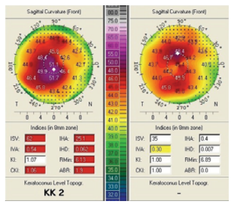
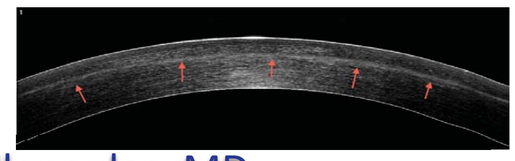
Mastering epi on and epi off CXL lessons learned over 14 years!





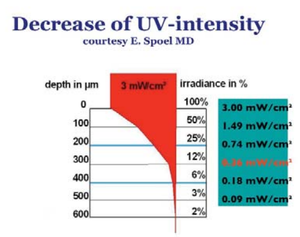
A. John Kanellopoulos, MD
Medical Director, Laservision.gr Institute, Athens, Greece
Clinical Professor, NYU Langone Medical School, NY

Financial interests, consult for:

- Alcon / Wavelight
- Allergan
- Avedro
- KeraMed
- i-Optics
- ISP Surgical
- Optovue
- Zeiss

From our Athens team: CXL contributions

- 2nd team to CXL **2002**
- Combining high fluence CXL with topo-guided reshaping of irregular corneas: **2005**
- Higher fluence: **2006**
- CXL and Kpro: **2006**
- Intrastromal treatments through femto-pockets: **2007 (**ESCRS)
- LASIK Xtra: **2008** (ESCRS)
- LASIK Xtra for hyperopia: **2011** (ASCRS)
- Combining CXL and AK: **2012** (ESCRS)
- Refractive CXL : **2013** (AAO)

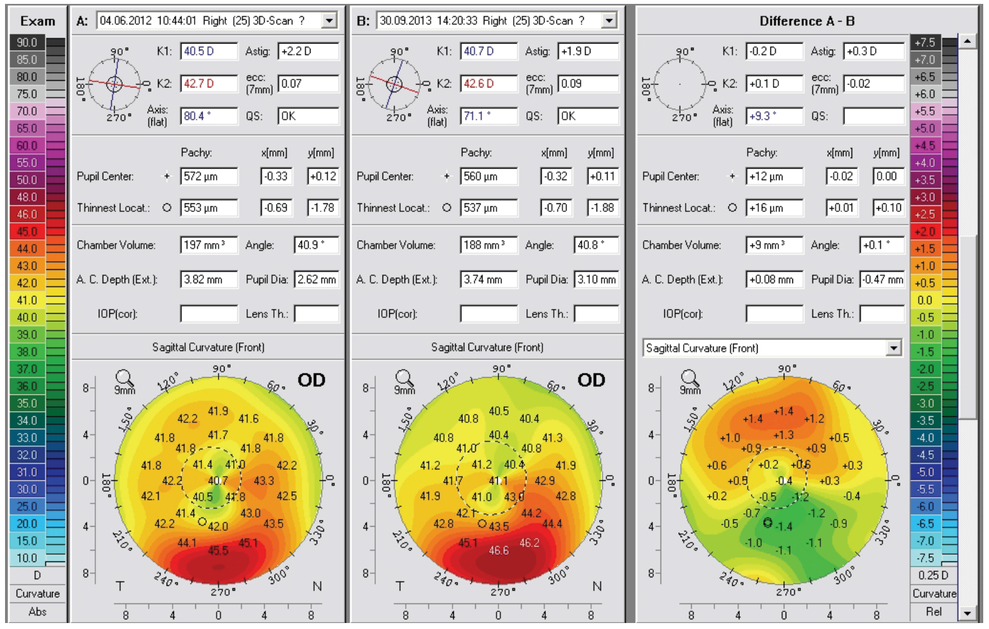


When to CXL?

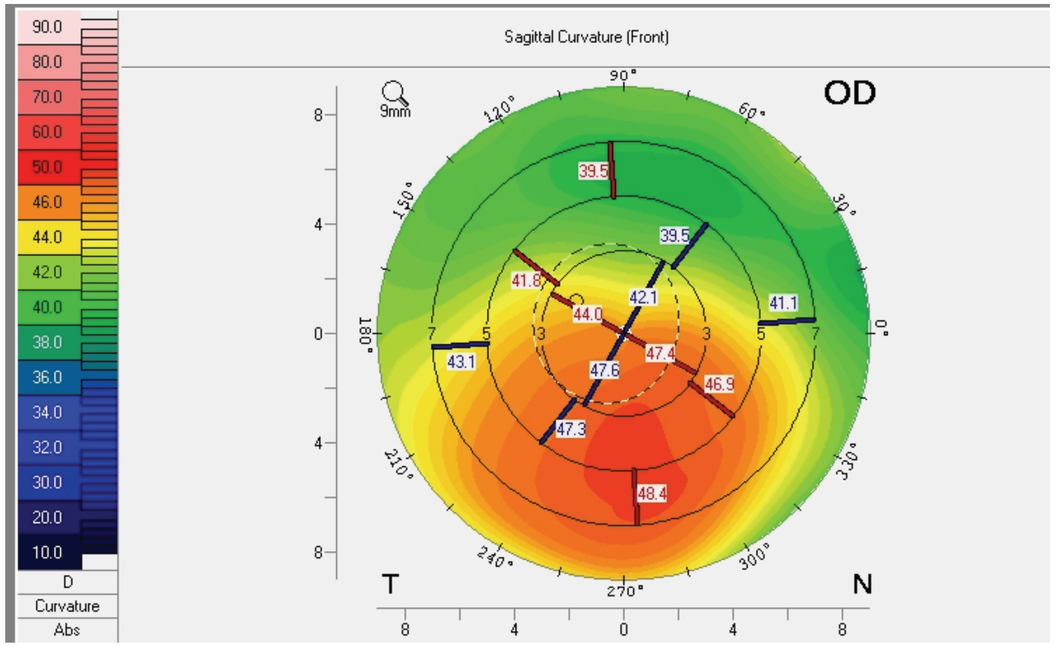
Multiple corneal imaging options:

- Placido disc topography
- Scheimpflug tomography
- OCT
- Multi color LED spot
- reflection topo (Cassini)

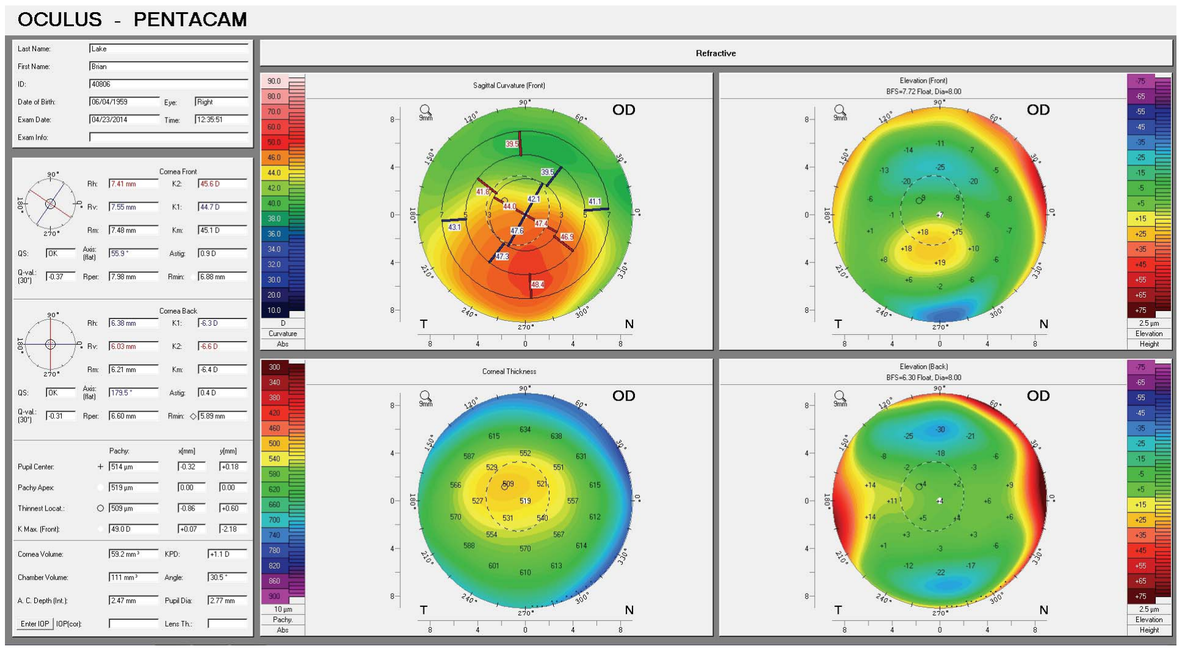
34 y/o F physician other eye AP X 3 years, getting married wonders if right eye is stable vision 20/20, K,s pach stable



