# Considering Possible Deleterious Interactions Between Refractive Treatments

When combining treatment modalities, it is necessary to be mindful of possible deleterious additive interactions between procedures.

BY MING WANG, MD, PHD; AND HELEN BOERMAN, OD, FAAO

The remarkable impact of LASIK on refractive surgery derives greatly from its successful clinical outcomes and relatively quick recovery; however, despite its success, both residual refractive error and visual quality complaints, such as glare and halo phenomena, have resulted in a minority of patients being dissatisfied postoperatively.[1-7] Studies have demonstrated that factors related to long-term symptoms include the level of treatment (preoperative myopia),[1,2] postoperative UCVA, and residual refractive error.[1] Others include increasing age, flatter preoperative minimum corneal curvature, and surgical enhancement.[3] The jury is still out regarding the correlation between glare and halo phenomena and pupil size—previous studies had found a correlation but more recent research has not.[1,2,4,5]

This article will present a unique case of a patient status post high myopic LASIK with both lower-order aberration (residual spherocylindrical refractive error) and higher-order aberration (night glare and halos) from two distinct sources: the central pupil and peripheral iridotomies. Although pharmaceutical pupil constriction reduces the central visual symptoms (night halo from large pupil size after LASIK), it exacerbates peripheral visual symptoms (secondary peripheral images). The take-home message of this case is as follows: the advent of many new modalities of refractive anterior segment treatments offers clinicians an increased amount of choices. However, when using multiple treatments, such as LASIK, peripheral iridotomy, and phakic IOLs, we must be mindful of the possible deleterious interactions between the procedures. It is critical to consider possible additive side effects not present with either treatment alone but that appear for the first time when treatments are combined, in order to avoid making the situation worse rather than better.

**TAKE-HOME MESSAGE**

- New treatment modalities, such as the ICL, can offer an alternative to treating residual refractive error after LASIK and avoid worsening post-LASIK glare.
- When combining treatment modalities, such as in this case, one needs to be mindful of possible deleterious interactions between treatments.
- Careful discussion with the patient of not only the risks of each procedure individually but also the possible additive and interactive effects of all treatment modalities should occur.

## CASE PRESENTATION

After visiting multiple refractive surgeons for their opinions, a 52-year-old woman came to our clinic for another opinion at the recommendation of her personal friend and co-managing optometrist. She had two chief complaints: residual refractive error (lower-order aberrations) and glare and halos (higher-order aberra-

tions), which were most prominent at night.

The patient's surgical history included LASIK in 1999 for a preoperative refraction of -10.00 D sphere in both eyes. The Visx laser (Advanced Medical Optics, Inc., Santa Ana, California) was programmed for -8.75 diopters of sphere (DS), delivering a total ablation of 102 µm and 464 pulses. Preoperative pachymetry averaged 600 µm in each eye. Two months later, her UCVA was 20/60 OD and 20/30 OS. A refraction of +1.00 +1.25 X 95 improved vision to 20/20 OD and 1.00 DS improved vision to 20/20 OS. She underwent bilateral LASIK enhancements using two cards in her right eye (1.75 DS; refraction, -1.00 +1.00 X 95) and one in her left eye (1.00 DS). Pachymetry measured 507 µm in each eye.

One week following the enhancements, the patient's UCVA was 20/80 OD and 20/200 OS. Refraction of -1.50 DS in her right eye and -2.00 DS in her left improved vision to 20/20 OU. Cycloplegic refraction was -1.50 DS in each eye.

When the patient visited our center for another opinion, her UCVA was 20/150 OD and 20/300 OS. The right eye improved to 20/20 with -3.00 DS and the left eye to 20/25 with -3.50 DS. Pachymetry averaged 487 µm OD and 510 µm OS. Photopic pupil sizes measured 5 mm OU and scotopic 6 mm OU. In both eyes, keratometry averaged 41.50 D.

The patient said she was using 0.1% pilocarpine to help with her night vision. Despite its effectiveness, she disliked the symptoms associated with the medication. Although she wanted spectacle independence, she was also concerned about her nighttime glare. Corneal topographies demonstrated pericentral and peripheral corneal irregularities as the likely cause of her glare. Additionally, she had dry eye symptoms, for which we recommended and inserted silicone punctal plugs.

## HOW WOULD YOU PROCEED?

We discussed several options with the patient and differentiated between those that would mainly be advantageous to addressing the refractive error (ie, lower-order aberration) and those that would mainly address the halos and glare (ie, higher-order aberrations). The surgical options included: (1) PRK, (2) topography-driven laser treatment, (3) Intacs ring segments (Addition Technology, Inc., Des Plaines, Illinois), (4) clear lens extraction plus PRK, or (5) phakic IOL (Visian ICL; STAAR Surgical, Monrovia, California).

