chapter 11

Femtosecond LASIK:
Practical Pearls From Five Years of Experience

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Through my past 17 years in Ophthalmology, I have been involved in LASIK surgery, and it has been a fascinating journey to experience and learn about the new techniques, technologies, etc. I started working with a femtosecond laser in 2002, in the time of the Intralase FS15, followed by the FS30. We started doing all our LASIK cases on the FS60 in the fall of 2006. We then became the first center in Athens, Greece (and one of the first centers in Europe) to go exclusively to femtosecond LASIK.

Throughout the past five years, we have gained experience with several femtosecond lasers. I feel that there are certain intrinsic surgical pearls that one attains through using a femtosecond laser, that I think would be interesting even for the experienced LASIK surgeon using a microkeratome. So, I will try and summarize these in this short chapter.

- In the preoperative evaluation, corneal thickness is of the essence in any LASIK case, and this should be reiterated in a femtosecond LASIK case, so we currently use two modes to evaluate corneal thickness (the Pentacam and the Pentacam II). Obviously we study, like most people, the anterior corneal surface and the posterior elevation, but more importantly I spend most of my time evaluating the normalcy of corneal thickness and looking at the *corneal pachymetry map* (Figure 11-1), which these tomographies can not give us. If the pachymetry map is round and has a symmetric thickness progression from the center to the periphery, I put more value to that as a diagnostic tool than any irregularity on the anterior curvature that may be the product of dryness or a transparent irregularity of the cornea. The example presented above is of normal anterior and posterior elevation and good thickness as noted (566 µm). Nevertheless, I consider this scan **abnormal** as the thinnest point is infero-nasal instead of central, and the thickness progression is a distorted elipse.

  We additionally use, in cases where the thickness is borderline or there is a question about the normalcy of the cornea, a pachymetric map produced by our corneal OCT device. We use the Optovue OCT device for corneal imaging, and the pachymetry map from the Optovue gives us accurate pachymetric measurements of the cornea. The pachymetry distribution of the cornea helps make the diagnosis between a normal cornea or a cornea that is more suspicious for ectasia. So, pachymetry is of the essence (Figure 11-2).
- On clinical evaluation, the difference in preoperative evaluation of femtosecond LASIK cases is spending careful attention to any superficial corneal scars. It is common that patients who are contact lens wearers—and they are the majority of people who decide to undergo LASIK for myopia, astigmatism, and/or hyperopia—may have had a sterile infiltrate or even a bacterial keratitis that was not significant enough for them to remember. We know that this may scar Bowman's membrane (and Bowman's membrane at that particular point may be absent) so in a regular microkeratome case, this would not be important as the microkeratome blade cuts through the cornea without serious consequenc-

Buratto L, Slade S, Tavolato M.
LASIK: The Evolution of Refractive Surgery (pp 95-100).