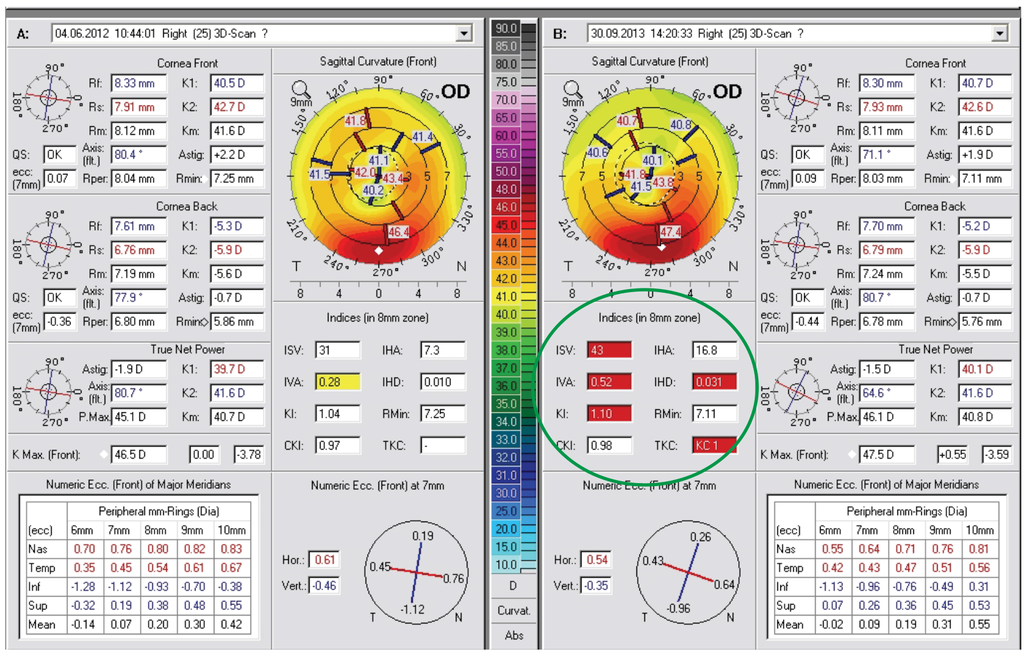
Post-LASIK ectasia?

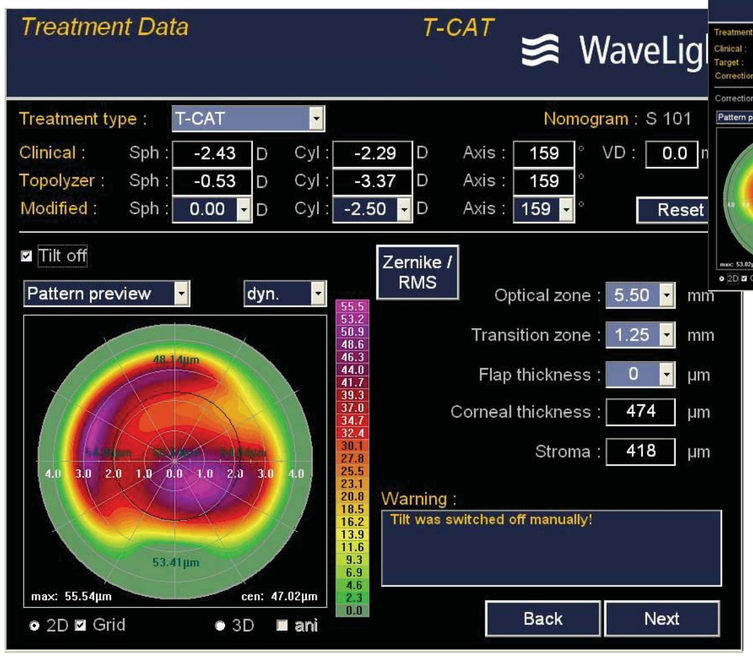


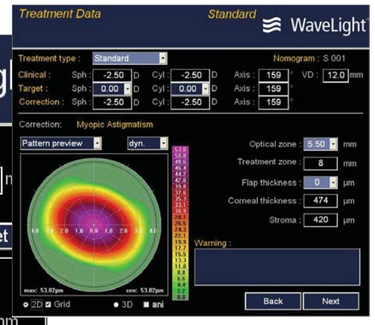
Post-LASIK ectasia?

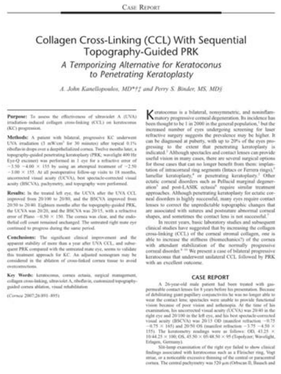


Most topometric asymmetry indices worse!









CASE REPORT

Collagen Cross-Linking (CCL) With Sequential Topography-Guided PRK

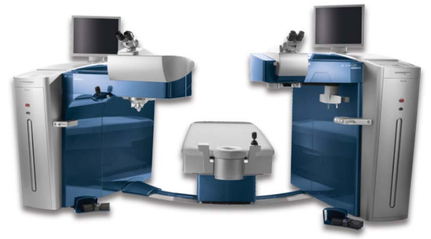
A Temporizing Alternative for Keratoconus to Penetrating Keratoplasty

A. John Kanellopoulos, MD†‡ and Perry S. Binder, MS, MD§*

Kanellopoulos, AJ: J Cornea 2007

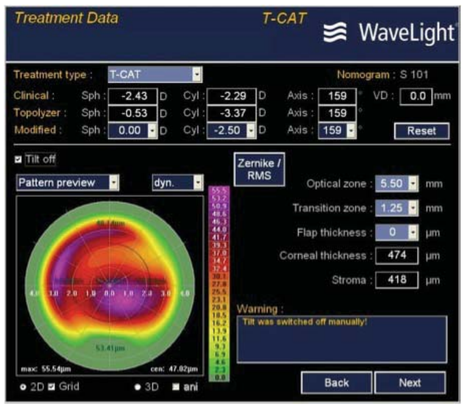
Topo-guided partial PRK

1-Topolyzer:Placido disc topography
2-Pentacam (Oculyzer)
3-Pentacam HD (oculyzer II)-Refractive suite
4-Vario (placido disc +pupil sensor+iris recognition+limbal landmarks recognition)



WaveLight® FS200 Femtosecond Laser

WaveLight® EX500 Excimer Laser



WaveLight® Refractive Suite

New York University School of Medicine Kanellopoulos,MD LaserVision.gr Institute for laser

The Athens Protocol 4 steps:

same day PTK > topoPRK > MMC > CXL (6mW/cm2 x 15 min)

1- PTK

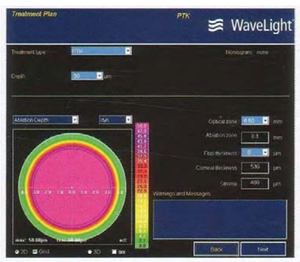


Figure 4.1: Epithelium removed with 50 micron PTK

2- topo -guided PRK

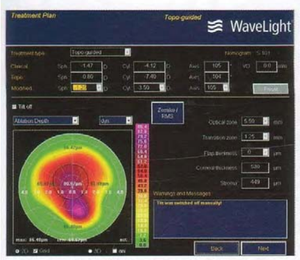


Figure 4.2: TC at treatment plan

3- 30” MMC

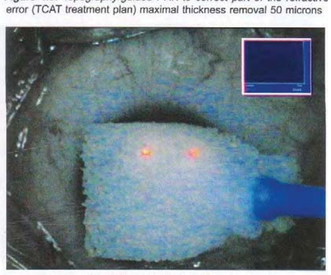
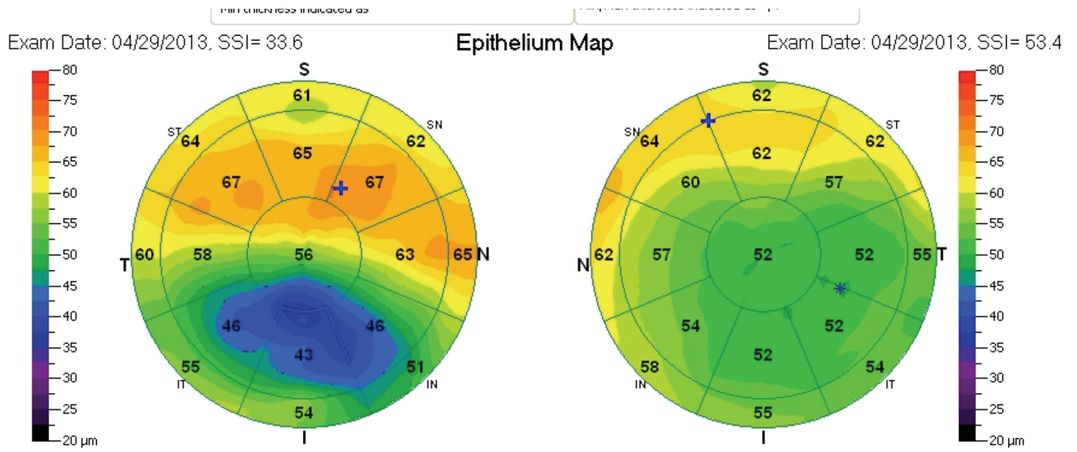


Figure 4.4: MMC solution 0.02% for 20 seconds

4-: CXL

Figure 4.3: Topography-guided PRK to correct part of the refractive error (TCAT treatment plan) maximal thickness removal 50 microns

