

Corneal collagen crosslinking in thin corneas



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CROSS-LINKING IS HERE TO STAY

- Established therapy for arrest of keratoconus (and other ectasias)
- Short-term studies: efficacy in stabilization of disease
- Long-term studies: progressive improvement in all parameters of disease years after the procedure

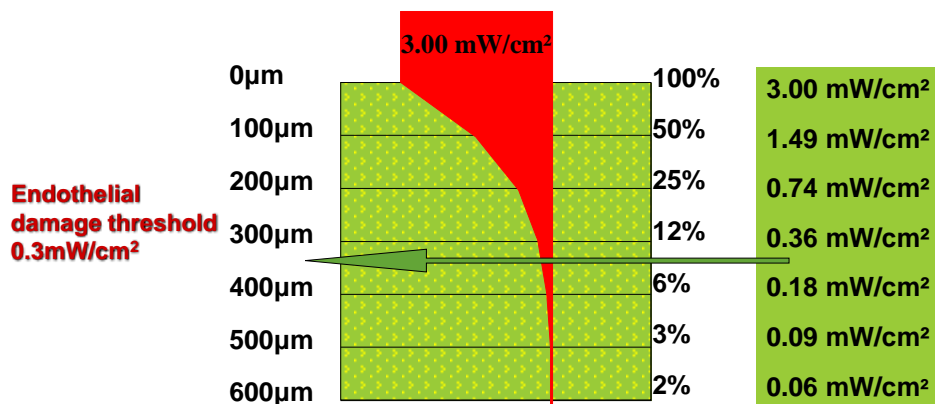
A common denominator in all forms of treatment

- Observation
- Spectacles
- Contact lenses
- Intrastromal inlays (rings, segments)
- Wavefront-/topography-guided PRK/PTK
- Phakic IOLs (ICL, iris claw)
- Refractive lens exchange
- EVEN AFTER KERATOPLASTY

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Stromal thickness has to be at least 400 microns after epithelial removal (may "push" it to 350 microns)



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What happens if the cornea is too thin?

- Endothelial injury
- Corneal edema
- Corneal scarring if edema is prolonged
- In extreme cases: corneal decompensation

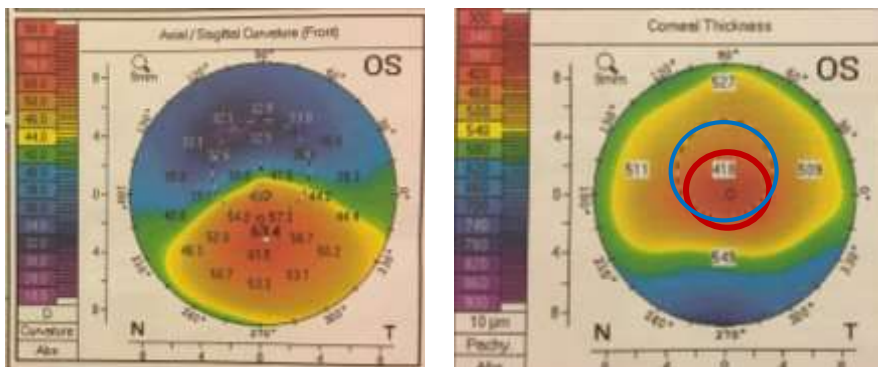
What are the current options for crosslinking thin corneas

- Hypoosmolar riboflavin
 - Hafezi et al., 2009; Raiskup and Spoerl, 2011; Stojanovic et al., 2014
- Transepithelial crosslinking
 - Leccisotti and Islam, 2010; Filippello et al., 2012; Caporossi et al., 2013; Gatzoufas et al., 2016
- Iontophoresis-assisted transepithelial CCCL
 - Bikbova et al., 2014; Vinciguerra et al., 2014; Jouve et al., 2017
- Customized epithelial debridement (epithelial island technique)
 - Kymionis et al., 2009; Mazzotta and Ramovecchi, 2014; Cagil et al., 2017
- Lenticule-assisted CCCL
 - Sachdev et al., 2015
- Contact lens-assisted CCCL
 - Jacob et al., 2014
- Individualized CCCL
 - Kling and Hafezi, 2017

What is the concept of epithelial island technique

- Define the area where the CT is less than 450 microns (usually in the central 2-3 mm: a “central island”)
- Debride the epithelium OUTSIDE this area out to the desired diameter (8.0 to 9.0 mm)
- In the area of intact epithelium, the thinnest location should be at least 350 to 380 microns
- The intact epithelium:
 - Maintains a thickness that is protective to the endothelium
 - Itself acts as a relative barrier to the passage of UV

