

# CONTACT LENS ASSISTED COLLAGEN CROSS - LINKING

## (CACXL) FOR CORNEAL ECTATIC DISORDERS

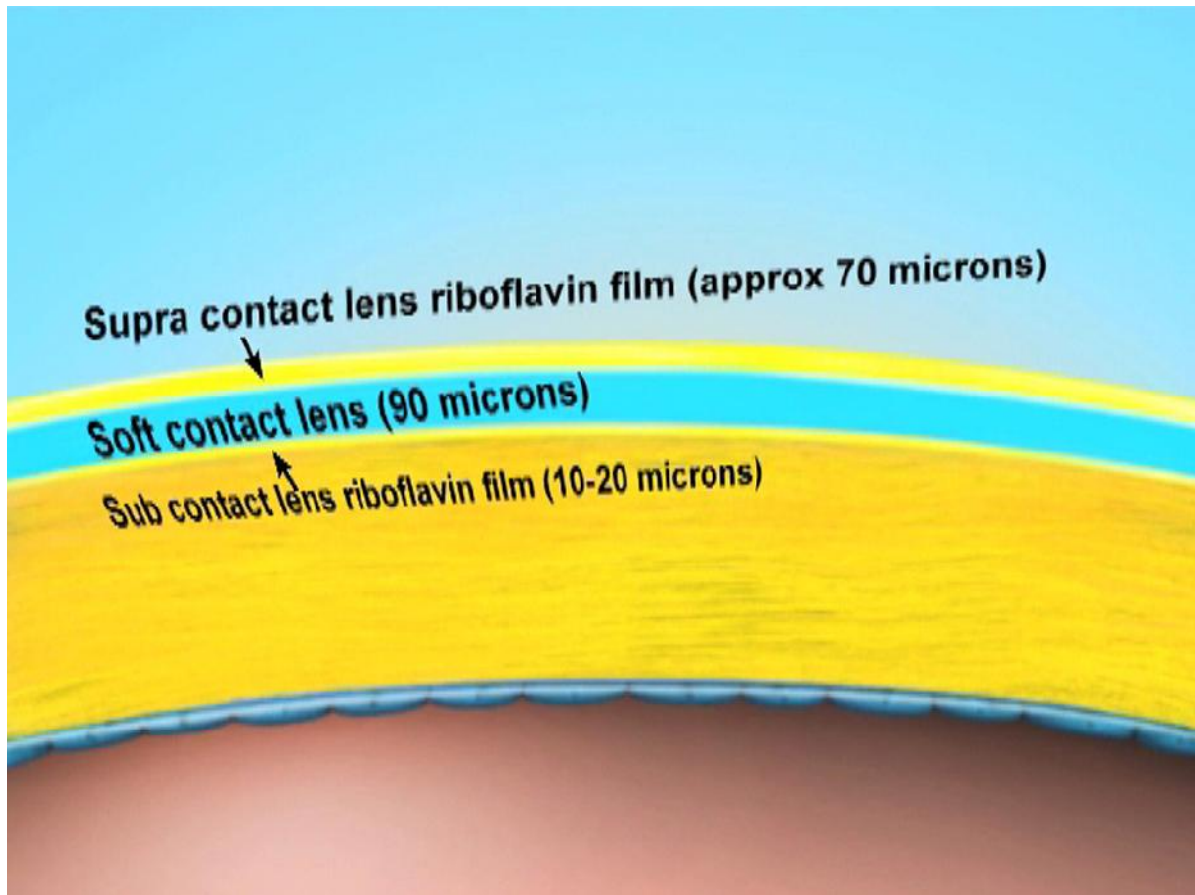
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### INTRODUCTION:

Collagen fibres in the human body are normally bonded together and stabilized by covalent cross-links. The tensile strength of mature collagen fibres is largely due to intermolecular covalent crosslinks. Collagen cross-linking (CXL) was described by Theo Seiler et al as a means to strengthen a weak and ectatic cornea. This works by utilizing UVA of 370 nm in the presence of the photosensitizer riboflavin, to create increased number of covalent bonds between corneal stromal collagen fibres.