Athens Protocol (topoPRK +CXL) KCN epithelial changes



before

after

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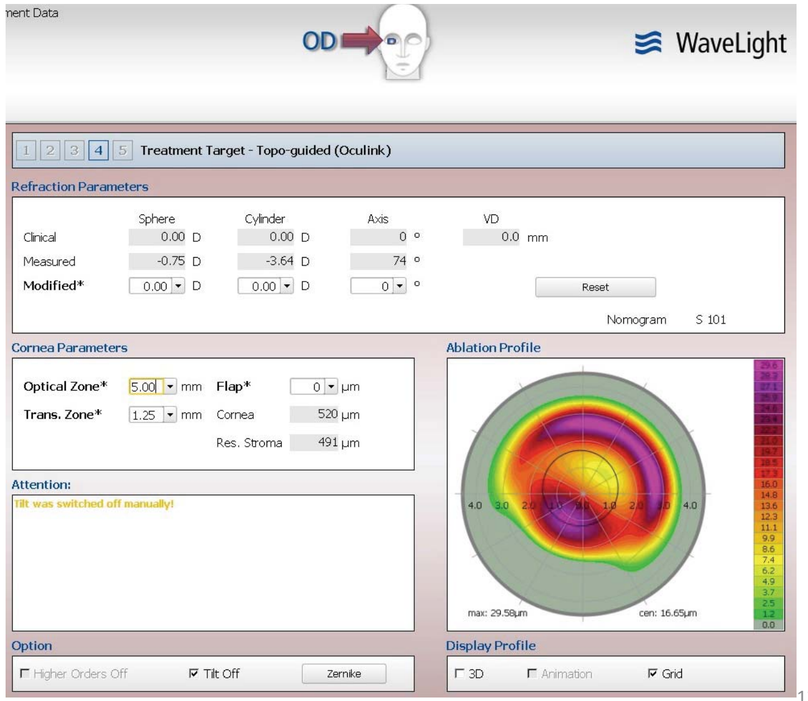
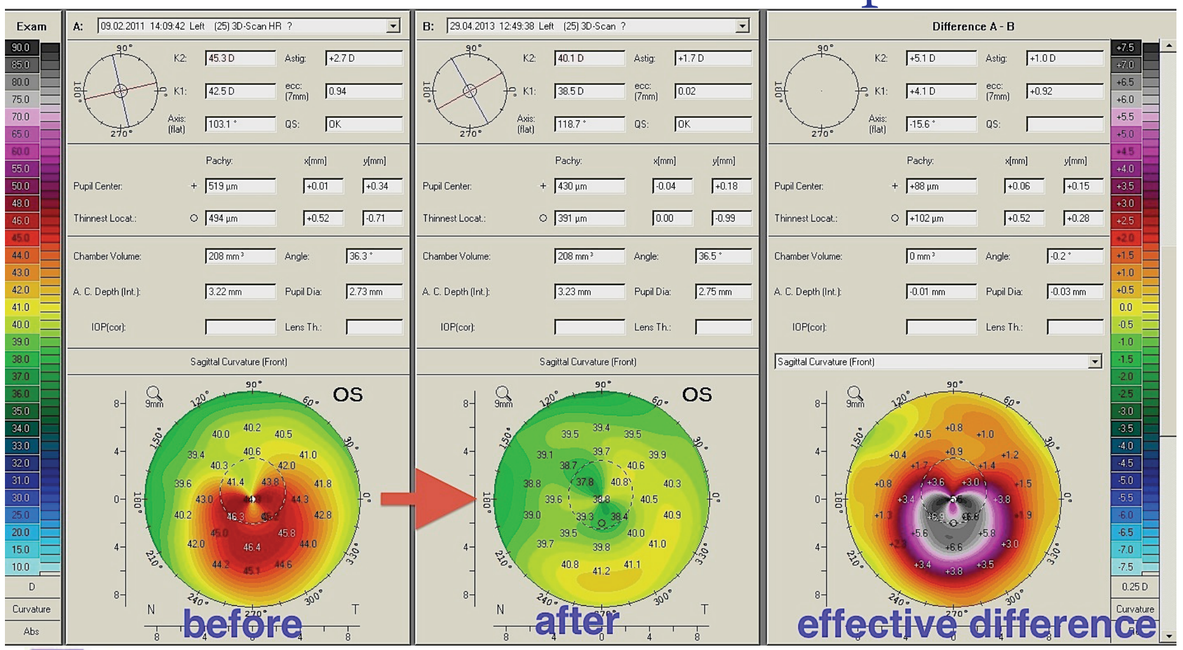
Step 4: attemted Rx to 0, OZ to 5 or 5.5mm, cyl axis to match topo axis not refractive axis



Athens Protocol example



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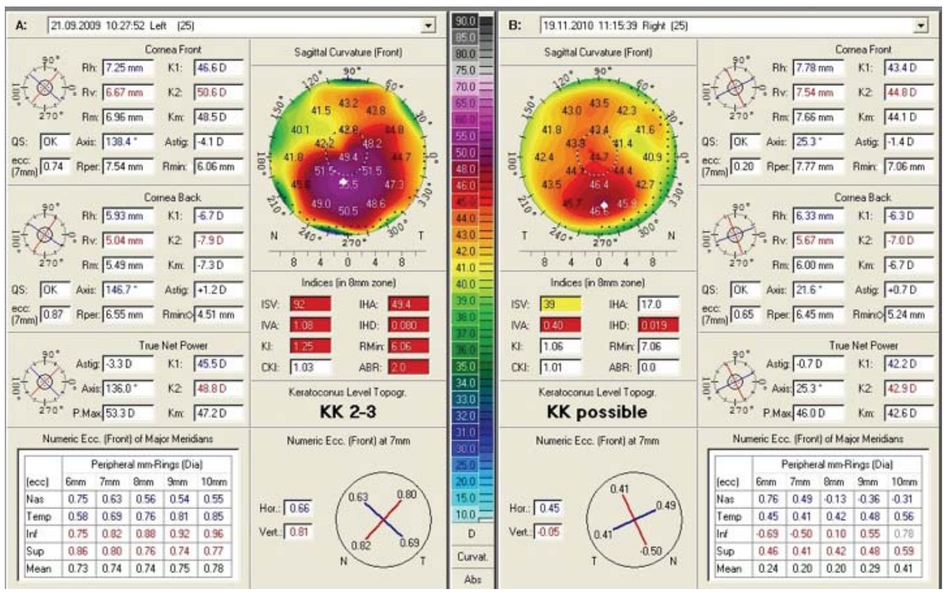
Kanellopoulos,MD

Average K from 48.5 to 44

Refraction -2.5-4.5@155 (20/70) to -1-1.5@10 (20/20)



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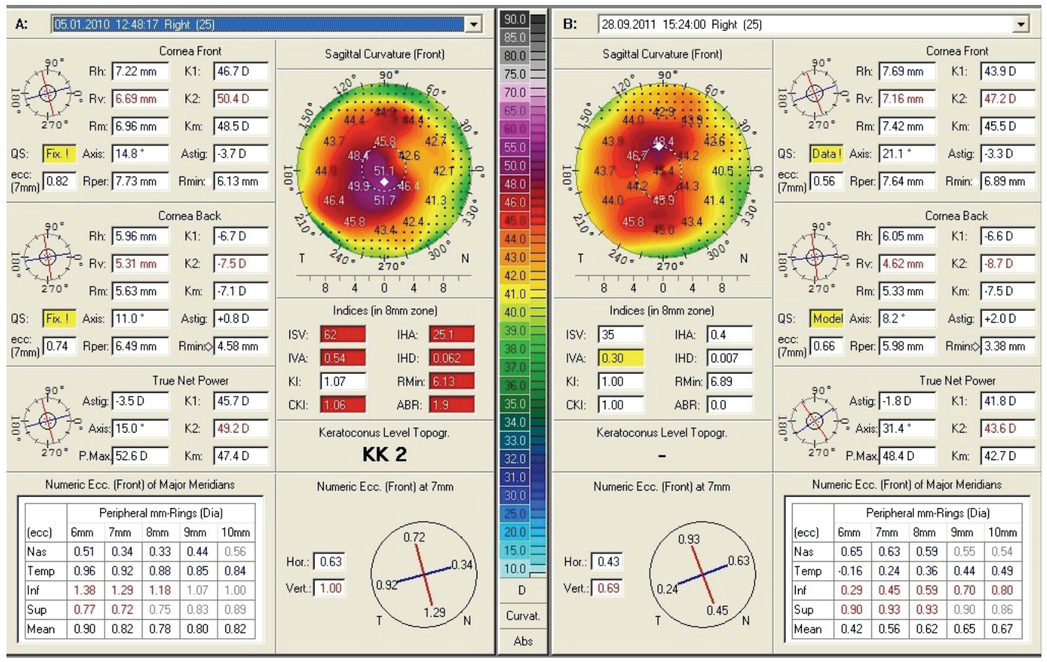
5 year follow up in a 15 y/o



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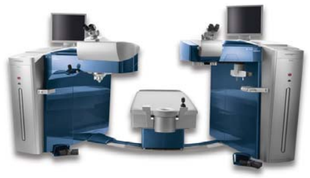
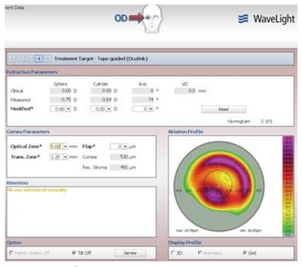
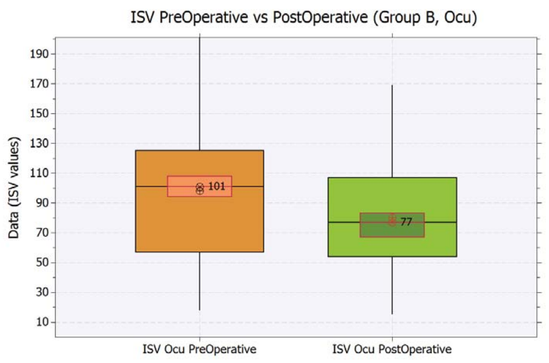
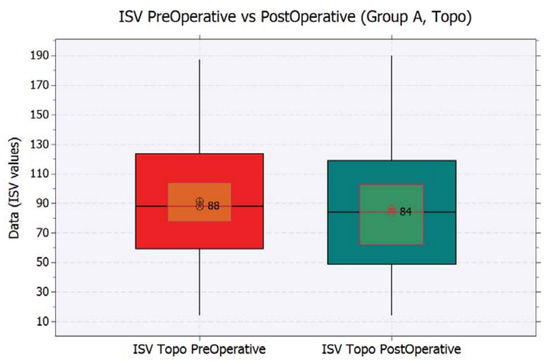