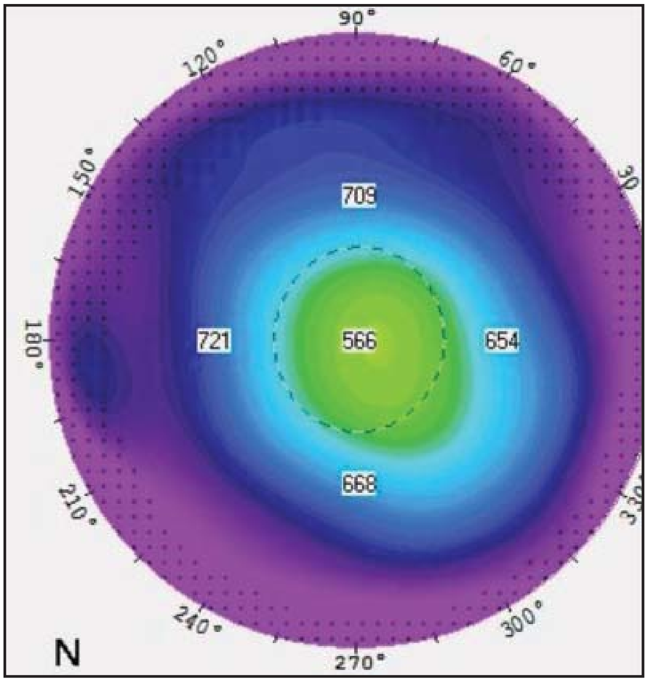

Figure 11-1. This is the most important map, in my opinion, for a LASIK candidate. This pachymetry map on the Pentacam shows inferotemporal skewing of the pachymetry escalation, suggestive of mild ectasia. This map may be irregular in normal anterior and posterior float, suggesting earlier detection. If it is normal and central, it gives me security even in cases with slightly irregural surface.

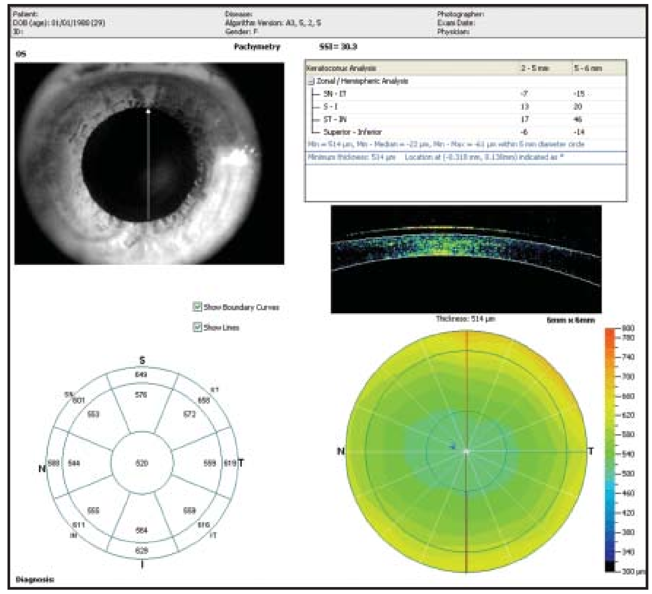

Figure 11-2. OCT devices can produce similar pachymetry maps of the cornea. This is one from the Optovue (CA) device showing normal cornea pachymetric distribution from center to periphery.

es from that corneal scar. In femtosecond LASIK, especially if we choose flaps less than 120 µm in thickness, the significant pressure from the bubble air created within the lamellar cut of the flap may find a Bowman's membrane scar as a point of least resistance and may "blow" the corneal coat through it and create a vertical gas breakthrough. This is also described as a femtosecond buttonhole.

So, great attention to such irregularities is mandated on slit-lamp biomicroscopy before the femtoLASIK surgery, especially in contact lens users. If this is omitted at the exam, most of these can be evident after the patient interface cone applanates the patient's cornea (especially in corneas that are overlined dark, iris is brown or dark brown in contrast to light blue or light green). Some actual irregularity of the cornea can be seen at that point and, if the surgeon is quick enough, the thickness of the flap can be changed from, let's say, 100 µm to 120 µm. This would be a more safe depth to perform a femto flap and avoid a vertical gasp breakthrough.

- Last, in preoperative evaluation, as we do with most LASIK cases, we access the actual ease with which the globe will be approached by the femtosecond laser patient interface cone. A lot of Southern Mediterranean men, a common patient that we see in Greece, have very deep-set eyes and very prominent eye brows. The eye brow bone is very prominent, making the distance between the tip of the nose and the actual surface of the cornea quite great and thus, a difficult approach with a femtosecond laser. Of the thousands of patients we have seen over the last 5 years, I had to exclude a few patients from having surgery because of that difficult access (Figure 11-3).

