



Analysis of Two-year Corneal Cross-linking Results in Keratoconus Patients

By

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I have no financial interests or relationships to disclose



PURPOSE

To assess and analyze the two-year results of corneal collagen cross-linking and to evaluate the efficacy of this procedure.

DESIGN

Retrospective study

METHODS

- 58 eyes of 40 keratoconus patients .
- The intervention was only epithelium-off (conventional) corneal collagen cross linking.
- The preoperative and postoperative data collected from every patient :
UCVA, BCVA, slit lamp examination, keratometry, refractometry, pachymetry and corneal topography.
- Postoperative follow up program was 1, 3, 6, 12, 24 months.

A

Surgical steps

B

8 mm zone marker to mark corneal area to be de-epithelized.

The Xlink, Opto device.

C

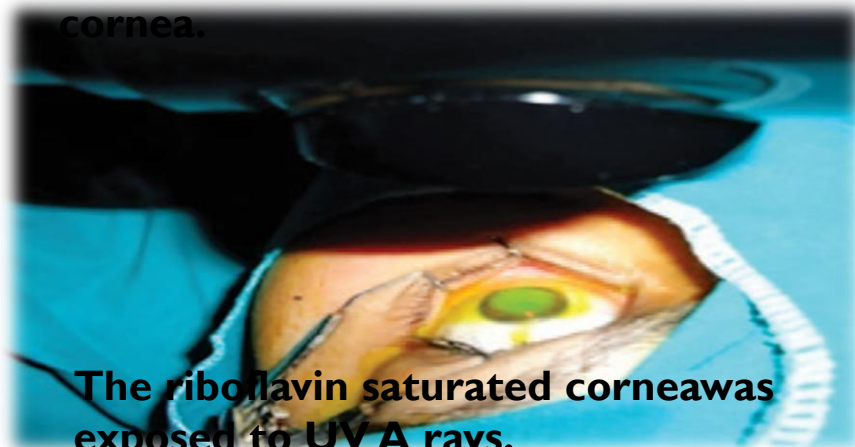
The epithelium is removed with a blunt tipped spatula

D

Sodium hyaluronate (Provisc, Alcon) was performed to preserve riboflavin on the cornea.

E

The riboflavin was instilled (while light was turned off).

F

The riboflavin saturated cornea was exposed to UVA rays.

RESULTS

- **The mean age** : 16.9 ± 6.35 years (range 12-39 years)
- **The mean follow-up** : 23.05 ± 1.55 months (range 12 to 30 months).
- 58 eyes of 40 patients with a follow-up of at least 24 months were analyzed..
- **BCVA :**
 - improved one line in 53.4% (31/58) of eyes.
 - remained stable in 36.2 % (21/58) of eyes ($P=0.006$).
 - decreased by only one line in 10.3 % (6/58).
- **Astigmatism:**
 - stable (within ± 0.50 D) in 86.2% (50/58) of eyes.
 - decrease by a mean of 1.20 D 13.8 % in (8/58) of eyes.

- **The K value of the apex :**

- decreased by a mean of 2.73 D in 65.5% (38/58) of eyes (P=0.004).
- remained stable (within ± 0.50 D) in 25.9% (15/58) of eyes .
- increased by 1.00 D in 8.6 % (5/58) of eyes.

- **The maximum K value :**

- decreased by a mean of 2.47D in 55.1% (32/58) of eyes (P=0.004).
- remained stable (within ± 0.50 D) in 38% (22/58) of eyes .
- increased by 1.00 D in 6.9 % (4/58) of eyes.