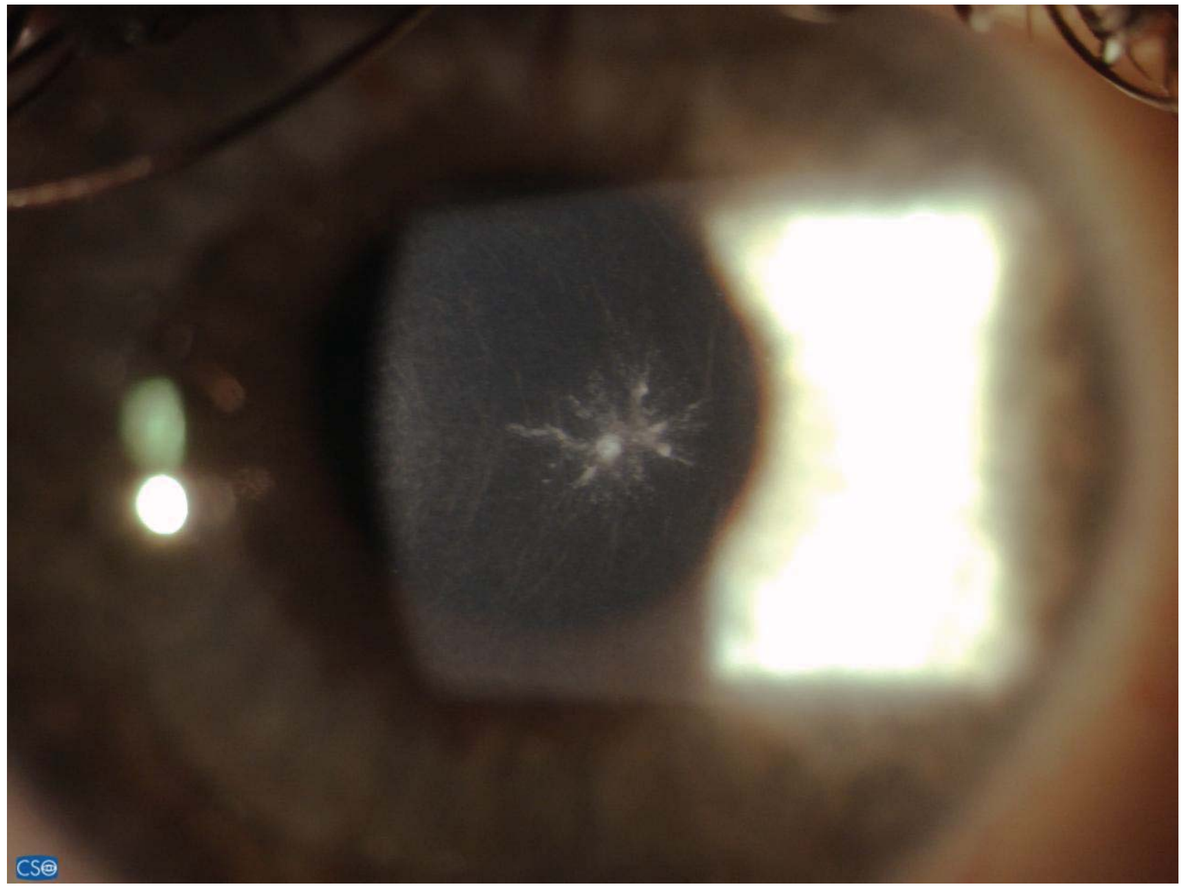


Oculink Vs Topolink in Athens Protocol





Oculink (Pentacam driven) appeared more effective!



Prophylactic higher fluence CXL in LASIK a novel technique

CXL meeting
Dresden 08

Henry Perry, MD and A. John Kanellopoulos, MD
Clinical Associate Professor New York University Medical School
Director, Laservision.gr Institute, Athens, Greece

epi-on = ¼ of epi-off

Cornea

Brillouin Microscopy of Collagen Crosslinking: Noncontact Depth-Dependent Analysis of Corneal Elastic Modulus

Giuliano Scarcelli,[1,2] Sabine Kling,[3] Elena Quijano,[1] Roberto Pineda,[4] Susana Marcos,[3] and Seok Hyun Yun[1,2,5]

Cornea

Brillouin Optical Microscopy for Corneal Biomechanics

Giuliano Scarcelli,[1,2] Roberto Pineda,[3] and Seok Hyun Yun[1,2,4]

Léon Brillouin

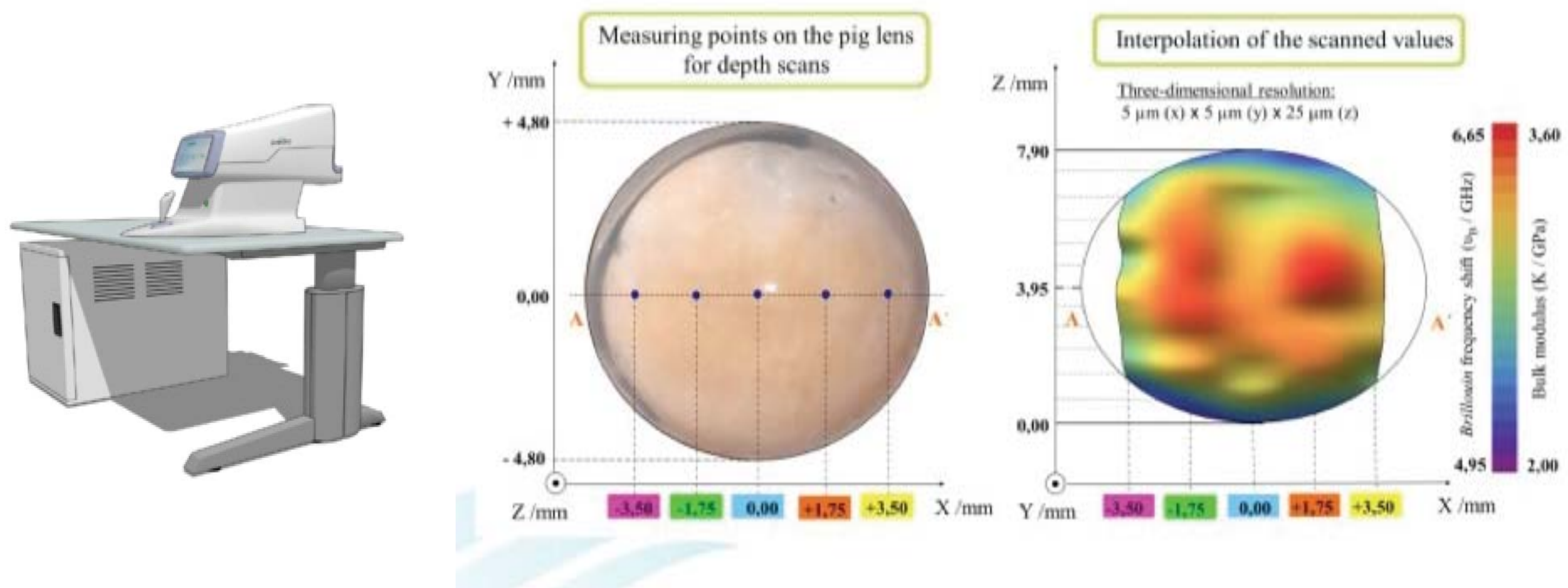
Léon Nicolas Brillouin (1889–1969)

Biomechanical assessment of CXL

Other options: Pascal ORA, Corvis

Avedro's Brillouin phonon spectrometer

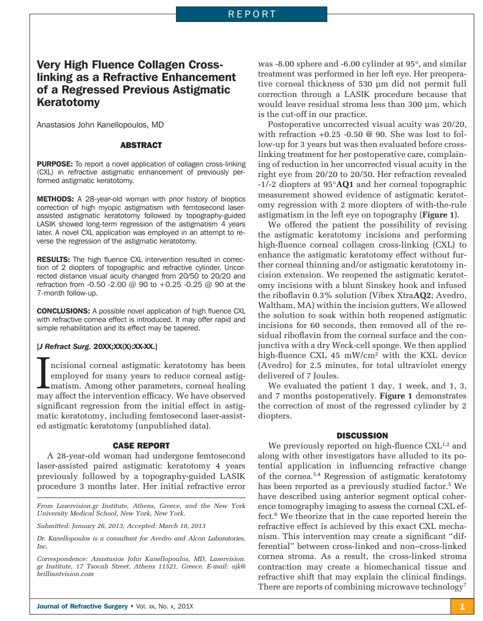
Commercial device by Avedro in 2004



The creation of CXL differentials within the cornea can have a refractive effect

2012 CXL Geneva

Kanellopoulos AJ:JRS 2013



REPORT

Very High Fluence Collagen Cross-linking as a Refractive Enhancement of a Regressed Previous Astigmatic Keratotomy

Anastasios John Kanellopoulos, MD

ABSTRACT

PURPOSE: To report a novel application of collagen cross-linking (CXL) in refractive astigmatic enhancement of previously performed astigmatic keratotomy.

