ABSTRACT

PURPOSE: To report topography-guided photorefractive keratectomy (PRK) with mitomycin C (MMC) after penetrating keratoplasty.

METHODS: A 34-year-old woman with irregular astigmatism after penetrating keratoplasty in the right eye underwent PRK. Topography-guided surface ablation using the customized aspheric treatment zone ablation (CATz) was programmed for a 5.00-mm optical zone and an 8.50-mm transition zone. Mitomycin C was applied to corneal stroma for 20 seconds immediately after excimer laser ablation.

RESULTS: Two months after surgery, the patient was very satisfied with the refractive outcome. Best spectacle-corrected visual acuity was 20/20 with a manifest refraction of -0.50 diopters. No haze formation was detected at 6-month follow-up. A significant improvement in the central 3 mm of the axial topography was noted.

CONCLUSIONS: Topography-guided ablation using MMC may be a reasonable alternative for the management of refractive error after penetrating keratoplasty. [J Refract Surg. 2009;25:S131-S135.]

Visual rehabilitation after penetrating keratoplasty has improved with advances in microsurgical techniques. However, 8% to 20% of eyes have irregular postoperative astigmatism that cannot be corrected with spectacles or contact lenses. The presence of irregular anterior surfaces, often associated with high amounts of higher order aberrations, limits best spectacle-corrected visual acuity (BSCVA) and visual quality.

Among the various techniques proposed for correcting postkeratoplasty astigmatism, conventional surface ablation has shown some efficacy. However, postoperative complications such as unpredictable refractive outcomes, refractive regression, and corneal haze are commonly seen. Recent reports of LASIK have been more encouraging, leading to a higher reduction of preoperative astigmatism. The major disadvantages of LASIK are related to the creation of the lamellar flap. Surface irregularities may lead to flap complications including free, incomplete, irregular, thin, or buttonhole flaps. The microkeratome cut also alters the biomechanical properties of the cornea, changing its curvature and optical properties. The changes may be unpredictable in a postkeratoplasty cornea.

Customized topography-guided ablation is a potentially better approach to irregular ametropia after keratoplasty. The principle is to minimize corneal surface irregularities that decrease visual quality. However, epithelial hyperplasia and stromal remodeling tend to mask attempts at custom ablation when photorefractive keratectomy (PRK) is performed. To avoid such an unpredictable epithelial response as well as regression and stromal haze formation, the prophylactic use of topical mitomycin C (MMC) during the PRK procedure has been suggested. Many studies have reported good refractive outcomes following PRK with mitomycin C, including a lower incidence of corneal haze formation. 

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In this case report describing the use of topography and wavefront analysis, we present the possible benefits of customized topography-guided PRK with MMC after penetrating keratoplasty for keratoconus.

**CASE REPORT**

**CLINICAL FINDINGS**

A 34-year-old woman who underwent penetrating keratoplasty 10 years ago for keratoconus presented with high astigmatism in the right eye. The patient was contact-lens intolerant in the right eye and had undergone penetrating keratoplasty in the left eye 3 months prior to presentation. Best spectacle-corrected visual acuity was 20/30, with a manifest refraction of $-2.00 \times -4.25 \times 65^\circ$ in the right eye. Slit-lamp examination of the right eye was unremarkable, with no opacities or sutures in the corneal button. The central corneal thickness measured using ultrasound pachymetry was 559 µm in the right eye. Preoperative OPD-Scan II (NIDEK Co Ltd, Gamagori, Japan) measurement showed a distorted point spread function (PSF) along with large refractive gradient across the pupil (OPD map) with multiple refractive powers centrally including emmetropia (light green) and myopia centrally along with significant astigmatism within the central 3 mm (OPD map) (Fig 1).

The right eye underwent topography-guided PRK using customized aspheric treatment zone ablation (CATz) with the NAVEX Advanced Vision Excimer laser platform (NAVEX; NIDEK Co Ltd). Final Fit (NIDEK Co Ltd) simulation incorporated a 5.00-mm optical zone and an 8.50-mm transition zone (Fig 2). A nomogram adjusted value of $-1.50 \times -4.25 \times 65^\circ$ was programmed for the refractive correction. Corneal elevation data were used instead of the wavefront aberration option for the treatment of the irregularities on the cornea. The full (100%) irregularity component was treated using an optical zone of 6.00 mm and a transition zone of 8.00 mm. After the refractive and irregularity ablations, six scans of phototherapeutic keratectomy with a 9.00-mm optical zone were delivered to the cornea. The laser ablation was centered halfway between the line of sight and visual axis (50% PDist option) (see Fig 2).