One of our first cases



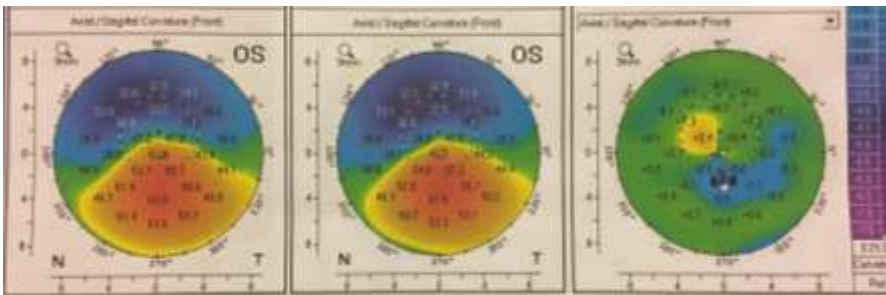
In the OR



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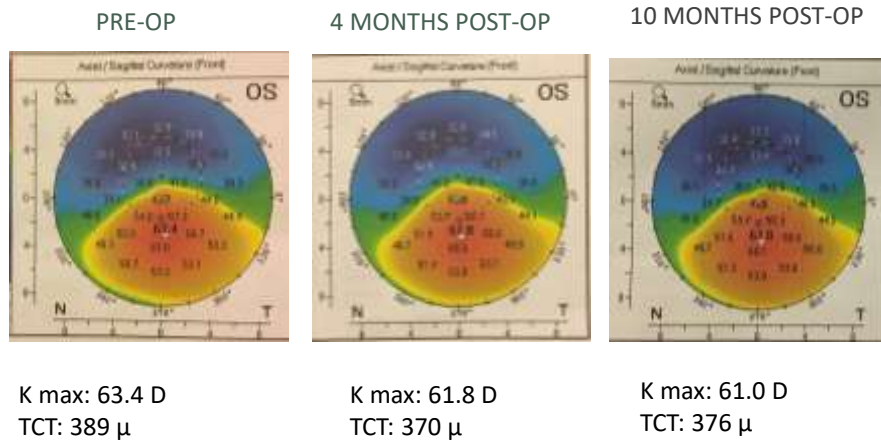
4 months after surgery



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Further follow-up



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Ongoing study in Cairo University

- 13 patients have completed one year of follow up
- Progressive keratoconus
- Mean thinnest corneal thickness (TCT): $377 \pm 12\mu$
- Range: 361-398 μ



Dr. Hisham Ashraf

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Safety: endothelial cell count (ECC)

- Mean pre-op ECC : 2277 cells/mm²
- Mean ECC at 6 months: 2233/mm²
- Percentage endothelial cell loss: 1.9%

Efficacy: demarcation line

Continuous demarcation line



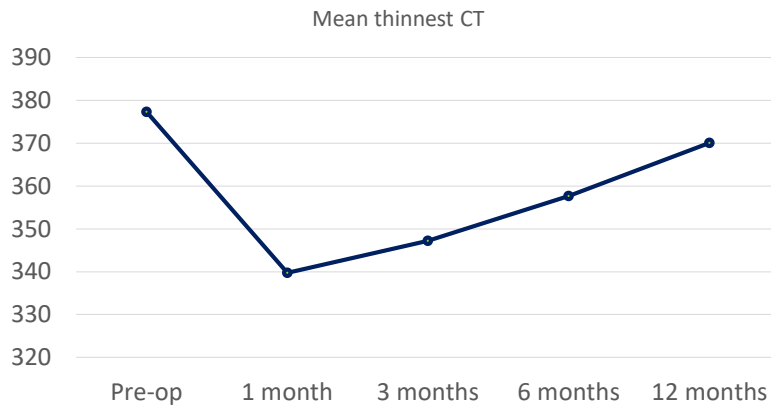
Demarcation line interrupted in area of intact epithelium



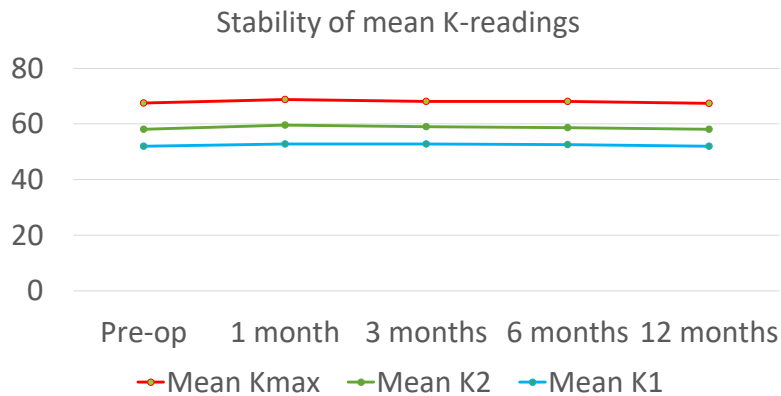
No clear demarcation line (Missed?)



