Collagen Cross Linking in the keratoconic eye

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Main points

- Basics in Cross Linking
- What effect does Cross Linking have
- Detecting keratoconic/keratectatic eyes
- Results in keratoconic eyes
- Special case
Transforming a soft tissue to a more stiffened tissue
Basics in Cross Linking

- X-linking of human collagen is a physiologic process, stiffening of connective tissue is well known in diabetes and aging.
- Diabetes is a protection factor against keratoconus.
- During X-linking new chemical bonds are induced.
Basics in Cross Linking

1. Combined application of UVA and riboflavin

riboflavin (vit. B2) \[ \text{Ultraviolet irradiation} \]

2. Production of oxygen radicals

\[ \text{O}_2^- \]

3. Induction of collagen cross-links

\[ -\text{CH}_2-\text{CH}_2-\text{CH}=\text{NH}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2- \]

collagen fibril \[ \text{collagen fibril} \]
Parameter used:

- Abrasio corneae Ø 9mm (full or part)
- 0.1% Riboflavin in 20% dextran until the anterior chamber is yellow colored
- 365 nm, 3mW/cm² for 30 minutes
- Corneal thickness at least 400 microns
Basics in Cross Linking
What effect does Cross Linking have?

- Stiffening the tissue
What effect does Cross Linking have?
Detecting keratoconic/keratectatic eyes

human cornea

Tension in $10^6$ Pa

Expansion in %

treated
untreated
What effect does Cross Linking have?

- Stiffening the tissue
- Increase in biomechanical stability
What effect does Cross Linking have?

biochemical stability

Collagenase activity
What effect does Cross Linking have?

**biochemical stability**
Detecting keratoconic/keratectatic eyes

iatrogenic keratectasia

cumulative incidence of keratectasia in %

months after LASIK

(Randleman, 2006)
Detecting keratoconic/keratectastic eyes
Detecting keratoconic/keratectactic eyes

At the posterior surface keratectasia is easier to recognize
Detecting keratoconic/keratectatic eyes
Detecting keratoconic/keratectatic eyes

Same case 9 months after Lasik
Results in keratoconic eyes

maximal K-reading / D

X-linking

9-03  3-04  9-04  3-05  9-05  5-06
Results in keratoconic eyes

maximal K-reading / D

X-linking
Results in keratoconic eyes
Results in keratoconic eyes

Clinical results phase II study (77 eyes)

Maximal K-values: change after 6 months

- Significant decrease: \(-0.6 \, \text{D} \pm 1.7\) (\(p = 0.049, t = 2.055\))

- Degree of change of K-values does not correlate with the height of preoperative K-values
Results in keratoconic eyes

BSCVA pre- and postoperative

- No significant change
  \[ P = 0.44, \; t = 0.78 \]

- Mean LogMAR VA
  - preoperative 0.25 (SD 0.22, Range 0-0.70)
  - postoperative 0.25 (SD 0.21, Range 0-0.70)
Results in keratoconic eyes

Endothelial cell loss 14 eyes, Milano
Corneal thickness should be at least 400 _m.

But: What shall we do in thin corneas (300 _m)?
- The human cornea can swell up to 2.3-fold in thickness
- Let the cornea swell by means of 0.1% riboflavin solution without dextrane up to a thickness of 400 microns
Special cases

Instillation of 0.1% riboflavin solution without dextrane
Optical pachymetry is related to optical constants:

Special cases

Optical pachymetry underestimates thickness in keratoconus corneas with opacities (for example, haze).
5 months after LASIK with DLK+4

Interface floating twice, antibiogram negative

Maximal antibiotic, antifungal, and steroid therapy

EDTA-therapy ineffective
5 days after X-linking standard antibiotic-steroid therapy
3 months later deep lamellar keratoplasty

Special cases
III. International Congress of Corneal Cross Linking

Zurich, Switzerland, December 7th-8th, 2007

http://www.ccl-congress.ch