The WaveLight FS200 Femtosecond Laser

This component of the WaveLight Refractive Suite combines speed, safety, and innovation.

BY A. JOHN KANELLOPOULOS, MD

The new WaveLight FS200 femtosecond laser is one-half of the new, integrated WaveLight Refractive Suite (Alcon Laboratories, Inc., Fort Worth, Texas). The most exciting feature of this Refractive Suite is how the excimer and femtosecond lasers are able to communicate, thereby saving the surgical staff time, eliminating calculation and inputting errors, and improving laser refractive outcomes, among other benefits. On its own, however, the FS200 femtosecond laser offers myriad impressive advantages, most notably the ability to make an array of corneal cuts; to choose the diameter, shape, thickness, depth, angle, and location of corneal flaps and their hinges; to treat an array of corneal shapes and sizes; and to eliminate the incidence of opaque bubble layer (OBL).

At the podium at the recent 11th Annual Refractive User's Meeting, Theo Seiler, MD, PhD, said that although the FS200 laser is still undergoing clinical trials, it is the best femtosecond laser he has used. My staff and I have been working with the FS200 laser in Athens since it gained Conformité Européenne (CE)-Mark approval. This article describes the FS200 laser in detail.

SPEED AND ENERGY

One of the most impressive features about the FS200 laser is its combination of speed and safety. I have been cutting 8-mm, 120-µm flaps in 6 to 7 seconds. Yet, the FS200 laser delivers a surprisingly low amount of femtosecond energy to the cornea. The FS200's engineers put a lot of effort into optimizing the pulse energy and separation between the applanation spots and lines so that the laser uses the least amount of energy necessary without sacrificing speed, accuracy, or stromal smoothness. The laser applies spots of femtosecond energy in a raster pattern on the cornea. My settings for corneal flaps are 8 µm for the spot separation and 1 µm for the line separation. If I use a pulse energy of 0.7 µJ, the large energy density will be 1.09 J per square millimeter. For side cuts, the spots and rings should be slightly denser to avoid ripping the epithelium and prevent epithelial ingrowth postoperatively (Figure 1).

As a result, the laser produces very smooth stromal beds.

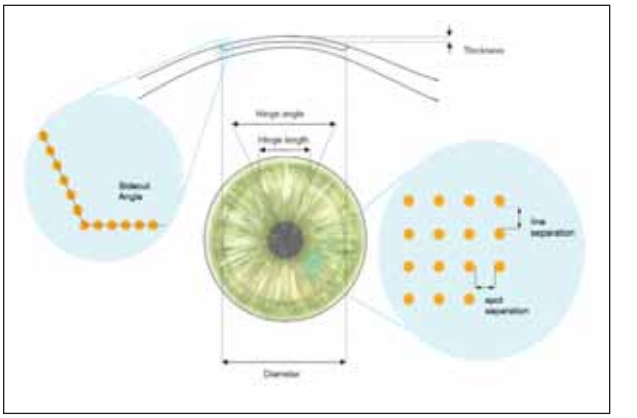

Figure 1. Spot parameters of the WaveLight FS200 femtosecond laser.

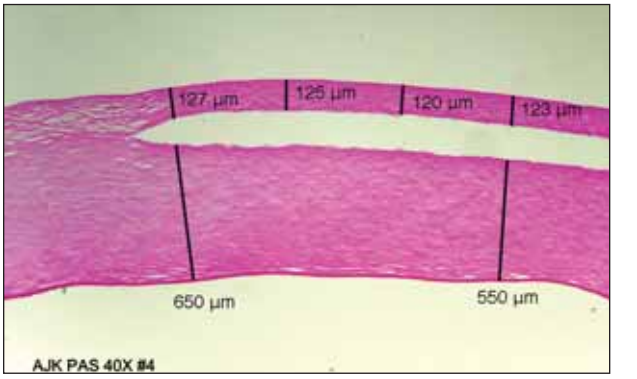

Figure 2. A histogram shows the smoothness of the stromal bed made with the WaveLight FS200 femtosecond laser.

My team and I are currently conducting histologic studies on human cadaver corneas, and the results thus far have been excellent (Figure 2).

CUSTOMIZABLE CUTS

The FS200 laser allows the surgeon to fully customize the size, shape, location, and depth of corneal cuts (Figure 3), allowing the surgeon to tailor the treatment to accommodate the needed ablation profile, corneal thickness, or other surgical considerations. The laser can make round or

elliptical cuts for corneal flaps as well as side cuts and reverse cuts for corneal segments and keratoplasties. Likewise, the FS200 laser offers presets for superior, nasal, and temporal hinges. For example, when planning a LASIK treatment for hyperopes or an ablation in the upper nasal area, the surgeon can place the flap's hinge in the lower temporal quadrant. For treating a patient who is -2.0 D @ -1.5 X 56º, he or she can position the flap hinge at 146º so it is out of the way. The surgeon may also adjust the angle of the hinge, which is beneficial for protecting the corneal nerves.