Intraoperative Issues

As far as the intraoperative issues, I pay special attention to explain to the patient that the part of procedure that involves a femtosecond laser is probably the most uncomfortable for the patient. This is because they will feel pressure, especially if it's a deep-set eye and we have to dilate the eyelids quite significantly with a lid speculum, and there will be a black out time (the time that the suction will be placed and the flap will be created). The "black-out" time has great variability, depending on the femtosecond laser and the diameter of the flap created, as well as the spacing between each individual spots. Our experience with the FS60 was a flap time creation of about 30 seconds, which is quite significant if one considers that a microkeratome LASIK is under 10 seconds. Our latest fem-

Figure 11-3. The patient-interface cone from the FS200 ready to be inserted into it's lock position.

Figure 11-4. This shows a common issue in deep set eyes. As the patient interface lowers to applanate the cornea, the nose and eyebrow may conflict with its nasal base. This problem is easily bypassed by tilting the head nasally.

Figure 11-5. The FS200 has an automatic feature on it's head-rest to tilt on either side.

tosecond device, the Alcon/WaveLight FS200, takes us about 10 to 12 seconds from docking to flap creation, reducing this black out time significantly and increasing patient comfort.

I find that carefully explaining this before the procedure is very helpful, as the patients then tolerate this procedure more comfortably. We also employ a countdown doing the flap creation, which helps limit patient anticipation. This lets patients know when the black-out period will end, which provides reassurance and can prevent the patient from moving

We have found, especially in Southern Mediterranean patients, especially men, that we need to significantly tilt the patient's head in order to get access to the cornea and avoid the femtosecond device pushing on the nose. This is uncomfortable for the patient and creates a lot of resistance and possible loss of suction during the procedure (Figures 11-4 and 11-5). So, while applanating the eye with the patient interface, I see directly on my screen how well the cornea is being applanated and how broad that area is. During this time, one of my assistants looks directly at any contact between the cone and the nose, and if there is any contact that is verbalized to me from the assistant, then we re-dock with the head now tilted a little bit more nasally, in order to avoid such contact. Obviously, after everything has been completed and we are ready to perform the procedure, the appropriate adjustment on the LASIK flap needs to be done on the laser computer software. I've found the need to decenter the flap that I see being planned on the computer, again nasally, maybe some times all the way up to 1 mm. If the head is tilted nasally and I do not perform the decentration during the procedure, my flaps tend to be deviated temporarily, which may be a problem.

So, although the flap may look well-centered on the screen, according to the pupillary image behind the cornea, if the head is significantly tilted to the side then I need to plan my LASIK flap to be exaggerated nasally (maybe 1 mm). I have found this a helpful pearl in having my flaps more well-centered. Particular care on this point needs to be taken in hyperopic patients, and I will discuss this more extensively in Chapter 21.

Last, intraoperatively I find it extremely important to have a very reproducible protocol. One has to consider that if we want to be extremely accurate in the flap thickness, we have to take into account the solution or the fluid that is going to be present between the epithelium of the cornea and the patient interface. For instance, if people use anesthetic gel before the procedure, that gel needs to be washed out extremely well. Otherwise, this gel may interfere with the actual thickness we are going to attain. If we recall, the thickness has been determined as the distance between the patient interface and the actual thickness planned. If 20 μm of lidocaine gel is between the patient interface and the corneal epithelium, then our flap is going to be cut 20 μm thinner than planned.

So, I always use a drop of alcaine and a drop of ofloxacin right before I start. This has been built into our normogram, as we usually get 5- to 10-μm thinner flaps than we actually plan on our femtosecond laser protocol. With thousands of cases now under our belt, both with the FS60 and last year with the FS200 by WaveLight, we feel comfortable that this is a very reproducible technique and does not interfere with the actual flap thickness and measurements afterward.

Also, although LASIK can become a routine, the part where the femtosecond laser generates the lamellar cut is very important, because this is the time where quick reaction is necessary if irregularity, vertical gas breakthrough, a scar, any abnormality, or patient movement can happen. In these cases the surgeon needs to step off the pedal and consider redocking and completing the procedure or aborting the procedure. With the latest femtosecond lasers, that reaction time has to be immediate. For instance, with the FS200 by WaveLight, the lamellar cut takes about 5 seconds, which is a very short time, and very quick response time needs to be made if any irregularity is noticed in the lamellar cut.

