Wavefront-Optimized Procedures Associated With Less Postoperative Spherical Aberration Versus Wavefront-Guided

My hypothesis regarding the effectiveness of the wavefront-optimized algorithm was reflected in my results.

BY FRED MATTIOLI, MD

The approval of customized laser refractive surgery in the United States in 2002 (Alcon Laboratories, Inc., Fort Worth, TX) and 2003 (Abbott Medical Optics Inc., Santa Ana, CA, and Bausch + Lomb, Rochester, NY) was accompanied by promises of "super" vision. Although the results with these systems were as good as or better than those obtained to date with conventional laser surgery, the promise of super vision has yet to be realized.

I believe that the biggest reason for this shortfall, if sphere and cylinder have been corrected, is that it is much easier to measure optical aberrations than it is to accurately correct them. The presence of clinically significant optical aberrations in the majority of eyes is generally minimal, with the exception of spherical aberration. Small variations in the pupil's size and position, and variable alignment with the aberrometer, will introduce measurable changes to the wavefront measurement, all of which tend to diminish the surgery's effectiveness in reducing aberrations.

With these considerations in mind, I began using the WaveLight Allegretto (Alcon Laboratories, Inc.) 400-Hz excimer laser platform. The Gaussian beam profile, eye-tracking system, and speed of ablation (less than 1 second per diopter on average for a myopic correction) were designed to minimize intraoperative variability in the refractive correction. I believed that, with these advantages and the wavefront-optimized algorithm to eliminate the induction of spherical aberration, I was likely to see low induction of postoperative higher-order aberrations (HOAs). I am happy to say that my results to date have met my expectations. I decided to test my theory that aberrations were as low or lower with the WaveLight system using the wavefront-optimized algorithm as they were with the Visx Star S4 using the CustomVue wavefront-guided algorithm (Abbott Medical Optics Inc.) by comparing a sample of eyes treated on both platforms. My center has both laser platforms.

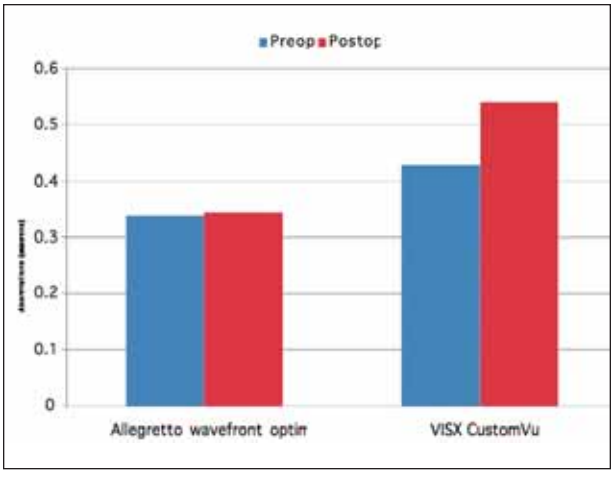

Figure 1. The pre- to postoperative change in total HOAs for all eyes.

DATA COMPARISON

Because the aberrometer's measurements can vary, I used a single instrument (WaveScan; Alcon Laboratories, Inc.) to measure pre- and postoperative aberrations on a series of 42 eyes. Of these eyes, 19 were treated with the Visx Star S4 with iris registration using the CustomVue wavefront-guided algorithm. The remaining 23 eyes were treated using the Allegretto wavefront-optimized algorithm. All eyes were myopic, except for two mixed astigmatism cases that were treated with the Allegretto system. Mean sphere was approximately -3.00 D for both groups, with a maximum treatment of -6.50 D. Average cylinder treatment was -0.75 D for both groups, with a maximum treatment of about -2.50 D. There was no statistically significant difference between the refractive errors in the two groups preoperatively, as determined by a t-test. Because the wavefront diameter affects the wavefront measurement, I also tested to see if there was any statistical difference between the diameter of the readings between the groups; there was not. Total HOAs were slightly higher in the CustomVue patients, but spherical aberration was not statistically significantly different between groups.

All eyes were refracted 1-month postoperatively. The postoperative sphere and cylinder corrections were not statistically different between the two groups of patients; the average sphere was 0.30 D in the Allegretto-treated eyes and 0.40 D in the Visx-treated eyes. The average cylinder was -0.40 D for eyes treated with both systems, and the average spherical equivalent was 0.09 for the Allegretto-treated and 0.21 for the Visx-treated eyes. All eyes were also measured again on the WaveScan system 1 month after surgery. I compared the postoperative readings with the preoperative readings for each system using a t-test.

