

## Case report

## Corneal endothelial damage after simultaneous PRK and corneal cross-linking in stable keratoconus

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## ARTICLE INFO

## Keywords:

Keratoconus  
Corneal cross-linking  
PRK

## ABSTRACT

**Purpose:** To describe a case of endothelial damage after photorefractive keratectomy (PRK) combined with corneal cross-linking (CXL).

**Observations:** A 34-year-old man with diagnosis of stable keratoconus presented at our clinic complaining of vision loss in the left eye after same-day simultaneous PRK and CXL. One year postoperatively, slit-lamp examination showed central corneal haze and specular microscopy demonstrated reduced endothelial cell density compared with the preoperative state. Corrected distance visual acuity decreased from 18/20 preoperatively to 20/60 postoperatively. The thinnest corneal thickness value decreased from 432  $\mu\text{m}$  preoperatively to 328  $\mu\text{m}$  postoperatively.

**Conclusions and Importance:** The present case demonstrates the importance of appropriate determination of treatment parameters for simultaneous PRK and CXL in keratoconus, even if the disease is stable prior to treatment.

## 1. Introduction

Keratoconus, which is characterized by corneal thinning and bulging that lead to visual loss, is the most frequent corneal dystrophy. While the etiology and pathogenesis are not yet clearly understood, it may represent a multifactorial disease, involving genetic and environmental factors.<sup>1,2</sup> In the last decade, riboflavin/UV-A corneal cross-linking (CXL) has been established as a treatment option for slowing down or halting disease progression, either in patients with keratoconus or post-LASIK ectasia.<sup>3</sup> Although photorefractive keratectomy (PRK) has been safely used for correcting refractive errors for almost three decades, the risk of reducing the corneal thickness and mechanical stability may represent relative contraindications to refractive surgery in keratoconus.<sup>4</sup>

Combined PRK and CXL has been used for the treatment of keratoconus in order to improve vision.<sup>5,6</sup> We present a patient with a diagnosis of stable keratoconus that has undergone simultaneous PRK and CXL in the left eye and had vision loss and corneal endothelial damage postoperatively.

## 2. Case report

In September 2015, a 34-year-old man with a previous diagnosis of bilateral stable keratoconus presented to our Institution. One year

earlier, the patient underwent simultaneous PRK (Schwind Amaris, Schwind eye-tech-solutions GmbH & Co, Germany) and conventional CXL using 3  $\text{mW}/\text{cm}^2$  UV-A device (Vega, CSO, Scandicci FI, Italy) for 30 minutes in the left eye after corneal stroma soaking using a 20% dextran-enriched 0.1% riboflavin solution (Ricrolin, Sooft Italia Spa, Italy). The operative report included information about the maximum and central corneal ablation depths, which were 89  $\mu\text{m}$  and 76  $\mu\text{m}$  respectively.

Before surgery, the corrected distance visual acuity (CDVA) was 20/20 in the right eye (manifest cylinder  $-1.00$  at axis  $140^\circ$ ), and 18/20 in the left eye (manifest sphere  $+0.50$  and manifest cylinder  $-3.00$  at axis  $110^\circ$ ). The preoperative corneal tomography maps performed by combined Placido disk/Scheimpflug camera (Sirius, CSO, Scandicci, Italy) demonstrated maximum simulated keratometry value ( $K_{\text{max}}$ ) at keratoconus apex of 49.6 D in the right eye and 50.0 D in the left eye; the thinnest corneal thickness values were 430  $\mu\text{m}$  and 432  $\mu\text{m}$  in the right and left eye respectively.

The corneal epithelial wound healing completed three days after surgery and the corneal tomography map was consistent with an ablation pattern to correct myopia; nevertheless, slit-lamp examination of the treated eye showed severe corneal haze and anterior chamber hypopyon (Fig. 1). The use of anti-inflammatory (dexamethasone) and antibiotic (levofloxacin) eye drops in the left eye was documented in the medical records. At two weeks postoperatively, hypopyon uveitis

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<https://doi.org/10.1016/j.ajoc.2019.02.002>

Received 9 October 2017; Received in revised form 10 October 2018; Accepted 5 February 2019

Available online 12 February 2019

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**Fig. 1.** Slit lamp microscopy image of the left eye at day 3 postoperatively. The picture shows marked conjunctival hyperemia and 1 mm hypopyon in the anterior chamber (arrow).

disappeared but corneal haze worsened. The patient has been complaining of decreased vision in his left eye since the time of surgery.

In September 2015, left eye CDVA was 20/60 with manifest sphere +1.0 and manifest cylinder +1.0 at axis 10°. The left eye corneal tomography map changed with respect to the preoperative state, and the thinnest corneal thickness was 328  $\mu\text{m}$ . Slit-lamp biomicroscopy showed grade 3 corneal haze; the endothelial cell density (ECD) was 1470 cells/ $\text{mm}^2$  and 2786 cells/ $\text{mm}^2$  in the central and peripheral cornea of the left eye respectively (Fig. 2); it was 2529 cells/ $\text{mm}^2$  and 2395 cells/ $\text{mm}^2$  in the central and peripheral cornea of the right eye respectively. The patient did not undergo any surgical procedure in the right eye.

