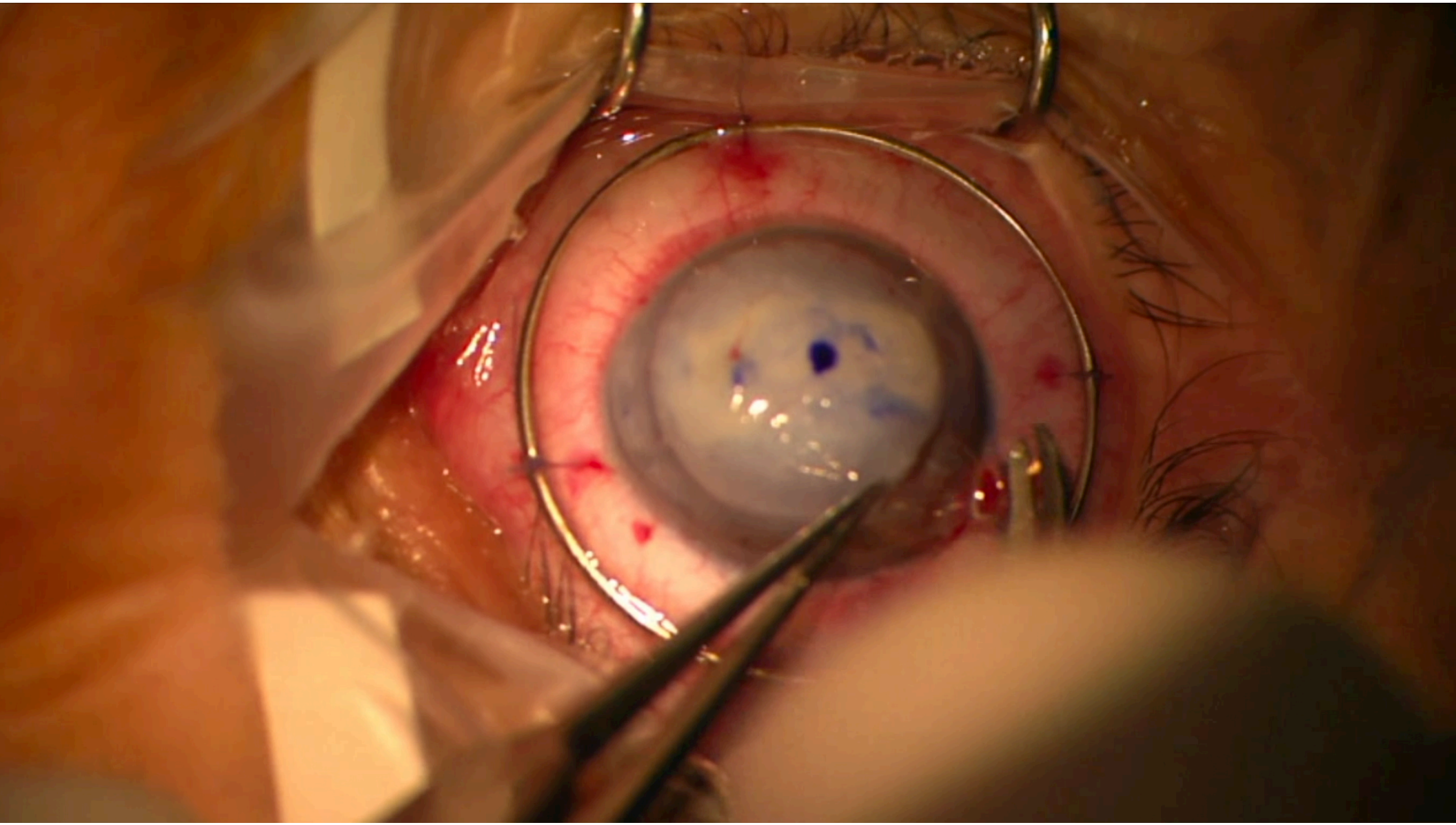
- Cornea Ectasia
  - Keratoconus
  - Pellucid Marginal Degeneration
  - Post-LASIK ectasia
- Corneal Infection
- Corneal Scar



PENETRATING KERATOPLASTY

- Advantages:
  - No interface-related visual problems
  - Ability to treat a combination of epithelial, stroma, and endothelial disease
  - Easier for eyes that require anterior segment reconstruction in a single procedure
- Disadvantages:
  - Significant refractive error
  - Higher risk of vision-threatening complications






PKP


DALK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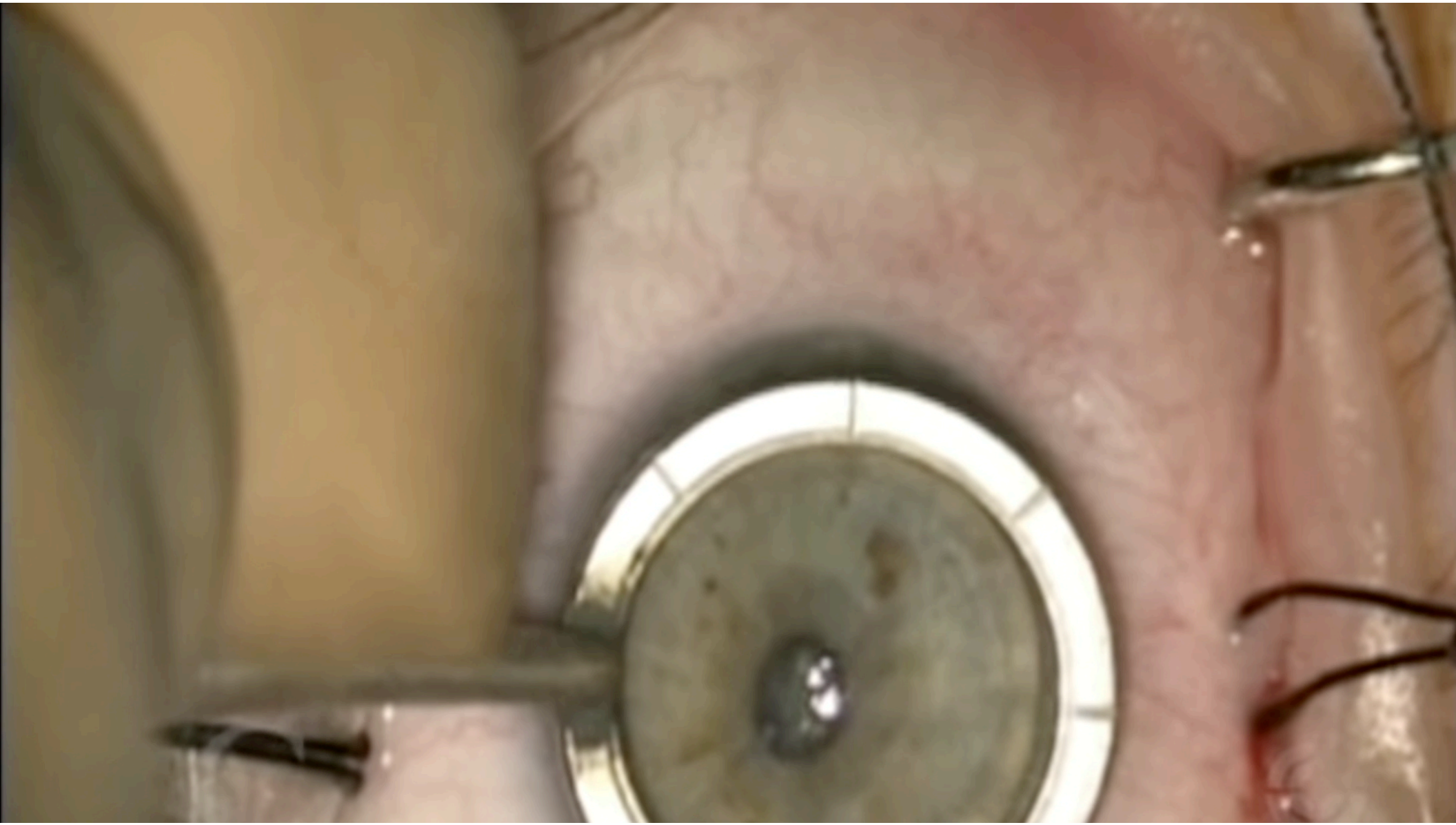


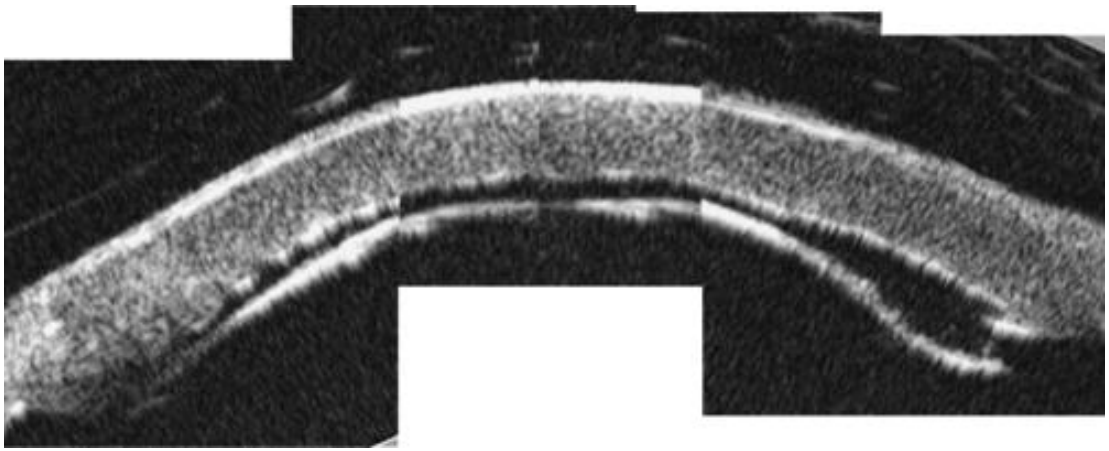
DEEP ANTERIOR LAMELLAR KERATOPLASTY

- Advantages:
  - Lower graft rejection risk
  - Minimal steroid-related complications
  - Ability to use a lower quality cornea donor
  - Better long-term graft survival

- Considerations:
  - May need to convert to full-thickness cornea transplant
  - Longer Surgery

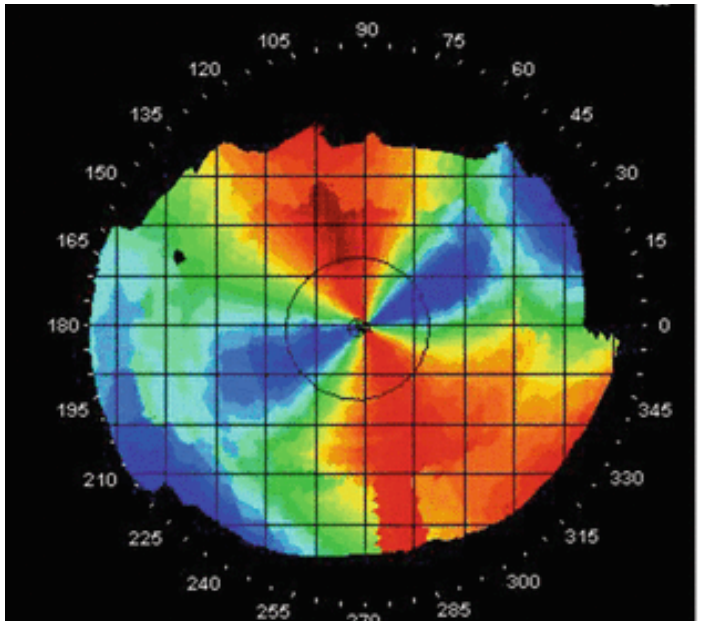
DEEP ANTERIOR LAMELLAR KERATOPLASTY

- Disadvantages:
  - Interface haze
  - Graft dehiscence
  - Pupillary block from air/gas bubble
  - Corneal stromal graft rejection
- Similar best-corrected visual acuity outcomes to PKP

