Very High Fluence Collagen Cross-linking 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 (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.


Incisonal 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from the initial effect in astigmatic keratotomy, including femtosecond laser-assisted astigmatic keratotomy (unpublished data).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 was -1.0 -2.0 diopters at 95° 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; 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 CXL1,2 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.3 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 and infrared laser technology and also effective stromal collagen shrinkage and higher fluence CXL for a refractive effect. Theoretically, this intervention can be titrated based on the ultraviolet exposure and effect.

We report the feasibility of high-fluence CXL to enhance the refractive effect of a previous astigmatic keratotomy. We are currently conducting concurrent studies to evaluate this effect as a primary adjunct to astigmatic keratotomy, with a possibility of reducing the astigmatic keratotomy arc needed to correct given numbers of cylinder because it appears to enhance the astigmatic keratotomy effect. Larger studies and longer follow-up may further elucidate the efficacy of this novel application of CXL.

**AUTHOR CONTRIBUTIONS**

Study concept and design (AJK); data collection (AJK); analysis and interpretation of data (AJK); drafting of the manuscript (AJK); critical revision of the manuscript (AJK); administrative, technical, or material support (AJK); supervision (AJK)

**REFERENCES**


