## **ASCRS 2014**

## **Novel Fully Customized Topography Crosslinking Application for Refractive Corneal Changes**



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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 4D!





## **CXL differentials within the cornea** can have a refractive effect

+6.0

0.25 D

Curvature



Very High Fluence Collagen Crosslinking as a Refractive Enhancement of a Regressed Previous Astigmatic Keratotomy

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ABSTRACT

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

A 28-year-old woman with prior history of bioptics high myopic astigmatism with femtosecond lase-igmatic keratotomy followed by topography guided SIK showed long-term regression of the astigmatism 4 years er. A novel CXL application was employed in an attempt to re-

RESULTS: The high fluence CQ, intervention resulted in nor of 2 clopers of topographic and refractive cylinder. Uncor-cted distance visual acuity changed from 20/50 to 20/20 and fraction from -0.50-2.00 @ 90 to +0.25 -0.25 @ 90 at the eventh follows m.

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

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ucisional corneal astigmatic keratotomy has been employed for many years to reduce corneal astig-matism. Among other parameters, corneal healing may affect the intervention efficacy. We have observed ignificant regression from the initial effect in astigatic keratotomy, including femtosecond laser-assistsd astigmatic keratotomy (unpublished data).

#### CASE REPORT

A 28-year-old woman had undergone femtosecond seer-assisted paired astigmatic keratotomy 4 years reviously followed by a topographyguided LASIK rocedure 3 months later. Her initial refractive error tom Loservision.gr Institute, Athens, Greece, and the New York nirvesity Medical School, New York, New York.

bmitted: January 28, 2013; Accepted: March 18, 2015 Kanallonaular is a canaultant for Anadro and Aleon L

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

### e and -6.00 cylinder at 95°, and simila was -8.00 sphere and -6.00 cylinder at 95°, and similar treatment was performed in her left eye. Her preopera-tive 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 fol-low-up for 3 years but was then evaluated before cross-linking treatment for her postoperative care, complain-ing of reduction in her uncorrected visual acuity in the

informed treatment for her postoperative care, comparing ing of reduction in her uncorrected visual acuity in the right eye from 20/20 to 20/50. Her refraction reveale -1/-2 diopters at 95°AQ1 and her corneal topographi neasurement showed evidence of astigmatic omy regression with 2 more diopters of with-the-ru astigmatism in the left eve on topography (Figure 1)

We offered the patient the possibility of revisi-the astigmatic keratotomy incisions and performing the astigmatic keratotomy incisions and performing (CXL) to enhance the astigmatic keratotomy effect without fu-ther corneal thinning and/or astigmatic keratotomy in-cision extension. We roopened the astigmatic keratoto-omy incisions with a bluru Sinsky hook and influxed the riboflavin 0.3% solution (Vibex XtraAg2; Avedro, Waltham, AdA) within the incision gathers. We allowed the solution to soak within both reopened astigmat ncisions for 60 seconds, then removed all of the r sidual riboflavin from the corneal surface and the co

unctiva with a dry Weck-cell sponge. We then applied high-fluence CXL 45 mW/cm<sup>2</sup> with the KXL device Avedro) for 2.5 minutes, for total ultraviolet energy laterand of 2 louise. delivered of 7 jointes. We evaluated the patient 1 day, 1 week, and 1, 5 and 7 months postoperatively. Figure 1 demonstrate the correction of most of the regressed cylinder by diopters

### DISCUSSION

Discussion We previously reported on high-fluence CXL<sup>22</sup> and along with other investigators have altuded to its po-tential application in influencing refractive charges of the cormes.<sup>24</sup> Regression of astignatic karatotomy has been reported as a proviously studied factor.<sup>14</sup> have described using anterior segment optical coher-ence tomography imaging to assess the coranel CXL set-fect.<sup>14</sup> We theorize that in the case reported herein the reported set work CML methods. refractive effect is achieved by this exact CXL mecha nism. This intervention may create a significant "dil ferential" between cross-linked and non-cross-linke comes stroms. As a result, the cross-linked stron contraction may create a biomechanical tissue refractive shift that may explain the clinical findi There are reports of combining microwave technolo