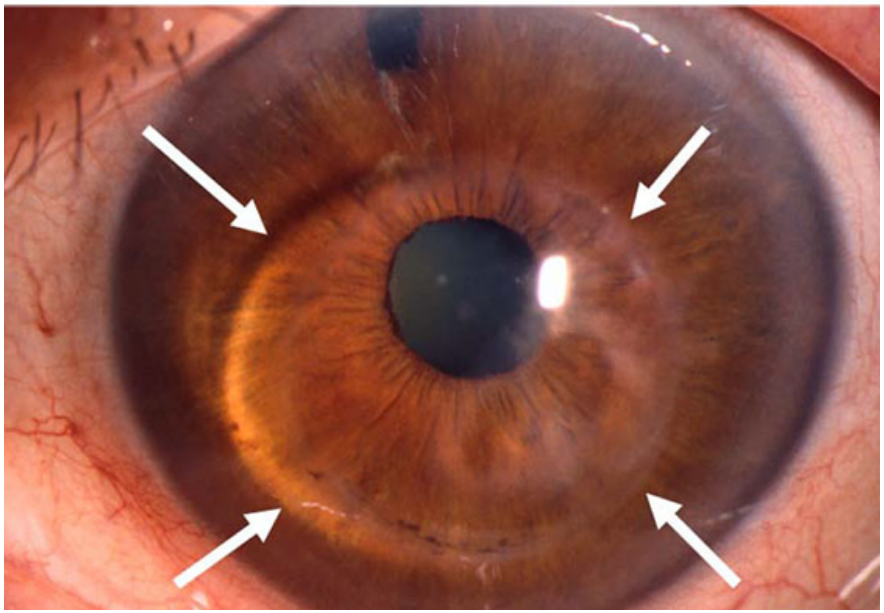


Complications After Cornea Transplantation: Astigmatism

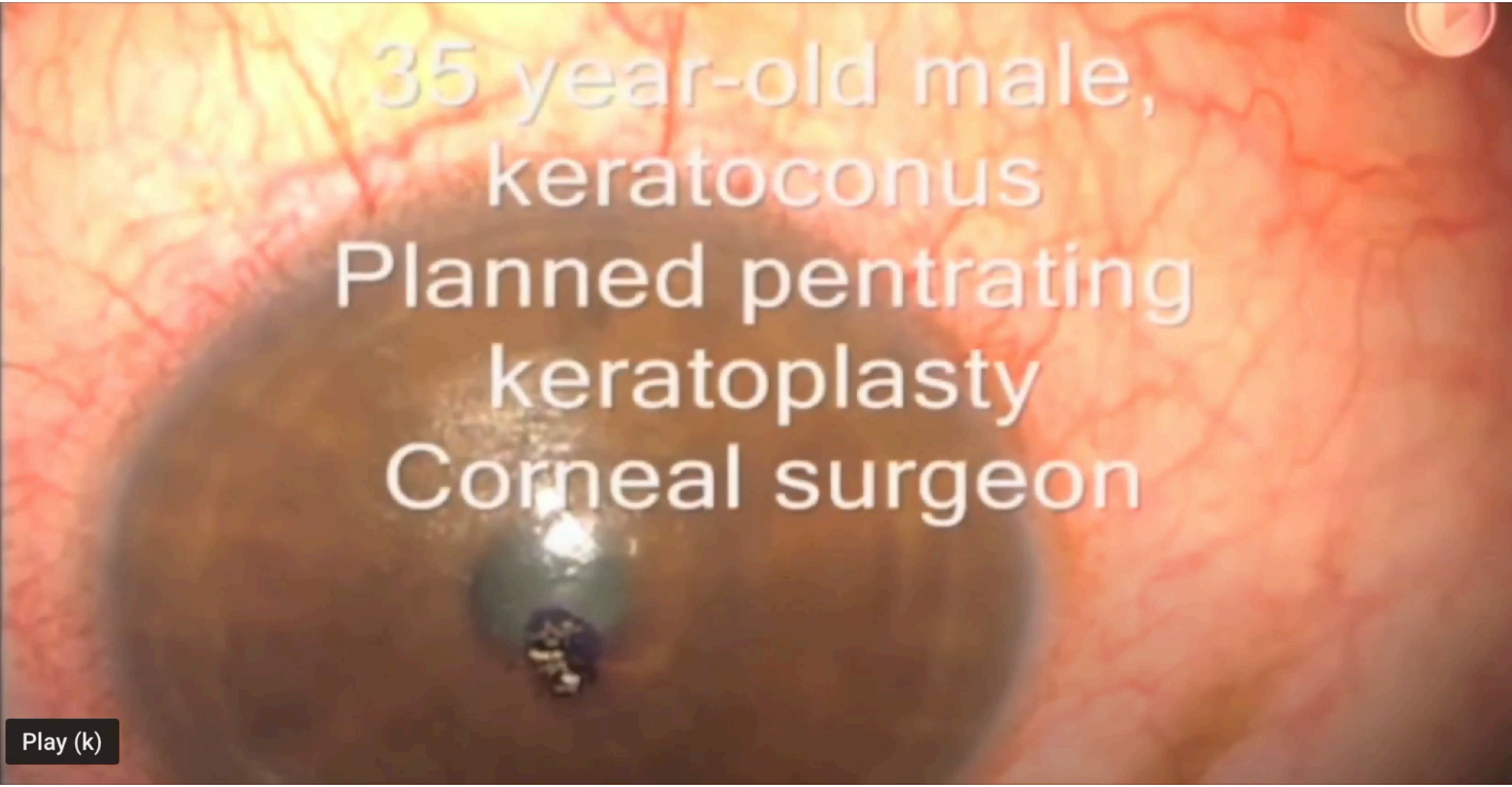
- Remove sutures
  - Selective vs. Total removal
  - Avoid suture removal before POM #3
- Prescribe correction
  - Glasses
  - Rigid Gas Permeable Lenses
  - Scleral Lenses
- LASIK or PRK (controversial)



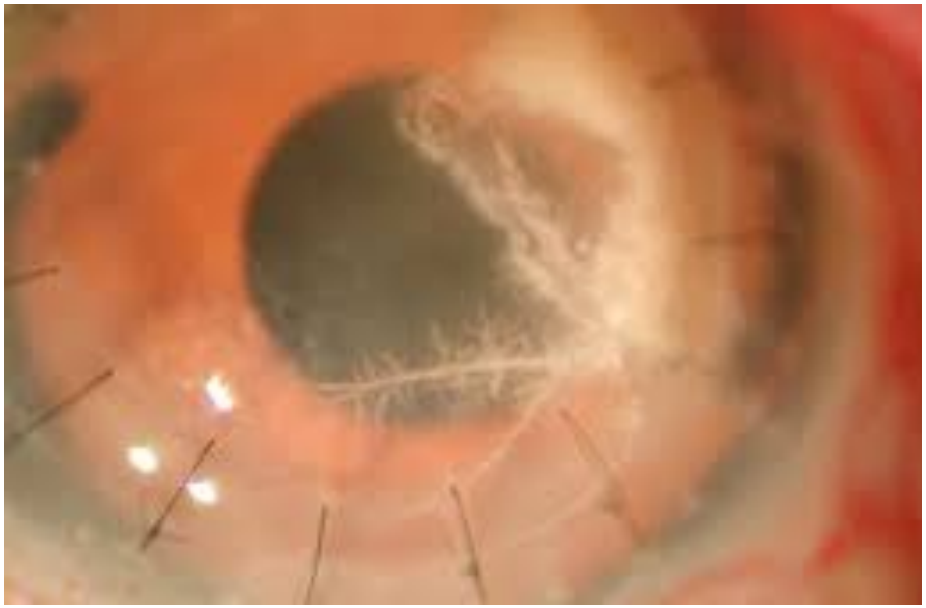
Complications AFTER Cornea transplantation: Poor Graft centration



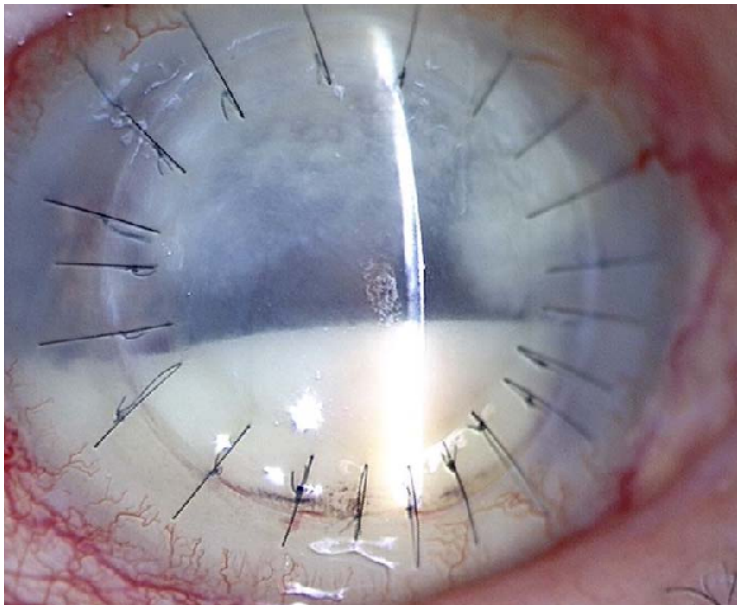
Complications After Cornea transplantation: Suprachoroidal hemorrhage


35 year-old male,
keratoconus
Planned pentrating
keratoplasty
Corneal surgeon
Play (k)

Complications After Cornea Transplantation: Keratitis



Interstitial Crystalline Keratitis (*Strep. Viridans*)



Fungal Keratitis (Candida spp.)

Where Are We Now?

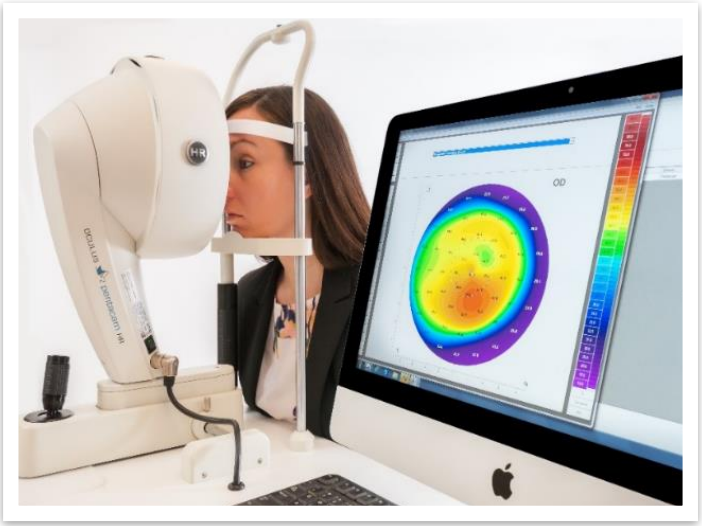
Screening for Keratoconus
Corneal Cross-Linking
Epi-On versus Epi-Off Cross-Linking

EARLY DIAGNOSIS IS IMPORTANT!

- The earlier progressive Keratoconus is diagnosed, the sooner treatment can be provided that may slow the progression of the disease.[1]

- Progressive disease often results in:
  - Loss of visual acuity and function
  - Decreased tolerance to contact lens wear

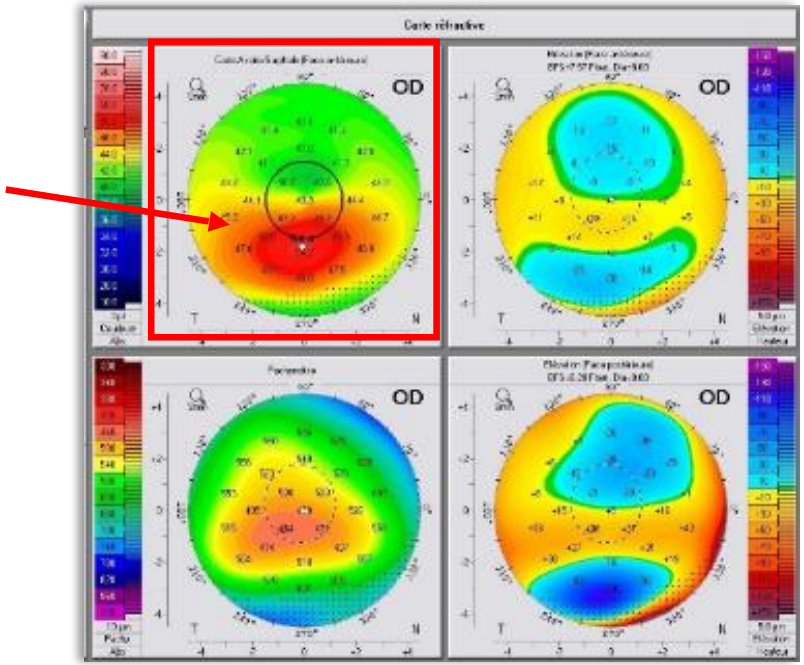
- Cross-linking (CXL) is an early intervention intended to slow the progression of keratoconus



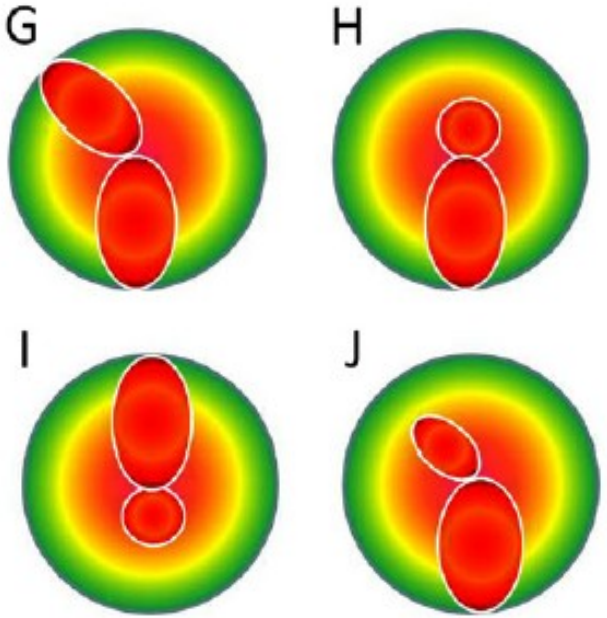
1. Gelles, J. D., OD, FIAO, FCLSA. (2017, April). The Optometrist's Role in Keratoconus Management. Advanced Ocular Care.

Diagnostic imaging: Topography

Irregular Topography/Tomography



Skewed Axis or Asymmetric Bowtie



OCULUS - PENTACAM 4 Maps Refractive

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First Name:	Mohamad		
ID:			
Date of Birth:	01/01/1994	Eye:	Left
Exam Date:	08/06/2013	Time:	11:18:10
Exam Info:			

Cornea Front

Rf:	7.32 mm	K1:	46.1 D
Rs:	6.64 mm	K2:	50.8 D
Rm:	6.98 mm	Km:	48.4 D
QS: OK	Axis: (flat) 179.9°	Astig:	4.7 D
Q-val: (8mm) -1.04	Rper: 7.95 mm	Rmin:	6.11 mm

Cornea Back

Rf:	5.88 mm	K1:	-6.8 D
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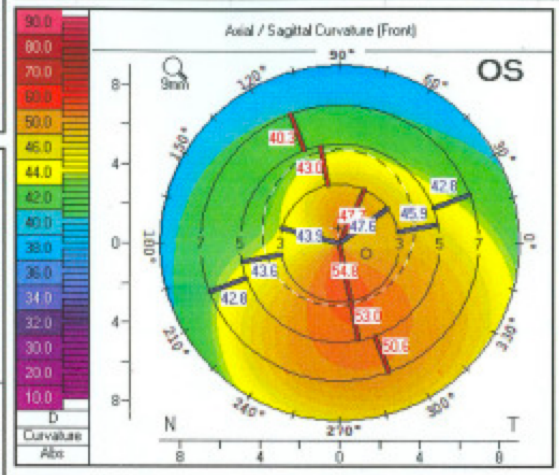
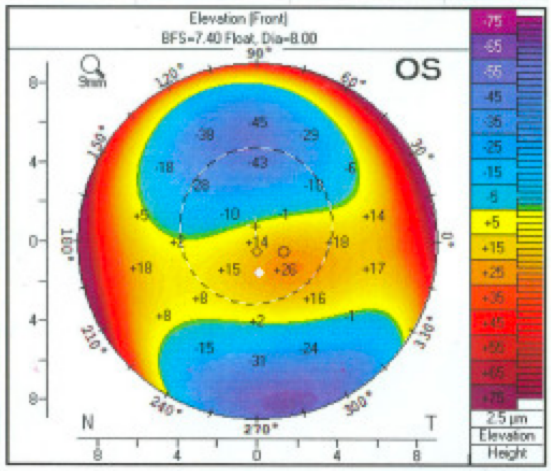
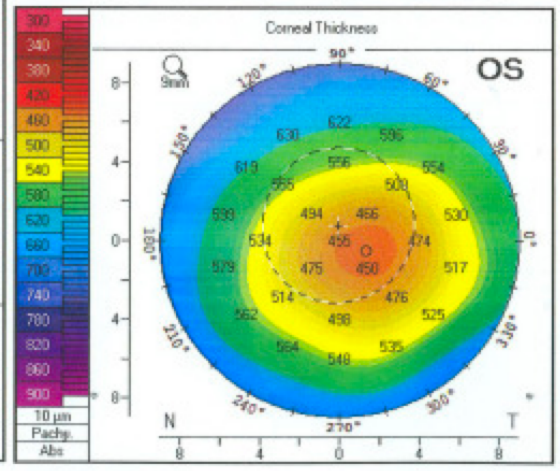
	Pachy:	x[mm]	y[mm]
Pupil Center: +	464 µm	-0.04	+0.39
Pachy Apex: ·	455 µm	0.00	0.00
Thinnest Local.: ○	446 µm	+0.67	-0.27
K Max. (Front):	55.3 D	+0.07	-0.80

