CASE REPORT

Topography-guided transepithelial phototherapeutic keratectomy to treat a partial laser in situ keratomileusis flap amputation over the visual axis

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We describe the use of topography-guided transepithelial phototherapeutic keratectomy (PTK) to restore excellent uncorrected distance visual acuity (UDVA) in an eye with extremely irregular topography as a result of a severe complication during laser in situ keratomileusis (LASIK) flap creation. Three months before the patient presented to our clinic, the microkeratome cut outward during LASIK flap creation, amputating the partially cut flap across the visual axis. Without a flap cut into the preserved one half of the cornea, complete flap amputation was not considered a safe option. Topography-guided transepithelial PTK was used to regularize the cornea and treat the resulting irregular astigmatism. Six months postoperatively, the cornea remained stable and the UDVA was 6/6+2.

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Laser in situ keratomileusis (LASIK) is the most commonly performed laser vision correction technique worldwide.[1] Laser in situ keratomileusis flaps are created with a mechanical microkeratome or a femtosecond laser.[2] In most cases, an incomplete flap can be managed conservatively, with a good visual outcome. However, a partial flap amputated over the visual axis presents a complex problem because of the grossly irregular corneal contour.

Topography-guided phototherapeutic keratectomy (PTK) uses a custom laser ablation based on the topographic profile of the corneal surface. Using this technique in a transepithelial manner might have an advantage over conventional PTK because the ablation starts on the measured surface, not on the stromal surface exposed by epithelial debridement. This latter surface might be more irregular than the epithelial surface given that the epithelial surface is partially regularized by epithelial remodeling. This allows regularization of a very irregular surface while minimizing tissue loss.

We present what we believe to be the first reported case of an amputated partial LASIK flap being corrected using topography-guided transepithelial PTK.

CASE REPORT

A 33-year-old man presented to our clinic seeking treatment after complicated LASIK surgery performed 3 months previously while he was overseas. Before surgery, he had moderate myopia (−1.50 diopters [D] in both eyes) and had planned to have LASIK, with the target being bilateral emmetropia. The right eye had uneventful surgery and on presentation had an uncorrected distance visual acuity (UDVA) of 6/3.8. The left eye had a UDVA of 6/30 and a corrected distance visual acuity (CDVA) of 6/19 with a subjective refraction of +0.50 −2.75 × 115.

Examination of the left cornea was seemingly normal; however, slitlamp microscopy showed a steep contour across the visual axis despite it being partially smoothed by epithelial remodeling in the 3 months since surgery. The microkeratome must have cut outward while the blade was over the central cornea, resulting in an exposed temporal stromal bed without an overlying flap, and left the normal nasal cornea without an incision. Fluorescein staining of the tear film showed the sharp delineation in the immediate postoperative period (Figure 1). No corneal stromal opacity or signs of current or previous inflammation were evident on examination. In addition, the internal structures of the eye were otherwise normal.

Corneal tomography (Precisio, iVis Technologies) showed the irregular intended treatment zone in the central cornea (Figure 2). The anterior elevation map showed a major height discrepancy between the amputated one half and healthy one half of the central corneal stroma. The posterior corneal surface appeared regular with no indications of an ectatic process.

A review 1 month later found no significant change in the patient's refractive or tomographic measurements. Thus, transepithelial PTK (iRES excimer laser, iVis Technologies) was scheduled to regularize the central cornea. The ablation was planned to minimize removal of corneal stroma by ablating the normal one half of the corneal stromal treatment zone down to a smoother contour over the visual axis and to smooth the exposed

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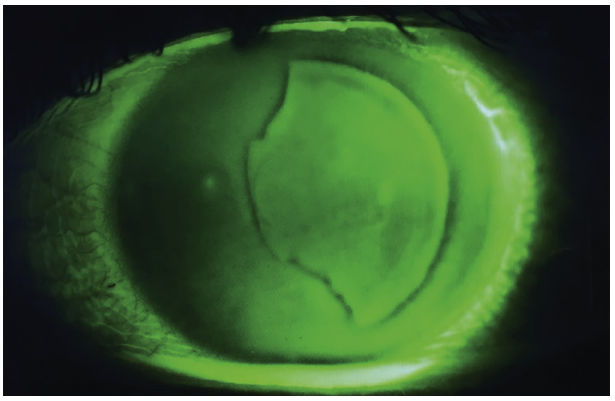

Figure 1. Fluorescein staining of the tear film over the left cornea immediately after the laser in situ keratomileusis flap creation complication.

temporal edge of the area denuded of flap tissue. The planned transepithelial PTK ablation consisted of −0.81 D cylinder at 124 degrees with a spherical therapeutic ablation of 0.54 D to minimize induced spherical aberration rather than attempting a spherical refractive correction. The optical zone of the treatment was 6.0 mm in diameter with a transition zone width of 9.27 mm. This required an ablation depth of 139 µm into the cornea, including epithelium.

The transepithelial PTK was performed with a total ablation time of 39 seconds, and recovery was uneventful. The patient wore a bandage contact lens for 4 days. Postoperatively, he received topical ketorolac 0.5% twice daily, dexamethasone 0.1% 4 times daily for 1 week, and ciprofloxacin 0.3% 4 times daily for 4 days. Four days after transepithelial PTK (after removal of the contact lens), the UDVA in the left eye was $6/9.5^{-2}$, the corneal epithelium had healed completely, and grade 1 stromal haze was evident. After PTK, the UDVA in the left eye was $6/4.8^{-2}$ at 1 month, $6/6^{+1}$ at 3 months, and $6/6^{+2}$ at 3 months. The CDVA improved to 6/4.8 with a spectacle refraction of plano −0.75 × 150. Tomography correspondingly showed that the central cornea had a much more regular shape (Figure 2).