METHODS: A 28-year-old woman with prior history of bioptics correction of high myopic astigmatism with femtosecond laser-assisted astigmatic keratotomy followed by topography-guided LASIK showed long-term regression of the astigmatism 4 years later. A novel CXL application was employed in an attempt to reverse the regression of the astigmatic keratotomy.

RESULTS: The high fluence CXL intervention resulted in correction of 2 diopters of topographic and refractive cylinder. Uncorrected distance visual acuity changed from 20/50 to 20/20 and refraction from -0.50 -2.00 @ 90 to +0.25 -0.25 @ 90 at the 7-month follow-up.

CONCLUSIONS: A possible novel application of high fluence CXL with refractive cornea effect is introduced. It may offer rapid and simple rehabilitation and its effect may be tapered.

[*J Refract Surg.* 20XX;XX(X):XX-XX.]

Incisional corneal astigmatic keratotomy has been employed for many years to reduce corneal astigmatism. Among other parameters, corneal healing may affect the intervention efficacy. We have observed significant regression from the initial effect in astigmatic keratotomy, including femtosecond laser-assisted astigmatic keratotomy (unpublished data).

CASE REPORT

A 28-year-old woman had undergone femtosecond laser-assisted paired astigmatic keratotomy 4 years previously followed by a topography-guided LASIK procedure 3 months later. Her initial refractive error was -8.00 sphere and -6.00 cylinder at 95°, and similar treatment was performed in her left eye. Her preoperative corneal thickness of 530 µm did not permit full correction through a LASIK procedure because that would leave residual stroma less than 300 µm, which is the cut-off in our practice.

Postoperative uncorrected visual acuity was 20/20, with refraction +0.25 -0.50 @ 90. She was lost to follow-up for 3 years but was then evaluated before cross-linking treatment for her postoperative care, complaining of reduction in her uncorrected visual acuity in the right eye from 20/20 to 20/50. Her refraction revealed -1/-2 diopters at 95°**AQ1** and her corneal topographic measurement showed evidence of astigmatic keratotomy regression with 2 more diopters of with-the-rule astigmatism in the left eye on topography (**Figure 1**).

We offered the patient the possibility of revising the astigmatic keratotomy incisions and performing high-fluence corneal collagen cross-linking (CXL) to enhance the astigmatic keratotomy effect without further corneal thinning and/or astigmatic keratotomy incision extension. We reopened the astigmatic keratotomy incisions with a blunt Sinskey hook and infused the riboflavin 0.3% solution (Vibex Xtra**AQ2**; Avedro, Waltham, MA) within the incision gutters. We allowed the solution to soak within both reopened astigmatic incisions for 60 seconds, then removed all of the residual riboflavin from the corneal surface and the conjunctiva with a dry Weck-cell sponge. We then applied high-fluence CXL 45 mW/cm² with the KXL device (Avedro) for 2.5 minutes, for total ultraviolet energy delivered of 7 Joules.

We evaluated the patient 1 day, 1 week, and 1, 3, and 7 months postoperatively. **Figure 1** demonstrates the correction of most of the regressed cylinder by 2 diopters.

DISCUSSION

We previously reported on high-fluence CXL[1,2] and along with other investigators have alluded to its potential application in influencing refractive change of the cornea.[3,4] Regression of astigmatic keratotomy has been reported as a previously studied factor.[5] We have described using anterior segment optical coherence tomography imaging to assess the corneal CXL effect.[6] We theorize that in the case reported herein the refractive effect is achieved by this exact CXL mechanism. This intervention may create a significant "differential" between cross-linked and non–cross-linked cornea stroma. As a result, the cross-linked stroma contraction may create a biomechanical tissue and refractive shift that may explain the clinical findings. There are reports of combining microwave technology[7]

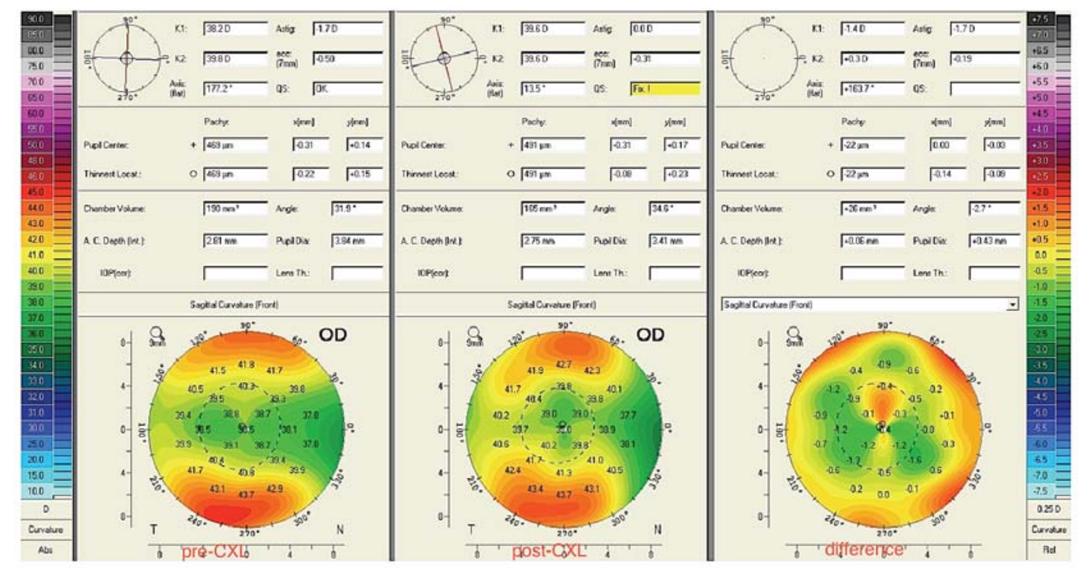
From Laservision.gr Institute, Athens, Greece, and the New York University Medical School, New York, New York.

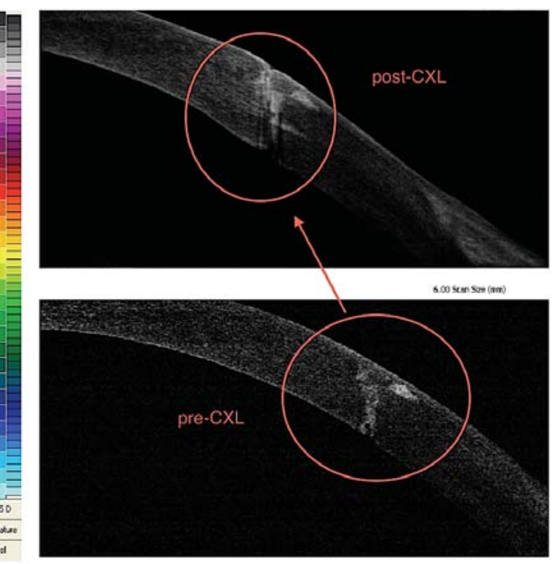
Submitted: January 26, 2013; Accepted: March 18, 2013

Dr. Kanellopoulos is a consultant for Avedro and Alcon Laboratories, Inc.

Correspondence: Anastasios John Kanellopoulos, MD, Laservision.gr Institute, 17 Tsocah Street, Athens 11521, Greece. E-mail: ajk@brilliantvision.com

Journal of Refractive Surgery • Vol. xx, No. x, 201X 1





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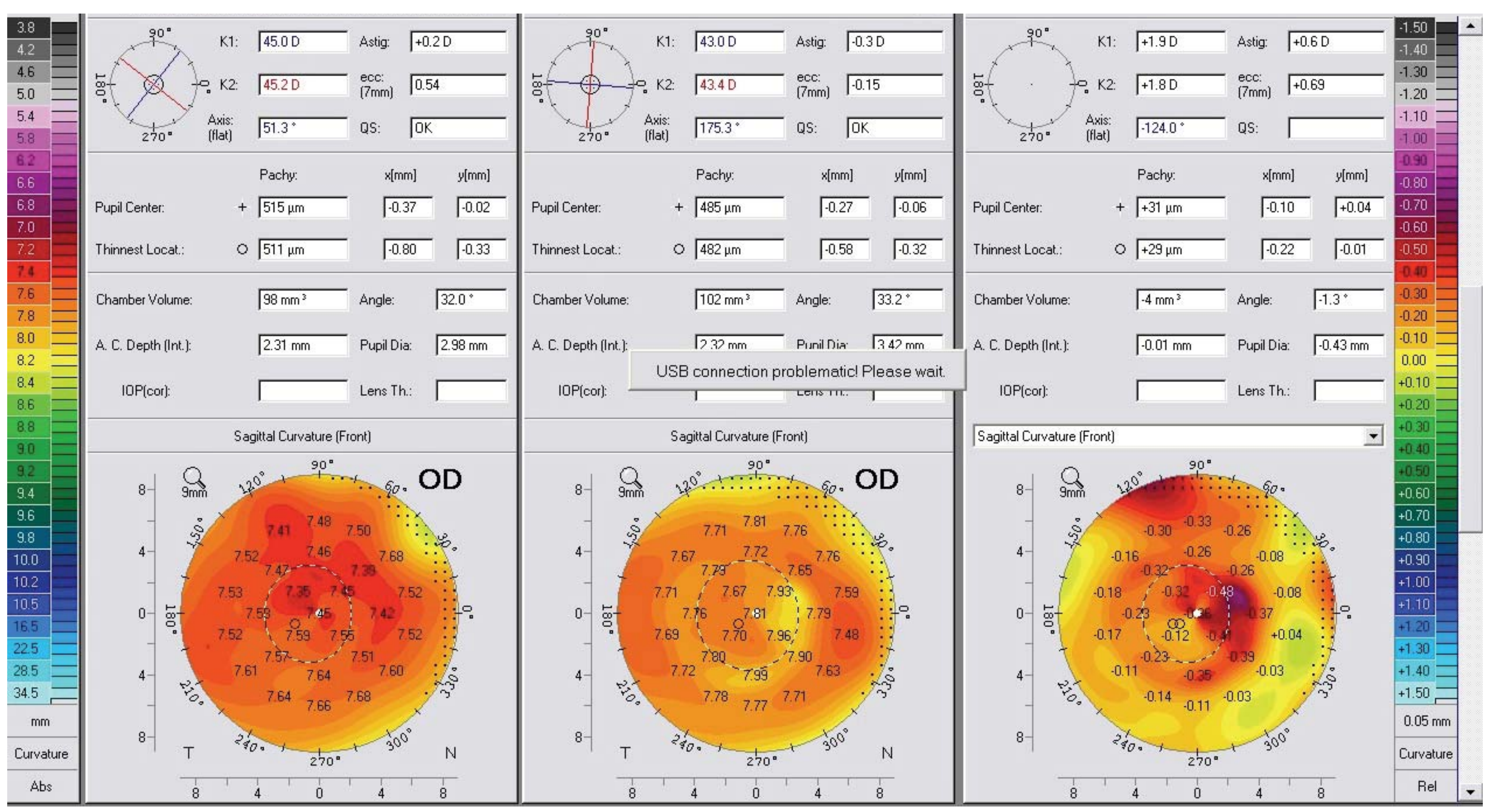
6 months myopic treatments **2D flattening !**