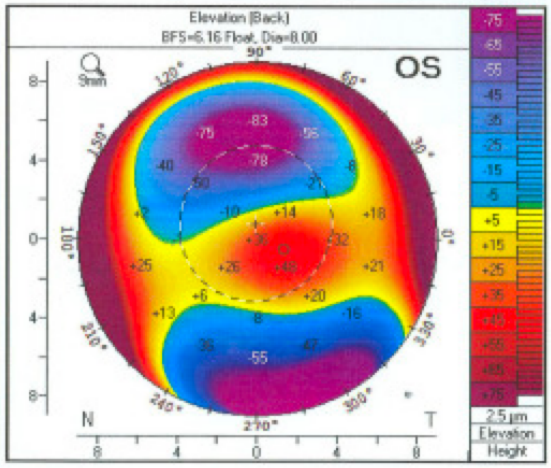
Cornea Volume:	55.1 mm³	KPD:	+2.1 D
Chamber Volume:	228 mm³	Angle:	43.8°
A. C. Depth (Int.):	3.40 mm	Pupil Dia:	3.88 mm
Enter IOP	IOP(Sum): +3.8 mmHg	Lens Th.:	

Refractive









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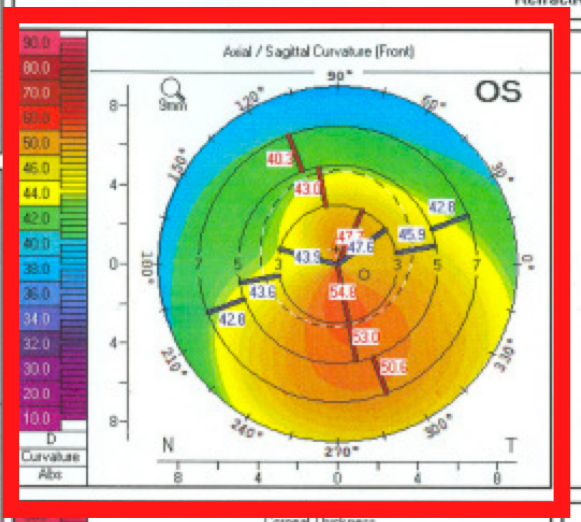

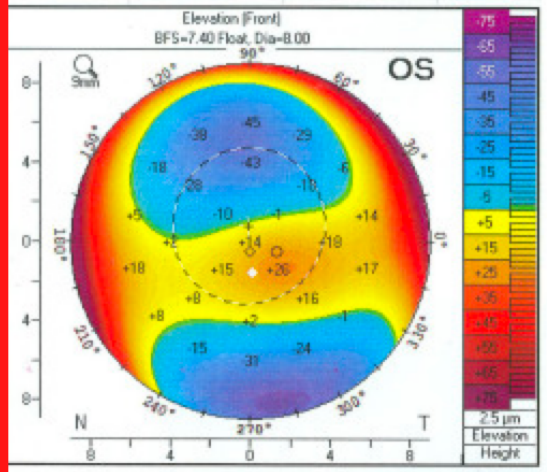

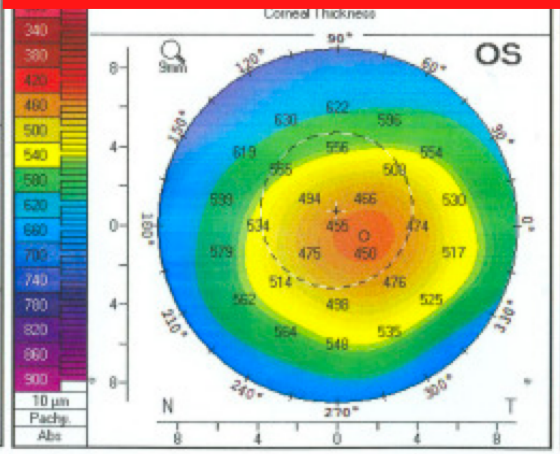

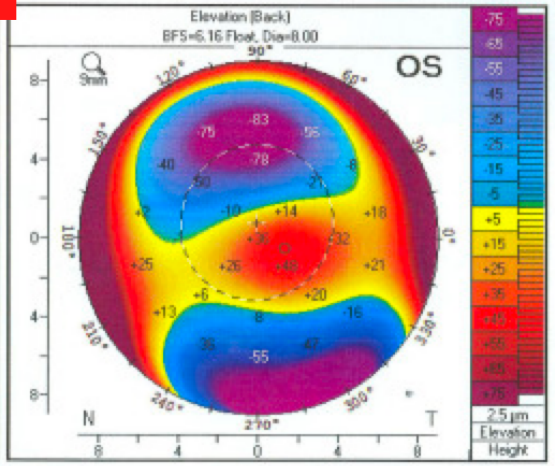

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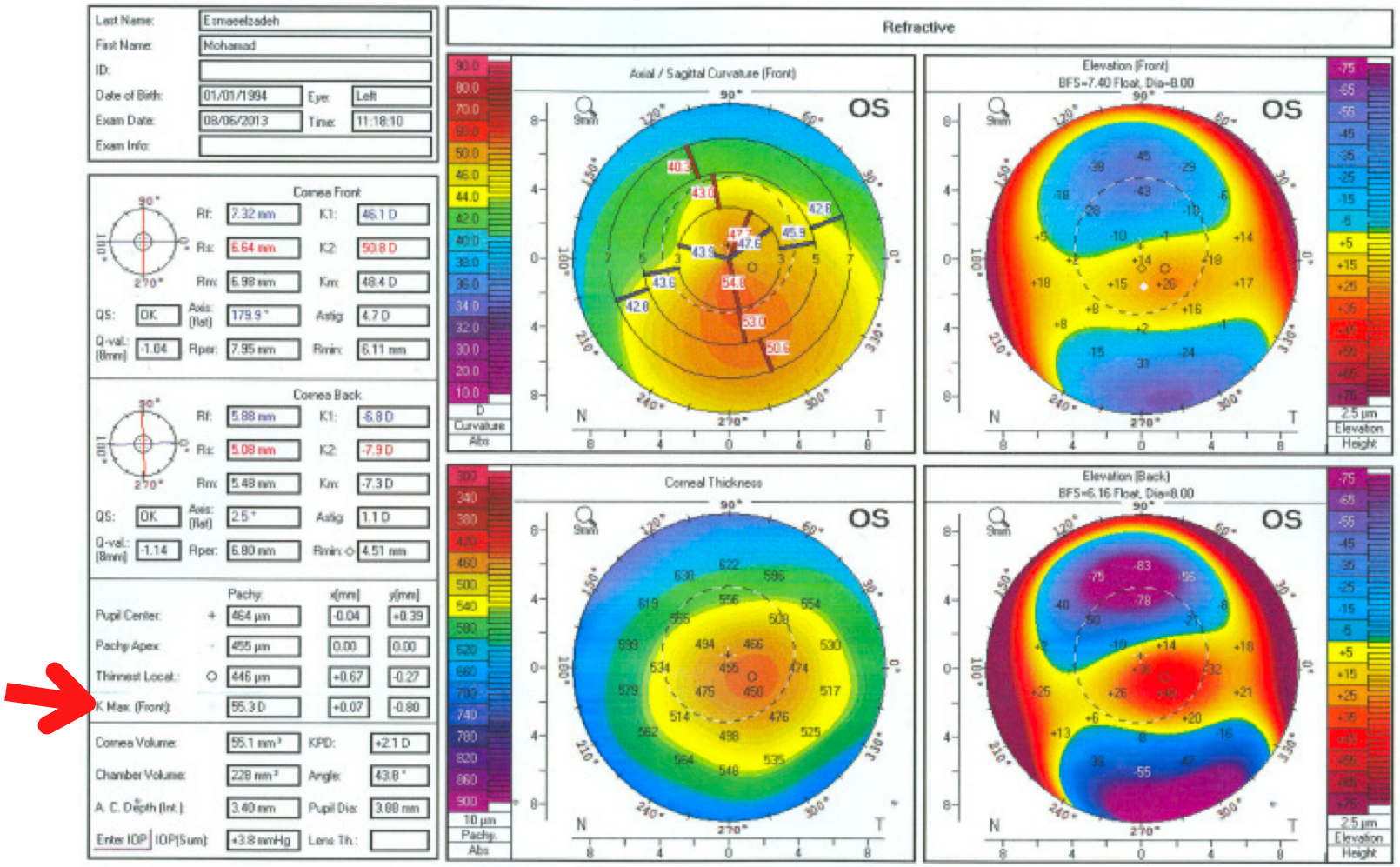

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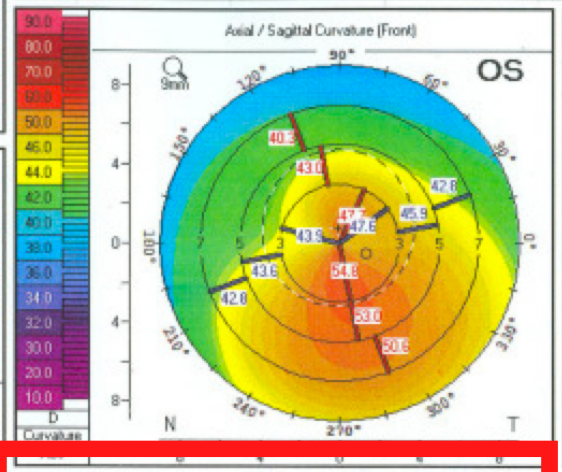
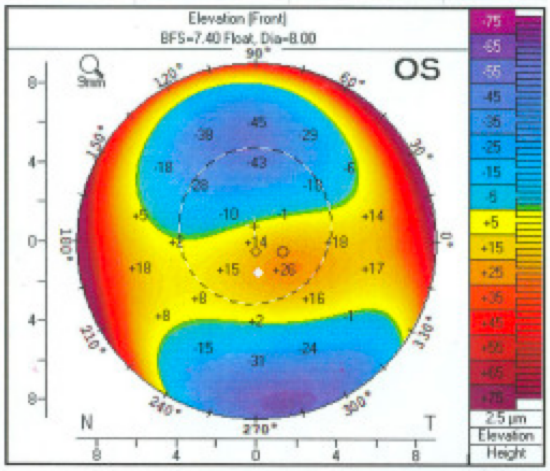
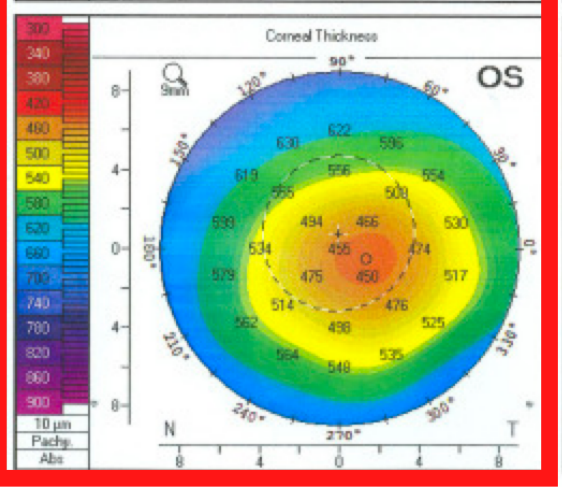
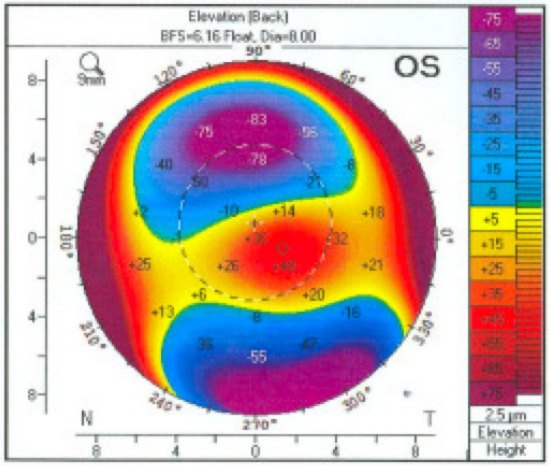
Refractive

