Long-term Safety and Efficacy of High-Fluence Collagen Crosslinking (CXL) of the Vehicle Cornea in Boston Keratoprosthesis (Kpro) Type 1

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Purpose

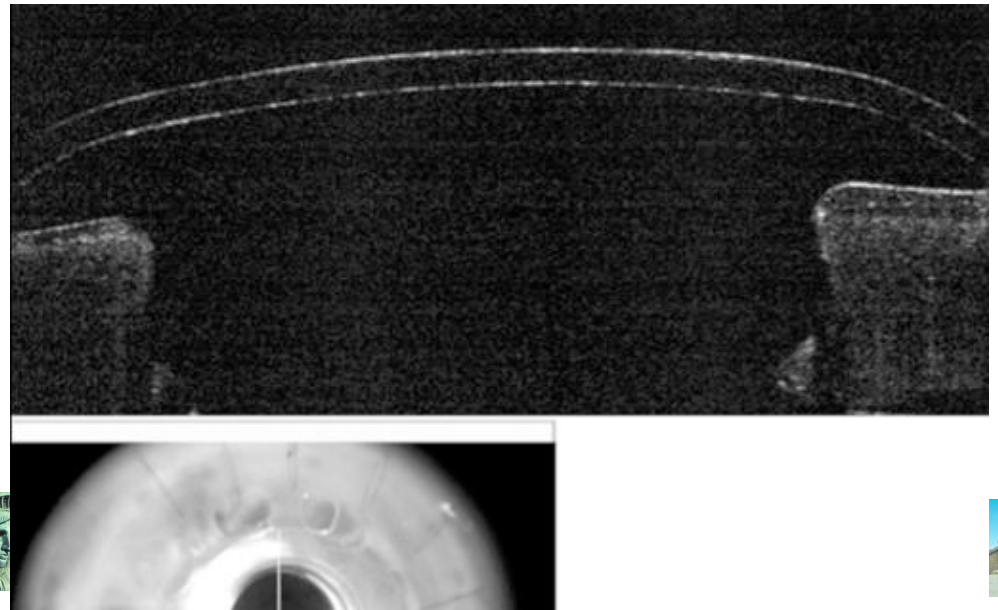
To evaluate safety, efficacy of CXL for achieving increased cornea rigidity and reduced enzymatic digestion in the vehicle cornea of Kpro 1.

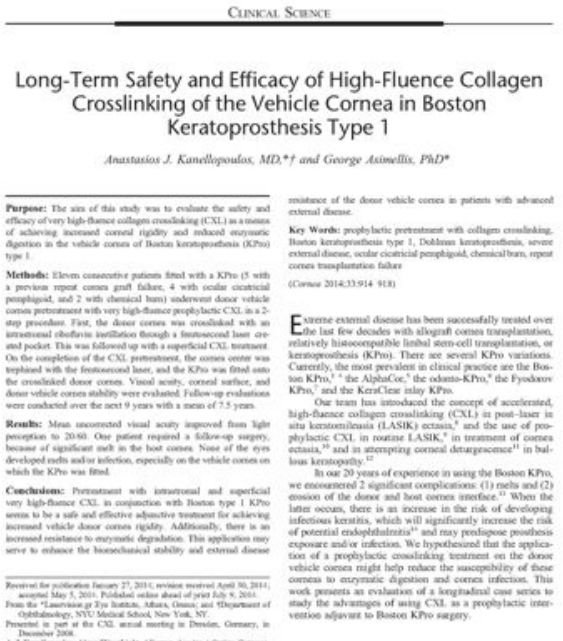
Methods

11 Kpro cases (5 with previous repeat cornea graft failure, 4 with ocular cicatricial pemphigoid, and 2 with chemical burn) received donor-vehicle corneal cross-linking (CXL) both intrastromally and superficially.

Visual acuity, corneal surface and donor vehicle cornea stability was evaluated up to 7.5 years.

Four years postoperative anterior-segment OCT imaging of case that had received prophylactic corneal crosslinking





CLINICAL SCIENCE

Long-Term Safety and Efficacy of High-Fluence Collagen Crosslinking of the Vehicle Cornea in Boston Keratoprosthesis Type 1

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Purpose: The aim of this study was to evaluate the safety and efficacy of very high-fluence collagen crosslinking (CXL) as a means of achieving increased corneal rigidity and reduced enzymatic digestion in the vehicle cornea of Boston keratoprosthesis (KPro) type 1.