Riboflavin is a photosensitizer and causes damage at lower UVA level of  $0.36\text{mW/cm}^2$ . Oxygen free radicals created lead to induction of collagen cross-links which in turn leads to more compact inter-lamellar connections. It also has an additional protective role by means of increasing absorption coefficient, thereby decreasing final irradiance at the endothelial level down to  $0.18\text{mW/cm}^2$ . However, 400 micron of riboflavin saturated stroma above the endothelium is considered safe to avoid adverse effects. In patients with corneas thinner than this, conventional CXL cannot be performed. For such patients with corneal stromal thickness between 350 - 400 microns after epithelial removal, a new technique called Contact Lens Assisted CXL may be performed. This was described by the author (Soosan Jacob).

A pre-corneal riboflavin film, a riboflavin soaked (UV-barrier free) soft contact lens of negligible power and a pre-contact lens riboflavin film are used to attain attenuation of UV irradiance to safe levels at the level of endothelium (Fig 1)

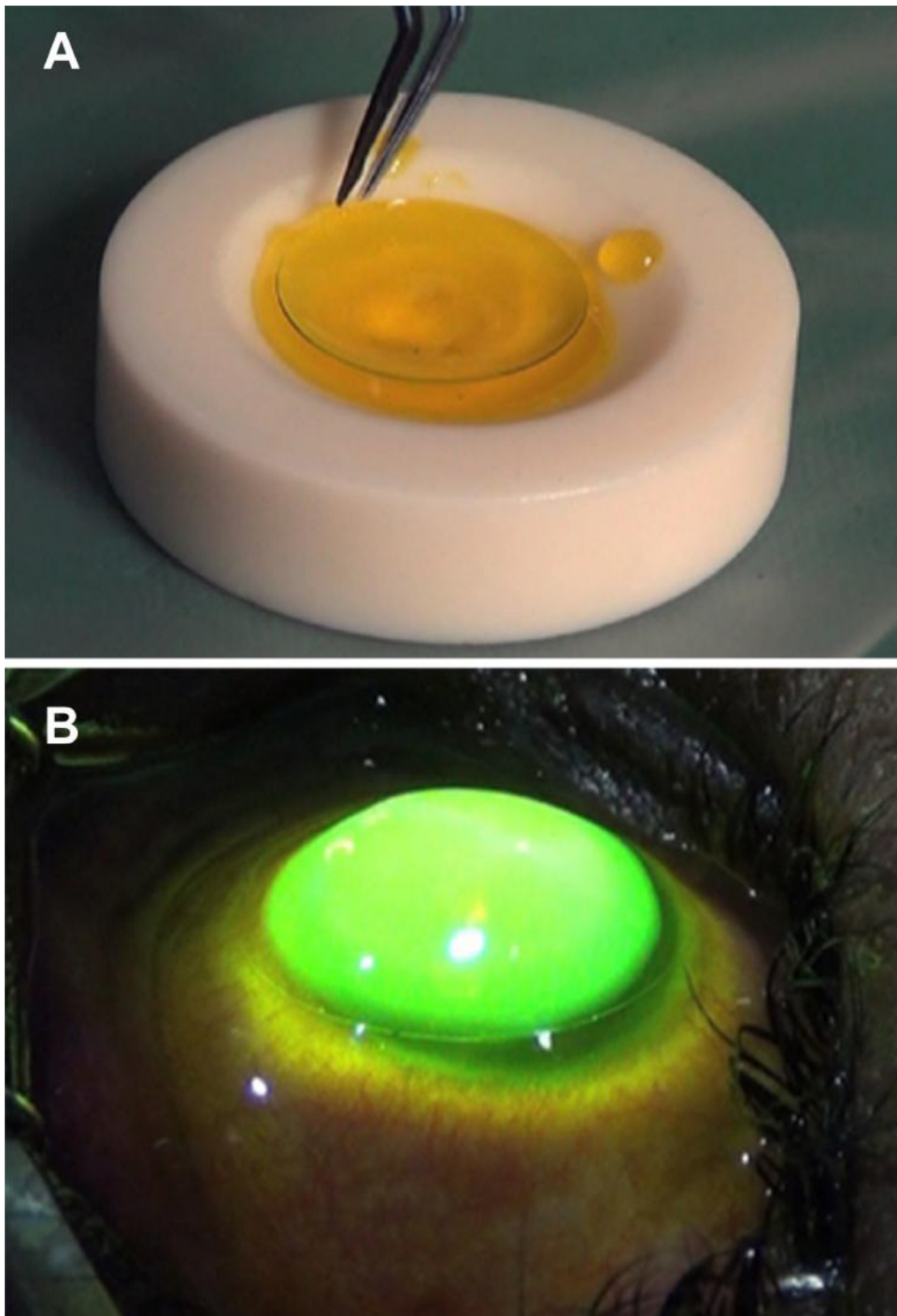


*Fig 1: A UV barrier free contact lens soaked in 0.1% riboflavin for half an hour is placed over the de-epithelialized corneal stroma also saturated with 0.1% riboflavin. The minimum pachymetry of stroma with contact lens should be above 400 microns. The supra- and sub-contact lens riboflavin films are also seen.*