One particular advantage that the FS200 laser has over other femtosecond devices is the ability to relocate the centration of the flap within a 10-mm–diameter area, even after the suction ring has been applied. This capability is discussed in further detail in the information to follow.

CUSTOMIZABLE APLANATIONS

The FS200 laser allows the user to vary the spot size, depth, and energy delivery of the femtosecond beam. The laser is equipped with a 10-mm homogeneous beam that can be adjusted. The benefit of being able to adjust the laser's settings is customization—the laser can make stromal cuts as shallow as 30 µm away from Descemet's membrane and as deep as 900 µm.

Furthermore, the FS200 femtosecond laser can make large-diameter corneal APLANATIONS, up to 13 mm. Large applanation zones enable surgeons to make comfortable margins in hyperopic LASIK (adjusting the desired flap reticule on the laser's computer monitor does not reduce the flap size; Figure 4). The second advantage of large applanation areas is that no intracorneal pocket is needed to disperse the cavitation gas created by the lamellar cut of the flap. The laser automatically cuts a square tunnel through the flap's hinge that allows the gas to escape to the cornea's surface (Figure 4). In contrast, the IntraLase FS femtosecond laser* (Abbott Medical Optics Inc., Santa Ana, California) creates a pocket deep in the cornea to disperse the excess gas and prevent an opaque bubble laser (OBL). This vent is not located under the suction ring, but rather in the sclera. So, the gas escapes through the side of the cut, underneath the cutting area.

SAFETY FEATURES

The FS200 laser is equipped with several important safety features. First, the laser calibrates itself for the correct focal point every morning before the first surgery. Additionally, it runs a brief self-check before each use, called the *beam control check* (BCC). This calibration compensates for deviations on the z-axis and depth of field due to use and changing ambient conditions in the OR. This controlled, closed-loop energy management system sets the exact distance between the laser's optics and each new glass applanation plate. The BCC takes only 4 seconds and ensures a reproducible flap thickness. Similar to the WaveLight excimer laser's PerfectPulse Technology system, the FS200 laser continuously monitors its energy, pulse length, and beam profile.

SUCTION

The FS200 laser's two-part Advanced Suction Technology (AST) features a unique design and its own built-in safety features (Figure 5A and B). First, the surgeon or technician places the disposable plastic suction ring over the sclera and depresses the foot pedal to apply suction. The ring imparts rather low suction; IOP rises to only 60 to 100 mm Hg, and the patient can still see. This is

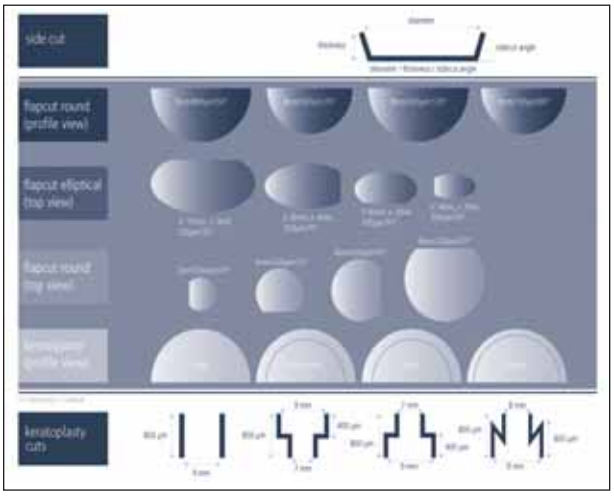

Figure 3. Possible flap and hinge cuts with the WaveLight FS200 femtosecond laser.

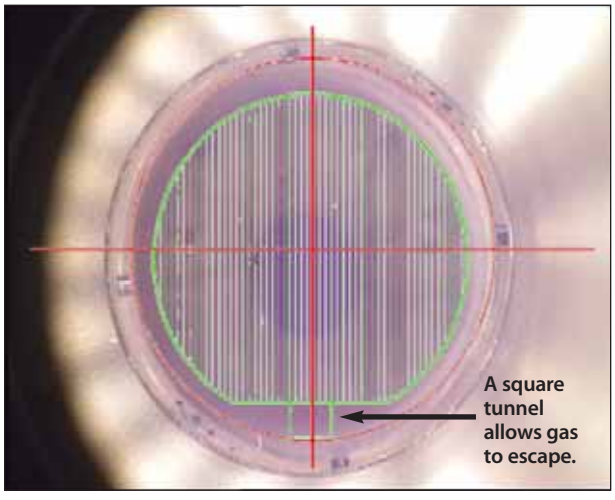

Figure 4. The FS200 femtosecond laser gives surgeons the ability to adjust flap placement after suction is applied.