First presented in the 2012 CXL meeting in Geneva •

K1: 1.4D

+0.3.0

+163.7

+ -22 µm

0 -22 µm

+26 mm

+0.06 mm

Astig: -1.7 0

OS:

Analy

Pupi Dia:

Lone Th:

s(mm)

0.00 -0.03

-0.14 -0.09

-27

Published: JRS 2013: Kanellopoulos AJ •

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Astig 1.7D

a(mm) s(mm)

0.31 +0.14

Pupi Dia:

29.0

+0.15

3.84 mo

OD

38.2 D

177.2

+ 469.000

O 469 L

Sacital Curvature (Front)

41.8 41.7

29.3

138.1

-403-

75.0

70.0

40.0

10.0

D

Curvature

Pupil Cente

Thinnest Loca

Chamber Volume

A.C. Depth Int 1

IOPIcort

39.6 D

+ 491 µm

Q 491 µm

Satillal Curvelue (Front)

39.8

Puni Dente

hinneet Local

Chamber Volume

C Depth (Int.)

**I**OPicert

5

Astig 0.0 D

-0.31

-0.08 +0.23

Analy

Pupi Dia:

Lon: Th:

42.3

39.8

1 39.9

y(mm)

+0.17

34.6

OD

3 41 mm

Pupil Center

hinnest Loca

Chamber Volume

A C Depth Int I

IOP(cor)

Sacital Curvature (Front

3

Zom)

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post-CXL

pre-CXL

6.00 Scan Size (mm



# Compelling clinical CXL evidence in the contralateral eye Hyperopic LASIK Xtra group



• CXL here appears to have a refractive effect through biomechanical stabilization in hyperopic LASIK

Published: Kanellopoulos and Cahn JRS Nov 2012

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## Purpose

• To evaluate the safety and efficacy of very high fluence, topography customized CXL (PiXL) treatments.

A.John Kanellopoulos, Novel Myopic Refractive Correction with Trans-Epithelial, Very High-fluence Collagen Crosslinking applied in a Customized Pattern: Early Clinical Results in a Feasibility Study. Clinical Ophthalmology. 2014; (forthcoming)

A.John Kanellopoulos, William J. Dupps, Ibrahim Seven, and George Asimellis, *Toric Topographically Customized Trans-Epithelial, Very High-fluence Collagen Crosslinking in Keratoconus. Journal of Cataract and Refractive Surgery*. 2014; (forthcoming)

A.John Kanellopoulos and George Asimellis, Customized Collagen Crosslinking for Hyperopia Refractive Correction: Epithelial Laser Debridement versus Trans-Epithelial (Intact Epithelium). Journal of Refractive Surgery. 2014; (forthcoming)



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## Topographically-Customized CXL Application

- We treated 30 consecutive cases of partially-sighted eyes with 5 different treatment patterns:
  - Transepithelial myopic pattern+plus O2
  - Myopic pattern following PTK (5mm OZ, 50 um)
  - Transepithelial toric pattern+O2
  - Transepithelial customised topography-guided pattern+O2
  - Presby-Hyperopic pattern, after donut-like PTK (50micron 6-9mm oz)





# **Myopic Treatment**

- Myopic profile central 4mm OZ transepithelial
- 4min Paracel+6min Vibex Xtra





# Astigmatic (toric) treatment

• Applied along the flat axis\*





\* Seven I, Dupps WJ. Patient-specific finite element simulations of standard incisional astigmatism surgery and a novel patterned collagen crosslinking approach to astigmatism treatment. *J Med Dev* 2013, doi:10.1115/1.4025980





## **Astigmatic (toric) treatment**



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## **Hyperopic treatments**





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## Hyperopic (presbyopic) treatment





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## Conclusions

- The novel technique based on refractive CXL application appears safe and effective in significant myopic corrective changes without the need of corneal stroma tissue removal.
- Alternative refractive correction technique. In the interim follow-up time evaluated, these cases showed an impressive and stable reduction in their myopia/ hyperopia and astigmatism.
- This pilot study may become a landmark study in a revolutionary new refractive and prespbyopic procedure.