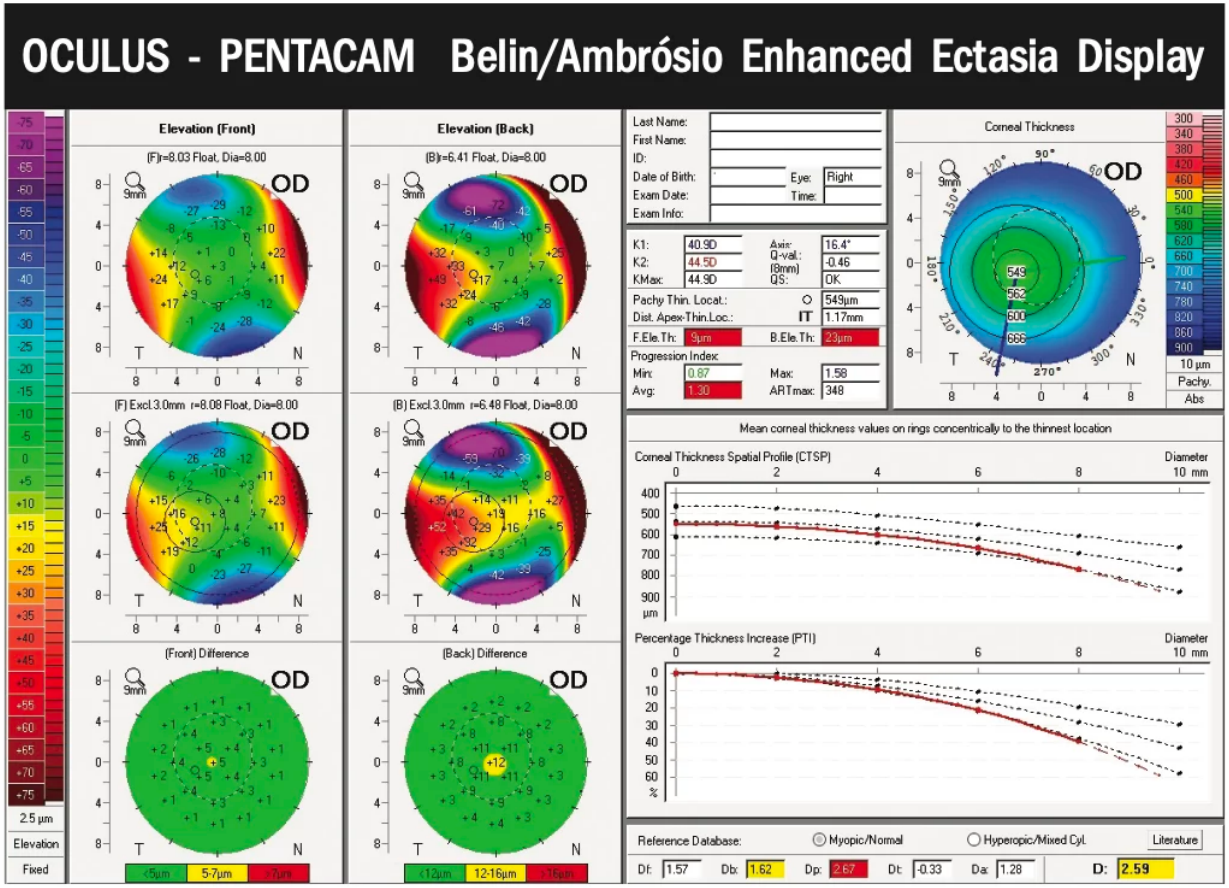




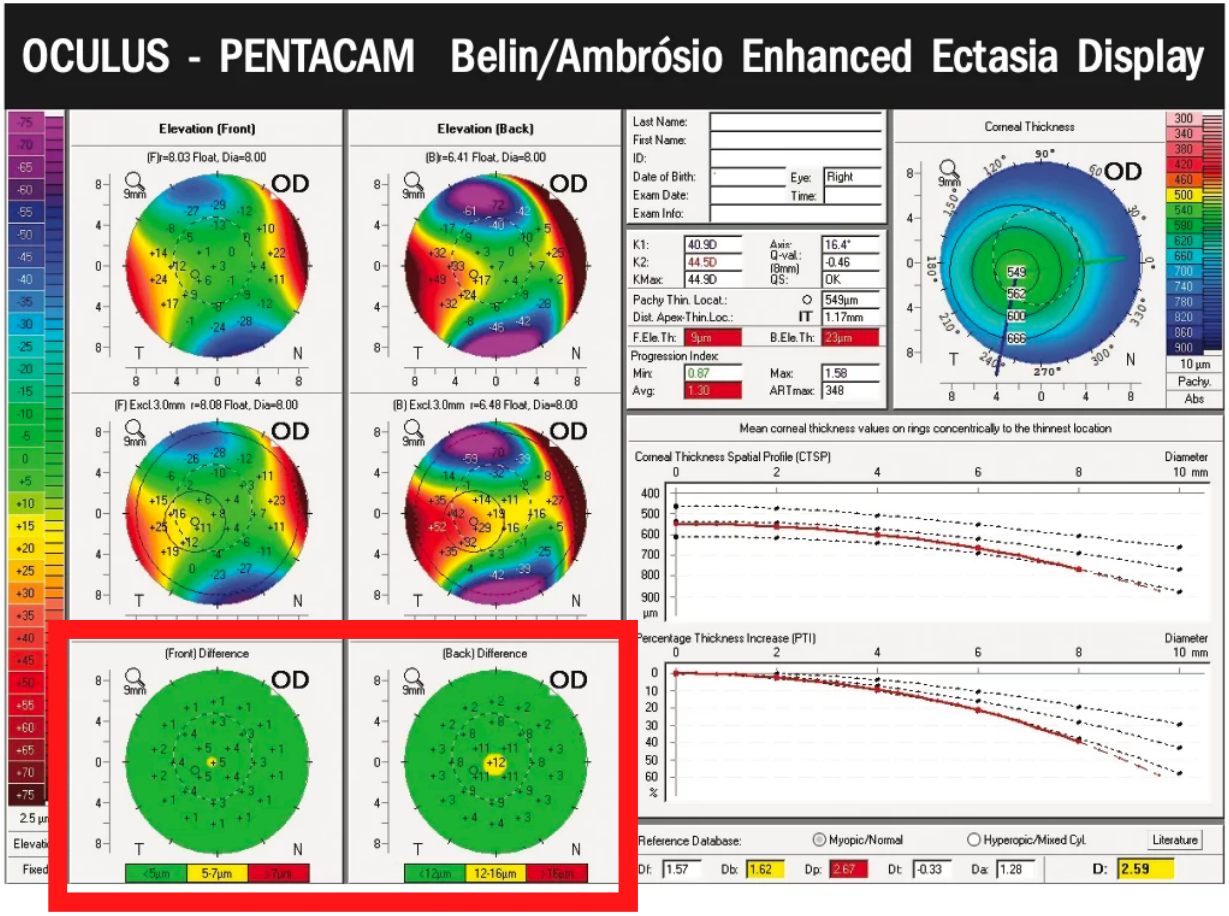




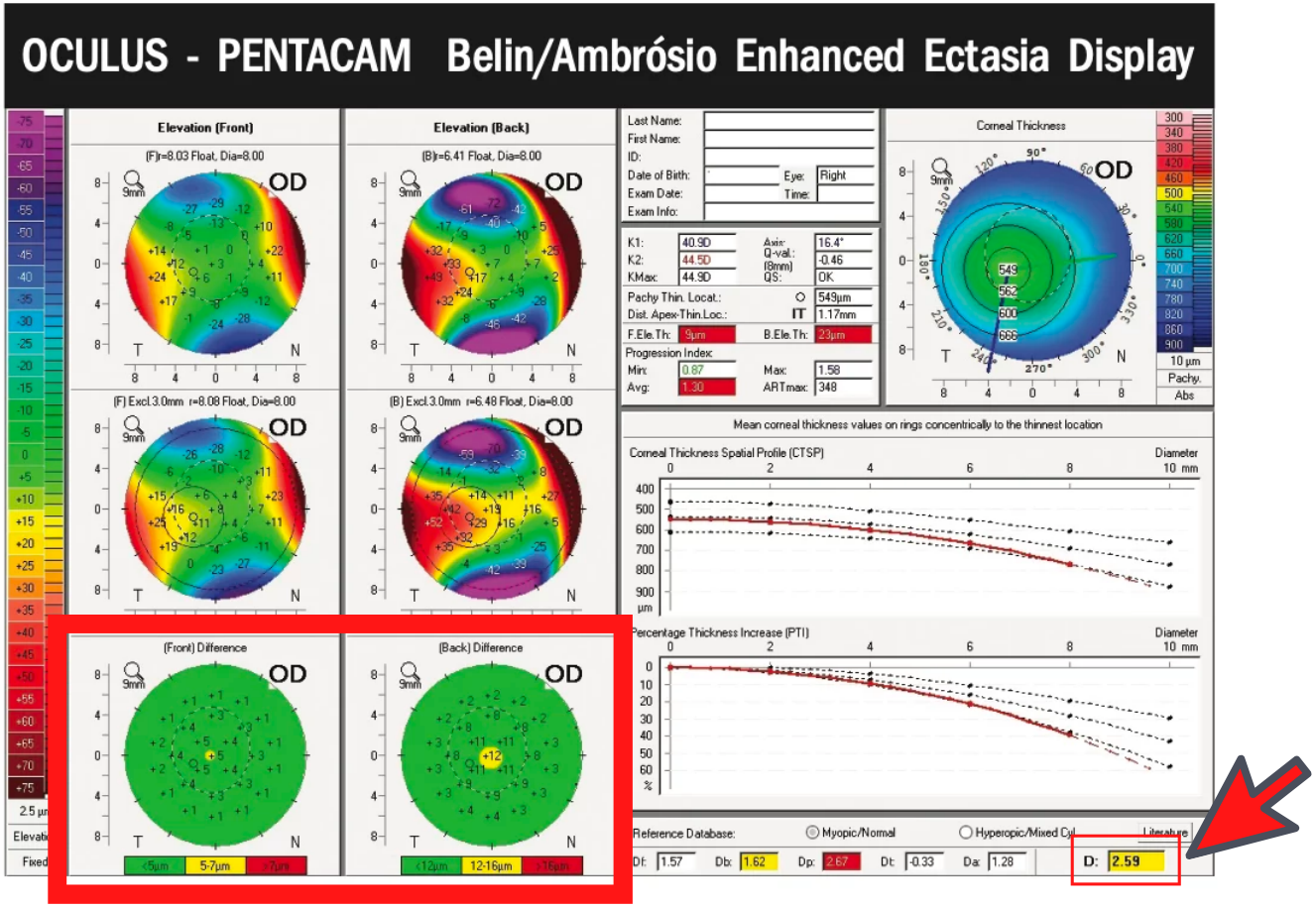
Pentacam: Belin-Ambrosio Deviation Display For Early Screening & Detection



Pentacam: Belin-Ambrosio Deviation Display For Early Screening & Detection

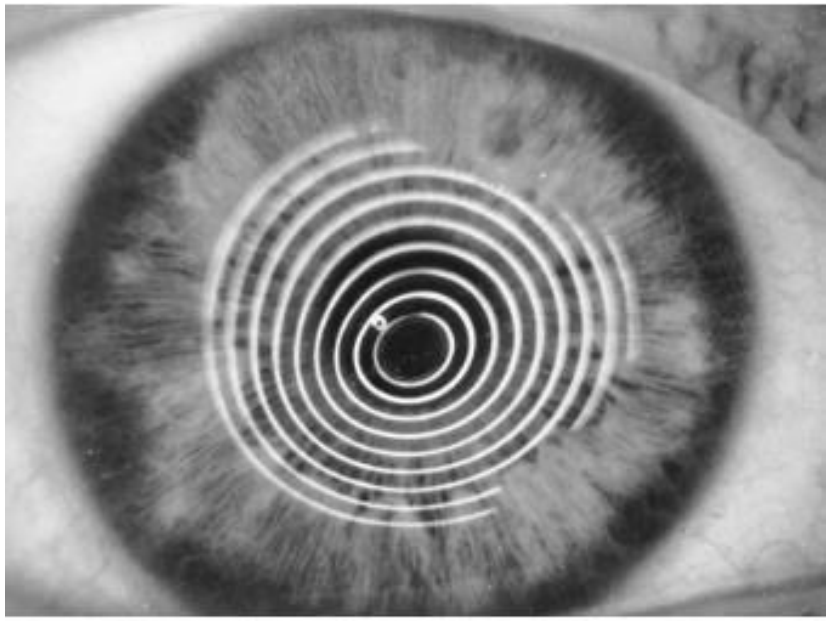


Pentacam: Belin-Ambrosio Deviation Display For Early Screening & Detection

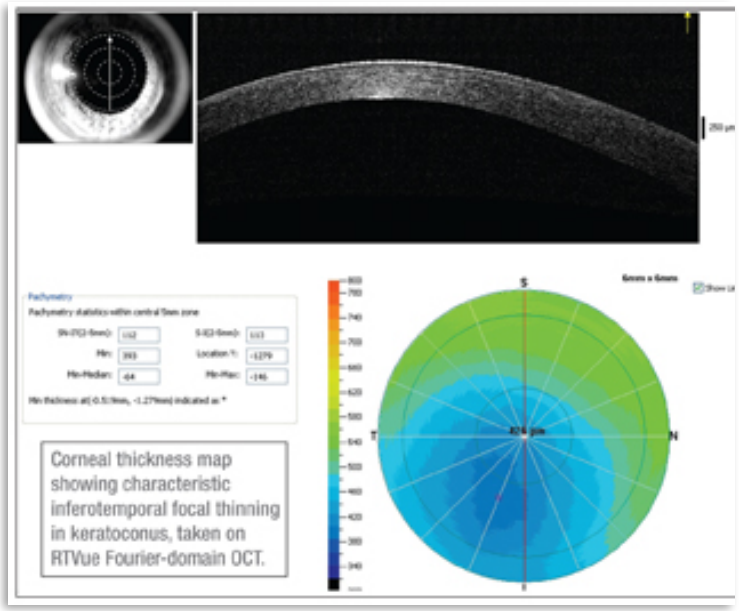


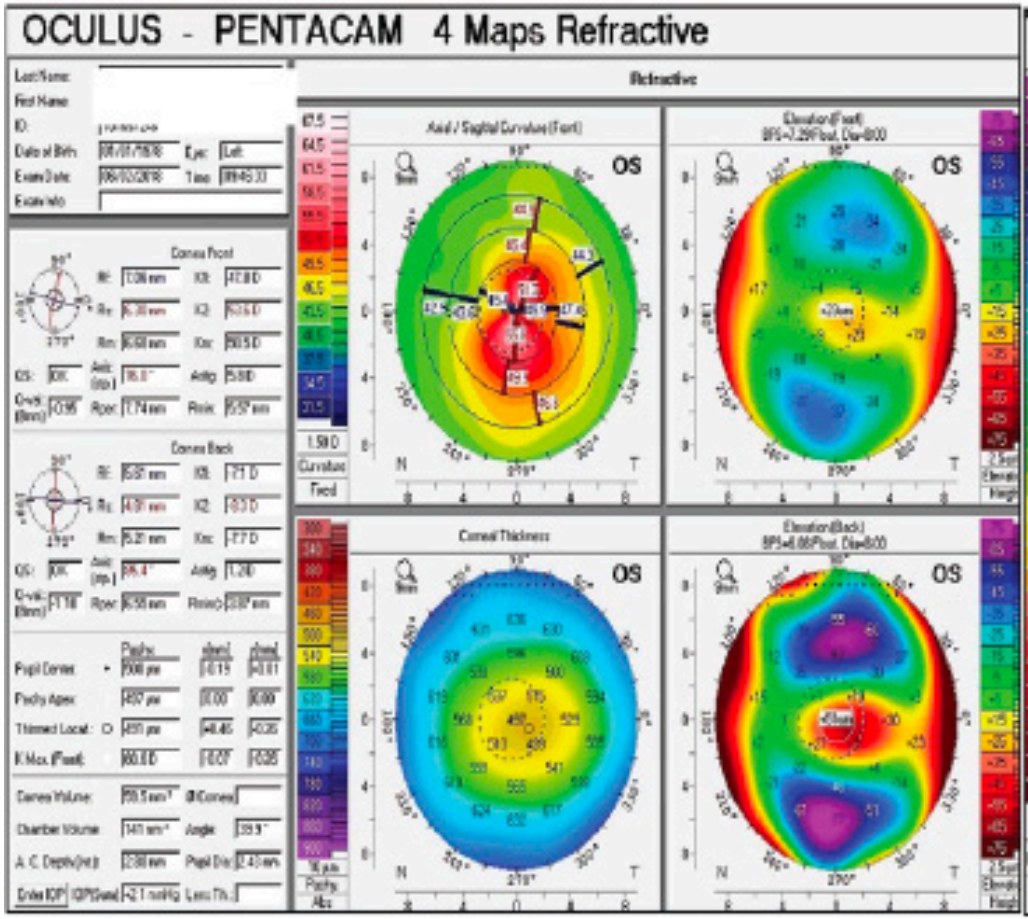
Screening for KCN… Without Topography?