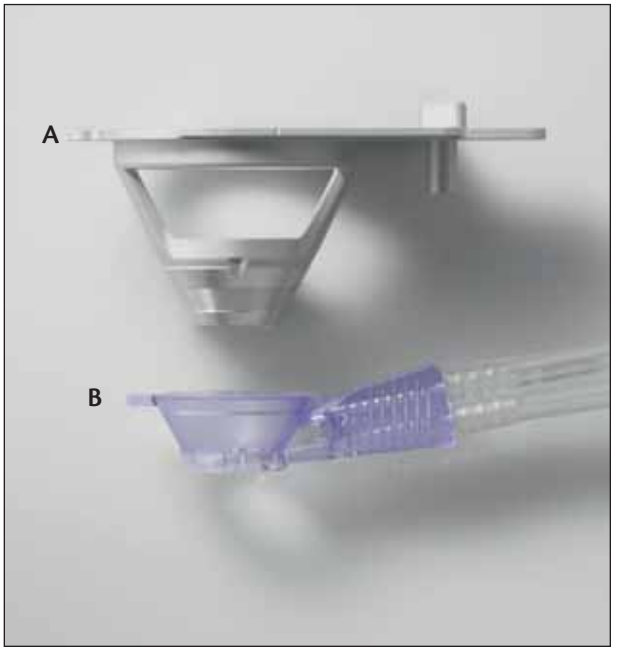

Figure 5. The WaveLight FS200 femtosecond laser's Advanced Suction Technology. First, a disposable plastic ring (A) makes contact with the sclera. After the surgeon applies suction, the cone that is attached to the laser's bridge (B) is suctioned to the scleral suction ring before the surgeon begins applanation.

the first opportunity to center or decenter the treatment area. Second, the operator lowers the applanation cone that is attached to the laser's bridge and docks it with the suction ring. A safety lock (a second suction ring) holds the cone in place. This second vacuum only interacts with the suction ring, not the eye. At this point, the surgeon may still adjust the cutting area before beginning the cut. When both vacuums are in place, the laser's screen shows a green bar indicating that the surgeon may apply the treatment. The suction ring remains on the eye for less than 30 seconds while the flap is cut.

This Advanced Suction Technology preserves the sclera's natural shape and minimizes IOP. The fixation ring contains peripheral spacers that minimize scleral deformation during suction and maintain IOP at a reasonable level (Figure 6). At the same time, the two-part system keeps the suction ring in place so the cornea cannot rotate.

ADDITIONAL FEATURES

The FS200 femtosecond laser also has a built-in high-quality Carl Zeiss microscope with stereo vision and a live video camera so the surgeon and staff may watch what is happening to the eye. The camera can also connect to an external television so that patients and family members in the waiting room can watch the surgery taking place in the OR. This is a valuable marketing tool—more impressive than watching corneal surgery on a DVD. Equally important, the camera lets the surgeon document the entire surgery for the patient's file.

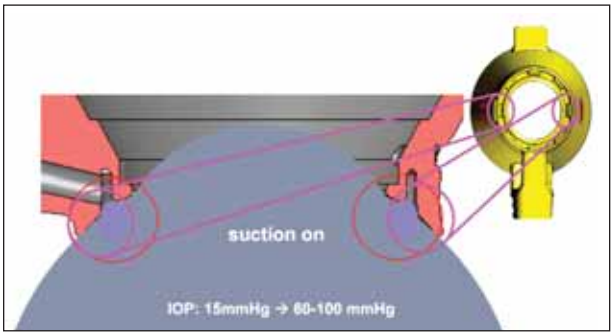

Figure 6. Peripheral spacers on the suction ring minimize scleral deformation during suction and maintain IOP.

In the OR, I really appreciate the new swiveling patient bed that transfers the patient very quickly between the two lasers. The bed's headrest can be raised and lowered without moving the bed. The headrest also tilts to make the patient comfortable. With femtosecond APLANATIONS, it is very important to keep the patient's nose out of the way. You do not want to press on the nose with the applanation cone and make the patient uncomfortable, because if he tries to move his head, you will lose the suction on his eye.

SUMMARY

Although the clinical results with this innovative laser are yet to be studied in large numbers, its performance appears promising. Time will tell if the FS200 femtosecond laser's innovative features will make it the leading contender for anterior segment surgeons. I look forward to testing the laser as part of the WaveLight Refractive Suite in a range of refractive applications. ■

**Trade names are the property of their respective owners.*

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