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Technology Issue

WaveLight Allegretto excimer laser – minimizing enhancements

With wavefront-guided and wavefront-optimized laser vision correction, glare and haloes after LASIK became rare. With Intralase, flap-related surgical complications have been virtually eliminated. With many laser systems, however, enhancements remain a challenge that needs to be overcome. Even though enhancement rate is not high and enhancements typically succeed in achieving the desired vision, neither patients nor doctors like having an additional procedure. WaveLight Allegretto excimer laser, developed in Germany and recently FDA-approved, solved the riddle of less than precise outcomes and the need for additional touch ups.

Why do some patients need an enhancement after their original LASIK or PRK? Two reasons. Either the original correction was imprecise or, as they healed, the correction regressed.

The precision of the initial correction depends on consistency of the laser beam shape and energy with each pulse, predictable corneal stromal hydration during the ablation, and each patient's specific corneal collagen response.

Regression depends on the size of the optical zone (larger effective zones result in less regression), corneal curvature profile (aspheric treatments results in more stable corrections than oblate ablations that are prone to more regression), smoothness of the ablation (smooth ablation result in more stable outcomes), and patient-specific healing response.

Corneal response and corneal healing are patient-specific. But, all the other factors are laser-dependant and can be modified to improve precision of the outcome and minimize the need for enhancement.

WaveLight Allegretto laser has the following features to maximize the precision of the initial correction:

- Stable beam size of 0.95 mm throughout the entire treatment
- Closed loop energy control throughout the entire treatment. The system checks energy stability three times as the laser pulse travels through the optical system. It automatically adjusts output energy to match the target.
- Proprietary spot placement pattern to prevent thermal heating. Only the fifth pulse is allowed to overlap the first. This provides time for plume evacuation and thermal relaxation. Therefore, each pulse delivers full energy to the tissue and is not blocked by the plume of the previous pulse.

WaveLight Allegretto laser also has unique features to maintain stability of refractive outcome and reduce regression:

- The effective optical zone is large and natural corneal asphericity is maintained (Figure 1). Due to the angle of incidence at which the laser pulses hits the cornea in the periphery, light is partially reflected away from the eye. This results in energy loss of up to 80%. If such loss is not compensated for in the laser's algorithm, the post-operative ablation profile will not achieve a full optical zone and natural corneal shape will not be maintained. WaveLight compensates for the energy loss in the

Continued with The Role of Wavelight on page 2

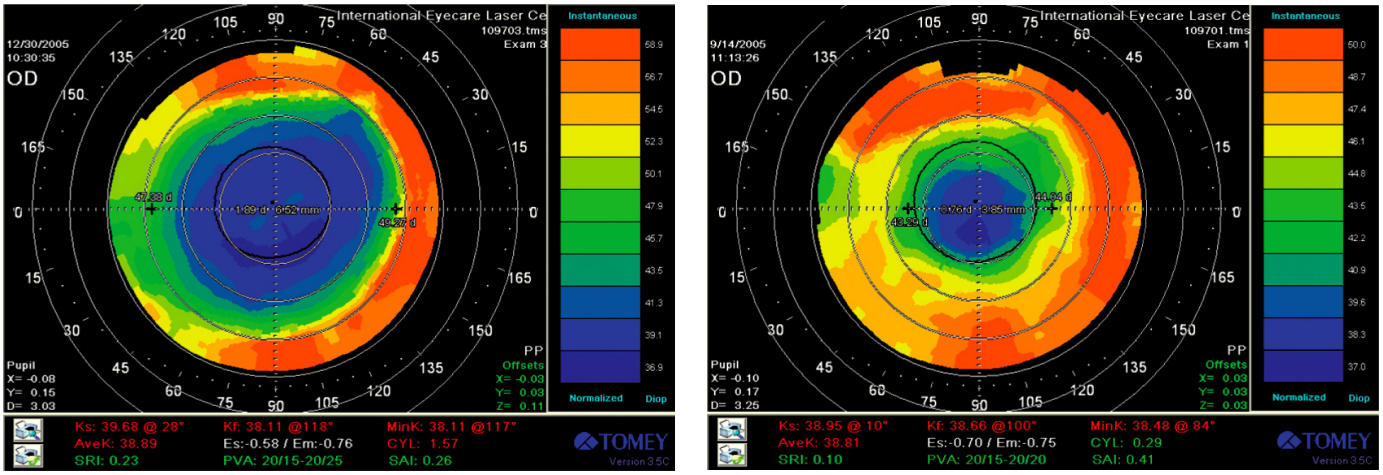

Figure 1. Effective optical zone with WaveLight laser (left) is significantly larger than with other lasers (right). Better quality of night-time vision is achieved.

Continued with The Role of Wavelight from page 1

periphery by delivering additional laser pulses at the periphery of the ablation zone (Figure 2). The pulse pattern and the amount are determined by the advanced Munnerlyn formula that incorporates each patient's specific keratometry values.