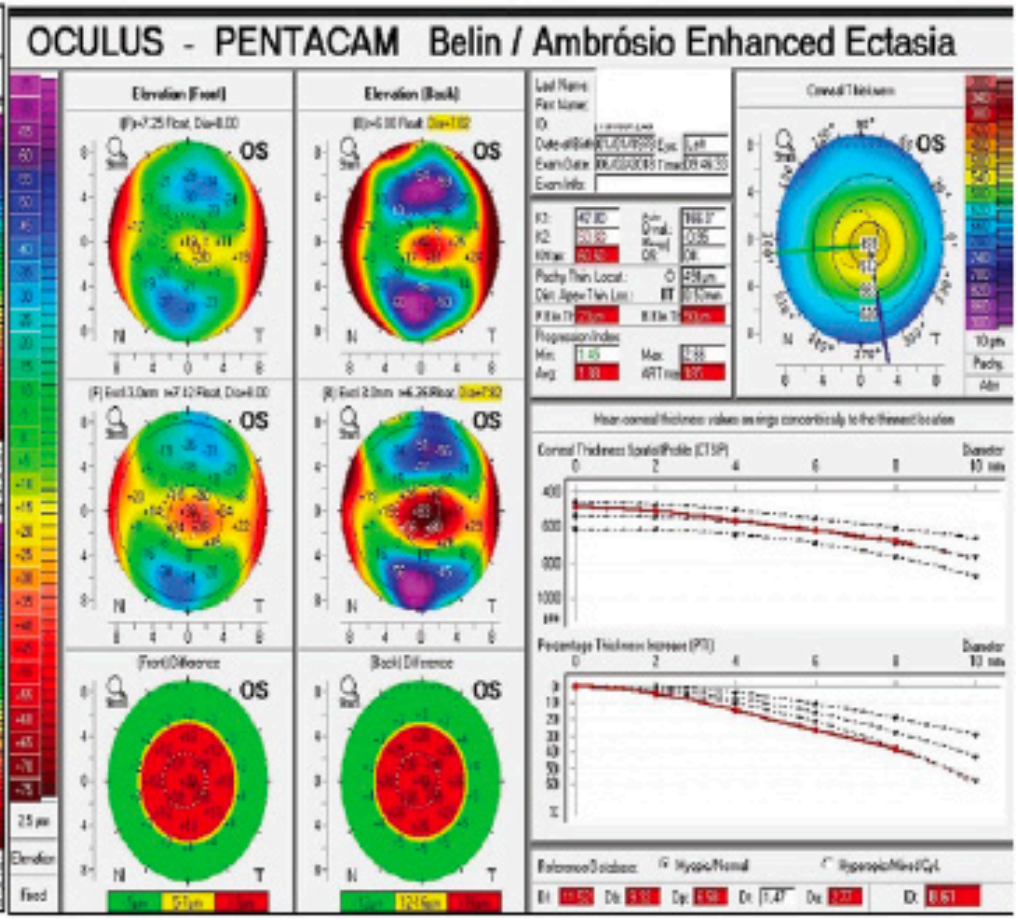
Irregular Mires on
Placido Topography



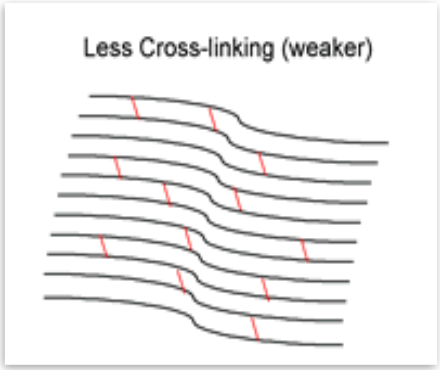
Anterior OCT with focal thinning

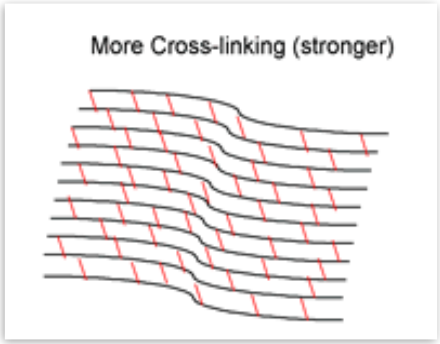



OCULUS - PENTACAM 4 Maps Refractive
Refractive
Axial / Sagittal Curvature (Front)
Elevation (Front)
Corneal Thickness
Elevation (Back)
OS


OCULUS - PENTACAM Belin / Ambrósio Enhanced Ectasia
Elevation (Front)
Elevation (Back)
Corneal Thickness
OS

WHAT IS CORNEAL CROSS-LINKING?





- 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-links[1]
- Shortening and thickening of the collagen fibrils
- Stiffening of the cornea[2]

[2]Beshtawi IM, O'Donnell C, Radhakrishnan H. Biomechanical properties of corneal tissue after ultraviolet-A-riboflavin crosslinking. J Cataract Refract Surg. 2013;39(3):451–62.

[1]Kamaev P, Friedman MD, Sherr E, Muller D. Photochemical kinetics of corneal cross-linking with riboflavin. Invest Ophthalmol Vis Sci. 2012;53:2360–7.

Early Studies of Cross-linking

- 1990s: UV light used to induced collagen cross-linking in riboflavin soaked porcine and rabbit corneas
  - Stiffer corneas more resistant to enzymatic digestion
  - Corneas contained higher molecular weight polymers of collagen
  - Safe for the endothelium if cornea thickness exceeded 400 microns

First Human Studies

- 2003: First human studies in Dresden
  - 16 patients with rapidly progressing keratoconus
  - All patients stopped progressing after treatment
  - 70% with flattening of their steep anterior corneal curvatures
  - 65% had an improvement in visual acuity
  - No reported complications

UNITED STATES CROSSLINKING TRIAL

- Prospective, randomized, controlled clinical trial
- 208 patients with unstable keratoconus
- Two Arms:
  - Treatment group: standard CXL (epi-off)
  - Control group: riboflavin alone without removal of the epithelium
- Results:
  - Treatment group had **1.6 diopters decrease** in maximum keratometry after 1 year
  - Control group had progression of disease
  - **Corneal haze** was the most frequently reported finding with the treatment group
  - No significant changes in endothelial cell count after 1 year

United States Crosslinking Study Group. United States Multicenter Clinical Trial of Corneal Collagen Crosslinking for Keratoconus Treatment. Ophthalmology 2017 Sep;124(9):1259-70.

Cornea Cross-linking Approval

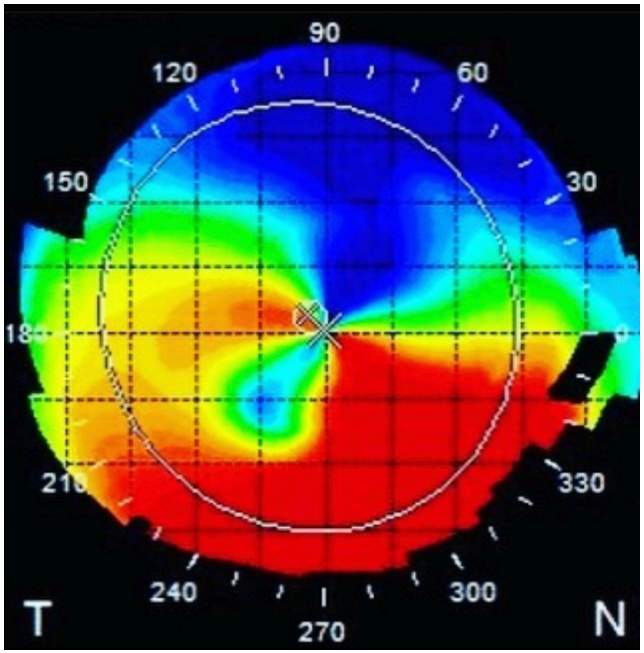
- 2011: orphan drug status was awarded by the FDA for Avedro
- April 18, 2016: FDA approval for corneal cross-linking

avedro

Avedro KXL

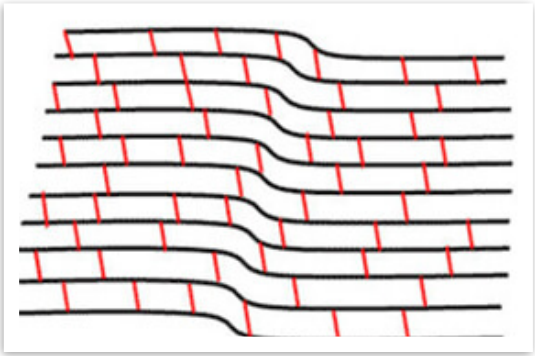
Inclusion Criteria

- 12 years of age or older
- Diagnosis of:
  - Unstable keratoconus
  - Pellucid Marginal Degeneration
  - Post-LASIK ectasia
- Minimum corneal thickness of at least 300
  - Measured by ultrasound or Pentacam
- At least 6 months since last corneal surgery

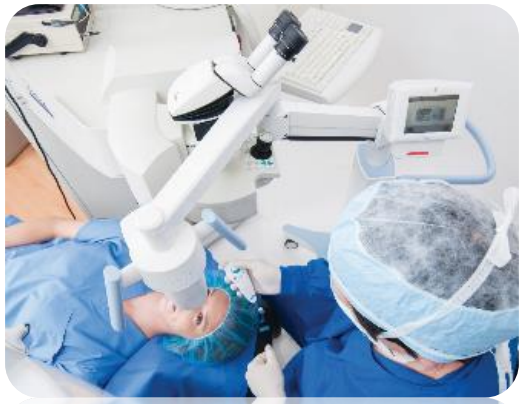


EXCLUSION CRITERIA

- Severe corneal scarring that markedly affects vision
- Pregnancy or breast feeding
- Active Herpes Corneal Disease
- Corneal pachymetry under 300 microns



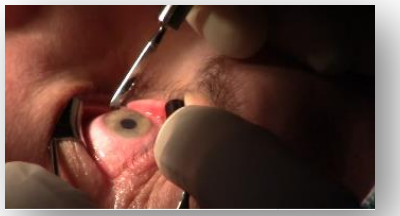
Aim of CXL is to halt or slow disease progression.



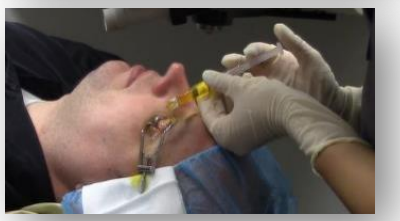
Cross-linking is <u>not</u> a refractive procedure.

Postoperative evaluation for correction required.

STEPS TO EPITHELIAL-OFF CORNEAL CROSS-LINKING
Dresden Protocol

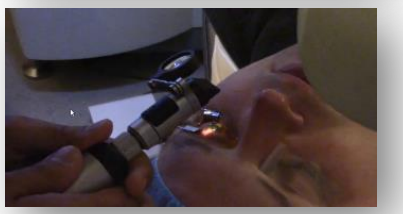


1. Remove epithelium



2. Soak cornea Photrexa® (riboflavin 5'-phosphate in 20% dextran ophthalmic solution)

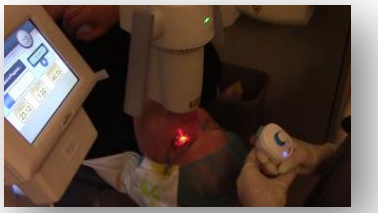
✓ 30 minutes



3. Check for flare

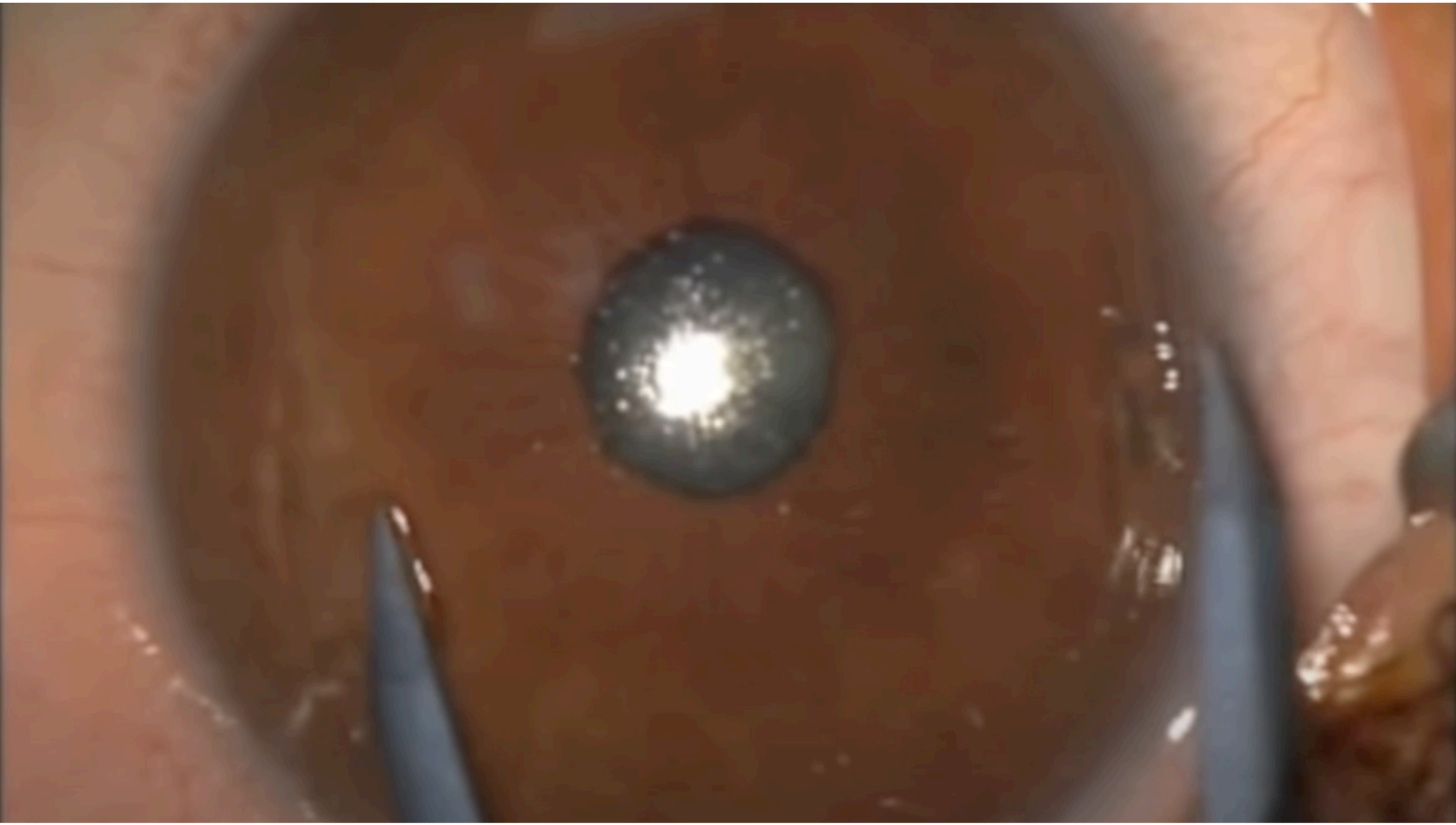
4. Once flare is observed, measure corneal thickness

✓ If corneal thickness is less than 400 um, instill 2 drops of Photrexa *(riboflavin 5'-phosphate in 20% dextran ophthalmic solution)* until the corneal thickness increases to at least 400 µm



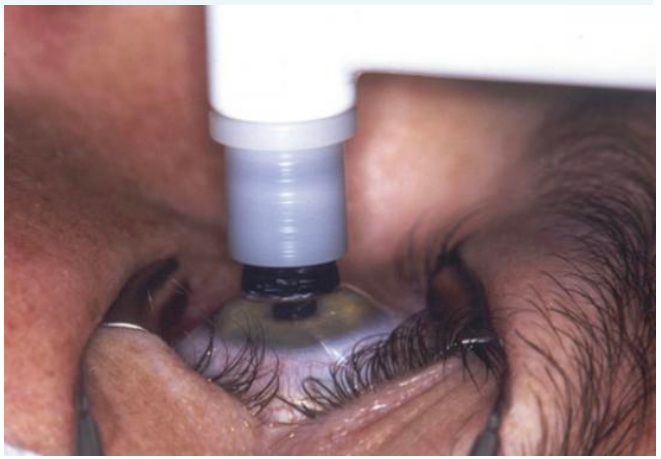
5. Irradiate for 30 minutes

✓ Continue applying Photrexa Viscous *(riboflavin 5'-phosphate in 20% dextran ophthalmic solution)* during irradiation.



