

# New Methods to Evaluate the Effect of Conventional and Modified Crosslinking Treatment for Keratoconus

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Akademisk avhandling

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**Title**

New Methods to Evaluate the Effect of Conventional and Modified Crosslinking Treatment for Keratoconus.

**Abstract**

**Background:** Today corneal crosslinking with ultraviolet-A photoactivation of riboflavin is an established method to halt the progression of keratoconus. In some cases, when the refractive errors are large and the visual acuity is low, conventional corneal crosslinking may not be sufficient. In these cases it would be desirable with a treatment that both halts the progression and also reduces the refractive errors and improves the quality of vision.

**Aims:** The aims of this thesis were to determine whether mechanical compression of the cornea during corneal crosslinking for keratoconus using a sutured rigid contact lens could improve the optical and visual outcomes of the treatment, and also to find methods to evaluate the effect of different corneal crosslinking treatment regimens.

**Methods:** In a prospective, open, randomized case-control study, 60 eyes of 43 patients with progressive keratoconus, aged 18-28 years, planned for routine corneal crosslinking, and a corresponding age- and sex-matched control group was included. The patients were randomized to conventional corneal crosslinking (CXL; n=30) or corneal crosslinking with mechanical compression of the cornea during the treatment (CRXL; n=30).

Biomicroscopy, autorefractometry, best spectacle corrected visual acuity, axial length measurement, Pentacam® HR Scheimpflug photography, pachymetry, intraocular pressure measurements and corneal biomechanical assessments were performed before treatment (baseline) and at 1 month and 6 months after the treatment.

One of the articles evaluated and compared the optical and visual outcomes between CXL and CRXL, while the other three articles focused on methods to evaluate treatment effects. In Paper I, the corneal light scattering was manually quantified from Scheimpflug images throughout the corneal thickness at 8 measurements points, 0.0 to 3.0 mm from the corneal centre, in patients treated with CXL. In Paper IV the corneal densitometry (light scattering) was measured with the Pentacam® HR software, in 4 circular zones around the corneal apex and at 3 different depths of the corneal stroma, in both CXL and CRXL treated corneas. Paper III quantified the biomechanical effects of CXL *in vivo*.

**Results:** Corneal light scattering after CXL showed distinctive spatial and temporal profiles and Applanation Resonance Tonometry (ART) -technology demonstrated an increased corneal hysteresis 1 and 6 months after CXL. When comparing the refractive and structural results after CXL and CRXL, CRXL failed to flatten the cornea, and the treatment did not show any benefits to conventional CXL treatment, some variables even indicated an inferior effect. Accordingly, the increase in corneal densitometry was also less pronounced after CRXL.

**Conclusions:** Analysis of corneal light scattering/densitometry shows tissue changes at the expected treatment location, and may be a relevant variable in evaluating the crosslinking effect. ART -technology is an *in vivo* method with the potential to assess the increased corneal hysteresis after CXL treatment. By refining the method, ART may become a useful tool in the future. Unfortunately, CRXL does not improve the optical and visual outcomes after corneal crosslinking. Possibly, stronger crosslinking would be necessary to stabilize the cornea in a flattened position.

**Keywords**

Keratoconus, crosslinking, light scattering, densitometry, keratometry, hysteresis, intraocular pressure.

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