**Photorefractive keratectomy.** PRK would effectively reduce the refractive error; however, it would also come with the risk of further corneal surgery, resulting in additional decrease of the optical zone. This would likely aggravate the patient's night glare symptoms.

**Topography-driven treatment.** Although the goal of this treatment is enlargement of the optical zone to decrease the halo and glare phenomena, it is currently unavailable in the United States.

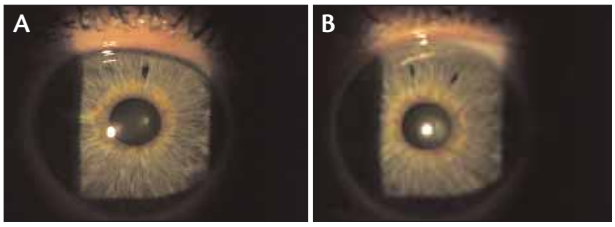


**Figure 1. Location and size of the (A) right and (B) left peripheral iridotomies with normal lid position. Note: one patent PI in the right eye causes the symptom in the one image and two in the left eye, coinciding with her symptom of two images.**

**Intrastromal ring segments.** Intacs also offers the option of providing a larger optical zone. The largest drawback is its refractive predictability, which is uncertain given the history of bilateral high myopic LASIK and enhancements.

**Clear lens extraction followed by hyperopic PRK.** In this case, the goal would predominantly be to enlarge the optical zone. The major disadvantage here is that at 52 years old, the patient's accommodative ability is destroyed. Clear lens extraction plus PRK also carries other threats, including the risks of intraocular surgery and retinal detachment due to posterior disturbances. Additionally, it is uncertain if the hyperopic treatment after lensectomy would reduce the patient's night glare.

**The Visian ICL.** This phakic IOL would also reduce the patient's refractive error and prevent more glare. She would also remain phakic.

We informed the patient that not only was she outside the US Food and Drug Administration (FDA) guideline for age, but also a risk of anterior cortical cataracts was possible. The FDA-approved age for candidates is 21 to 45 years of age; however, this technology may be offered to patients of any age. If the patient is presbyopic, he should understand the need for either monovision or reading glasses. Patient selection includes stable refraction, the absence of ocular pathology, and a minimum anterior chamber depth of 2.8 mm.

Still, the advantage of the ICL over corneal surgery was that the incidence of patient symptoms, such as glare, halos, and night vision problems, decreased or remained unchanged after ICL surgery.[6] Surgically induced cataracts were seen in 2.7% of patients in an FDA study.

If this were your patient, how would you proceed?

## HOW WE PROCEEDED

After fully discussing the options, including the risks and benefits of each, we concluded that the ICL was the

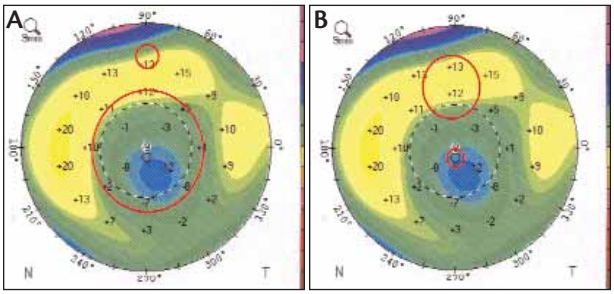


**Figure 2. Schematics of pupil and PI size superimposed on elevation map. (A) Without pilocarpine, the patient experienced more central glare due to corneal irregularities and less peripheral symptoms (secondary peripheral symptoms) due to the PIs. (B) With pilocarpine, the patient experienced less central symptoms due to corneal irregularities but more peripheral symptoms due to enlargement of the PIs.**

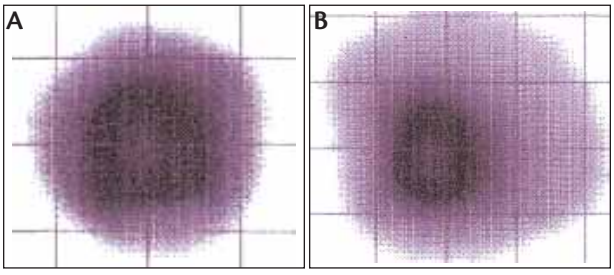


**Figure 3. (A) Glare from central corneal irregularity is enhanced at normal pupil size. (B) Glare caused by the PI is enhanced when the patient instills pilocarpine to reduce central glare by miosis.**

best option. We took a conservative approach and monitored her for several months to ensure refractive stability. We also recommended she try soft contact lenses as a simulation for surgery. If she was happy with merely addressing the refractive error, we would proceed with the planned refractive approach.

