Delayed corneal epithelial healing after hyperopic laser-assisted subepithelial keratectomy in patients with accommodative esotropia

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We report 2 cases of delayed epithelial healing in accommodative esotropia with high hyperopia after laser-assisted subepithelial keratectomy (LASEK). Persistent epithelial defects at the corneal center in both eyes of each patient completely healed between 3 weeks and 2 months postoperatively. Within 6 months, the esotropia was successfully corrected and vision was restored without a corneal opacity. High hyperopic correction in LASEK might be correlated with delayed epithelial wound healing.

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Accommodative esotropia is one of the most successfully treated forms of strabismus.1 Glasses, although the simplest treatment modality, are for some individuals cosmetically unsatisfactory. Bilgihan et al.2 presented the first case report of a 19-year-old man successfully treated with photorefractive keratectomy for refractive accommodative esotropia, and a recent study3 showed favorable corneal excimer laser surgery results for correction of accommodative esotropia in 23 patients. Refractive surgery is another treatment option, allowing correction of both hyperopia and accommodative esotropia in a single procedure. In the 2 cases we present, we found that postoperative corneal wound healing in highly hyperopic patients with accommodative esotropia was delayed relative to the progress typically made by myopic patients.

CASE REPORTS

Case 1

A 34-year-old woman with accommodative esotropia whose vision had been corrected with glasses desired laser-assisted subepithelial keratomileusis (LASEK) for cosmetic reasons. The manifest refraction was +4.50 −1.00 × 110 in the right eye and +6.00 −1.00 × 10 in the left eye; the corrected distance visual acuity (CDVA) was 20/16 and 20/60 due to left-eye amblyopia, respectively. The angle of deviation without correction was 30.0 prism diopters (PD) of esotropia and 6.0 PD of hyperopia at distance, which was 4.0 PD of esotropia and 6.0 PD of esotropia with correction. The mean keratometric power was 45.3 diopters (D) in the right eye and 45.6 D in the left eye (Figure 1, E and F). The horizontal corneal diameter was 11.7 mm and 11.4 mm, respectively. Slitlamp examination revealed normal corneas with no sign of limbal insufficiency. The corneal topography also was normal.

The cornea was ablated in the 5.0 to 9.0 mm zone to a depth of 43 μm in the right eye and 59 μm in the left eye using the conventional LASEK procedure (Visx Star S4, Visx, Inc.), applying 20% alcohol for 25 seconds and irrigation with balanced salt solution. Bandage soft contact lenses (Acuvue Oasys, Johnson & Johnson Vision Care, Inc.) with a base curve radius of 8.80 mm were prescribed until the epithelium was completely healed. Prednisolone 1.0%, moxifloxacin 0.5%, and diclofenac 0.1% applied 4 times a day was administered for 1 week, after which the prednisolone and diclofenac were discontinued.

The epithelial defect at the center persisted in both eyes for 18 days (Figure 1, A and B). The wounds were completely healed without opacity at 1 month in the right eye and 2 months in the left eye (Figure 1, C and D). After 6 months, the uncorrected distance visual acuity (UDVA) was 20/25 to 20/20 in the right eye and 20/60 in the left eye. The angle of deviation without correction was 6.0 PD of hyperopia at distance without esotropia. The
Figure 1. Corneal epithelial defect at the center detected on day 18 after LASEK surgery in the right eye (A) and left eye (B) in Case 1. The wounds were completely healed without opacity at 1 month in the right eye and at 2 months in the left eye. Six-month slitlamp photograph of the right eye (C) and left eye (D). Preoperative topography of the cornea in the right eye (E) and left eye (F) and postoperative topography in the right eye (G) and left eye (H). Central steepening of the cornea was observed.
mean keratometric power was 50.4 D in the right eye and 51.5 D in the left eye and the manifest refraction, +0.25 \(-0.25 \times 5\) and +1.75 \(-1.0 \times 170\), respectively (Figure 1, G and H).

Case 2

A 22-year-old woman with accommodative esotropia requested correction by corneal refractive surgery. The manifest refraction was +4.0 \(-0.5 \times 168\) in the right eye and +4.0 \(-0.25 \times 18\) in the left eye, and the CDVA was 20/16 and 20/15, respectively. The patient had accommodative esotropia higher than 30.0 PD, which was reduced to 4.0 PD with +3.5 D glasses. The mean keratometric power was 44.625 D in the right eye and 44.25 D in the left eye (Figure 2, A and B). The horizontal corneal diameter was 10.8 mm and 11.1 mm, respectively. Slitlamp examination revealed normal corneas with no sign of limbal insufficiency.

