

Contact Lens Assisted Collagen Cross Linking for Thin Keratoconic Corneas

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Introduction

Keratoconus is relatively rare disease of the cornea with reported frequency approximately 1 in 2000 in the general population. It is an asymmetrical, bilateral, progressive and non-inflammatory ectasia of cornea due to a gradual biomechanical instability of cornea.

Corneal collagen cross linking (CXL) with riboflavin and UVA is a new technique of corneal tissue strengthening by using riboflavin as a photosensitizer and UVA to increase the formation of intra- and inter-fibrillar covalent bonds by photosensitized oxidation.

The key indication for use of collagen cross linking with riboflavin and UVA is to inhibit the progression of disease process. As UVA can damage to ocular structure, including endothelium, 400 microns of corneal stroma is required for safe crosslinking.

Role of Corneal Thickness

With an irradiance of 3mW/cm² of UVA (at corneal surface) and riboflavin 0.1%, 95% of UVA light is absorbed within the cornea resulting in a reduction of final irradiance at the endothelial level down to 0.18 mW/cm² whereas at 300µm depth, irradiance is 0.37mW/cm². Hence 400 µm of riboflavin saturated stroma (after epithelium removal) above the endothelium is considered safe to avoid adverse effects. In patients with cornea thinner than this, conventional CXL cannot be performed. For such patients, either contact lens assisted (CACXL) or hypotonic CXL are performed.

CROSS-LINKING IN CORNEAS WITH MINIMUM THICKNESS LESS THAN 400 MICRONS AFTER EPITHELIAL REMOVAL

Hypotonic CXL

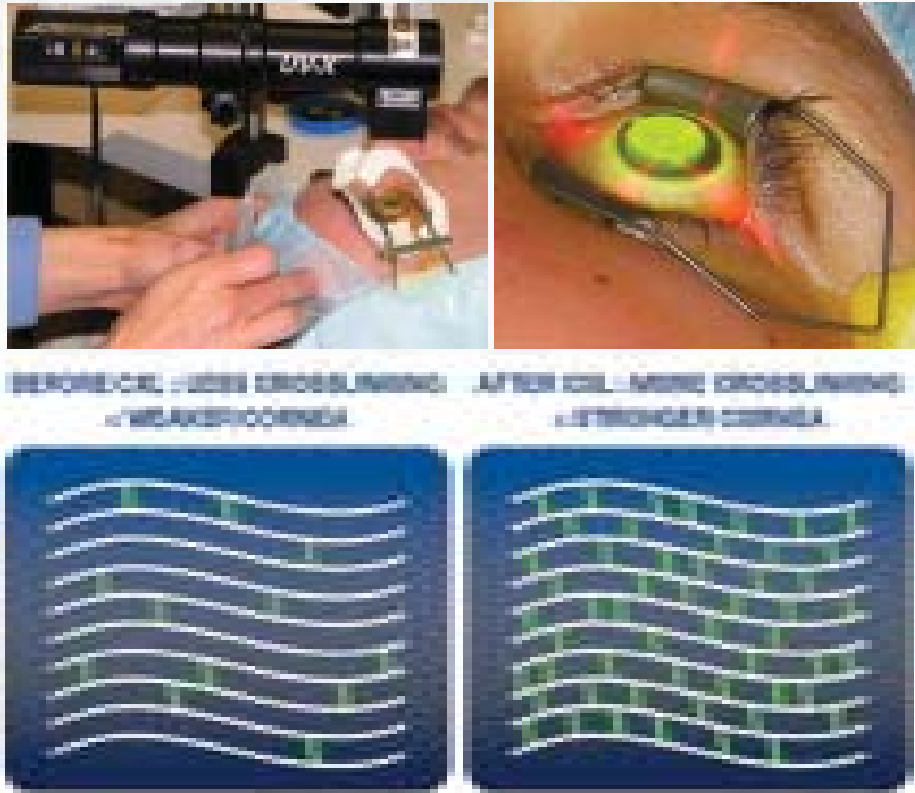
Epithelial debridement and application of iso-osmolar riboflavin 0.1% every 3 minutes for 30 minutes is followed by application of hypoosmolar solution every 20 seconds for 5 minutes more or till corneal pachymetry showed minimum corneal thickness above 400 microns. Stromal swelling shows distinct interindividual variation ranging 36 to 105 microns and from 3 to 20 minutes in different corneas. So some corneas do not swell enough to make hypoosmolar CXL possible. Again, the unstable hypoosmolar riboflavin film used for thin corneas results in higher irradiance at the endothelium than the dextran riboflavin film, putting the endothelium at risk if the stroma is swollen to only 400µm.