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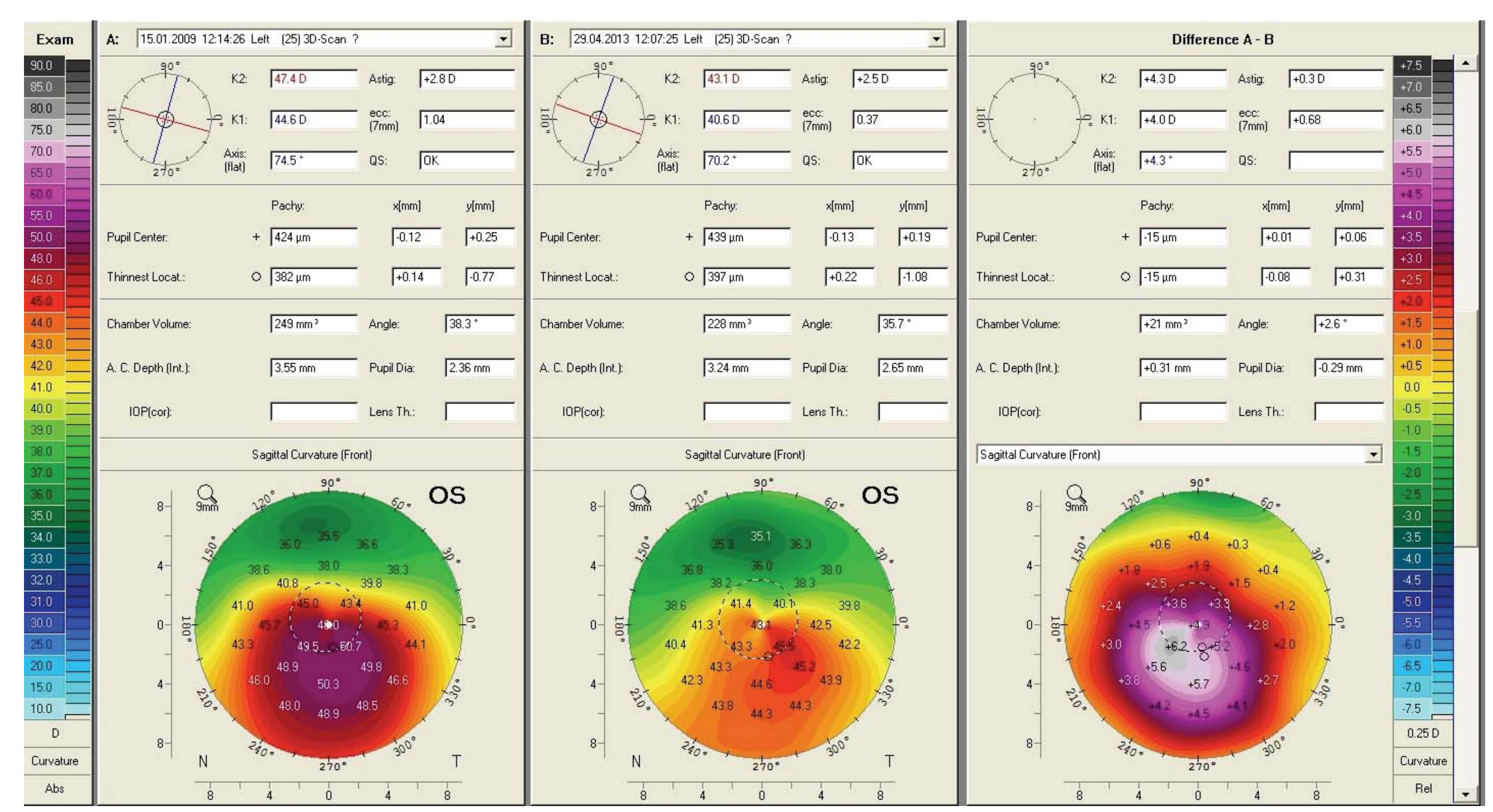
Is CXL a refractive procedure?

Most investigators speak of "disease reversal" when flattening occurs after CXL in ectasia

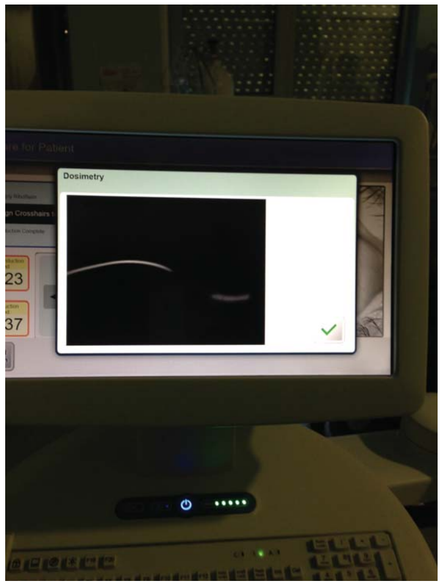
This is a simple 3mW CXL-alone case from **2005**

No scar developed, Now 2013 has Flattened 12D!!!



New York University School of Medicine Kanellopoulos,MD LaserVision.gr Institute for laser

Novel Avedro KXL-II Device
Riboflavin penetration captured
by Build –in Scheimpflug image



Myopic profile central 4mm OZ transepi
4min Paracel+6min VibexXtra

KXL2 - Treatment Report

Patient: [redacted]
ID: 001817
D.O.B.: 16-Aug-1944

OD Exam Date: 24-Jul-2013 13:40:12

Notes:

avedro
The World Leader in Corneal Cross-linking Science

No.	Shape Type	Time (mm:ss)	Total Energy (J/cm²)	X Position (mm)	Y Position (mm)	Axis (degs.)	Dim. 1 (mm)	Dim. 2 (mm)	Arc (degs.)
1	Circle	4:11	11.3	0.0	-0.0		4.0		

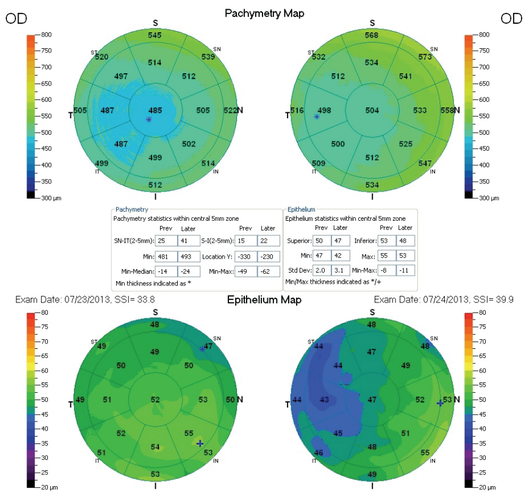
Indices
K's at 3mm:
Avg. K (D):
Pupil Ø (mm):
Limbus Ø (mm):
Min. Pachy (µ):

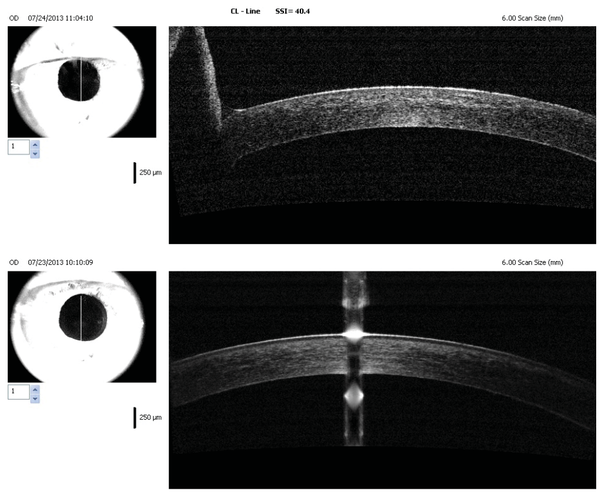
Additional Notes

Treatment Power: 45 mw/cm² - Continuous.

