

Unexpected Flattening After Post-PRK Haze Removal

BY ARUN C. GULANI, MD; DAVID WALLACE, MD; MING WANG, MD, PhD; AND ALEKSANDAR STOJANOVIC, MD

CASE PRESENTATIONS

No. 1

A 37-year-old man underwent PRK in October 2012. His preoperative refraction was -4.50 D sphere OU. He developed mild haze bilaterally, worse in his right than left eye, despite the intraoperative use of an antimetabolite. Four months postoperatively, his UCVA was 20/30 OD and 20/20 OS.

The surgeon used a new, fine diamond burr to buff the epithelium and scar. The ophthalmologist took care to prevent the burr from contacting the cornea in any one location for any length of time. Multiple trips to the slit lamp were taken during the procedure to avoid excessive scar removal. The procedure left the patient with a hyperopic refraction and a flat zone inferotemporally in his right eye (Figure 1). His UCVA fell to 20/80 and his BCVA to 20/30 with a refraction of +4.25 -1.00 × 150 OD.

With a soft contact lens of +4.00 D power in place, he reads 20/30+ but still has ghosting.

No. 2

A 52-year-old man underwent PRK in 2005 for the treatment of -6.00 D of myopia. No mitomycin C (MMC) was used during the initial surgery. The patient developed visually significant haze in his right eye. With a refraction of -3.00 D, his BCVA measured 20/50 OD. His UCVA remained 20/20 OS. Despite relatively normal topography, the patient was bothered by the visual acuity of his right eye (Figure 2A).

The patient underwent superficial keratectomy with diamond burr polishing of the scar and a 2-minute application of 0.02% MMC. The surgeon was careful to prevent the burr from contacting the cornea in any one location for any length of time. Multiple trips to the slit lamp were taken during the procedure to avoid excessive scar removal.

Re-epithelialization was not delayed. The patient began complaining of poor visual acuity 1 week postoperatively, and at the 1-month postoperative visit, his refraction was +7.00 +3.00 × 090 OD. His topography is shown in Figure 2B.

Questions

How would you handle these two cases? How would you counsel the patients? Which therapeutic modalities would you consider?

—Cases prepared by John Lyon, MD;
Ming Wang, MD, PhD; and Parag A. Majmudar, MD.

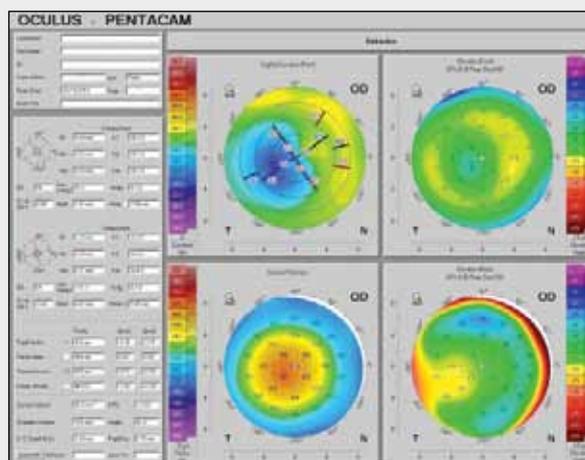


Figure 1. Image with the Pentacam Comprehensive Eye Scanner (Oculus Optikgeräte GmbH) of the patient's right eye after haze removal in case No. 1.

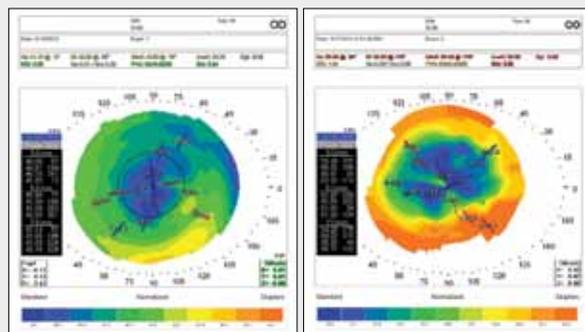


Figure 2. Topographic maps of the right eye of the patient in case No. 2 after the initial PRK (A) and 1 month after superficial keratectomy (B).