- The beam energy distribution is Gaussian rather than "top hat". It allows for a smoother ablated surface and less regression.
- The laser has the fastest ablation rate of any other lasers. Faster ablation not only improves patient comfort due to decreased time under the laser, but it also decreases stromal dehydration and the variable healing response it my induce.

In summary, WaveLight excimer laser is the new generation laser vision correction technology. With it, less than 1% enhancement rate can be achieved.

Three-year experience with IntraLase at Pacific Vision Institute

Three years ago, we began doing all-laser LASIK with IntraLase femtosecond laser. At the time, we were the first in San Francisco and one of the few in the U.S. It was obvious from the start that LASIK results were superior and that flap-related complications disappeared immediately once we switched to femtosecond technology. Patients were aware of the data as well and often came asking specifically for all-Laser LASIK.

To date, over a million procedures have been performed with IntraLase. As the laser progressed from 15kHz to 30kHz to 60kHz, it now takes less than 20 second to create the flap. The bed is smoother than with the latest generation mechanical microkeratome. The percentage of patients seeing better than 20/20 is greater. The technology, however, is complex. Outstanding results can only be achieved when the laser settings and procedure techniques have been optimized. As our experience with IntraLase accumulated, we have developed a systematic approach to optimizing laser settings and techniques, called Femtodynamics (Ocular Surgery News, July 2006).

With Femtodynamics, we can use the appearance of the opaque bubble layer (OBL) formation, the ease of flap lift, the width of the sidecut, and the postoperative corneal appearance to adjust laser settings and procedure techniques to create a consistently perfect flap. We can also minimize OBL. This is especially important if the laser used for the actual ablation utilizes iris registration. For iris registration to work accurately, the iris detail must be visible. Therefore, the cornea must be clear. Opaque bubble layer may obscure proper iris registration and compromise the results. For such lasers, experience with optimized IntraLase settings and techniques is critical to achieving good results. Lasers not utilizing iris registration are less sensitive to OBL presence during the ablation. Nevertheless, perfected IntraLase energy setting and procedure techniques optimize corneal appearance and vision results after LASIK with all the lasers.

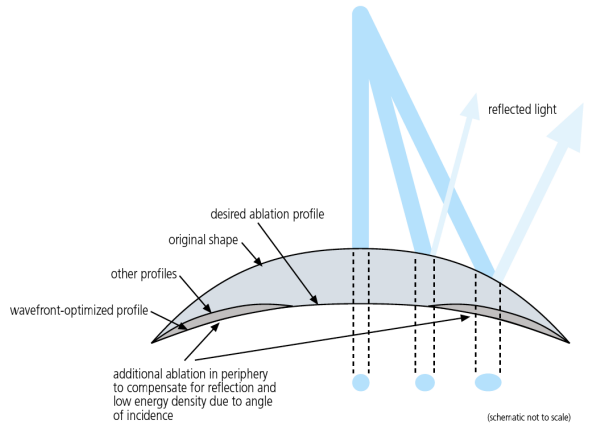

Figure 2. Compensation for energy losses with additional pulses to the corneal periphery. This preserves natural corneal asphericity, results in wide optical zone, more accurate correction, less regression, and better, more stable vision.

IntraLase settings and procedure techniques

Pocket
- Depth
- Width
- Spot separation

Raster
- Spot/Line separation
- Energy

Side Cut
- Angle
- Energy

Flap
- Diameter
- Thickness
- Hinge angle

Procedure Techniques
- Docking
- Centration
- Flap lift

What is a truly custom vision correction? (and why it matters)

When a patient asks for "custom LASIK" or "wavefront LASIK", what they are really asking is: "Can you please help me see better?" This question initiates a multi-step analysis of each individual patient, ultimately leading to a specific recommendation and a decision to proceed with an option that is right (or "custom") for this patient.

First, who is the patient? Age, gender, occupation, daily activities, why do they want their eyes corrected? Do they want to see better without glasses or contacts or do they want to see better than what they are currently seeing with glasses and contacts? Next, what is their refractive error? What is their eye health? Previous surgery, corneal symmetry, corneal curvature, corneal thickness, higher order aberrations, anterior chamber depth and width, endothelial