Corneal thickness changes



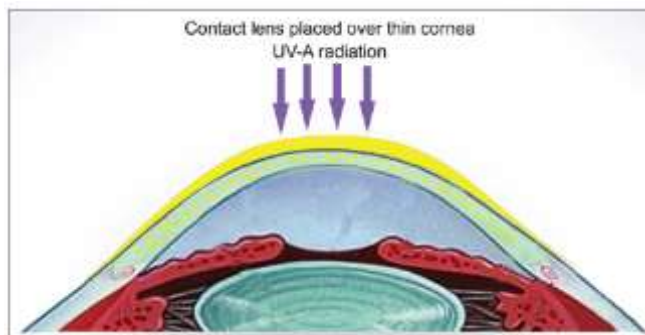
Efficacy: stability of K-readings



Preliminary conclusions

- Epithelial island cross-linking caused endothelial cell loss of 1.9%
- K-readings were stable over a one-year period
- A demarcation line was seen in some cases in the area of intact epithelium, which might indicate that:-
 - Lateral diffusion allows the stroma in this area to receive riboflavin from the surrounding de-epithelialized stroma
 - The intact epithelium does not completely block UV from the stroma
- Corneal thickness changes are similar to those seen after conventional CCCL

Contact-lens assisted CCCL



[Indian J Ophthalmol. 2019 Jan;67\(1\):8-15. doi: 10.4103/ijo.IJO_1403_18.](#)

Current concepts in crosslinking thin corneas.

[Deshmukh R¹](#), [Hafezi F²](#), [Kymionis GD³](#), [Kling S⁴](#), [Bhan R⁵](#), [Padmanabhan P⁶](#), [Sachdev MS¹](#).

Ongoing study at Cairo University

- Progressive keratoconus
- 20 eyes of 13 patients completed 9 months of follow-up
- Mean pre-operative thinnest CT: $380 \pm 10 \mu$
- Range of TCT: 357-398 μ



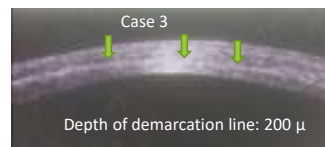
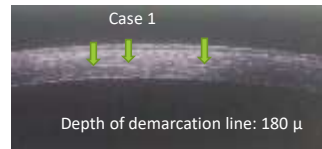
Dr. Mostafa Noor

Safety: endothelial cell count (ECC)

- Mean pre-op ECC : 2940 cells/mm²
- Mean ECC at 9 months: 2862/mm²
- Percentage endothelial cell loss: 2.7 %

Demarcation line

- A demarcation line was seen in all cases
- Mean depth: $199.6 \pm 24.5 \mu$ (range, 145-255 μ)
- (Compare to conventional crosslinking: 300 μ)



Change in K-readings

	Pre-op	9 months after surgery
Mean K1	48.9 D	49.0 D
Mean K2	55.3 D	55.5 D

Preliminary conclusions

- A demarcation line was seen in all cases confirming a treatment effect.
- The depth of the demarcation line (DL) was around 200 μ , compared to 300 μ in conventional epi-off CCCL*.
- The contact lens impregnated with riboflavin adds approximately 100 μ of thickness, but also absorbs part of the UV.
- Therefore a treatment effect should be seen down to 200 μ
- Endothelial cell loss was 2.9 % at 9 months
- K-readings were stable up to 9 months
- Main long-term concern is the efficacy of a reduced treatment effect

* Seiler T, Hafezi F. Corneal cross-linking-induced stromal demarcation line. *Cornea*. 2006 Oct;25(9):1057-9.

Final note

- All solutions for thin corneas are based on delivering less UV energy to the cornea to preserve endothelial integrity
- There is usually a price to pay in terms of efficacy
- The quest remains for a solution that strikes a delicate balance that affords adequate safety without compromising efficacy

THANK YOU FOR YOUR
KIND ATTENTION