Variations in Technique

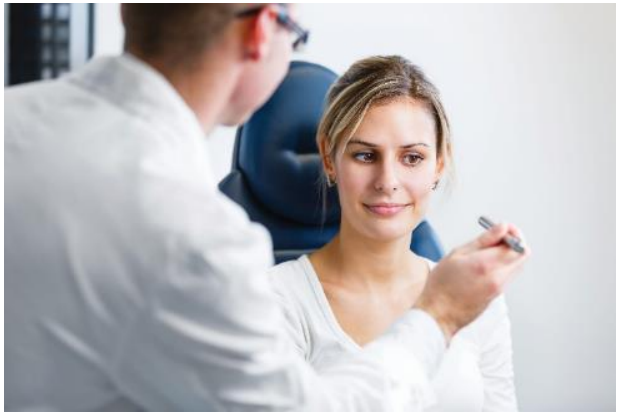
- Epithelial Debridement
  - Mechanical debridement
    - Amoils Brush
  - Alcohol-assisted Debridement
    - 100% Alcohol
    - Isopropyl Alcohol 70%
  - Direct debridement



Variations in Technique: Osmolarity

- Use of hypo-osmolar riboflavin in thin corneas with a thickness between 320 to 400 microns thick
- Helps to thicken the cornea to the minimum of 400 microns

Follow-up schedule



VISIT	PLAN
Day 1 to 1 Week	• Topical antibiotic, steroid • Frequent lubricants • No eye rubbing • Remove BCL once epithelium heals
Month 1	OCT Imaging Tomography/Topography Vision assessment Contact lens refitting evaluation
Month 3, 6, 12 *(Follow ups potentially performed and billed by diagnosing physician depending on practice preference)*	• Continued evaluation utilizing tomography/ topography • Vision assessment

Potential Side Effects

Corneal haze

- Permanent in 10%
- 90% goes away in 6 months

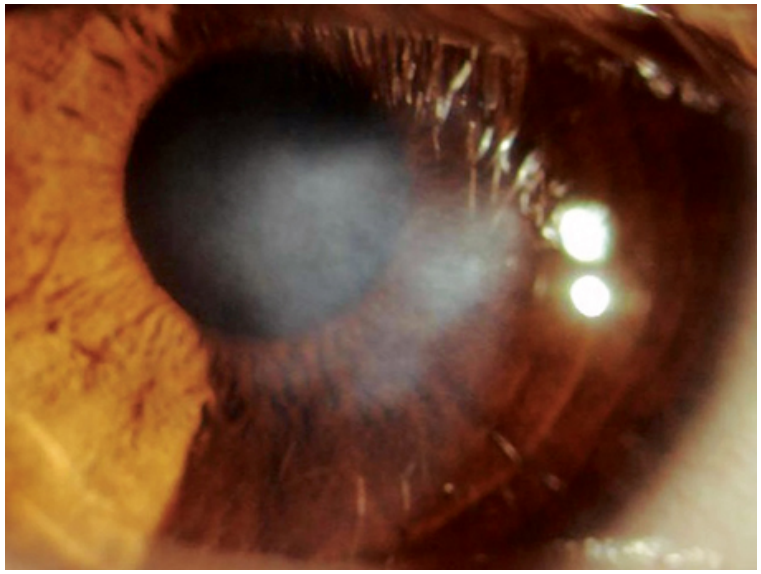
Persistent epithelial defect

Endothelial damage

- Risk if cornea pachymetry < 400 microns before irradiation with UV light

Punctate Keratitis

- Resolves by 1 year



Access to Cross-Linking in the U.S.

FDA APPROVED & ON-LABEL

Use of Photrexa® Viscous & Photrexa® with the KXL® system for the treatment of progressive keratoconus or corneal ectasia following refractive surgery

(On-label use of a legally marketed drug)

OFF-LABEL

Use of Photrexa Viscous & Photrexa with the KXL system for any indication other than progressive keratoconus or corneal ectasia following refractive surgery

(Off-label use of a legally marketed drug)

UNAPPROVED

Use of any other drug, device, or procedural protocol (i.e., epi-on) for cross-linking

(Except as part of an investigational new drug (IND) study)

EPI-ON VS EPI-OFF CROSS-LINKING

EPI-ON

- 2-3 day recovery of vision versus 2-3 months
- Less discomfort
- Lower risk of corneal infections
- Lower risk of corneal haze

EPI-OFF

- Better absorption of therapy
- More corneal flattening
- Decreased risk of progression of ectasia post-treatment

Wen D, Song B; Li Q et al. Comparison of Epithelium-Off Versus Transepithelial Corneal Collagen Cross-Linking for Keratoconus: A Systematic Review and Meta-Analysis. Cornea 2018. 37:8 1018-1024.

Summary

- Patients with progressive keratoconus should be educated regarding risks and benefits of CXL.
- Referring ophthalmologists and optometrists are a critical part in ensuring early diagnosis, monitoring, and continuing care of these patients.

Resources for patients

- Livingwithkc.com website
  - Informational videos
  - Q&A for patients
  - Insurance coverage
- National Keratoconus Foundation (NKCF)
  - www.nkcf.org
- Facebook groups for Keratoconus

Shaping Our Future

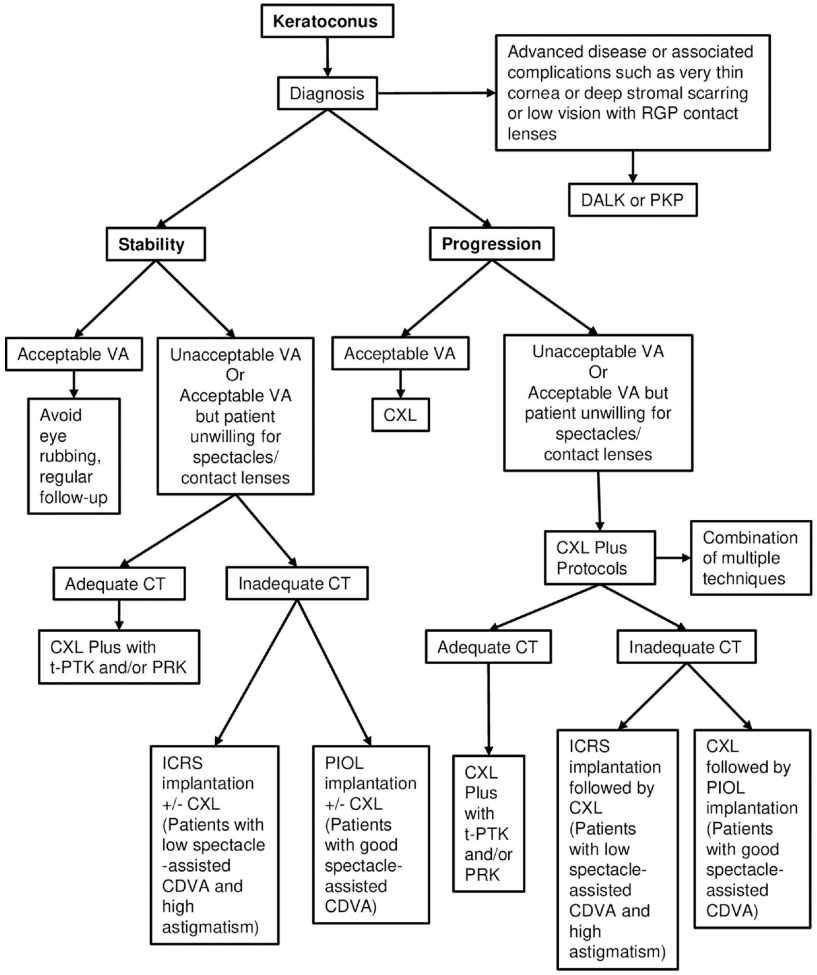
Pipeline Treatments
“Refractive-Plus”
Screening Protocols

Pipeline Treatments

Photoactivated chromophore for infectious keratitis (PACK-CXL)

- Proposed Mechanisms:
  - 1) Destroy pathogens
  - 2) Halt replication
  - 3) Stronger covalent bonds among collagen fibers
- Knyazer et al.: PACK-CXL associated with faster healing time in bacterial ulcers
- Also found to be effective in fungal, parasitic, and herpes keratitis

”Refractive-Plus” Procedures



"Refractive-Plus" Procedures

- Cross-linking + refractive procedure
- Off-label
- Refractive results less predictable

Corneal Cross-linking (CXL) and Photorefractive Keratectomy (PRK)

- Kanellopoulous et al. looked at CXL + PRK compared to CXL followed by PRK
- Same day cross-linking + PRK advantageous
  - Better BCVA and UCVA
  - Greater mean reduction in keratometry
  - Less corneal haze

Athens Protocol

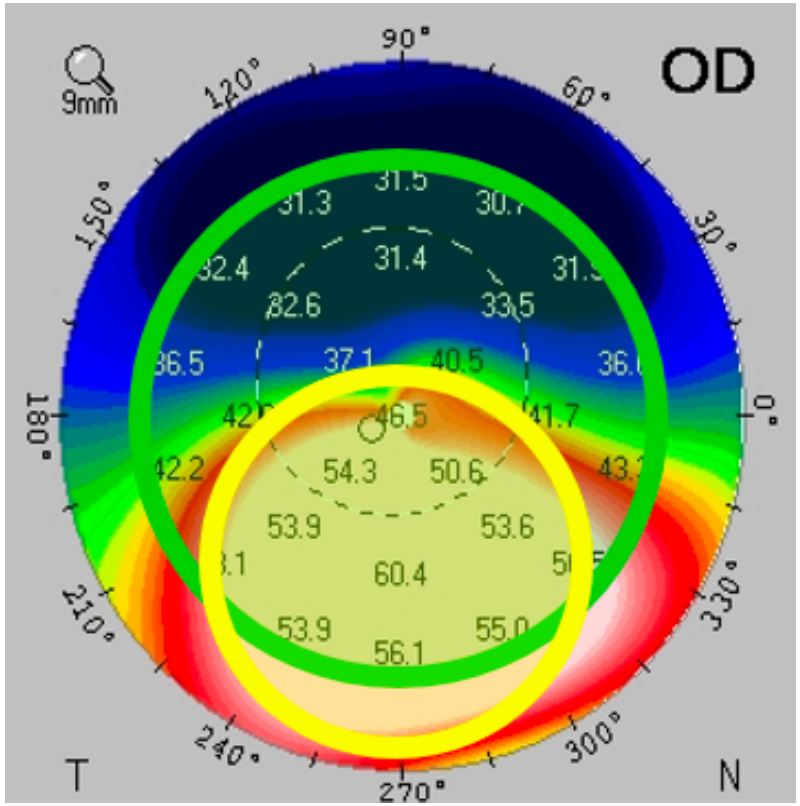
1. Place topical anesthetic and aspirating lid speculum
2. Perform 6.5mm, 50 micron phototherapeutic keratectomy (PTK) to remove the corneal epithelium
3. Apply partial topography-guided PRK treatment
    a. Effective optical zone diameter 5.5mm
    b. 50 μm maximum ablation depth for approximately 70% treatment of cylinder and sphere
4. Apply a cellulose sponge soaked in mitomycin C (MMC) 0.02% solution over the ablated tissue for 20 seconds
5. Irrigate with 10mL of chilled balanced salt solution
6. Collagen cross-linking procedure
    a. Apply 0.1% riboflavin sodium phosphate ophthalmic solution every 2 minutes for 10 minutes
    b. Start UV-A irradiation with of mean 370-nm wavelength and 3 mW/cm2 radiance at a distance of 2.5 cm from the cornea for 30 minutes
7. Place bandage contact lens

Other “Refractive-Plus” Procedures

- Phakic IOLs
  - Used for both iris-fixated lenses and posterior chamber lenses
  - Placed 6-12 months after CXL to establish corneal and refractive stability
- LASIKxtra
  - Accelerated CXL immediately after laser ablation
  - One drop of riboflavin soaks in the stroll bed for 60-90 seconds
  - LASIK flap replaced prior to radiating the cornea
  - 3 minutes of 10 mW/cm2 OR 60-90 seconds of 30 mW/cm2 of UV-A light
  - Not meant for eyes with keratoconus but as a preventative measure
- Conductive Keratoplasty (CK) - unclear benefit

Customized Cross-linking

- Treatment area just directed to cone
- Advantage:
  - Smaller epithelial defect
  - Faster recovery
  - Less Haze
- Disadvantage
  - Unclear efficacy
  - Unclear safety profile
  - Not FDA-approved



Accelerated Cross-linking

- Similar to FDA-approved Dresden Protocol but with higher powers
- Use a higher powered light source (greater than standard 3.0 mW)
- Possible advantages:
  - Increasing stiffening effects
  - Increasing the flattening effects
- Possible drawbacks:
  - Unclear benefit (no information on outcomes and safety)
  - Possible short and long-term side effects (endothelial damage)
  - Not FDA-approved

“WHAT ARE THE BARRIERS FOR SCREENING OUT EVERY CASE OF KERATOCONUS?”

- Protocol
- Equipment
- Manpower
- Community Awareness

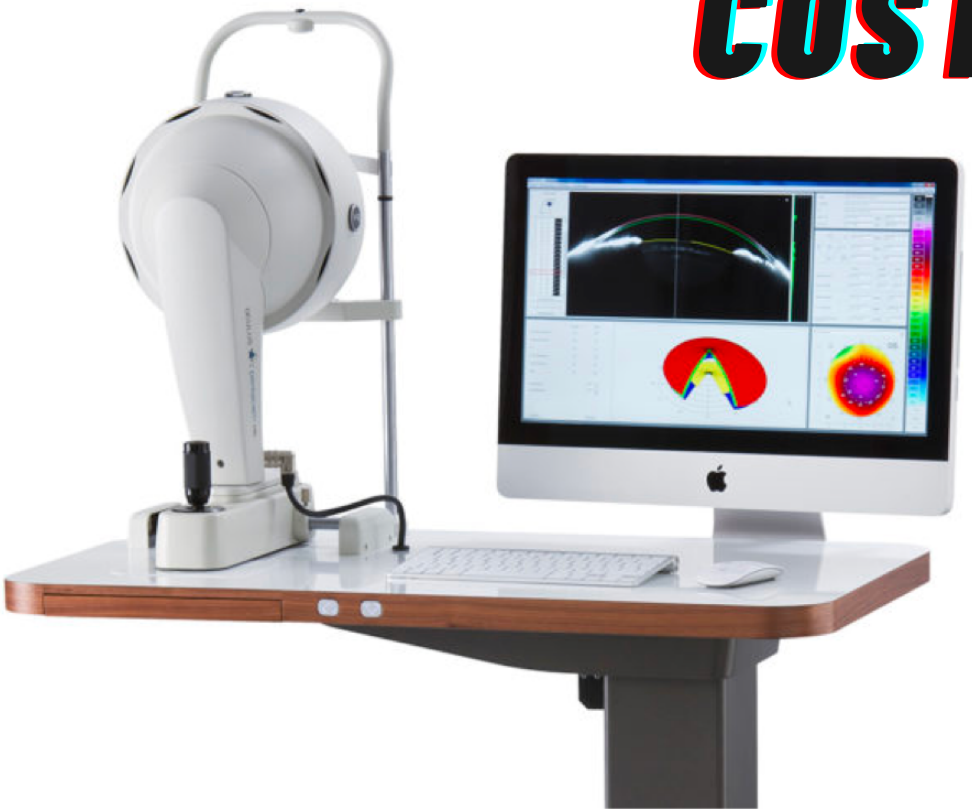

PROTOCOL


HOW AND WHEN DO WE SCREEN?
- BEST AGE?
- IN-OFFICE OR SCREENING EVENTS?