The pre- to postoperative change in total HOAs for all eyes is shown in Figure 1. The postoperative measurements obtained with the Allegretto wavefront-optimized procedure for total HOAs and spherical aberration were statistically equivalent (total HOAs, $P = .82$; spherical aberration, $P = .30$). The results using the CustomVue wavefront-guided technique were not, however. Specifically, total HOAs with the CustomVue treatment were higher after surgery ($P = .015$), with most of that difference attributable to a large increase in spherical aberration (preoperative, 0.11 µm; postoperative, 0.34 µm; $P = .002$).

INTERPRETATION OF RESULTS

It was reassuring to see that my hypothesis regarding the effectiveness of the wavefront-optimized algorithm was borne out by the data I collected. One could argue that a system that measures and treats based on detailed HOAs has the potential to perform a superior ablation, but the delivery system significantly influences results. The Allegretto wavefront-optimized algorithm reduces the induction of spherical aberration during surgery, a function of both the algorithm and the high-speed, small-spot laser used to perform the ablation. This is reflected in the

Wavefront-Guided vs Wavefront-Optimized

Results from a prospective, contralateral study comparing wavefront-guided LASIK using the Visx Star S4 with CustomVue Excimer Laser System (Abbott Medical Optics Inc., Santa Ana, CA) to wavefront-optimized LASIK with the Allegretto Wave Eye-Q excimer laser system (400 Hz; Alcon Laboratories, Inc., Fort Worth, TX) were recently reported at the ASCRS meeting.[1]

The study—not funded by either laser manufacturer—was conducted at Stanford University by Edward E. Manche, MD, and enrolled 90 eyes of 45 patients. All patients underwent flap creation with the IntraLase FS Femtosecond Laser (Abbott Medical Optics Inc.), according to Dr. Manche, who is the director of cornea and refractive surgery and a professor of ophthalmology at the Stanford University School of Medicine, Stanford, California.

Included patients had an average age of 38 years (range, 24-55). The mean manifest spherical equivalent was -4.56 ±1.97 D in the wavefront-guided group and -4.70 ±1.73 D in the wavefront-optimized group. Dr. Manche reported that preoperative cylinder and higher-order aberrations were similar between the two groups.

Overall, the results were excellent. More than 75% of all patients achieved final results of better than 20/20 UCVA. Dr. Manche noted that the guided group had significantly better UCVA at all time points compared to the optimized group; less induction of total higher-order aberrations, coma, and trefoil; and better predictability.

According to Dr. Manche's reported results, the guided platform performed better on cylindrical correction (residual cylinder of +0.16 ±0.23 vs +0.23 ±0.33 D in the optimized group). No statistically significant differences were observed between the two groups in terms of low-contrast acuity or safety.

Dr. Manche acknowledged no financial interest in the products or companies mentioned herein. Dr. Manche may be reached at (650) 498-7020; edward.manche@stanford.edu.

1. Manche EE. Prospective randomized eye-to-eye comparison of wavefront-guided PRK and wavefront-optimized PRK. Paper presented at: The ASCRS Symposium on Cataract, IOL and Refractive Surgery; April 12, 2010; Boston , MA.

negligible increase in HOAs observed in my patient sample. The CustomVue platform performed similarly with regard to lower-order aberrations (sphere and cylinder) but did not demonstrate the ability to treat the HOAs measured preoperatively. Spherical aberration is the primary contributor to troublesome total HOAs. It appears, in this data set, that the ability to effectively manage spherical aberration at the time of surgery (ie, with the Allegretto platform) is more important than the measurement and attempted correction of more detailed HOAs (ie, with the CustomVue platform).

THE BOTTOM LINE

The most important feature of any excimer laser system is its ability to accurately and predictably treat a wide range of refractive errors. Most current laser systems can meet that goal. The ability to control optical aberrations is the next important criterion. In my experience, the Allegretto wavefront-optimized algorithm has demonstrated an ability to eliminate the induction of spherical aberration, thereby reducing or eliminating any increase in HOAs. Other authors have found no difference between the HOAs from the Visx Star S4 and the WaveLight-optimized treatment[1] and wavefront-optimized versus other wavefront-guided treatment (eg, CustomCornea).[2] Still others have noted that HOAs were lower postoperatively as a percentage reduction from preoperatively with the Visx (although there was a more restrictive limit on preoperative HOAs treated with the WaveLight platform).[2]

It would be a useful exercise in your practice to determine if the wavefront-guided treatment algorithm of your laser system is producing a similar effect. The ability to measure and then treat the wavefront is crucial to success. If your wavefront-guided system is unable to do either or both in a predictable manner, then your results may not be as "custom" as you would like. ■

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