### 3. Discussion

Riboflavin/UV-A corneal cross-linking has been demonstrated to be safe for the treatment of progressive keratoconus and iatrogenic corneal ectasia. Complication rates range from 1% to 10% and include primarily delayed epithelial healing, sterile infiltrates, corneal haze, infectious keratitis and endothelium decompensation. Endothelial decompensation has been described after Dresden protocol<sup>7</sup>; minimum corneal thickness of 400  $\mu\text{m}$  is recommended in conventional CXL treatment to avoid such complication.<sup>8</sup> On the other hand, additional risk factors, as excessive stromal thinning after use of hyperosmolar riboflavin solutions,<sup>9</sup> and high UV-A energy density (e.g., due to wrong calibration of the UV-A device; either inadequate stromal soaking with riboflavin prior to UV-A irradiation or no instillation of riboflavin over the corneal surface during UV-A irradiation of the stroma, etc.)<sup>10</sup> can contribute to the endothelial cell damage after conventional CXL.

This case report highlighted the risk of corneal scarring and endothelial damage causing visual loss after simultaneous PRK and CXL in

stable keratoconus. According to the literature, the maximum recommended ablation depth is 50  $\mu\text{m}$  in keratoconus.<sup>11</sup> In the present case, the ablation for transepithelial PRK has been set with a variable depth ranging between 76  $\mu\text{m}$  and 89  $\mu\text{m}$  across the optical zone. In keratoconus, the corneal epithelial thickness has been shown to be significantly lower than normal eyes. In this case, although the predicted amount of stromal ablation was below the recommended maximum stromal ablation depth of 50  $\mu\text{m}$ , the thinnest corneal thickness was 328  $\mu\text{m}$  (i.e., 104  $\mu\text{m}$  thinner than preoperatively; 432  $\mu\text{m}$ ) one year postoperatively. Possible explanation would include a corneal epithelium that was thinner than expected at the time of surgery and/or progression of keratoconus over time likely caused by increased tissue mechanical instability after surgery. The excessive dehydration (and thinning) of corneal stroma due to hyperosmolar riboflavin solution and UV-A irradiation of the corneal stroma immediately after PRK may be the cause of stromal and endothelial damage due to direct UV-A phototoxic effect on irradiated endothelial cells. It cannot be excluded that a part of the decrease in endothelial cell density may be due to optical distortions induced by corneal scarring. The hypopyon uveitis was a sign of severe inflammation of the anterior uvea and endothelium caused by surgery; it, however, remitted completely by topical corticosteroid therapy in two weeks.

In such cases, it may be prudent for corneal surgeons to perform conventional CXL as a stand-alone procedure in keratoconus and, after corneal stabilization (i.e., one year later), performing transepithelial PRK for vision improvement.

In conclusion, this report on a case with stable keratoconus demonstrates the importance of careful determination of treatment parameters for refractive surgery.

### Acknowledgements and disclosures

#### Funding

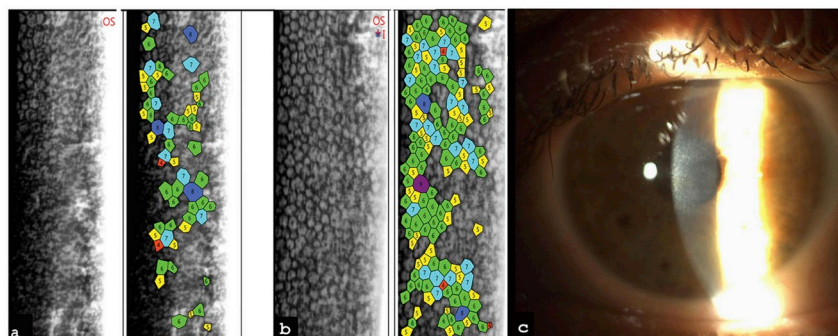
No funding or grant support.

#### Conflicts of interest

The following authors have no financial disclosures: S.S., M.L.

#### Authorship

All authors attest that they meet the current ICMJE criteria for Authorship.



**Fig. 2.** Objective evaluation of the treated cornea 1 year after surgery. a) At specular microscopy, the central cornea showed an endothelial cell density (ECD) of 1470 cells/ $\text{mm}^2$  b) The ECD in the peripheral cornea of the left eye was 2786 cells/ $\text{mm}^2$ , confirming the diagnosis of central endothelial decompensation caused by surgery. c) Slit-lamp microscopy showed severe central corneal haze, which may influence the ECD measurements in the corresponding area.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ajoc.2019.02.002>.

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