EQUIPMENT

EQUIPMENT

COST VS EFFICACY



- MANUAL KERATOMETRY?
- AUTOREFRACTION?
- STANDARD TOPOGRAPHER?
- PENTACAM?


MANPOWER


WHO WILL SCREEN?
WHO WILL INTERPRET TESTING?


community
awareness!

How do we educate our community about keratoconus?

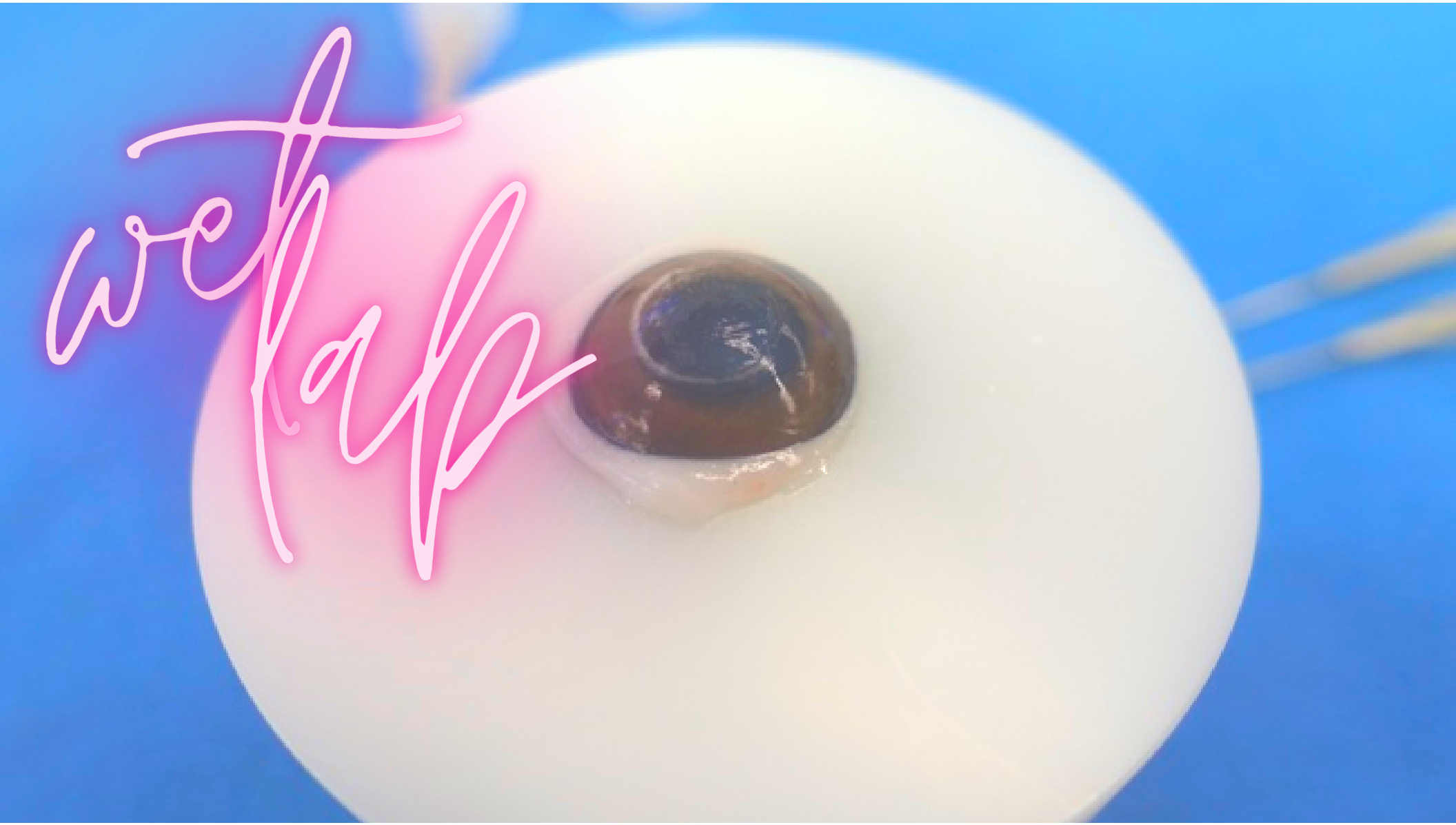
- social media awareness
- educational events
- press releases
- fundraising events
- in-office educational materials

Let's Connect!

@michelelee_md

Michele Lee, MD

mdlee09@gmail.com


wet lab

Procedure Overview

Epithelial debridement

1. Using topical anesthesia, debride the epithelium to a diameter of approximately 9 mm using standard aseptic technique.

Induction

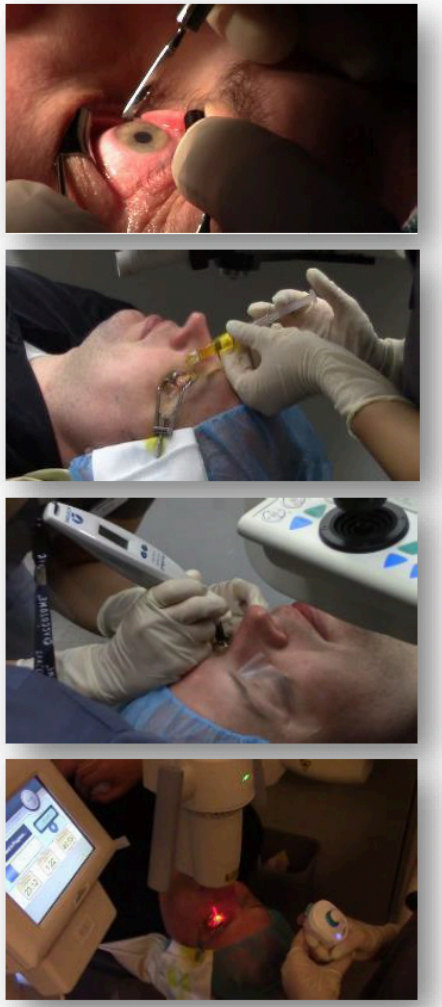
2. Instill 1 drop of **Photrexa® Viscous** topically on the eye every 2 minutes for 30 minutes.

Check Flare and Corneal Thickness

3. Observe eye for yellow flare
    - If the yellow flare is not detected, instill 1 drop of **Photrexa Viscous** every 2 minutes for an additional 2 to 3 cycles. Repeat until yellow flare is observed.
4. Corneal thickness of 400 µm,
    - Swell the cornea using hypotonic **Photrexa®** every 5 to 10 seconds until the corneal thickness increases to at least 400 µm.

UV Irradiation

5. Irradiate the eye for 30 minutes using the **KXL® System.** Continue instillation of 1 drop of **Photrexa Viscous** topically on the eye every 2 minutes for 30 minutes.



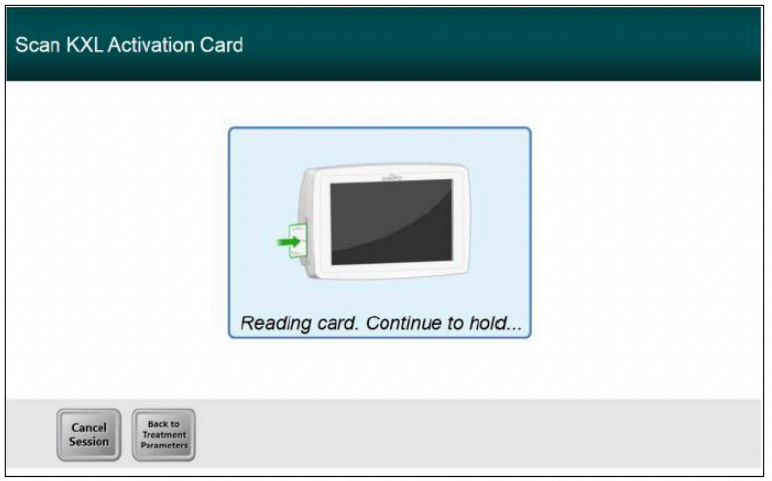
GLAUKOS

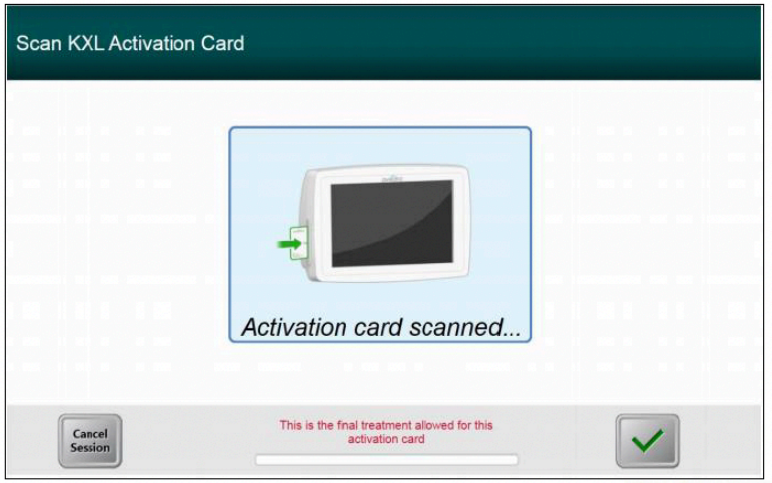
Starting the procedure

1. Power on the device
2. Press “Start New Treatment” button
3. Confirm treatment parameters
4. Scan treatment activation card
5. Sync remote

Scan Activation Card

- Place the activation card in the RFID reader until the system emits a beep.
- After a multi-use activation card has been scanned, the display will show the number of treatments remaining on the card.
- Single-use cards may be discarded after the treatment is complete.

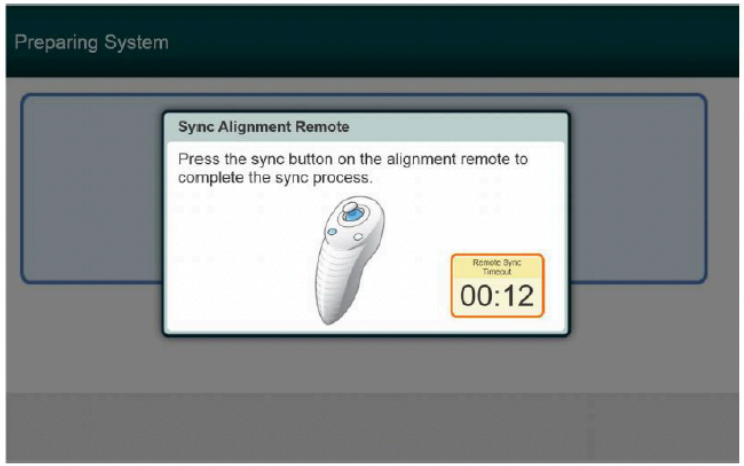


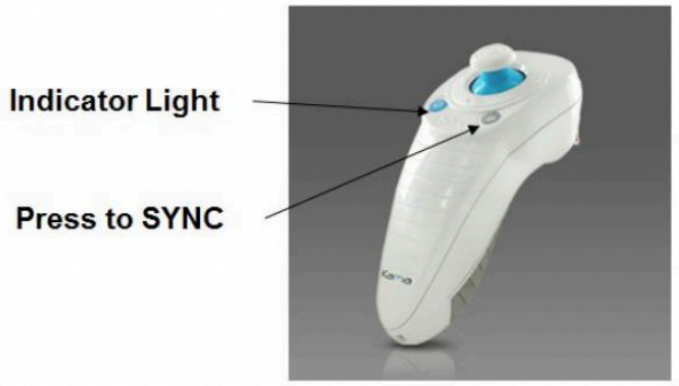


GLAUKOS

Sync the Alignment Remote

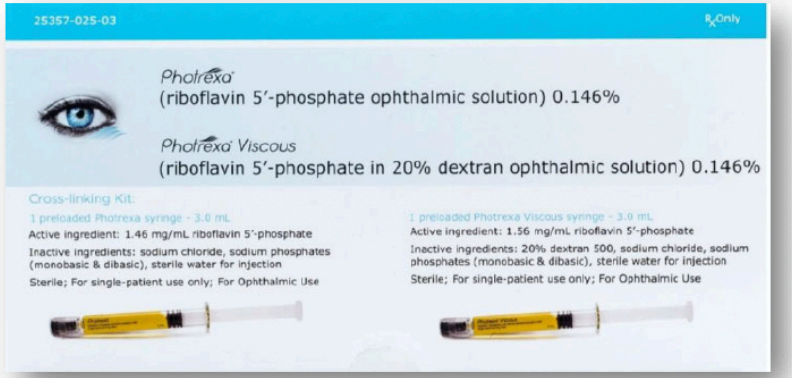
- A window is displayed prompting user to sync remote (for 15 seconds)
- Press the “S” button on the remote to synchronize the remote during that time frame.
- If remote goes out of sync, a pop-up message will notify the user.