Two drops of topical anesthetic were instilled into the right eye, and a lid speculum was inserted for maximum globe exposure. The epithelium was removed manually using a blunt blade without ethanol, and MMC 0.02% was applied to corneal stroma for 20 seconds immediately after excimer laser ablation. One drop of topical moxifloxacin and one drop of 1% prednisolone acetate were instilled, and a bandage contact lens was placed on the cornea.

Two months after surgery, the patient was very satisfied with the refractive outcome. Best spectacle-corrected visual acuity was 20/20 with a manifest refraction of $-0.50 \ D$. At 5 months postoperatively, the manifest refraction was $-0.50 \times -1.25 \times 30^\circ$, maintaining 20/20. The patient reported mild glare in mesopic conditions but remained satisfied with the outcome. No haze formation was detected at the 6-month follow-up (Fig 3).
Corneal Topography and Wavefront Analysis

Simulated keratometry and keratometric astigmatism values in the right eye before and after surgery are shown in the Table. Figure 4 shows axial topography difference maps for the right eye, demonstrating an asymmetric ablation with a more homogeneous surface in the central 3 mm. An intended flattening inferiorly was seen on the postoperative axial topography map. Preoperative higher order aberration root-mean-square was 2.348 µm. After surgery, total higher order aberrations increased to 2.874 µm, dominated primarily by trefoil, which increased by a factor of 1.47. The PSF was slightly more distorted 6 months postoperatively compared with preoperatively (see Fig 1). The refractive wavefront map (OPD map) showed a large band of confluent hyperopic power (blue) instead of multiple refractive powers centrally. The central 3 mm had mild astigmatism postoperatively.

Discussion

Highly aberrated corneas and poor visual quality are common findings after penetrating keratoplasty. Several reports have suggested customized ablations to minimize such irregularities. Asymmetric ablations are required to smooth the cornea surface by treating localized defects guided by topographic data. Figure 2 shows the asymmetric ablation delivered by the irregular component of the ablation. Figure 4 shows a significant improvement in the central 3 mm of the axial topography. Figure 1 shows that the central pupillary areas had one refractive power instead of multiple powers and that the astigmatism was significantly reduced in this region. The smoother corneal topography likely resulted in the two-line gain of BSCVA. The dif-

Figure 2. Simulation and treatment parameters for an eye that underwent topography-guided treatment after keratoplasty. The irregular ablation shows greater ablation (red) inferiorly compared with superiorly (yellow-green).

Figure 3. Slit-lamp examination 6 months after CATz ablation with mitomycin C 0.02%. No opacities are observed.
ference map shows that the treatment was delivered to the intended region and that the ablation simulation in the Final Fit (see Fig 2) was a good predictor of the postoperative topography.

Despite modern treatment algorithms (topography-guided ablations, wavefront-guided ablations) and laser delivery (small flying spots), postoperative wound-healing response remains an important issue. To minimize the risk of corneal haze formation and better modulate the wound-healing process, PRK with intraoperative MMC has been suggested as an alternative approach to LASIK. In this patient, we used intraoperative prophylactic MMC 0.02% for 20 seconds. Epithelium was manually removed without ethanol due to a synergistic effect of ethanol and MMC in the corneal stroma.

Wavefront analysis showed a highly aberrated eye and an increase of the total higher order aberrations and a slight deterioration of the objective image quality. Conversely, a significant reduction of low order aberrations and corneal topography irregularity was seen. Patient satisfaction was high, and mild symptoms were present but were not visually significant 6 months postoperatively. The greatest source of visual degradation is residual refractive error. We believe that reducing the significant manifest cylinder was the reason for the patient’s satisfaction postoperatively. Neural processing likely played a role in the reduction of symptoms postoperatively.

Despite the good outcome reported in this study, more patients and longer follow-up are needed to confirm the efficacy and safety of customized surface ablation treatments after penetrating keratoplasty. Topography-guided ablation may be a reasonable alternative for the management of refractive error after keratoplasty.

**REFERENCES**


<table>
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<tr>
<th>Time</th>
<th>SE (D)</th>
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<td>20/20</td>
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</table>

SE = spherical equivalent refraction, BSCVA = best spectacle-corrected visual acuity, SimK = simulated keratometry, KA = keratometric astigmatism

**Table**: Refractive Data in the Right Eye and Simulated Keratometry Values Derived From Corneal Topography

**Figure 4.** A) Pre- and B) postoperative axial topographic maps and the difference map (A–B) show the decrease in corneal astigmatism. Pupil contour is delineated by the gray line in the difference map and by a white line in the axial maps.