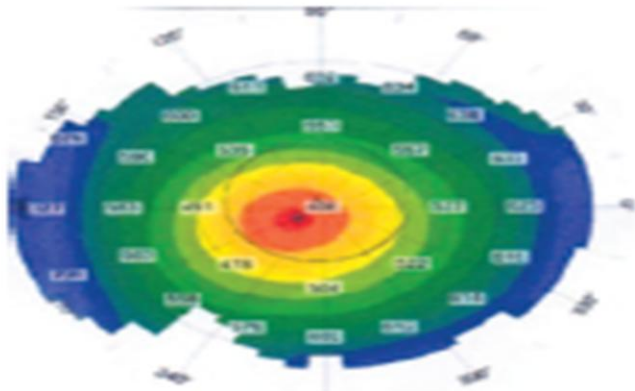
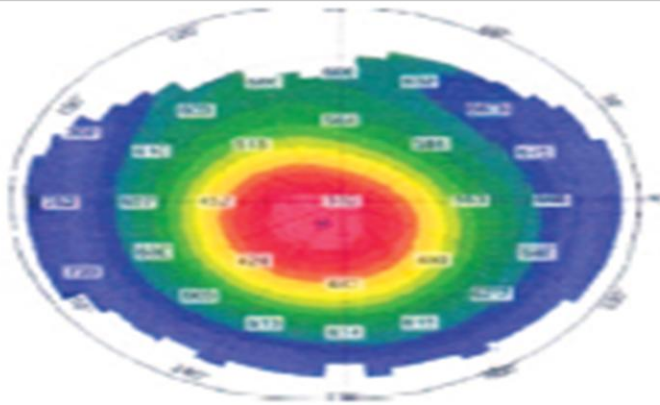
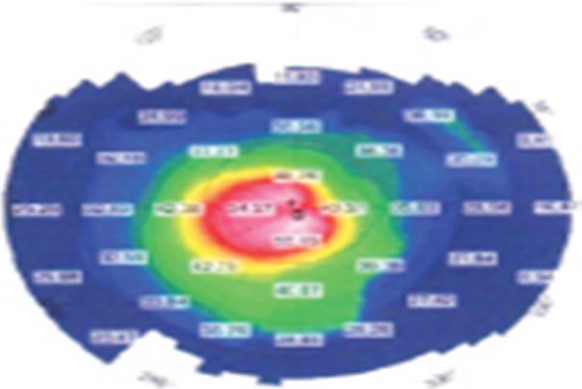
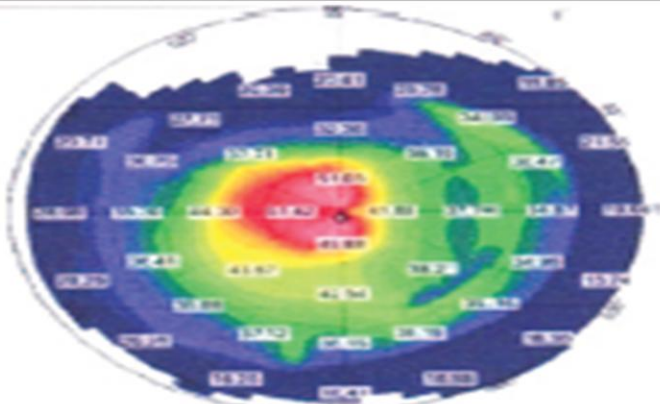
- **Corneal wavefront analysis:**

revealed that spherical and higher-order aberrations did not show significant variations in the follow-up period.