Methods: Eleven consecutive patients fitted with a KPro (5 with a previous repeat cornea graft failure, 4 with ocular cicatricial pemphigoid, and 2 with chemical burn) underwent donor vehicle cornea pretreatment with very high-fluence prophylactic CXL in a 2-step procedure. First, the donor cornea was crosslinked with an intrastromal riboflavin instillation through a femtosecond laser created pocket. This was followed up with a superficial CXL treatment. On the completion of the CXL pretreatment, the cornea center was trephined with the femtosecond laser, and the KPro was fitted onto the crosslinked donor cornea. Visual acuity, corneal surface, and donor vehicle cornea stability were evaluated. Follow-up evaluations were conducted over the next 9 years with a mean of 7.5 years.

Results: Mean uncorrected visual acuity improved from light perception to 20/60. One patient required a follow-up surgery, because of significant melt in the host cornea. None of the eyes developed melts and/or infection, especially on the vehicle cornea on which the KPro was fitted.

Conclusions: Pretreatment with intrastromal and superficial very high-fluence CXL in conjunction with Boston type 1 KPro seems to be a safe and effective adjunctive treatment for achieving increased vehicle donor cornea rigidity. Additionally, there is an increased resistance to enzymatic degradation. This application may serve to enhance the biomechanical stability and external disease resistance of the donor vehicle cornea in patients with advanced external disease.

Key Words: prophylactic pretreatment with collagen crosslinking, Boston keratoprosthesis type 1, Dohlman keratoprosthesis, severe external disease, ocular cicatricial pemphigoid, chemical burn, repeat cornea transplantation failure

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Extreme external disease has been successfully treated over the last few decades with allograft cornea transplantation, relatively histocompatible limbal stem-cell transplantation, or keratoprosthesis (KPro). There are several KPro variations. Currently, the most prevalent in clinical practice are the Boston KPro,[1–3] the AlphaCor,[4] the odonto-KPro,[5] the Fyodorov KPro,[6] and the KeraClear inlay KPro.

Our team has introduced the concept of accelerated, high-fluence collagen crosslinking (CXL) in post–laser in situ keratomileusis (LASIK) ectasia,[8] and the use of prophylactic CXL in routine LASIK,[9] in treatment of cornea ectasia,[10] and in attempting corneal detumescence[11] in bullous keratopathy.[12]

In our 20 years of experience in using the Boston KPro, we encountered 2 significant complications: (1) melts and (2) erosion of the donor and host cornea interface.[13] When the latter occurs, there is an increase in the risk of developing infectious keratitis, which will significantly increase the risk of potential endophthalmitis[14] and may predispose prosthesis exposure and/or infection. We hypothesized that the application of a prophylactic crosslinking treatment on the donor vehicle cornea might help reduce the susceptibility of these corneas to enzymatic digestion and cornea infection. This work presents an evaluation of a longitudinal case series to study the advantages of using CXL as a prophylactic intervention adjuvant to Boston KPro surgery.

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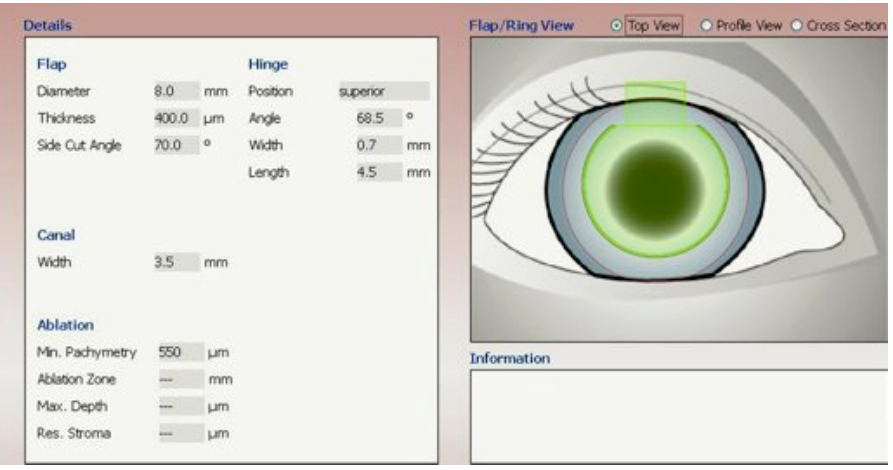
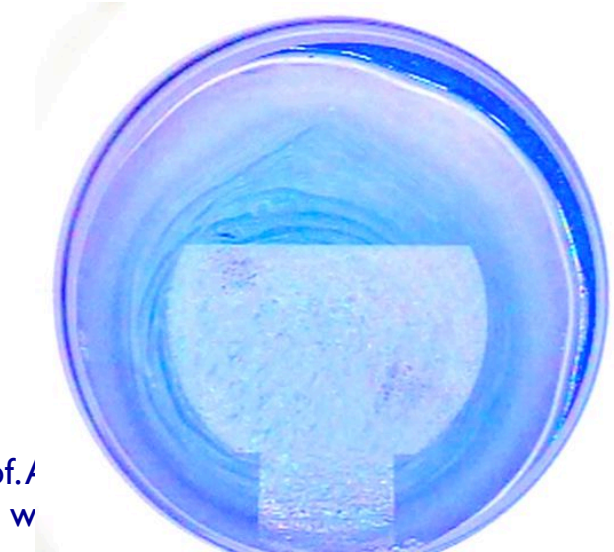
Inner donor cornea collagen cross-linking through the femtosecond laser-created pocket.

