Keratoconus is a progressive disorder leading to severe vision deterioration due to irregular astigmatism and corneal scarring. Treatment options must improve two distinct parameters: corneal biomechanical stability and optical inefficiency of the irregular cornea.

Prior to the introduction of corneal collagen crosslinking (CXL), techniques for the treatment of keratoconus were incapable of halting its progression. As a result, most patients remained dependent on rigid contact lenses due to high and progressive irregular astigmatism. Recently, however, surgeons have successfully used CXL to impede the progression of keratoconus.1,2 This procedure builds the bonds between the collagen molecules and, therefore, increases corneal rigidity and stability.

CXL is based on the absorption of UV-A radiation by the cornea after riboflavin, a photosensitizer, is infused in the stroma. The combination of the irradiation and the stiffening effect penetrates a maximum of 300 µm into the cornea, leading to corneal stabilization for several years after application. However, visual performance in patients treated with CXL shows little or no improvement.3 Therefore, application of laser ablation has been introduced, with simultaneous treatment of PRK followed by CXL.

BACKGROUND

PRK has been used as a treatment for the visual rehabilitation of keratoconic patients for several years; however, its main drawback is that it is a tissue removal technique. The stromal thinning introduced by ablation most likely triggers further destabilization of corneal biomechanics, progression of keratoconus, and astigmatism.

In cases of stable or forme fruste keratoconus, surface ablation techniques have promising results, with several studies reporting the use of laser ablation to correct astigmatism in patients with stable keratoconus.4,5 Alpins et al reported a series of 32 eyes treated with photoastigmatic refractive keratectomy; patients were followed for up to 10 years with no evidence of keratoconic progression.4 In a series of 24 eyes treated with PRK, Mortensen et al reported that, after 2 years, there was no need for penetrating keratoplasty (PK).5 The use of customized, topography-guided ablation to treat keratoconus has also been reported.6,7 Koller et al treated 11 eyes with customized PRK and reported improvement in refractive astigmatism, topography, and quality of vision in all patients.6 In a study by Cennamo et al, 25 eyes treated with topography-guided PRK also had improved topography and visual outcomes.7

Given that CXL is capable of stiffening the cornea and halting progression of keratoconus, the combination of laser ablation and CXL provides a promising treatment for keratoconus. However, a two-step procedure with CXL followed by PRK after a 1-year interval has three major limitations.8 First, the stiffened, crosslinked corneal tissue is removed by PRK in an additional step, potentially decreasing the possible benefits of CXL. Second, the efficacy of this approach is limited because the corneal ablation rate could be different in crosslinked versus virgin corneas. (This could lead to unpredictable refractive results). Third, there is an increased possibility of post-PRK haze formation because 6 months after CXL, the anterior stroma is repopulated by new keratocytes.

Due to these aspects, we consider topography-guided PRK immediately followed by CXL as the best option for treating keratoconus. The main advantage of this technique is that the ablation does not interfere with the already crosslinked part of the cornea. On the contrary, crosslinking...
of the ablated stroma offers the advantage of depopulating keratocytes and reducing the possibility of haze formation. The ablation is capable of reshaping the corneal surface, and CXL then halts progression of the disorder.

SIMULTANEOUS TREATMENT

Since 2007, we have been conducting a comparative study of treatment with CXL versus treatment with simultaneous topography-guided PRK and CXL. Both groups were matched with regard to patient age and keratoconus stage; only keratoconic patients who tolerated neither hard contact lenses nor full spectacle correction with manifest refraction were treated.

PRK treatment was planned based on the patient’s corneal thickness. Limited treatments of up to 54 µm were performed; the ablation depth was mapped out by modifying the target correction. In the group of patients treated with PRK, CXL treatment was performed immediately following the ablation. Both groups were treated with the standard CXL protocol.

After the procedure, there was no keratoconic progression in either group; however, patients treated with simultaneous topography-guided PRK and CXL demonstrated a rapid and significant improvement in UCVA and BCVA. Topographic evaluation showed marked improvement of irregularity (Figure 1), including significant reduction of corneal coma-like aberrations. In the group of patients treated with CXL alone, a limited reduction in topographic astigmatism was observed after 6 months’ follow-up, with no significant improvement in visual outcomes.

Even though corneal stabilization is achieved with CXL, the major aspect taken under consideration for the planning of this combined procedure was the postoperative corneal thickness. Consequently, treatments were performed with respect to the goal of sufficient postoperative thickness. Thus far, results of our study show that even with relatively small correction, the patient benefit is substantial.

CONCLUSION

The goal of simultaneous topography-guided PRK and CXL is to offer keratoconus patients corneal stability as well as functional vision. Reaching functional vision involves improving UCVA, BCVA, and corneal irregularity so that patients are less dependent on contact lenses to achieve better quality of vision. Topography-guided PRK is a predictable and effective technique to achieve remodeling of the corneal surface and rehabilitation of refractive impairment. CXL is capable of stabilizing the corrected cornea and inhibiting keratoconic progression.

Simultaneous PRK followed by CXL seems to be a promising treatment capable of offering patients functional vision and halting progression of the disorder. Performing this technique with careful observation of safety aspects may offer patients with keratoconus the opportunity to gain functional vision, avoid complications of long-lasting contact lens use, and reduce the need for later PK.

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