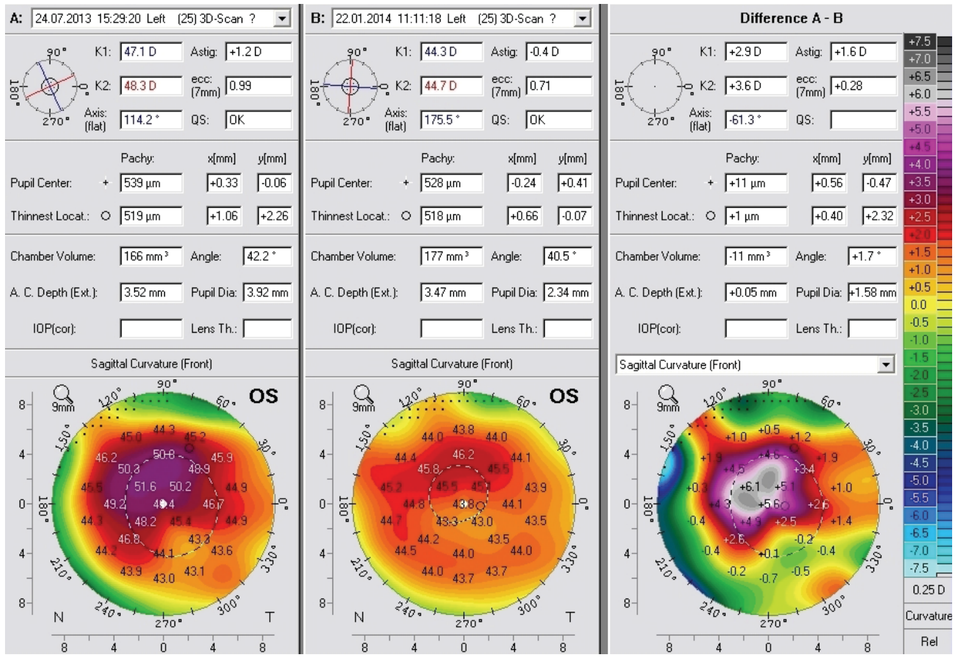
Version: 1.0.7.0 Copyright © 2013 Avedro, Inc.

Myopic profile central 4mm OZ transepi
4min Paracel+6min VibexXtra

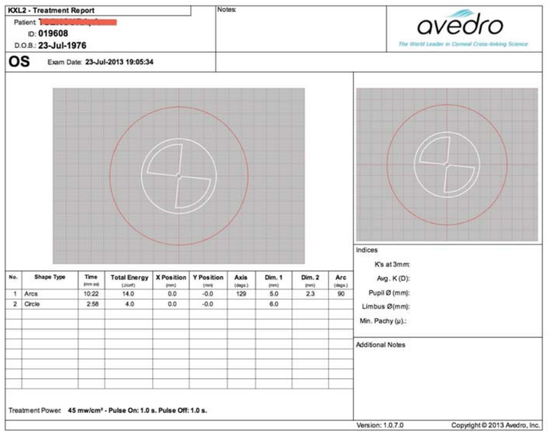


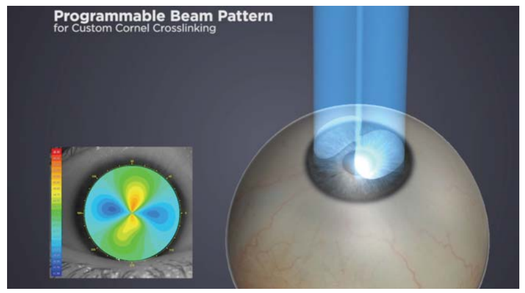


PiXL custom topo-assisted 7 months

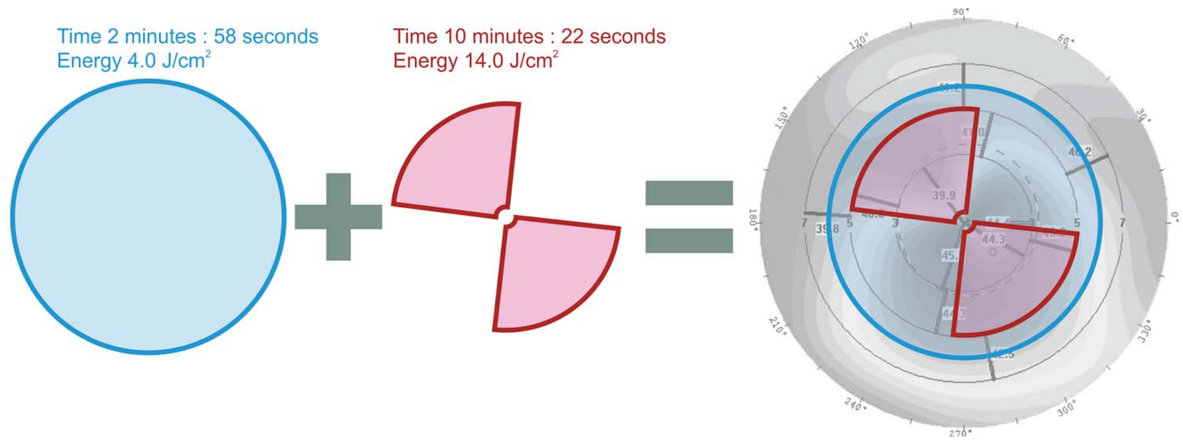


Toric profile-transepi:
4min Paracel+6min VibexXtra

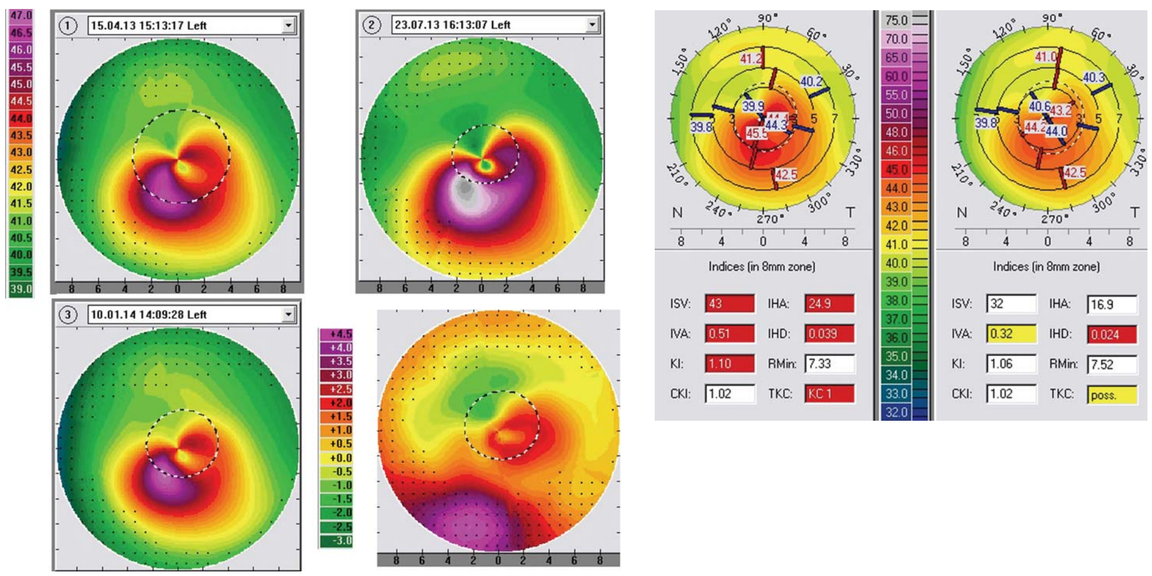




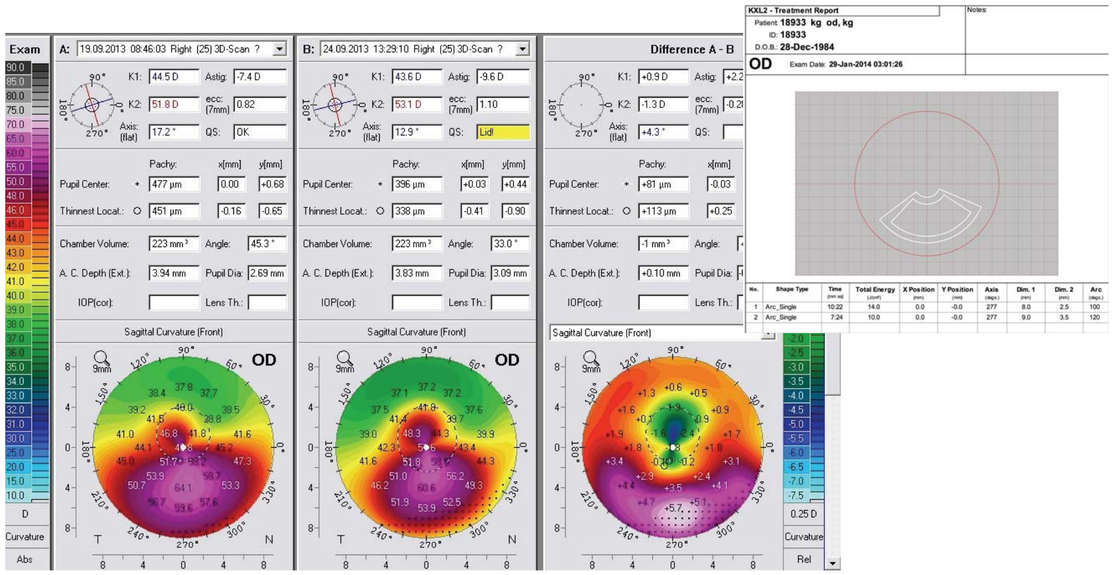
8 month topography-customised tran-epithelial CXL treatment