ARUN C. GULANI, MD

The lesson of the presented cases is that scars affect the shape of the cornea. Based on my experience, the hyperopic refraction given is not the real refraction, so chasing that error will increase the patients' hyperopia.

As evidenced by my corneoplastique algorithm,¹ there are various ways in which I approach all kinds of corneal scars to achieve emmetropic outcomes using an excimer laser in PRK mode. Without the benefit of a clinical picture (which could be the most helpful piece of information), in this case, I would plan for a two-staged procedure.

First, I would manually perform epithelial removal. I find that, with patience, I can often gently lift slivers of scar tissue away from the center of the cornea with a fine-tipped, nontoothed forceps. Rather than produce corneal divots or irregularity, this approach reveals clear, smooth, compact anterior stroma. It is important to avoid using any fluids on the cornea and to keep it dry throughout this process.

Next, I would perform an excimer ablation targeting -1.25 D sphere with the laser in PRK mode and would apply MMC for 30 seconds. (A clinical photograph would help me to decide how much central myopia to key in.) Upon irrigating the eye with balanced salt solution, the clarity of the cornea will be surprising, and the central light reflex will be circular (rather than oval and irregular), signifying the endpoint.

The postoperative course would be the same as after a straightforward PRK procedure with a bandage contact lens. One month postoperatively, I would measure the patient's refraction, which would now be accurate, and then perform an enhancement.

After about 2 to 4 weeks, I would be able to measure the true refraction and proceed accordingly to emmetropic outcomes.

DAVID WALLACE, MD

Like Dr. Gulani, I believe a clinical photograph might provide better information than a topographic study, and it is unfortunate that the former is not available.

To be candid, even in the hands of an experienced ophthalmic microsurgeon, a fine diamond burr is a crude tool to use for optical/refractive sculpting across the central cornea in the context of post-PRK therapy. It cannot compare to the submicron accuracy of an excimer laser and, therefore, will always wreak relative optical havoc (refractive alterations, irregular astigmatism, and irregular contour/topographic change with consequent ghosting, higher-order aberrations, loss of clear focus, decreased contrast, etc.). I am a bit surprised that haze removal was

even attempted in the first case, when the primary surgery was performed as recently as October 2012. A diamond burr may be an excellent instrument for polishing a pterygium bed or even for dissecting a Salzmann nodule, but in my opinion, it should not be used to remove post-PRK haze for exactly the reasons highlighted here.

In the original FDA clinical trials of PRK using large-spot lasers—research that predated the MMC era—haze occurred in some cases, but study restrictions precluded any follow-on intervention. Fortunately, in a majority of those cases, the haze abated on its own within 2 years (D. Durrie, MD, personal communication, 2007). It can be difficult for surgeons to sit on their hands and observe patients for such a long period, but in cases like these, that might have been exactly the right thing to do.

At this point, unfortunately, the damage has been done, and I am not aware of any therapeutic modality that can consistently correct structural, optical, or topographic irregularities of this type. Several investigators outside the United States have experience with topography-guided ablation using the WaveLight 400-Hz Eye-Q Laser (Alcon Laboratories, Inc.), but I do not believe that even this relatively elegant approach is successful in all cases due to the limitations of topographic resolution in the central cornea and to the unpredictability of wound healing. I have heard Dr. Gulani's presentations on this topic. Theoretically, his corneoplastique approach has merit, but I have neither seen nor observed patients treated in that manner.

MING WANG, MD, PhD

My comments mainly focus on the second case, but both have similarities. On topography, the front elevation map shows significant anterior corneal depression, as much as $+14\ \mu\text{m} - (-18\ \mu\text{m}) = 32\ \mu\text{m}$. (If you pick the $-18\text{-}\mu\text{m}$ point, look across the visual axis, and pick the height of the corresponding point on "the other side of the river," it is $+14\ \mu\text{m}$.) The location of the most depressed area is 1 mm inferotemporal to the visual axis. The front curvature map demonstrates significant anterior corneal flattening, near the "bottom of the valley" (at 1.5 mm inferotemporally), of as much as $33.60\ \text{D} - 43.70\ \text{D} = 10.00\ \text{D}$. The pachymetry map shows significant thinning ($431\ \mu\text{m}$) at this inferotemporal location.