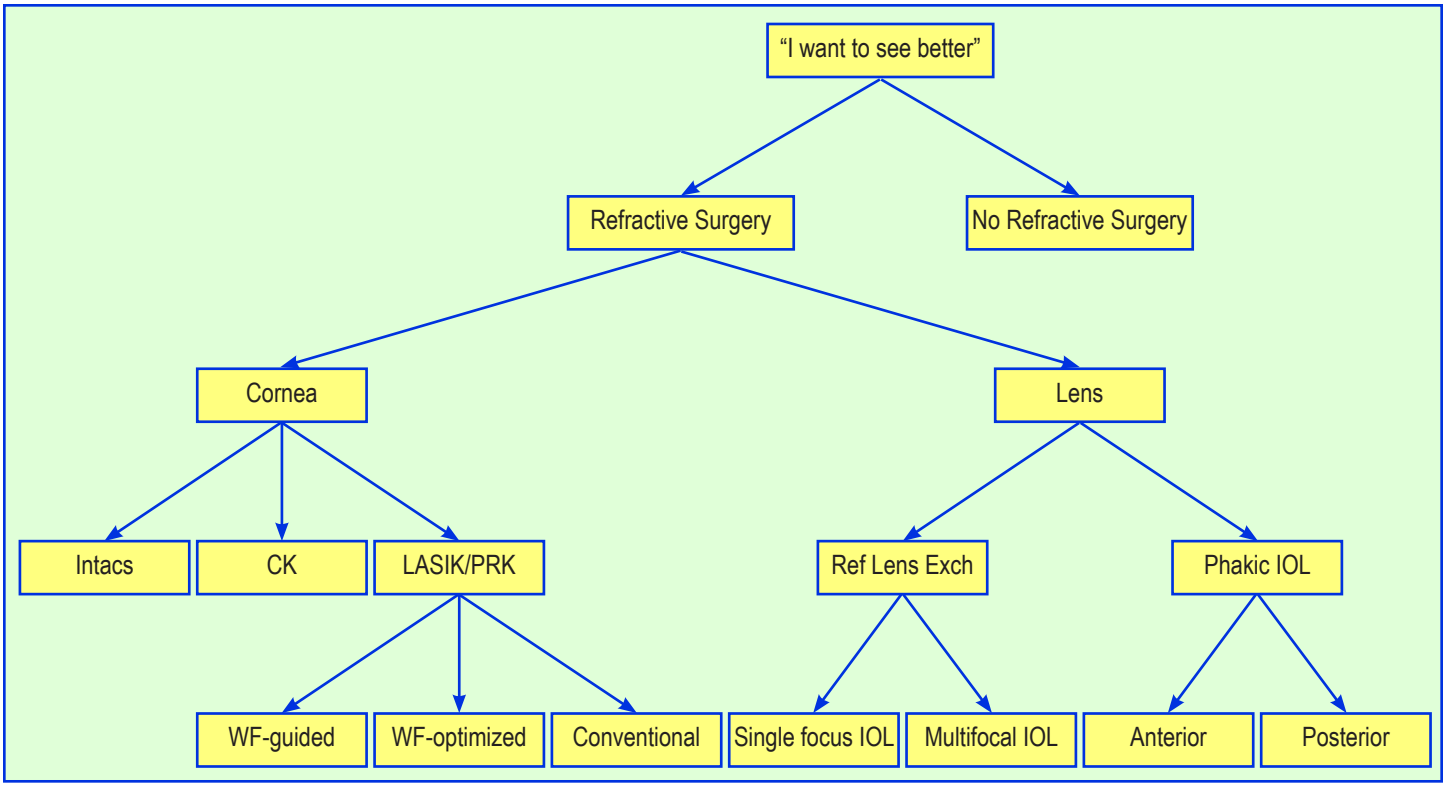

Figure 3. Integrating multiple technology platforms and procedures achieves successful outcomes.

cell assessment. We take all these parameters into consideration when deciding what procedure, what laser, what technology will help the patient achieve their goal.

Once we decide the patient is a good candidate for surgical vision correction, we determine if their correction has to be cornea- or lens-based. We recommend lens-based correction to older patients, patients with extreme refractive error and patients with very thin corneas. Refractive lens exchange vs. phakic IOL decision is made based on the status of the patient's accommodation, which is typically related to their age. Cornea-based correction is recommended to patients with perfectly normal corneas. Laser vs. conductive keratoplasty decision is made based on the status of their distance vision. If distance vision needs to be improved, we typically recommend laser vision correction. If only near vision needs to be improved, conductive keratoplasty may be a better option. If the corneal thinning disorder is diagnosed, Intacs is an excellent solution

Laser vision correction customization is next. PRK or LASIK? Depends on the corneal thickness and symmetry. Wavefront-guided, wavefront-optimized, or conventional? Depends on the level of correction, how close phoropter refraction matches wavefront refraction, and the amount and type of higher order aberrations. Patients with high levels of higher order aberrations may benefit from wavefront-guided corrections. Patients with high prescriptions, flat corneas, unusual keratometry values, and previous lens replacement procedures may benefit from wavefront-optimized corrections.

Our ultimate goal is to deliver to each patient a solution that achieves exactly what they want. Multi-laser and multi-technology capabilities are essential to successful outcome. ■

Calendar of the Upcoming Events for PVI Affiliated Doctors:

07/25/07	Cataract and Lens Grand Rounds.
03/21/08	San Francisco Cornea, Cataract, and Refractive Surgery Symposium.

Sight Gags *by Scott Lee, O.D.*

"I'm almost ready to go. I just need to put on all my eye make-up."

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