#### **TECHNIQUE:**

Pre-operatively, Xylocaine 2% and pilocarpine 2.0% are instilled to aid in epithelial 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 is applied every 3 min for 30 minutes. At the same time, a Soflens Daily Disposable soft contact lens® (Bausch and Lomb, USA) made of hilafilcon without UV filter and of 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 the 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 400 micron, treatment is continued. The central 9 mm of the cornea is exposed to UV-A light of 370 nm with an irradiance of  $3\text{mW/cm}^2$  for 30 minutes (CL-UVR Rapide™, Appasamy Associates, India). During CACXL, any buckling of contact lens is tackled by reapplying sufficient riboflavin solution under and above the contact lens when required, allowing it to spread uniformly and also by encouraging the patient not to move his eyes or squeeze his lids. Riboflavin applied over the contact lens fills any persistent troughs on the contact lens surface as well as gives a uniform layer over the lens (corresponding to standard CXL requirements<sup>1</sup>). At the end of surgery, the eye is washed and a fresh bandage contact lens applied till corneal epithelial healing. Post-operatively, antibiotic drops are given till epithelial healing followed by fluorometholone-tobramycin eye drops once epithelial healing is complete. The patient is also advised to wear UV protective glasses (Fig 2).



*Fig 2: A- The soft contact lens soaked in riboflavin is seen. B- The cornea is exposed to 370 nm of UVA light for normal or accelerated protocol.*

**ADVANTAGES:** Using the CACXL technique, an average additional thickness of about 110 microns is obtained. It is important to use a contact lens that does not have a UV barrier in-built for this technique. This can be simply checked by placing the contact lens under the UV beam of the UV light source. Contact lenses that block or decrease UV irradiance should not be used.

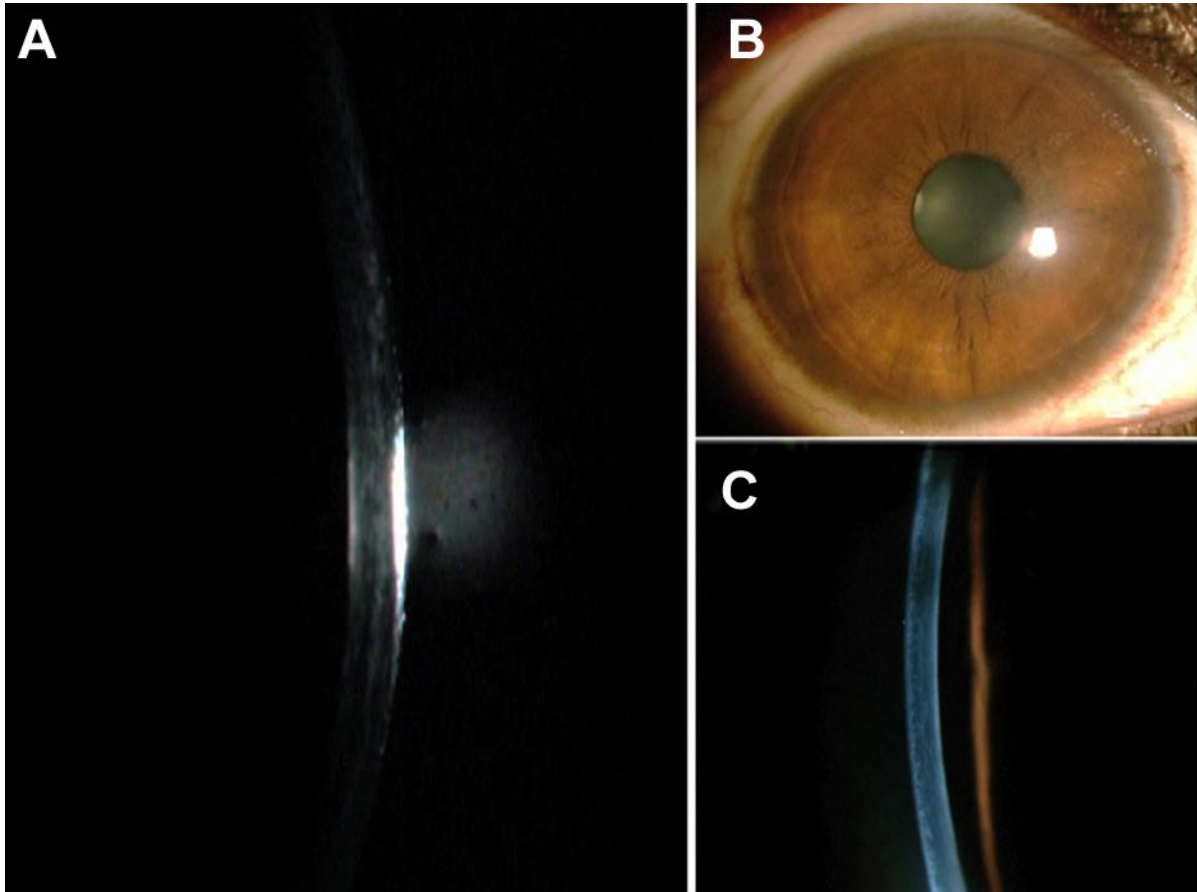
CACXL has advantages in being able to include patients with corneas between 350 to 400 microns (after epithelial removal) for cross linking. As is it not dependent on the swelling properties of the cornea, it makes CXL possible in a larger group of patients. For patients with thickness less than 350 microns, it might be possible to combine CACXL with a limited amount of hypotonic swelling. However our personal preference in very thin or very steep corneas is to perform a deep anterior lamellar keratoplasty.