Contact lens assisted CXL (CACXL)

A precorneal riboflavin film, a riboflavin soaked (UV barrier free) soft contact lens of negligible power and a precontact lens riboflavin film are used to attain attenuation of UV irradiance to safe levels at the level of endothelium.

Procedure

Xylocaine 2% and pilocarpine 2% are instilled twice to aid in epithelium removal and to promote miosis and reduce UVA exposure to the lens and retina. The central 9 mm of corneal epithelium is abraded. Isoosmolar riboflavin 0.1% in dextran T500 or in HPMC is applied every 3 minutes for 30 minutes. At the same time, a disposable soft contact lens made of hilafilcon without UV filter and negligible power is immersed in isotonic riboflavin for 30 minutes. At the end of 30 minutes, adequate corneal saturation with riboflavin is confirmed by visualization of a green flare in anterior chamber using slit lamp. The riboflavin soaked contact lens is then applied on the corneal surface and thickness



remeasured. Once confirmed to be more than 400microns, treatment is continued. The central 9mm of cornea is then exposed to UV-A light of 370nm of irradiance of 3mW/cm² for 30 minutes. Riboflavin solution is reapplied both under and above the contact lens when required. During CACXL hot and cold spots from buckling of contact lens is avoided by applying a layer of solution over the contact lens to fill any persistent troughs on the contact lens surface. Post operatively antibiotic drops are applied and a bandage soft contact lens is retained until corneal epithelial healing.

CACXL is not dependent on swelling properties of cornea. In CACXL functional thickness of cornea is increased by increasing the amount of riboflavin containing substance anterior to stroma. This is done by precorneal riboflavin film, a riboflavin soaked (UV barrier free) soft contact lens of negligible power and a precontact lens riboflavin film. The increased functional thickness of the cornea decreases UV irradiance at level of endothelium.

Intraoperative dehydration may be caused by use of riboflavin 0.1% in dextran T500. So pachymetry should

be done after half an hour of corneal soaking of riboflavin and CACXL should be proceeded only when functional thickness is more than 400microns. It can be avoided by using 0.1% riboflavin in HPMC. It can also be decreased by using accelerated CXL. In accelerated CACXL treatment time is decreased by using higher irradiance keeping the total energy constant.

Special caution :

Extra care has to be taken to confirm a functional thickness above 400microns at all times. If it is less, then a few drops of hypotonic solution (distilled water) may be applied to hydrate the cornea.

Conclusion :

In CXL irradiation level exceeds endothelial toxic threshold. CACXL adds artificially to corneal thickness using riboflavin soaked contact lens and a precorneal riboflavin film of known thickness and thereby increases safety. It, thereby, extends the benefit of safely undergoing cross linking to a large number of patients with thin corneas and with a greater chance of properly and safely completing the procedure.

References :

1. Wollensak et al: stress strain measurements of human and porcine corneas after riboflavin-UVA induced cross linking
2. Hafezi et al: collagen cross linking with UVA and hypotonic riboflavin solution in thin corneas.
3. Spoerl et al: Induction of cross links in corneal tissue.
4. Jacob et al: Contact lens assisted collagen cross linking.