One option would be treatment with ocular surface hydration, collagen punctal plugs, and cyclosporine ophthalmic emulsion 0.05% (Restasis; Allergan, Inc.), after which the patient would be observed until refractive stability was achieved. He could then be fit with a rigid gas permeable contact lens.

I would recommend against conventional hyperopic PRK, because it would increase the patient's irregular astigmatism and reduce, but not eliminate, his hyperopia.



Hyperopic PRK using the Visx C-CAP (custom-contoured ablation pattern; Abbott Medical Optics Inc.) would be difficult to perform and not very predictable. Moreover, because the treatment would have to remove the elevated superonasal rim, it would increase the patient's hyperopia, necessitating lens surgery. The cornea is too irregular to allow registration for wavefront-guided PRK, and treatment could actually increase this irregularity. Outside the United States, topography-guided PRK would be an option, but the high amount of treatment could still mean an increase in corneal irregularity.

I frequently perform gel-assisted phototherapeutic keratectomy to treat irregular astigmatism. On the downside, central treatment would increase the patient's hyperopia, necessitating lens surgery.

The creative placement of one Intacs segment (Addition Technology, Inc.) could bulk up the cornea, but the result would be hard to predict and could increase the irregular astigmatism. Placing two segments could stretch and smooth the cornea, but the resulting hyperopia would necessitate lens surgery.

Dr. Gulani's approach would be a possibility in this case. The last resort would be deep anterior lamellar keratoplasty or penetrating keratoplasty. Both are major surgeries, and the latter carries the risk of endothelial rejection.

**ALEKSANDAR STOJANOVIC, MD:
HOW I MANAGED CASE No. 1**

The patient described in the first case was referred to me for customized topography-guided ablation of his right eye to treat his irregular astigmatism, very oblate asphericity, and significant hyperopic shift. Upon examination on July 17, 2013, the patient's distance UCVA was 20/80, and his distance BCVA was 20/30, corrected by +8.00 -1.00 × 5. Only trace haze was visible paracentrally inferotemporally at the slit lamp. The same area demonstrated flattening on Placido topography.

The inferior-temporal depression was evident on Scheimpflug elevation topography along with hyperoblate asphericity (anterior Q-value, 2.41; total anterior plus posterior Q-value, 3.72) within the central 3.5 mm. There was no significant protrusion of the posterior corneal surface and no sign of three-point touch between the highest anterior elevation, the posterior elevation, and the thinnest point (422 μm; Figure 3).

Optical coherence tomography (OCT) of the cornea revealed traces of haze. The epithelial thickness map showed significant variation, with a thickening of up to 79 μm in a circular area decentered inferior-temporally. The lowest pachymetry reading on OCT was 433 μm (Figure 4).

Wavefront aberrometry (at the 5-mm zone) showed increased higher-order aberrations with the total root

mean square of 1.12 μm, dominated by corneal coma and spherical aberration (Figure 5). Biometry measurements using the Lenstar LS900 (Haag-Streit AG) showed that the patient's eyes had comparable axial lengths, but the average keratometry readings were approximately 3.50 D flatter in his right eye.

I decided to perform transepithelial Scheimpflug topography-guided surface ablation based on the elevation map using the iVis-Suite (iVis Technologies). I planned to use a customized, transepithelial, "no-touch" technique aimed at central optical regularization of the corneal surface and optimization of the corneal asphericity centered on the visual axis.²⁻⁶ Multifocality of the patient's very oblate cornea made deciding the desired spherical correction difficult. Both of his eyes had had similar axial lengths and refractions before the initial refractive surgery, but his right eye now refracted at almost +8.00 D versus near emmetropia for his left eye. Because the difference in average keratometry was only 3.50 D, I opted for a respective undercorrection of hyperopia, with the assumption that the refraction of +8.00 D was due to the very oblate asphericity and very localized flattening.

