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Technique of simultaneous femtosecond laser assisted Myoring implantation and accelerated intrastromal collagen cross-linking for management of progressive keratoconus: A novel technique

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ABSTRACT

Purpose: To describe a novel surgical technique for the management of progressive keratoconus by simultaneous femtosecond laser-assisted Myoring implantation and accelerated corneal intrastromal collagen cross-linking with Dextran Free Riboflavin.

Methods: After creating a corneal pocket with femtosecond laser, Dextran Free Riboflavin was injected into the intrastromal pocket. Then the Myoring was implanted in the corneal pocket and accelerated corneal intrastromal collagen cross-linking was performed with no epithelial debridement.

Results: The cornea remained clear and the central keratometry was decreased significantly with marked improvement in uncorrected visual acuity up to two years following treatment. Anterior segment OCT revealed good centration and intended implant depth with desirable increase in the corneal stromal reflectivity confirming effective collagen cross-linking.

Conclusion: Simultaneous femtosecond laser-assisted Myoring implantation and accelerated corneal intrastromal collagen cross-linking with Dextran Free Riboflavin is a safe and effective technique for management of keratoconus and improving vision.

1. Introduction

Keratoconus (KC) is a non-inflammatory corneal ectasia, that usually starts at adolescence and progresses until the third to fourth decades of life [1]. It can also occur after refractive surgery [2]. In the case of contact lens intolerance, several surgical options are available to improve visual acuity, including intracorneal rings (ICR) including segments (intacs and Ferrara) and continuous rings (Myoring), toric phakic intraocular lens implantation, deep anterior lamellar keratoplasty and finally penetrating keratoplasty [3–10].

ICR have been shown to improve contact lens tolerance and visual acuity in a selected group of patients with mild to moderate KC. However, long-term follow-up shows that ICR fails to provide a permanent flattening effect especially in progressive cases [2,4].

In 1998, Spoerl et al. introduced collagen cross-linking (CXL) by the photosensitizers riboflavin and ultraviolet A light as the first treatment that changes the intrinsic biomechanical properties of corneal collagen. Although this treatment may stop progression of keratoconus, the ability to achieve visual rehabilitation for improved visual outcome is limited. Therefore, combining corneal cross-linking (CXL) with visual rehabilitation methods—such as intracorneal implants, may improve the long-term visual outcomes in patients with keratoconus [11–14].

The standard CXL treatment requires epithelial debridement, which results in pain and discomfort for the patient. Leaving the epithelium untouched, however, may significantly impair the efficacy of the cross-linking process .However; retained epithelium may limit diffusion of riboflavin to the corneal stroma. The inability of the dye to penetrate the intact epithelium sufficiently also increases the risk of UV damage to the eye. However, bypassing the epithelium by injecting riboflavin directly into an intracorneal pocket seems to be safe and effective, preserving the epithelium and avoiding pain and discomfort seen after epithelial removal [15–20].

Herein, we present a technique for management of progressive keratoconus with intrastromal accelerated CXL with Dextran Free Riboflavin without epithelial debridement combined with continuous corneal intrastromal ring (Myoring) implantation.

2. Surgical technique

The surgical technique is characterized by a 4-step procedure:

1. Femto-assisted 10 mm corneal pocket creation with a femto laser machine in depth of 300 microns (Fig. 1).

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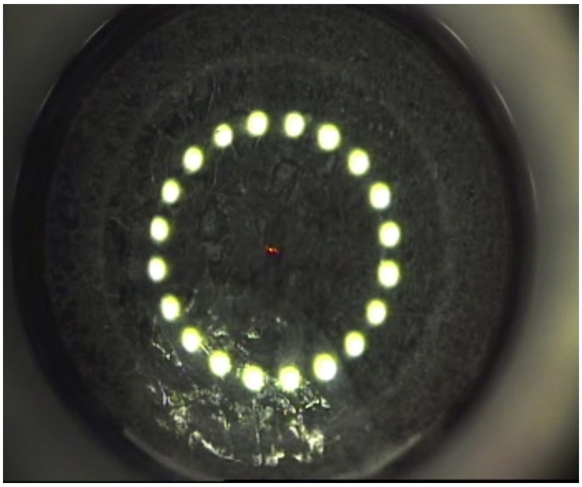

Fig. 1. Femto-assisted corneal pocket creation with a femto laser machine (Femtec).

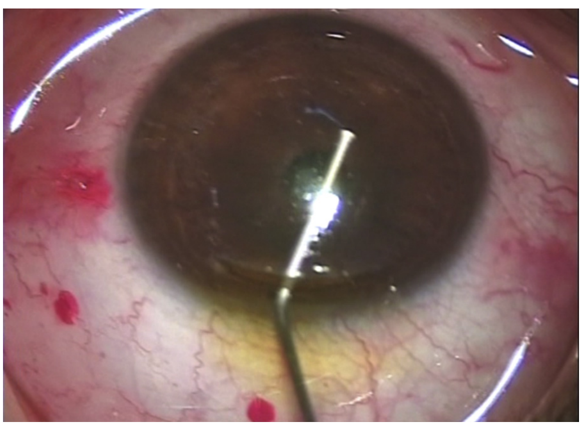

Fig. 2. Instillation of Dextran-Free Riboflavin into the corneal pocket.