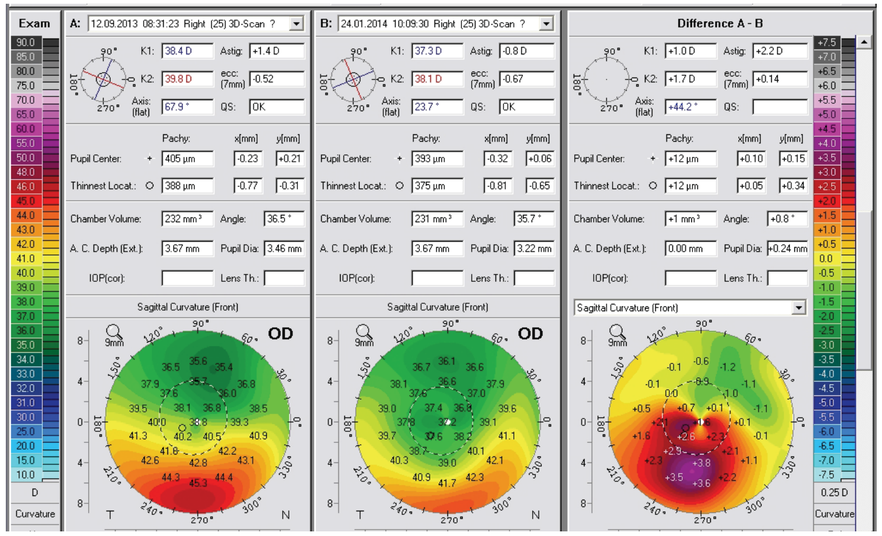
Customized astigmatism correction



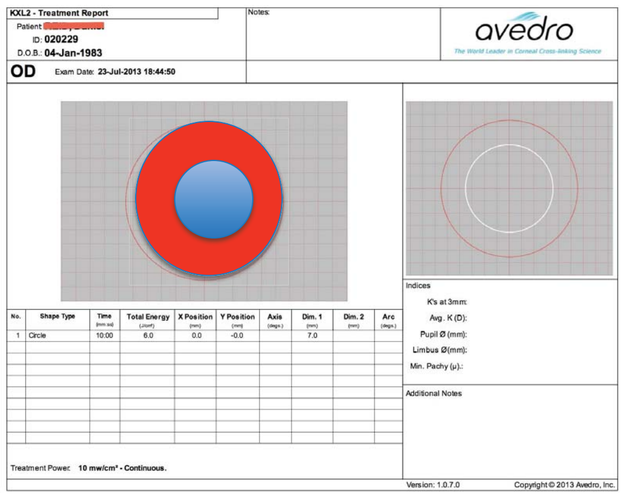
Customized CXL for KCN!

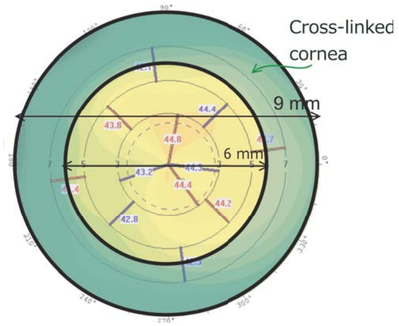


KCN s/p Athens Protocol in 2006 residual cone and cylinder
3 months after PiXL it appears to work in CXL corneas as well

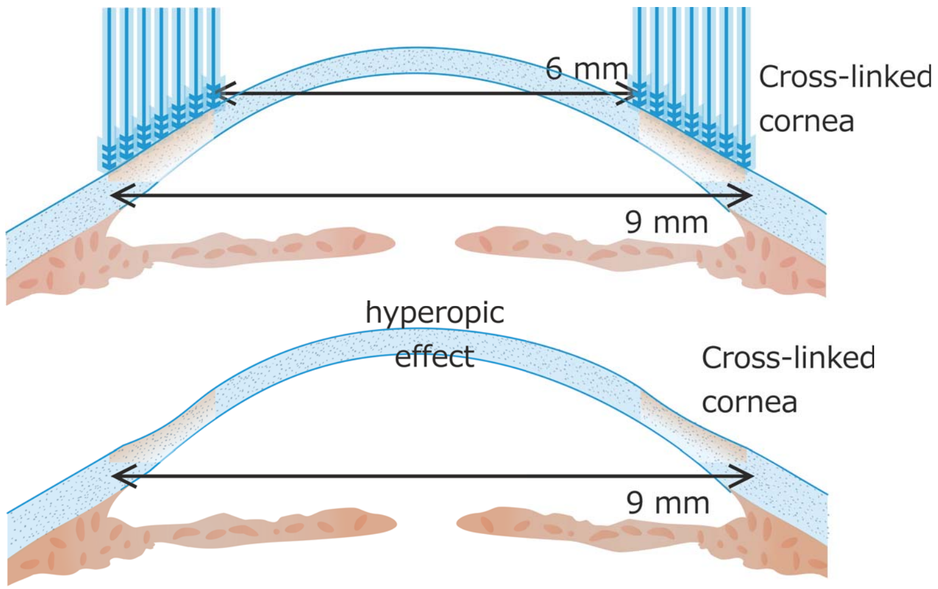


“ profile Hyperopic” oz 6-9mm
“hyperopic PTK” 6-9oz 30 microns

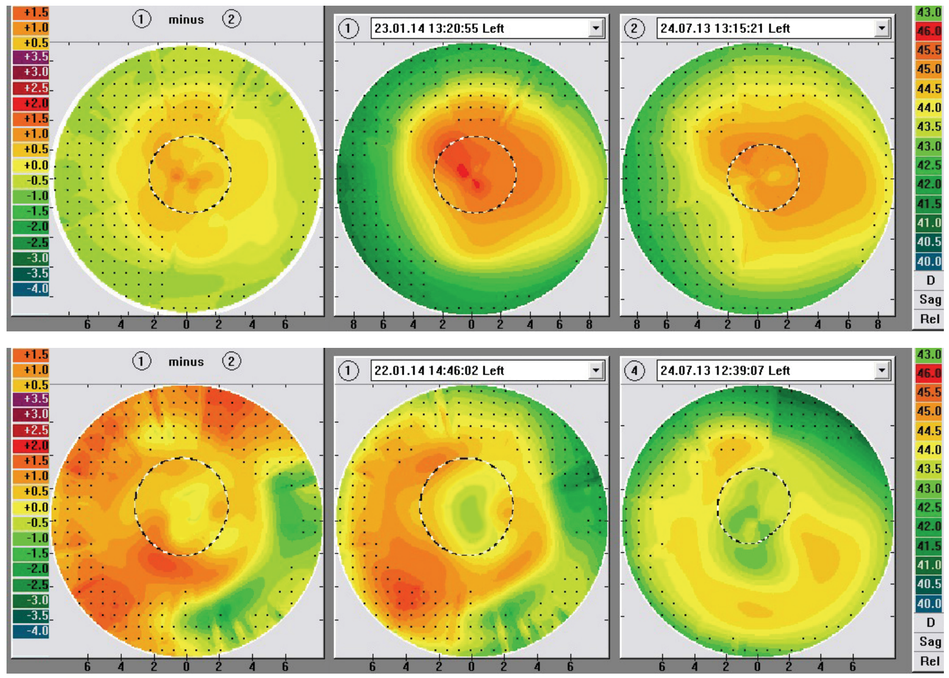




The myopic shift
(hyperopia-presby treatment)



Placido topo data



Our current CXL protocols

1-**Athens Protocol**: topo PRK +10'x 10mw/cm^2

2-**LASIK Xtra:** 1' (90") 30mW/cm^2 all HYPEROPES

2-**PRK Xtra**: 1' (90") 30mW/cm^2

3- **femtoAK Xtra**: 3' 30mw/cm^2-no soaking!

4-Cataract incision Xtra: 45mW/cm2 for 2.5 min

5-TransepiCXL: 0.25% ribo + 30mW X 3'

6-Infection: 0.25% riboflavin + 45mW/cm^2 x 5 '

Conclusions CXL

CXL can **stabilize ectasia, cornea melt, infection**

Topography-guided PTK and CXL synergistic

CXL in routine LASIK=**LASIK Xtra**

CXL **refractive treatments** proving safe and effective for small refractive errors

Future: pattern CXL, titratable CXL

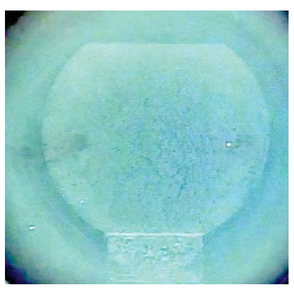
New York University School of Medicine Kanellopoulos,MD LaserVision.gr Institute for laser

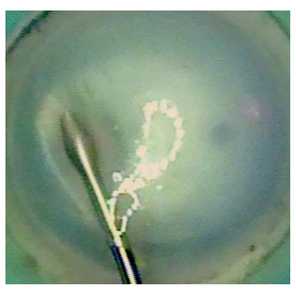
My opinion of the future of refractive surgery?

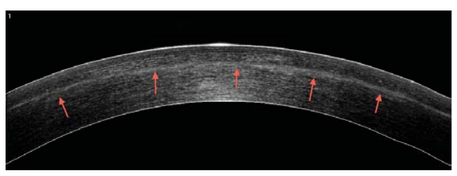
- Refractive femto corneal lenticule removal
- Fine-tuned and stabilized by pattern CXL

(adjust small refractive errors, adjust asphericity etc)

- all through the original femto pocket







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