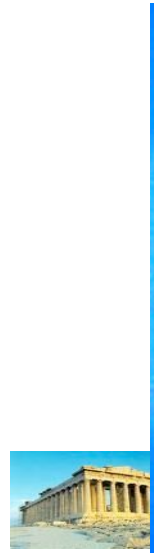
A. FS200 femtosecond laser programming interface

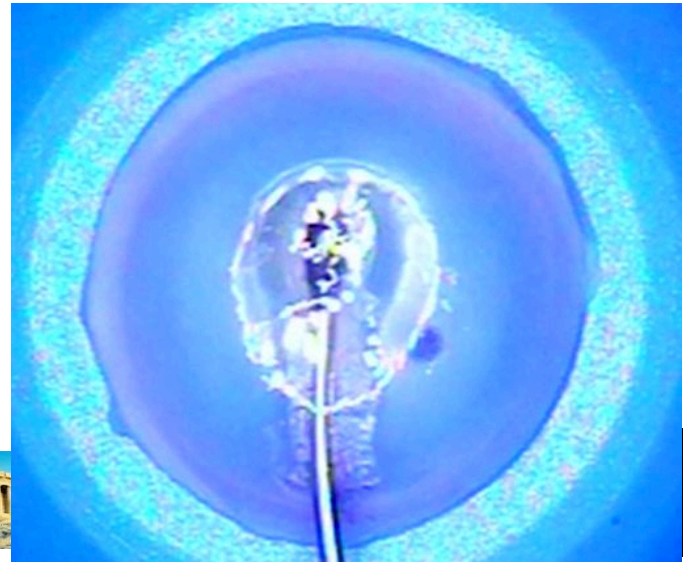
B. Screen capture of the 8-mm diameter, 400 µm deep femtosecond laser assisted pocket creation