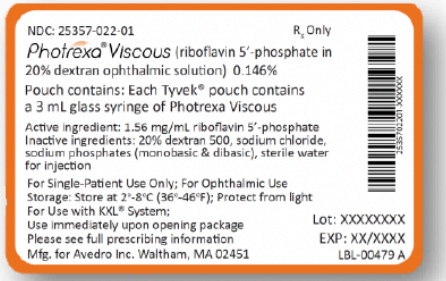


GLAUKOS

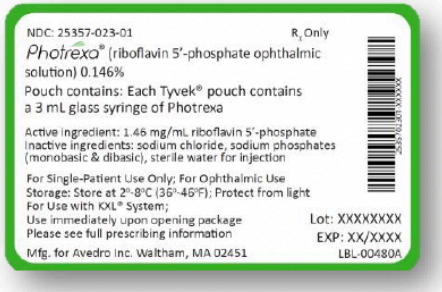
Included in the Treatment Kit



Activation Card



Photrexa Viscous



Photrexa

GLAUKOS

Common Procedure Supplies

Equipment

KXL System
Procedural Microscope
Ultrasound Pachymeter
Treatment Activation Card
Wastebasket
Tray/Mayo Stand
Clock Timer

Medications

Photrexa Viscous
(orange label)
Photrexa
(green label)
Topical Anesthetic
Post-operative Drops
(patient's)

Tray Supplies

Lid Speculum
(e.g. Lieberman/solid blade)
Epithelial removal supplies
4 x 4 Gauze
Surgical spears
(e.g. Weck-Cel)
BSS Solution

Other Supplies

Betadine Prep Swabs
Surgical Gloves
Surgical Bonnet
Surgical Tape
Bandage Contact Lens
Table Drape





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Tray example

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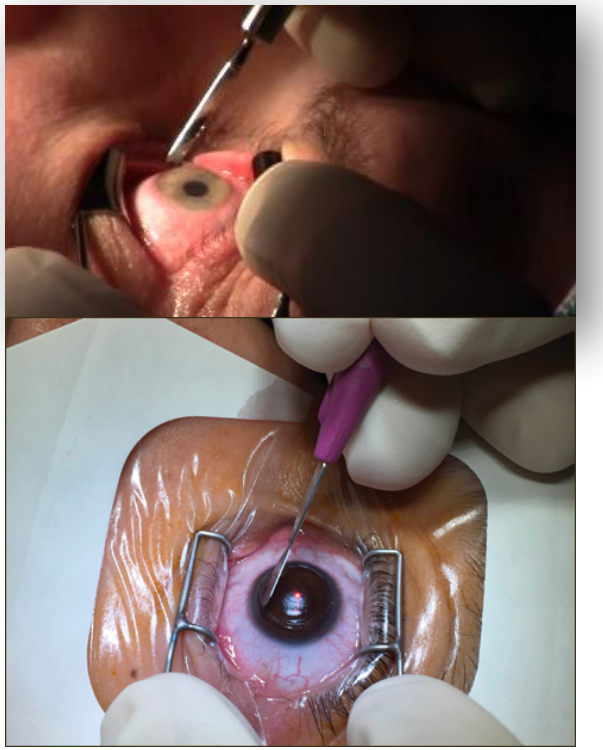
Step 1: Epithelial Debridement

- Method 1:
  - Soak cornea light shield in alcohol
  - Apply for 10-12 seconds
  - Use a combination of Weck-cell sponges, micro-hoe, crescent blade, or PRK spatula to remove loose epithelium

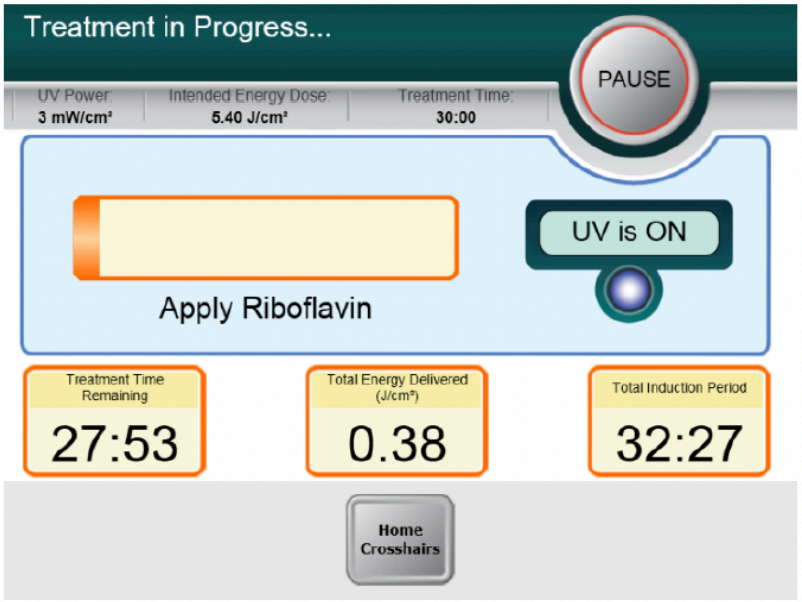
- Method 2:
  - Apply 8mm well on the cornea
  - Inject alcohol into the well
  - Let sit for 10 seconds
  - Use Weck-cell sponges to soak up the alcohol then remove the well from the eye
  - Use a combination of Weck-cell sponges, micro-hoe, crescent blade, or PRK spatula to remove loose epithelium



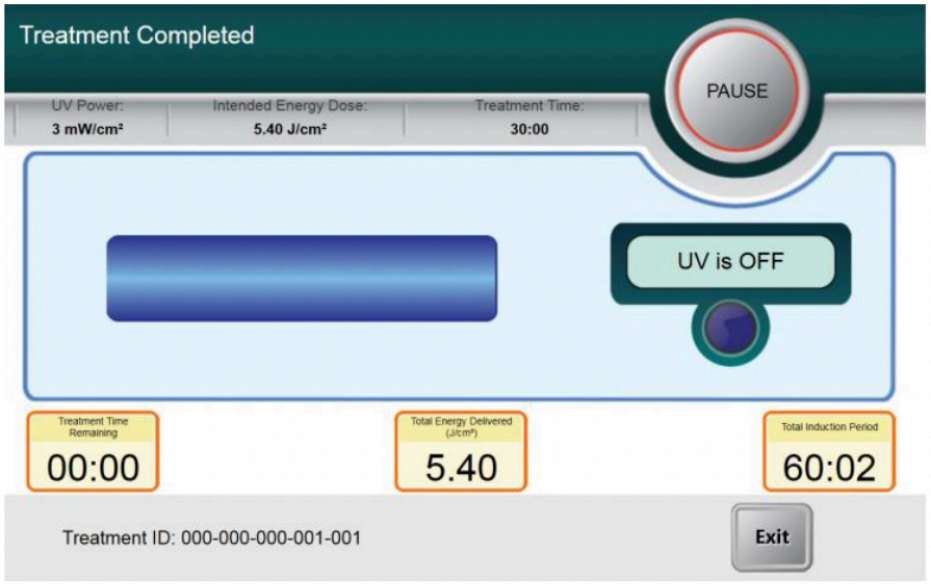
Step 2: Induction

- 1 drop of Photrexa viscous every 2 minutes
- Machine will signal when to put in the next drop
- If cornea thickness < 400, can use Photrexa (non-viscous)

Treatment Screens



Every 2 minutes, the status bar illuminates in orange and displays the "Apply Riboflavin" reminder and the system beeps.



The treatment stops automatically after the treatment timer expires.

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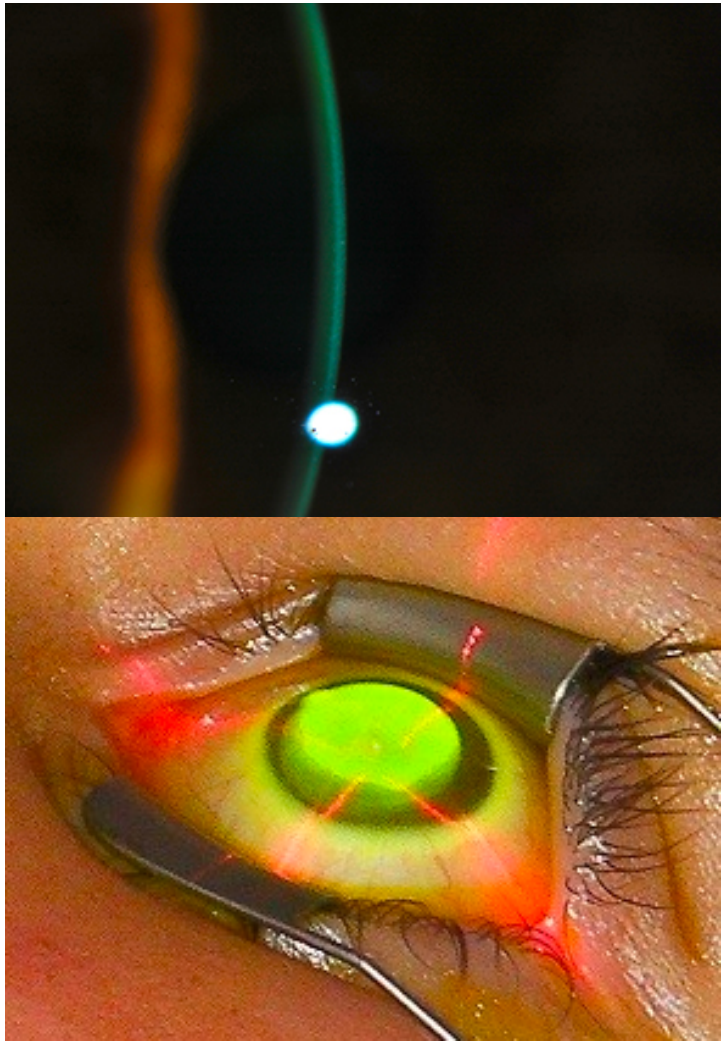
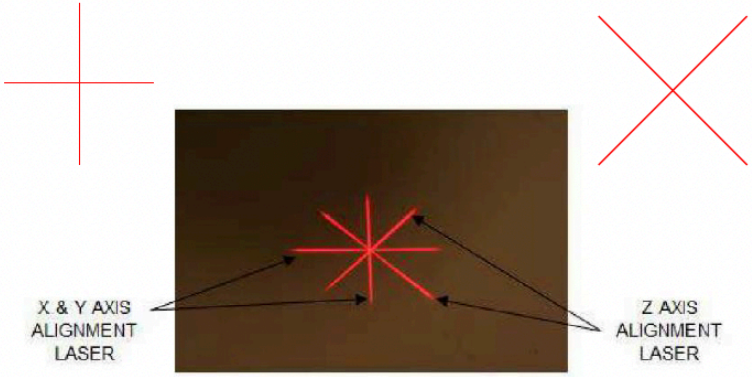
Step 3: UV Irradiation

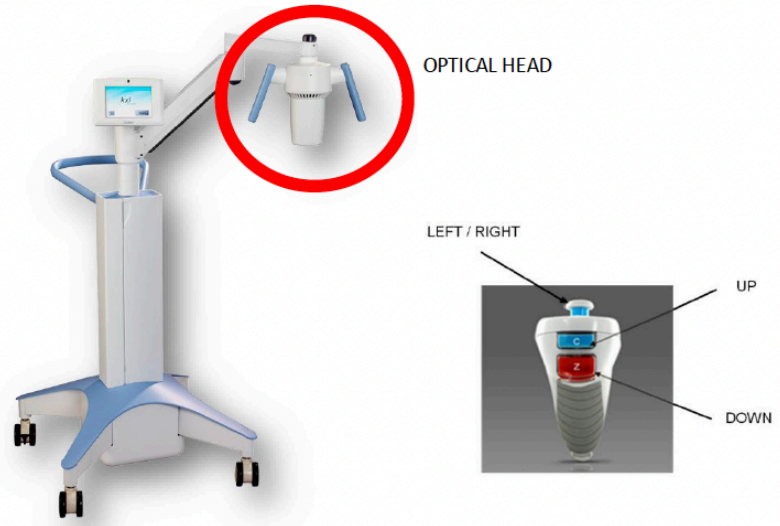
- Check for Flare
  - If no flare use Photrexa viscous every 2 minutes until flare detected
- Check pachymetry
  - OK to proceed if > 400 microns
  - DO NOT PROCEED if < 400 microns
    - 1) Photrexa every 5-10 seconds
    - 2) BSS drops every 5-10 seconds
- Place speculum to open eye
- Align Crosshairs of UV lamp
- Continue riboflavin eye drops every two minutes

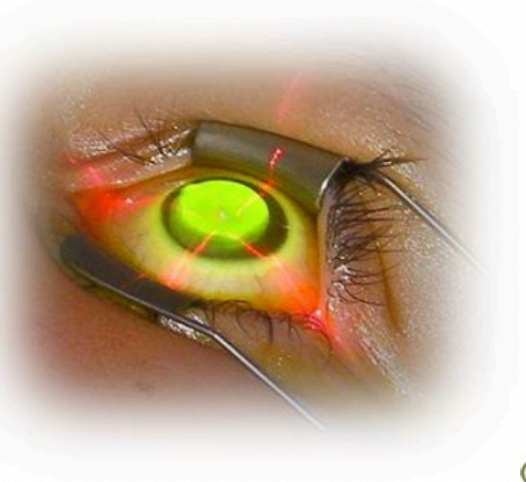


Crosshair Alignment

- Align the Optical Head over the patient eye, positioning the “X & Y Axis” crosshair at the center of the pupil.
- Align the “Z Axis” crosshair to the center of the “X & Y Axis” crosshair by moving the optical head up and down.
- Fine tune the alignment using the remote.







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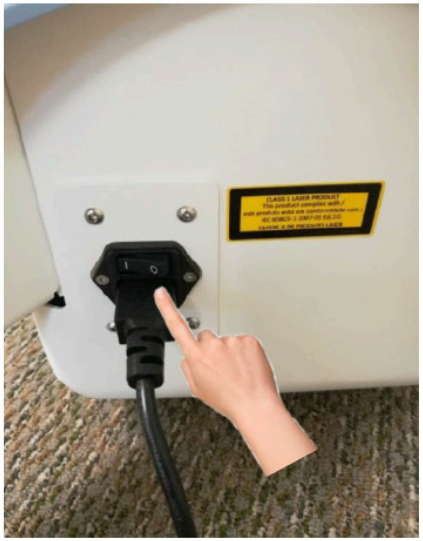
Post-op Considerations

- A bandage contact lens should be applied.
- Surgeons may apply their standard of care for postoperative management of PRK patients.
- This may include:
  - Antibiotic
  - Steroid
  - NSAID
  - Lubricating drops

- As always in the practice of medicine, it is up to the physician's discretion regarding the most appropriate care for their patients.

Power Off

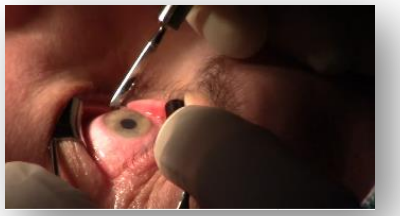


- Press “Power Off”
- Confirm
- Toggle Main switch to “Off” position on the base of the KXL system above the power cord

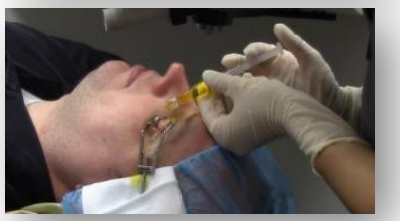
Today's Wetlab

- Affix the pig eye to the styrofoam block
- Set up the cross linking machine
- **Step 1**: Epithelial Debridement - 8-9mm
- **Step 2**: Induction - Photrexa drop every 2 minutes
- Check pachy, flare
  - What do you do if pachymetry is under 400 microns?
  - What do you do if you do not see flare?
- **Step 3**: UV Irradiation - center crosshairs, riboflavin drop every 2 minutes

STEPS TO EPITHELIAL-OFF CORNEAL CROSS-LINKING
Dresden Protocol

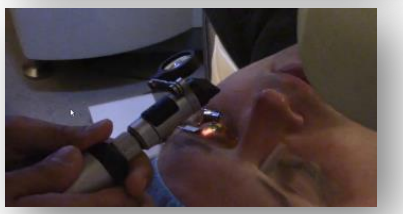


1. Remove epithelium



2. Soak cornea Photrexa® (riboflavin 5'-phosphate in 20% dextran ophthalmic solution)

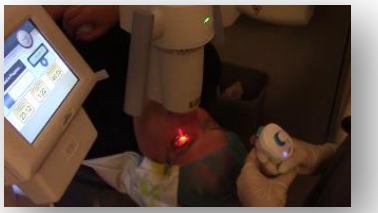
✓ 30 minutes



3. Check for flare

4. Once flare is observed, measure corneal thickness

✓ If corneal thickness is less than 400 um, instill 2 drops of Photrexa *(riboflavin 5'-phosphate in 20% dextran ophthalmic solution)* until the corneal thickness increases to at least 400 µm



5. Irradiate for 30 minutes

✓ Continue applying Photrexa Viscous *(riboflavin 5'-phosphate in 20% dextran ophthalmic solution)* during irradiation.