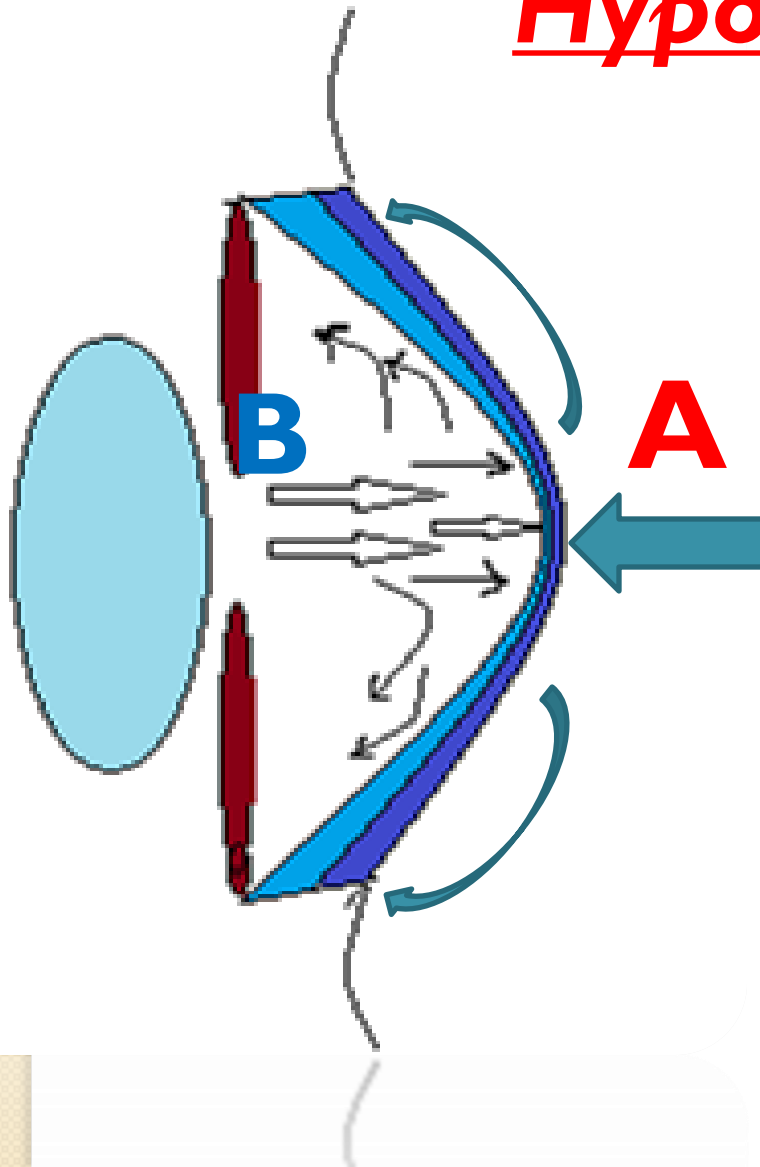
- **The coma component:**

showed a very significant reduction at six months after treatment and persisted throughout the follow-up period (P=0.003).

Example of data analysis of one eye:

Variant Date	Preoperative February 2012	Postoperative March 2013
Pachymetric map		
Tangential curvature map		
UCVA	3/60	5/60
BCVA	6/30	6/20
K readings	49.49 @ 18 54.04 @ 108	47.29 @ 8 51.98 @ 98
K average	51.66 D	49.20 D
Astigmatism	4.55 D	4.69 D
Corneal thickness at the thinnest location	389 μ m	308 μ m
Corneal thickness at periphery	623 μ m	668 μ m

CXL Hammered Cornea Hypothesis



**A) Pull-back
force: (posterior
force)**

**B) Push- forward
force: (anterior
force)**

A) Pull-back force: (posterior force : 1st hammer)

This force pulls the central cornea backwards (posteriorly) by the action of increased peripheral corneal rigidity and thickness leading to decrease corneal curvature (k readings) thus improving the visual acuity.

B) Push- forward force: (anterior force: 2nd hammer)

This force pushes the central cornea forwards (anteriorly) by the action of intraocular pressure (IOP) which is most at the central cornea representing mean IOP vector from the anterior capsule of the crystalline lens directed towards the posterior corneal surface leading to maximal accumulation of aqueous with forward direction of aqueous currents causing continuous pressure of the posterior corneal surface.

The final result of these 2 forces is that the posterior corneal surface is under 2 hammers:

- *First Hammer :*

Rigidity of anterior cornea with continuous pulling back force of peripheral thickened cornea.

- *Second Hammer :*

Continuous pushing forward force of IOP.

So thinning of central cornea mainly takes place in the central posterior cornea.

CXL Optical Gain Hypothesis

- The optical effects after corneal collagen cross linking is decrease the K readings resulting from:
- Decreased corneal curvatures (↑ r) :
Decrease corneal curvature leads to increase radius of curvature and decrease K readings.
- Decreased refractive index (↓ n) :
Decrease central corneal thickness resulting in decrease refractive index of the cornea (bulk loss) leads to decrease K readings.
- Role of precorneal tear film :
Improved post CXL precorneal tear film stability leads to improved optical system function and vision.
- *This combined optical effects of the CXL leads to marked decrease of myopia up to 4 diopters in this study.*

CONCLUSIONS

- Corneal cross-linking is beneficial as both visual preserving and visual improving procedures.
- K readings are the main indicator of success or failure of CXL.
- Central corneal thickness is an indicator of improvement, there is a reciprocal relationship between them.
- Best chance is for patients with corneal thickness $> 400 \mu\text{m}$.
- Most postoperative visual improvement resulted from decrease of myopia whereas there was no remarkable improvement of astigmatism.
- Decreased mean post CXL central corneal thickness by average 7 μm leads to decreased post CXL average K by 1 D.

My Message

“We are still young and creeping in the field of cross-linking just to open the door to the future.”

M. Iqbal