Figure 2. Preoperative topography of the cornea in the right eye (A) and left eye (B) in Case 2 and postoperative topography in the right eye (C) and left eye (D). Central steepening of the cornea was observed.
Using the pretreatment and posttreatment procedures in Case 1, the cornea was ablated in the 6.0 to 9.0 mm zone to a depth of 48 μm in the right eye and 55 μm in the left eye. Postoperative corneal epithelial erosion at the center persisted in both eyes for 3 weeks. After 6 months, the UDVA was 20/22 to 20/20 in both eyes with clear corneas. The angle of deviation was orthotropic at distance. The mean keratometric power was 49.00 D in the right eye and 49.75 D in the left eye (Figure 2, C and D) and the manifest refraction, +1.5 –1.0 × 125 and –0.25 –0.3 × 40, respectively.

## DISCUSSION

We have reported delayed epithelial wound healing in 4 eyes of 2 highly hyperopic patients with accommodative esotropia after LASEK. In both cases, the final clinical outcome was successful, showing corrected esotropia and hyperopia.

Corneal wound healing is a complex process mediated by autocrine and paracrine interactions of cytokines, growth factors, and chemokines produced by epithelial cells, stromal cells, immune cells, the lacrimal gland, and the corneal nerves. These interactions orchestrate the corneal wound-healing response and contribute to the maintenance and restoration of corneal clarity. The full return of normal structure and function can take months, even years, according to the type of surgery and individual variations in the wound-healing response. The other factors that might influence wound healing and corneal surface remodeling include the surgical technique used, excimer laser systems, and ocular movements, resulting in irregular ablated surfaces, delayed epithelial healing, and altered stromal remodeling.

Delayed corneal wound healing after LASEK for high hyperopia is presumably the result of variable causes:

1. Abrupt topographic changes affecting cellular migration after epithelial injury. Serra and Lombardo reported significantly slower epithelial progression in higher spherical and cross-cylinder ablation groups than in a low spherical ablation group, probably due to a more rapid and steeper corneal profile in the ablation zone. The marked asymmetry of the stromal bed in the medium corneal periphery might explain less migration of the epithelial edge in astigmatic ablation than in spherical ablation. In cases with high hyperopic LASEK, a too steep cornea, due to tear disturbance, can interfere with central wound healing (Figures 1, G, H, and 2, C, D).

2. Corneal nerve distribution damage. The subbasal nerve plexus is a radiating pattern of nerve fiber bundles converging toward an area approximately 1.0 to 2.0 mm inferior to the corneal apex; the subepithelial nerve plexus network is limited to the midperipheral cornea. Subbasal nerve density and diameter are known to be significantly decreased following LASEK and to return to preoperative levels only after 6 months. In our 2 cases, the subepithelial nerve plexus network appeared to be damaged after hyperopic LASEK, which might have delayed wound healing. The hyperopic ablated area (calculated as 43.96 mm² in the first patient and 35.33 mm² in the second patient) was wider than the myopic ablated area (calculated as 28.26 mm² in a 6.0 mm optical zone), which indicated significant nerve distribution damage.

3. Use of flatter therapeutic soft contact lenses (base curve radius 8.80 mm), which cause mechanical friction at the center in cases with a relatively steep cornea (base curve radius 6.55 to 6.88 mm).

4. The closer proximity of the laser-ablated area to the limbus in cases of hyperopic LASEK relative to myopic LASEK, which possibly diminishes the regenerative capacity of limbal stem cells. Furthermore, a small-diameter cornea, as in the present cases, might, in hyperopic relative to myopic LASEK, lead to ablation of the peripheral cornea closer to the limbus, which in turn can lead to delayed wound healing.

In conclusion, we reported post-LASEK delayed wound healing in 2 cases of high hyperopia with accommodative esotropia but with good correction of the esotropia. Ophthalmologists and patients considering LASEK should be aware of the possibility of delayed epithelial healing in cases of high hyperopia with small corneas.

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