Patient Selection for Wavefront-Guided Treatments

This strategy is often not indicated for primary treatments.

BY GUY M. KEZIRIAN, MD, FACS

More than a decade has elapsed since the first wavefront-guided treatments were performed on the human eye. Theo Seiler, MD, PhD, performed the first treatment of this kind in 1999 in Dresden, Germany. The initial enthusiasm was high. Eagle vision! Visual acuities of 3.0 or better! Custom treatments for every eye!

But much has been learned over the years, and most of these expectations have led to disappointments. This question presents itself: Is there a role for wavefront-guided treatments in a modern refractive practice?

For most refractive surgeons, the answer is a resounding no. The greatest consideration is the laser, as platforms vary widely in their ability to deliver a pure refractive correction without inducing higher-order aberrations (HOAs), especially spherical aberration. With some lasers, conventional ablations induce large amounts of spherical aberration, and the only way to access optimized ablations is to use custom modules. However, assuming you use a modern platform, few eyes will benefit from wavefront-guided treatments. Most will do as well or better with treatments based on the refraction alone. The primary treatment goal in these eyes is not to reduce existing aberrations but to correct the refractive error without inducing new aberrations.

TAKE-HOME MESSAGE

- When wavefront-guided treatments were first developed, the assumption was that all eyes would benefit from custom treatments.
- If the treatment of significant HOAs is to be effective, there must be a corneal etiology.
- Modern lasers do not induce significant aberrations.

Most refractive surgeons know that wavefront-guided treatments offer limited benefits to their patients. Utilization of such treatments with the WaveLight Allegretto (Alcon Laboratories, Inc., Fort Worth, Texas), for example, is low—and the Allegretto is one of the few lasers that demonstrated reduction of HOAs with wavefront-guided treatments.[1] The reason is simple: Most eyes do not need wavefront-guided treatments, and these treatments may make the condition of some eyes worse. For most surgeons, it is more efficient and better to perform conventional, refraction-based treatments.

PRACTICAL PRINCIPLES

Through my work with many laser technologies, I have developed several practical principles to guide patient selection for wavefront-guided treatments. These principles assume that the laser can reduce HOAs—although few have been shown to do so. If you are working with an older laser that does not have optimized ablation profiles among its conventional treatments, you may want to use wavefront-guided treatments whenever possible, as conventional treatments induce spherical aberration even with moderate treatment amounts.

My guidelines are based on two simple concepts. First, it is impossible to reduce HOAs that do not exist. This seems obvious, but it was not as obvious when wavefront-guided technologies were first developed, when the assumption was that all eyes would benefit from custom treatments. We now know that most vir-

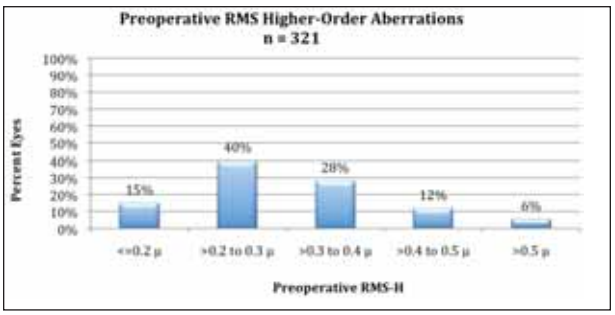

Figure 1. Distribution of the magnitude of RMS of HOAs in the SurgiVision Regulatory Consultants, Inc., FDA study of the WaveLight Allegretto Excimer Laser System, in myopic eyes.

gin eyes have subclinical levels of HOAs and will not benefit from a treatment designed to reduce them. Second, if significant HOAs do exist, they must have a corneal etiology to be effectively treated with current technologies. Lenticular aberrations are not effectively reduced with corneal-based wavefront-guided treatments because the treatment changes how light travels through the lens after surgery. In fact, wavefront-guided procedures performed on the cornea to treat lenticular aberrations can increase HOAs.

GUIDING PATIENT SELECTION

To determine the suitability of a patient for wavefront-guided treatments, ask yourself seven questions:

1. Do clinical symptoms suggest that HOAs are affecting vision? For example, is the preoperative BCVA worse than 1.0 (20/20), or does the patient complain of night glare? If the answer is no, there are likely few HOAs and they do not have much effect on vision.

2. Is the topography regular? In the absence of an asymmetric bowtie, nonorthogonal astigmatism, or other abnormalities, the lens is the probable cause of any HOA-related visual symptoms. Do not perform wavefront-guided treatments on eyes with regular topographies. Treating lenticular HOAs on the cornea creates an irregular cornea and may make symptoms worse.