The significant improvement in CDVA was expected in this case. However, the patient was happy with his uncorrected visual outcome, although he still noticed a slight difference versus the UDVA in the fellow eye (6/3.8). He noticed a mild halo effect in dim lighting. No further treatment was planned at that time.

DISCUSSION

Because of the variety of potential LASIK flap complications, it is not practical to have a standard management technique to cover all options. However, conservative choices, such as replacing free flaps, amputating very irregular flaps, and retreatments with LASIK or photorefractive keratectomy (PRK) 3 months later, are in general considered appropriate. Replacement of an irregular flap and immediate topography-guided PRK have also been performed successfully.[3] Topography-guided PRK has been described in the regularization and correction of keratoconus,[4] irregular astigmatism, and corneal scarring.[5] It has also been successfully used in the management of other types of flap complications, including irregular astigmatism subsequent to complete flap loss.[6]

The case we report here presented special challenges. The uncut nasal one half of the corneal stroma meant that manual or mechanical complete amputation would have been virtually impossible. Also, during the time since the original surgery, significant epithelial remodeling had occurred, smoothing the initially sharp demarcation over the visual axis.

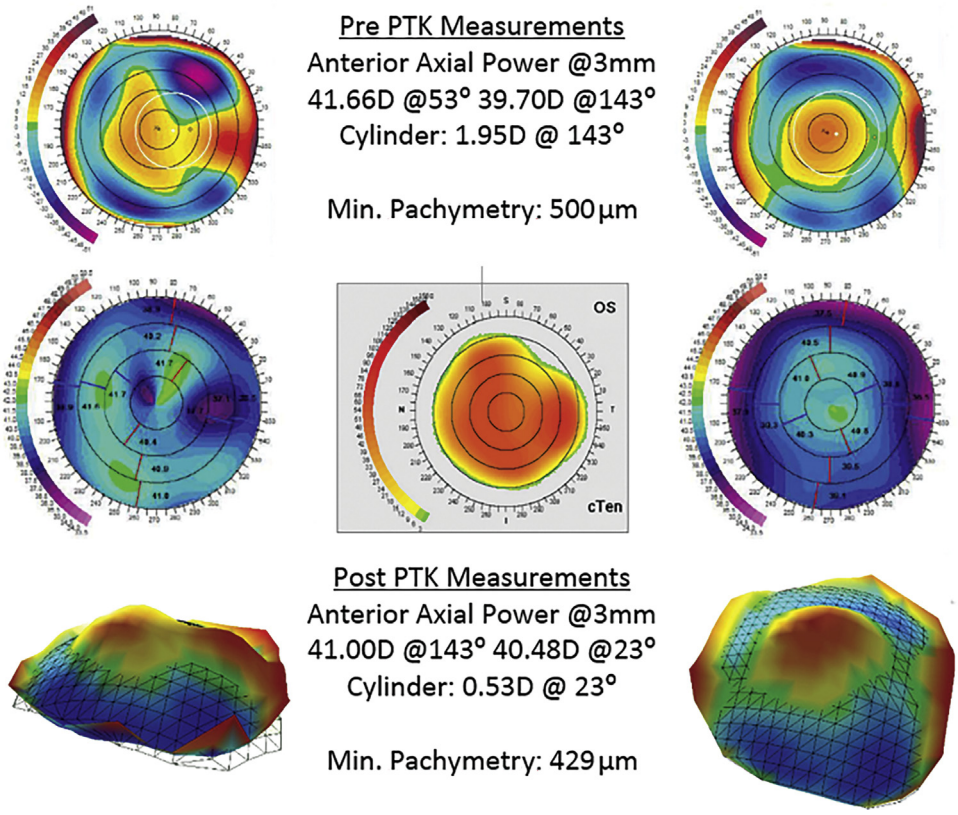

Figure 2. Summary of pre-PTK tomography, PTK ablation, and post-PTK tomography. Images on the left, from top to bottom, are the pre-PTK anterior elevation map, with the yellow circle indicating site of minimum pachymetry; the pre-PTK axial power map; and the pre-PTK 3-dimensional reconstruction. Center image shows the PTK ablation treatment applied. Images on the right, from top to bottom, are the post-PTK anterior elevation map, with the yellow circle indicating the site of minimum pachymetry; the post-PTK axial power map; and the post-PTK 3-dimensional reconstruction (PTK = phototherapeutic keratectomy).

Whether the refractive and visual quality outcomes in this case eye will persist long term is not be certain. Six months after the treatment, there was no sign of scarring or early regression. Variations in symmetry, depth, and diameter of the ablation have been associated with haze, scarring, and regression and the induction of higher-order aberrations.[7,8] Despite these long-term risks, correction of such an extreme degree of central corneal irregularity using topography-guided transepithelial PTK appears to have been a good decision. We believe topographic guidance offered a much safer and more efficient way of regularizing the extremely irregular cornea than attempting a complete manual lamellar dissection and amputation or performing PTK with a masking agent to try to regularize the cornea. Topography-guided transepithelial PTK safely restored excellent UDVA with minimal tissue loss. Should regression of the serendipitous refractive effect of the therapeutic ablation lead to a loss of UDVA, this patient could still have a refractive ablation in the future.

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