C. Intrastromal infusion of 0.1% riboflavin solution with the olive-tip cannula.







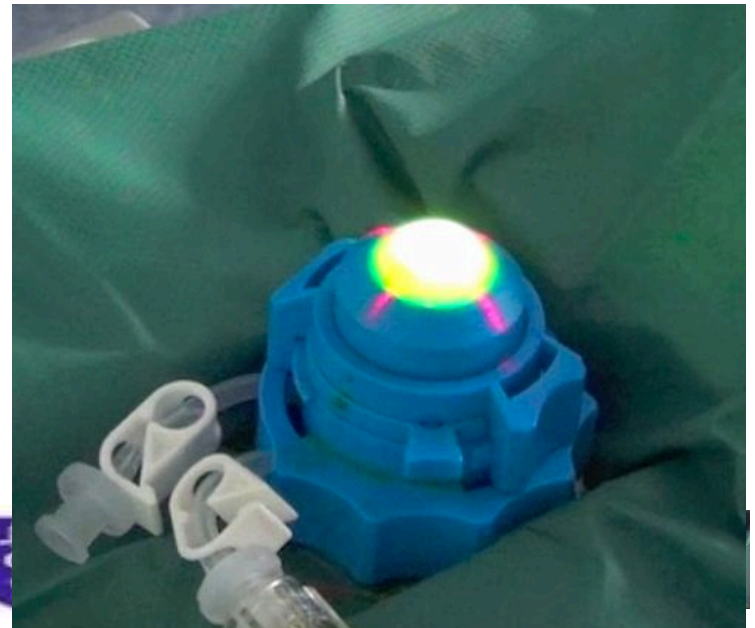


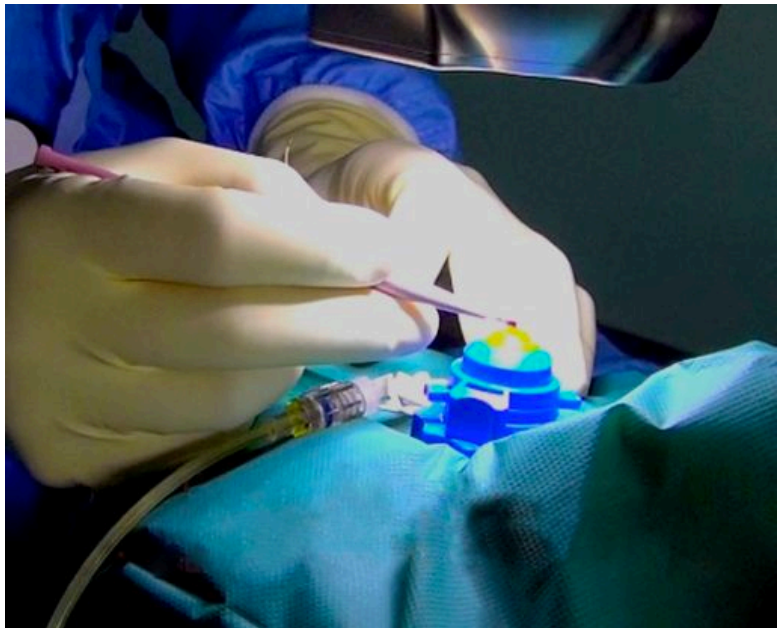
Collagen crosslinking of the cornea, the anterior part of the donor cornea after epithelial debridement and installation of riboflavin solution with very high-fluence CXL.

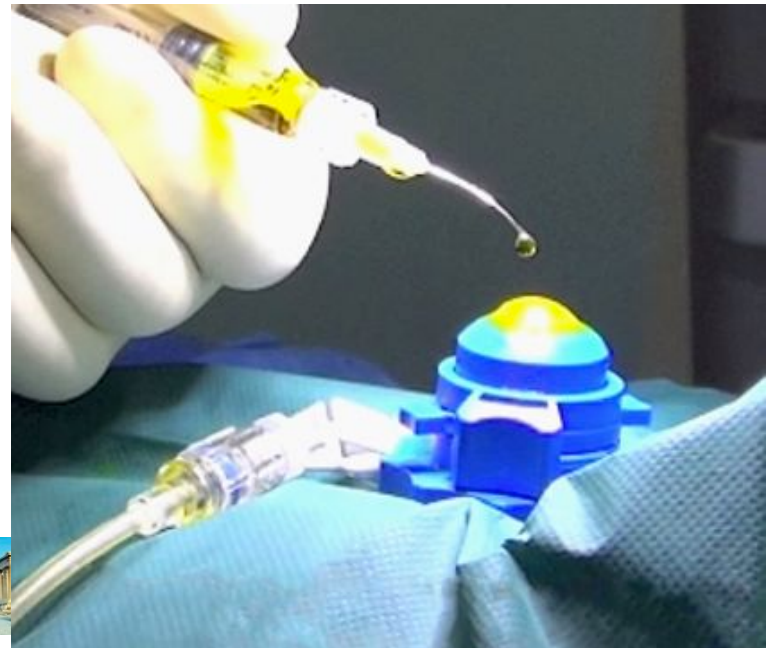
A. The first cross-linking session of the donor cornea through intact epithelium and riboflavin solution injected in the lamellar pocket with 30 mW/cm2 for 4 minutes.

B. Scraping donor corneal epithelium with a crescent blade prior to soaking the stromal surface, in preparation for the second cross-linking session.

C. Soaking the de-epithelialized donor cornea with riboflavin solution as preparation for the second cross-linking session.







Results

- Mean UDVA improved from LP to 20/60. No eye developed melt or infection, especially on the vehicle cornea

Discussion

Through our 20 years of our experience with extreme external disease and the utilization of Boston keratoprosthesis to address it, the main obstacles of prosthesis and visual rehab stability we have encountered and reported have been intraocular pressure (IOP) control, infection and intraocular inflammation.

One of the two major difficulties in managing these patients has been antibiotic prophylaxis, as these eyes are especially susceptible to microbial infections, which, following the keratoprosthesis surgery, become almost invariably endophthalmitis in a unichamber eye with very poor prognosis.

The second significant post-operative management problem is donor vehicle cornea and/or host cornea melts, , especially near the graft-host interface and using antiproteolytics such as oral tetracycline type medications and/or topical progesterone may be an effective alternative.

Conclusions

- Pre-treatment with intrastromal and superficial CXL in Boston Type 1 Kpro appears to be a safe and effective adjunctive treatment for increased vehicle donor cornea rigidity and potentially increased resistance to enzymatic degradation.
- This application may serve to enhance the biomechanical stability and external disease susceptibility of the donor vehicle cornea in these advanced external disease cases.