We have also performed accelerated CACXL using  $10\text{mW}/\text{cm}^2$  power for 9 minutes to give a total energy level of  $5.4\text{ J}/\text{cm}^2$ . This has the added advantage of decreasing intra-operative dehydration that occurs during prolonged use of dextran containing solution. Intra-operative deturgescence can also be decreased by using 0.1% riboflavin in a mixture of HPMC and saline (VibeX Rapid™, Avedro) instead of riboflavin in Dextran.

It is of vital importance to maintain a safe limit of 400 microns of riboflavin containing medium (stroma + contact lens) above the endothelium for safe cross linking. Therefore, at the beginning of surgery, the thinnest point on the cornea should be marked and ultrasonic pachymetric measurements should be taken after epithelial debridement, after riboflavin soaking and during UV application, making certain at all times that the 400 micron safe limit is maintained. A pre-contact lens riboflavin film is also maintained in front of the contact lens which corresponds to the pre-corneal riboflavin film in standard cross-linking. Studies

with standard cross-linking have shown that the mean UV irradiance at 400 microns stroma is  $0.68 \text{ mW/cm}^2$  (above the toxic level of  $0.36 \text{ mW/cm}^2$  to the endothelium) without this film and  $0.21 \text{ mW/cm}^2$  with the film<sup>1</sup>.

As UV attenuation begins at the level of the contact lens, CACXL does decrease the effective dose of UV that is incident at the level of the corneal stroma, however our early studies<sup>2</sup> have shown encouraging results for cross-linking these thin corneas (Fig 3). To conclude, in CXL despite a reduction of irradiance from the corneal surface toward the deeper layers of corneal stroma, irradiation levels still exceed endothelial toxic threshold in thin corneas. CACXL adds artificially to corneal thickness using a riboflavin soaked contact lens of known thickness and thereby increases safety. It therefore extends the benefit of safely undergoing cross linking to a larger number of patients with thin corneas and with a greater chance of successfully and safely completing the procedure. However, precautions should be taken to maintain a combined corneal thickness above 400 microns at all times.



*Fig 6: A,C- Demarcation line seen after CACXL. B- Slit view of cornea after CACXL*

**REFERENCES:**

1. Wollensak G, Aurich H, Wirbelauer C et al. Significance of the riboflavin film in corneal collagen crosslinking. J Cataract Refract Surg 2010;36(1):114-120.
2. Jacob S, Kumar DA, Agarwal A et al. Contact lens assisted collagen cross linking (CACXL): A new technique for cross linking thin corneas. JRS (in press)