In light of her relatively flat and thin corneas and dry eyes, the Visian ICL offered a safe option for this patient. Although typically used for higher myopes, the Visian ICL is available in powers as low as -3.00 D, which made it a viable option in this instance.

After several months of confirming the patient's refractive stability and thoroughly educating her—so that she understood the Visian ICL would correct the refractive error only, and she would likely still need pilocarpine for glare—she elected to proceed. After measuring her anterior chamber depth at 3.22 OD and 3.31 OS, we proceeded with Nd:YAG peripheral iridotomies (PI) in both eyes.

## FOLLOW-UP

One week later, the patient called her co-managing doctor, concerned about new photopsia in both eyes. With the left eye occluded, she noted one hazy image superiorly in the right eye, and with the right eye occluded, she noticed two superior hazy images in the left. These symptoms, now occurring in daylight conditions, decreased when she squinted.

Our impression was that the new photopsia symptoms were secondary to light coming through the PIs, which are located just outside the previous LASIK ablation zones, and not quite occluded by the upper lids at their normal resting position. Figure 1 illustrates the location and size of the PIs during normal lid position.The additive effects of the PIs located at the edge of the LASIK treatment zone created this new symptom.

**Central versus peripheral glare.** Figure 2 illustrates schematics of the patient's pupil and PI size superimposed on the corneal elevation map. With normal pupil size, the patient experienced more central glare due to central corneal irregularities and pupil size. She also experienced less peripheral image symptoms due to the PIs. When 0.125% pilocarpine was applied to the eye, the patient experienced less pupil symptoms; however, she then experienced more peripheral image symptoms because her PIs were enlarged. The patient alleviated these symptoms by squinting her eyes. Figure 3 demonstrates point spread functions due to glare from central corneal irregularity (enhanced at normal pupil size) and glare caused by the PI (enhanced when the patient instills pilocarpine to reduce central glare by miosis).

**Future treatment options.** After discussion with her optometrist, the patient elected to hold off on ICL implantation and try tinted contact lenses to reduce her peripheral symptoms. At the patient's 1-month follow-up after the Nd:YAG PIs, she reported that colored contact lenses helped. She also wished to return to her pre-YAG status with respect to the glare. We educated her that the peripheral symptoms (ie, secondary images) should gradually decrease, partly due to a slight self-closure of the PIs and partly due to neural adaptation. In the meantime, we recommended patience, continued use of the tinted contact lenses, and experimenting with three formulations of pilocarpine (ie, 0.125%, 0.25%, 0.5%). Although pilocarpine reduced her central visual symptoms (ie, night halos), the patient informed us that the stronger formulation caused more pronounced peripheral images (due to the PIs).

Although the incidence of visual disturbances, such as secondary peripheral images, is relatively uncommon in patients following laser PIs, these symptoms are more likely to occur in patients with partially or fully exposed laser iridotomies.[7]

We have already discussed future options with the patient, in the event that her symptoms do not decrease to a tolerable level in the next few months. These include

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corneal tattooing, botulinum toxin injections (Botox; Allergan, Inc., Irvine, California) to lower the lid position, or surgical closure of the PIs. All options are not without risk, so we advised patience during this healing period. We are still managing this patient at the time of writing this article.

## WHAT HAVE WE LEARNED FROM THIS CASE?

As demonstrated in this case, managing postrefractive surgery complications is clinically challenging. It is critical to have appropriate patient selection and thoroughly educate patients about the risks and benefits of all possible procedures.

When multiple treatment modalities are used together to address refractive complications, careful consideration should be made of not only the risks of each procedure individually, but also the interaction between the treatments. It is important to consider potential new complications that are not present with each treatment alone, but that appear when treatments are combined. Each patient should be informed of this possible appearance of new complications arising from combining the treatments and play an active role in the decision-making process. ■

*Helen Boerman, OD, FAAO, is the Clinical Operations Manager and Residency Supervisor at the Wang Vision Institute, Nashville, Tennessee, and Adjunct Faculty at Indiana University, Bloomington, Indiana. Dr. Boerman states that she has no financial interest in the products or companies mentioned. Dr. Boerman may be reached at tel: +1 615 321 8881; e-mail: drboerman@wangvisioninstitute.com.*

*Ming Wang, MD, PhD, is a Clinical Associate Professor of Ophthalmology, University of Tennessee; Attending Surgeon, Saint Thomas Hospital; and Director of the Wang Vision Institute. Dr. Wang states that he has no financial interest in the products or companies mentioned. Dr. Wang may be reached at tel: +1 615 321 8881; e-mail: drwang@wangvisioninstitute.com.*

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