2. Instillation of Dextran-Free Riboflavin into the corneal pocket (Fig. 2).
3. MyoRing implantation into the corneal pocket (Fig. 3).
4. Accelerated UV irradiation without epithelial debridement with UV-X (IROC Innocross AG, Bahnhofstrasse, Switzerland) UV intensity of 9 mW/cm^2 for 10 min.

After topical anesthesia, an intracorneal pocket in the depth of 300 micron was created via a small incision tunnel by means of a femtolaser machine (Femtec TECHNOLAS Perfect Vision GmbH, Bausch + Lomb, USA). Then sterile Dextran-Free Riboflavin (0.1%) MEDIOCROSS M; (Huenberg, Switzerland) was instilled into the corneal pocket via standard canula of 0.3-mm diameter through the incision tunnel. The instillation of the dye resulted in a "yellowish turbidity" in the anterior and the posterior stroma indicating that the dye distributes both anteriorly and posteriorly through the pocket. A flexible MyoRing intracorneal implant (DIOPTEX GmbH) was inserted into the corneal pocket. The cornea was subjected to a 10-min irradiation treatment with UV-A light of 365 nm (UV-X) and UV intensity of 9 mW/cm^2. A bandage contact lens Air Optix® (AQUA, Ciba Vision, Duluth, GA, USA) was placed on the cornea for 5 days allowing the self-sealing corneal incision to be healed and decreasing ocular discomfort [20].

3. Report of a case

A 23-year-old female was referred for decreased vision in her left eye. Her uncorrected visual acuity (UCVA) was 20/120 and her best spectacle-corrected visual acuity(BCVA) was 20/80 with −6.00–5.75@130. Ocular examinations and imaging revealed advanced progressive keratoconus. She underwent simultaneous femtosecond laser assisted Myoring implantation and accelerated intrastromal collagen cross-linking. Her UCVA and BCVA 3 months after surgery reached to 20/40 and 20/30, respectively. After 24 months, both UCVA and BSCVA improved to 20/30 and the refractive error was unremarkable (+0.37–0.12@30). The cornea was clear even in the early postoperative phase. (Fig. 4) The mean *K* flattened by 7 diopters (D) after 3 months and was stable 2 years after surgery. The changes in topography between preoperative status and one year after surgery are shown in Figs. 5 and 6. Two years after surgery the vision was stable and the cornea remained clear Fig. 7.

High resolution optical coherence tomography (Casia anterior segment OCT) one year after surgery, showed desired effect of CXL on the corneal stroma and appropriate depth of the ring Fig. 8.

Specular microscopy pre-operatively and also one year after surgery showed an endothelial cell count of near 3000 cells per mm^2, average cell area of 300 microne and coefficient variation of 20 with no significant difference between pre-operative and post-operative endothelial cell count, size and hexagonality. The small increase in the cell count after surgery is due to the flattening effect of the Myoring on the center of the cornea that causes slight crowding of endothelial cells in corneal center post-operatively Figs. 9 and 10.

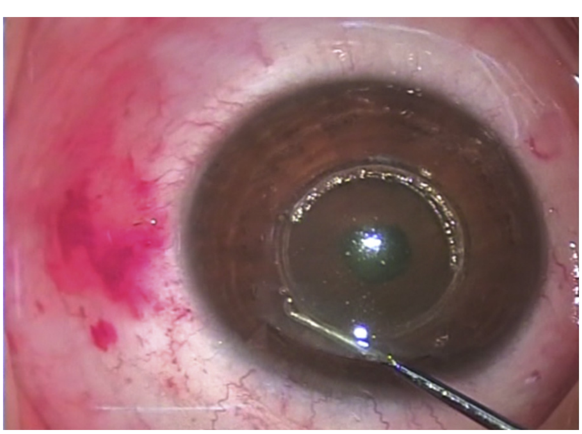

Fig. 3. MyoRing implantation into the corneal pocket.

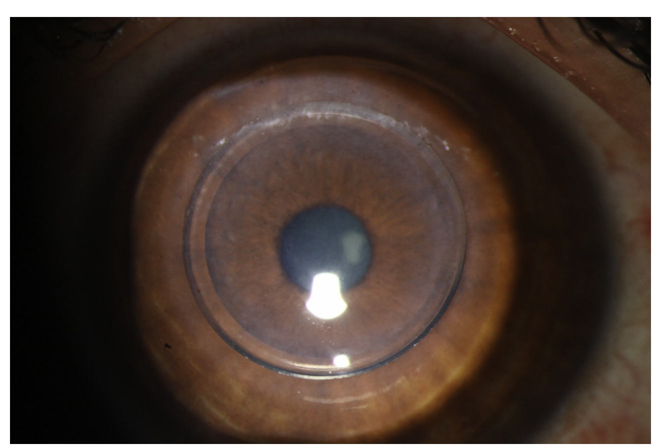

Fig. 4. The cornea was clear even in the early postoperative phase.