We traditionally perform both the femto flaps before we go on to the excimer laser, as we have found it easier than doing the flap first and laser second on one eye and then going back to the other eye to do flap first and excimer laser. In our experience, that has been more uncomfortable to patients, because they invariably find the femto part being the toughest, and we feel that overcoming that part first is more convenient.

Also, the key element here is to explain to the patient the focal point, both with the femto and the excimer laser. Obviously, this is standard with all of our LASIK protocol: recheck the patient's name, date of birth, and the eye being treated. In a day with multiple patients and a lot of confusion in the office, we have to always anticipate the possibility of having the wrong patient under the wrong data, a problem that could potentially happen in a busy laser center.

Then the procedure goes on to the laser room with both our Intralase FS60 platform that is coupled with the 400 Hz WaveLight laser, as well as the new refractive suite by WaveLight Alcon, where the femtosecond is the FS200 and the excimer laser is the EX500 Concerto by WaveLight. The bed connecting the femto and the laser is the same, so the patient is automatically transferred on to the excimer laser. I wait to lift the flap after the femtosecond laser has finished and the data on the excimer laser are ready to go. I use an aspirating speculum because, right before I lift the flap, I try to irrigate the eye. The pressure from the procedure can cause meibomian gland secretions to present in the corneal surface and, if the eyes are not irrigated and that is fluid not evacuated from the surface, it can find its way under the flap or the surface that is going to be treated with the laser. So, an irrigating or aspirating speculum is used to irrigate the surface well and then I lift the flap only after the data on the excimer are ready to go and we have checked that this is the correct patient that is represented on the excimer laser panel.

The online pachymetry present in the EX500 is an excellent tool for double-checking the correct flap thickness and whether there is enough corneal space on the stroma to perform the ablation planned. In our older platform, the FS60 by Intralase and the 400 Hz WaveLight laser, we use a Sonomed pachymetry measurement in order to attain this number. With the EX500, this is done automatically by the laser, optically, and is present on the screen, but right after the flap is lifted. So, then the procedures take place and the flap is repositioned. We use copious irrigation, at least half a bottle of BSS, with a disposable, single-use Hersh Visitec LASIK cannula, to irrigate under the flap and the surface, and again this is where the aspirating speculum is being activated, in order to evacuate all the solution and not have debris from the laser room air or the meibomian secretions re-enter the flap.

The flap is then repositioned. If it is a femto flap, I do not use a wet, Weckcell sponge to "fine tune it" in place, because I have found that LASIK flaps with the femtosecond laser have less slippage on the surface and if I manipulate the flap with a wet spear-sponge I may create striae. So I try to lay the flap down correctly. I use a drop of milky Pred Forte solution, in order to drop it on the surface of the eye, and that drop helps me delineate the flap edges and make sure the flap is in the correct position.

And, finally, I use a Johnston applanator. This is a nice tool to applanate the flap onto the stromal bed and take out microstriae from high myopic corrections. The device is available from Rhein, and it is basically a very large, 20-mm lens. It is very flat (about 30 D), and by pushing the lens in the center of the cornea, we make sure that the actual central part of the flap is applanated onto the laser bed that has just been ablated.

Following that, a few drops of ofloxacin are instilled. Then, we always use an Acuvue daily contact lens of zero power to lay on the cornea, extra antibiotic drops of ofloxacin and Pred Forte on the contact lens, and then we release the LASIK speculum carefully. We leave the contact lens in for approximately 15-18 hours to minimize the friction between the actual eyelids of the patient and the LASIK flap. We have found this measure, performed the past 3 years in our practice, to almost eliminate the chance of flap slippage and flap striae, although it is, I have to admit, sometimes uncomfortable for some patients in the morning as they wake up and have had this lens in for several hours.

So, this is our LASIK protocol for femtosecond laser, and it is illustrated in a video on our website: www.brilliantvision.com/FS200.