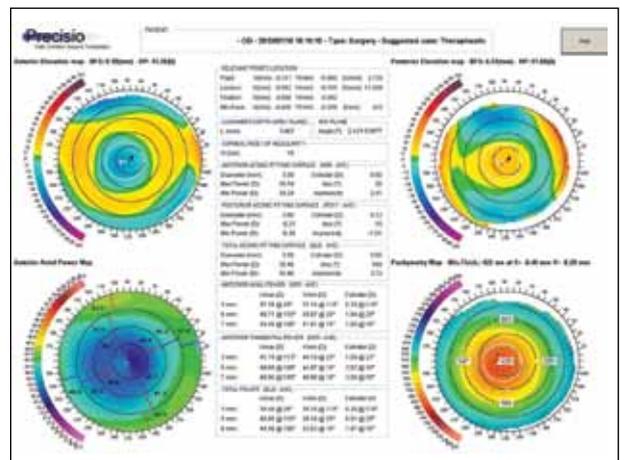


Figure 3. Scheimpflug-Precisio (iVis Technologies) topography/tomography showing (clockwise) anterior elevation, posterior elevation, axial keratometric topography, and pachymetry map.

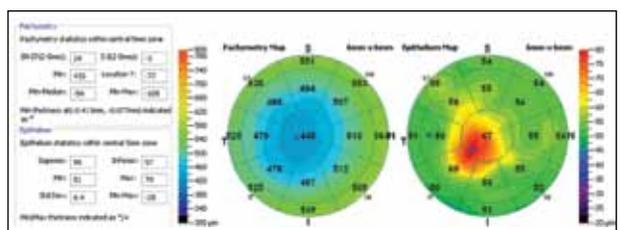


Figure 4. Epithelial and corneal thickness mapping on corneal OCT (RTVue; Optovue, Inc.).

(figures 3-5, courtesy of Aleksandar Stojanovic, MD.)



Figure 5. Aberrometry measurement taken with the Nidek OPD-Scan II (Nidek, Inc.).

The ablation plan (Figure 6) showed a maximum stromal ablation depth of 56 μm and residual stromal thickness of 421 μm . The maximum ablation depth was not in the area of the thinnest cornea and would instead leave it nearly unchanged. The total ablation depth (epithelial plus stromal) would exceed 79 μm in the area of the thickest epithelium, ensuring that the stroma would be ablated at all points. I deemed the planned ablation safe with respect to minimally affecting corneal biomechanical stability.

The next day, I performed uneventful surgery with a 30-second application of 0.05% MMC. I monitored the eye's re-epithelialization during the first 5 days after surgery and removed the bandage contact lens after 7 days. The patient received a prescription for tapering local steroids and artificial tears. Follow-up was scheduled with his referring ophthalmologist. ■

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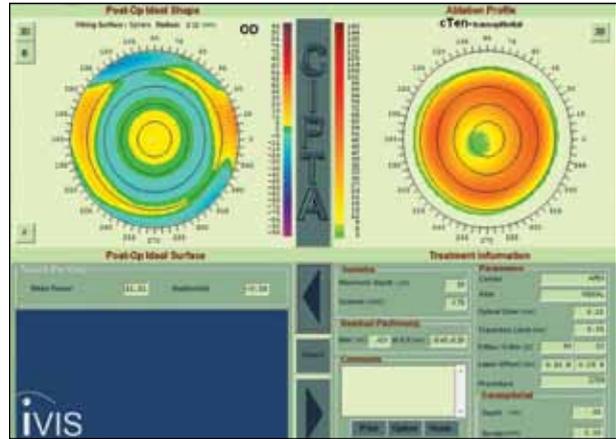


Figure 6. iVis topography-guided customized ablation plan with the desired outcome on the left and the ablation map on the right.

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