3. Do the topography and aberrometry correlate? If not, then there are significant lenticular aberrations. Do not perform wavefront-guided treatments if the topography and aberrometry show dissimilar patterns. A possible exception to this rule may be treatments using the Amaris laser system (Schwind eye-tech-solutions, Kleinsotheim, Germany), which is purported to use ray tracing to modify the corneal ablation in anticipation of the postoperative optics (personal communication with

WAVEFRONT-GUIDED ENHANCEMENTS

Special considerations apply to the use of wavefront-guided treatments in eyes that have previously undergone surgery:

- Refractive errors in highly aberrated eyes can be difficult to measure using aberrometry, and in these cases wavefront-guided treatments often result in poor refractive outcomes.
- Aberrometers do not image central aberrations very well. Rays passing through the nodal point of the eye are unaltered by definition and can miss significant central distortions. Eyes with central islands are therefore not generally considered to be good cases for wavefront-guided treatments.
- IOLs present special challenges to aberrometers. Reflective glare from the IOL can compromise the ability to obtain a good image. IOL tilt or decentration can lead to wildly inaccurate readings. Multifocal IOLs are not only difficult to measure, but using wavefront-guided treatments over a multifocal IOL can lead to corneal distortions. Generally, eyes with IOLs are best treated for their clinical refractive error and not with wavefront-guided treatments.
- Conversely, eyes previously treated with small optical zone ablations or that have decentered ablations can do well with wavefront-guided treatments, provided a good image can be obtained and the wavefront refraction agrees with the clinical refraction. For some surgeons, however, topography-guided treatments are the first choice for these eyes.

Schwind eye-tech-solutions engineers). More data are needed to validate this claim.

4. Is the treatment amount less than 4.00 D? HOAs are minuscule in magnitude compared with lower-order aberrations (ie, sphere and cylinder). In the presence of large refractive errors, the utility of treating HOAs with wavefront-guided ablations is reduced. Studies suggest that eyes receiving treatments of greater than 4.00 D do not benefit from wavefront-guided ablations.[1]

5. Is it possible to obtain a quality aberrometry image? This is difficult in many eyes due to problems with the ocular surface, lens opacities, debris in the vitreous, and fixation errors, among others. Wavefront maps will interpolate data when parts of the pattern are poorly imaged, possibly leading to significant treatment errors. Most aberrometers indicate the quality of the image. You must only use wavefront maps that have excellent image quality for treatments. This consideration limits the patient population for most wavefront-guided treatments to those under 45 years of age.

Another check of the reliability of the aberrometry image is agreement of the wavefront-calculated refraction with the manifest or clinical refraction. The sphere and cylinder amounts, and especially the cylinder axis, must agree, or the patient will be left with significant refractive error. If the aberrometer cannot accurately measure the refractive error, any detected HOAs are unreliable.

6. Are the HOAs large enough to be treated? The noise in any aberrometry measurement is about 0.10 to 0.15 µm due to factors such as variability of the tear film, errors in fixation, lens movement, and detection of the aberrometry pattern. The signal-to-noise ratio must reasonably exceed 1:1 for treatment to be effective; otherwise, the treatment will introduce more artifact than benefit. Most clinicians use 0.35 to 0.40 µm root mean square of HOAs (RMSH) as a minimum threshold for performing wavefront-guided treatments. Such eyes are rare. In the US Food and Drug Administration (FDA) study for the WaveLight laser, only 18% of eyes had more than 0.40 µm of preoperative RMSH (Figure 1).[1]

7. Is the cornea normal? In some eyes, clinically significant HOAs with a corneal etiology may be due to forme fruste keratoconus, early pellucid marginal degeneration, or contact lens warpage. Most surgeons would opt to observe these eyes for stability before treating them, if they would treat at all.

CONCLUSION

In clinical practice, wavefront-guided treatments in primary cases are not often indicated (See *Wavefront-Guided Enhancements*). Modern lasers do not induce significant aberrations when they treat refractive errors, and therefore much of the initial impetus for developing wavefront-guided treatments has been removed. Few eyes have clinically symptomatic HOAs, and when they do they often originate in the lens or from pathologic conditions such as keratoconus, previous treatments, or other conditions. The science behind wavefront-guided treatments has led to many improvements in refractive surgery and especially in laser technologies, but wavefront-guided treatments per se are seldom beneficial. ■

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1. Stonecipher KG, Kezirian GM. Wavefront-optimized versus wavefront-guided LASIK for myopic astigmatism with the Allegretto Wave: Three-month results of a prospective FDA trial. *J Refract Surg*. 2008;24(4):S424-430.