Handout

LASIK: Basic steps for safety and great results

Senior Instructor: A. John Kanellopoulos
Co-instructor: G. Pamel

Synopsis

Didactic approach to basic principles in LASIK. Excimer technology will be analysed, as well as microkeratome function and use. Indications, methodology and technique will be approached in a basic didactic function including post-operative care and management of the most common complications. Patient selection and treatment criteria will be discussed as well. This course will focus on the novice clinician, but will reiterate the basic principles for the experienced as well.

Objective

The participants will share our experience and pearls of indications, patient selection, surgical technique and complication management for safe and effective results.
COURSE TITLE: LASIK: Basic steps for safety and great results

OUTLINE:

1-Common indications for LASIK surgery are:
   - anisometropia
   - significant ametropia
   - intolerance of contact lens use
   - intolerance of spectacle use

3-Common procedures that have preceded LASIK are:
   1. RK and AK,
   2. PRK
   3. INTACS
   4. Clear lens extraction

4-LASIK for myopia, astigmatism and hyperopia
   a)- Indications
   b)- Surgical technique adaptations for specific refractive errors
   c)- Adjuvant medications
   d)- post-operative management
   e)- Possible complications and their management

5-LASIK patient selection
   a)- Indications
   b)- medical contraindications
   c)- personality dangers
   d)- pre-operative evaluation and refractive error

6- LASIK instrumentation-microkeratomes
   a)- basic principles
   b)- pre-operative evaluation parameters
   c)- Surgical technique
   d)- Possible complications and their management
   e)- maintenance issues

7- LASIK instrumentation-excimer lasers
   a)- basic principles
   b)- pre-operative evaluation parameters
   c)- Surgical technique
   d)- Possible complications and their management
   e)- maintenance issues

8-LASIK in action
   Step-by-step action on several procedures on tape, question-answer session and coverage of basic problem shooting with the panelists
Femtosecond LASIK: Practical Pearls From Five Years of Experience

Anastasios John Kanellopoulos, MD

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 ellipse.

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-
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 femtosecond LASIK 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 femtosecond flap and avoid a vertical gas 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-
Femtosecond LASIK: Practical Pearls From Five Years of Experience

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 decenteration 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 femto 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 appplanation 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.
The LASIK Flap: Ideal Size and Construction

Over this surgeon’s career, his idea of the perfect LASIK flap matured along with the technologies available for its creation.

BY A. JOHN KANELLOPOULOS, MD

In my 22 years of practicing ophthalmology, I have been involved with LASIK for the past 18. It has been a fascinating journey to learn all the new techniques and technologies and experience performing this rewarding procedure firsthand.

Throughout the time I used a mechanical microkeratome, the idea of the perfect flap matured. It was in 2002, when I first started working with a femtosecond laser, that I realized that all the parameters I had fantasized about for an ideal LASIK flap could now be done with the ease of punching numerical buttons on a computer screen. Even so, it is hard to forget the years of calculating corneal diameter, thickness, and curvature and choosing keratome rings, microkeratome pass speeds, and blade sharpness, of calibrating blades and timing the suction on the eye—all with a complicated surgeon-specific algorithm to obtain the perfect flap.

After 10 years’ experience creating flaps with the femtosecond laser, and about five femtosecond laser models later, I believe my preferences and my ability to create the ideal flap have solidified. I use the FS-200 laser (Alcon Laboratories, Inc.), and my ideal flap for a myopic treatment is 8 mm in diameter and 100 µm deep. It has been only with this femtosecond laser that I can consistently create a thin flap without going too thin (under 90 µm). Opaque bubble layer (OBL) with femtosecond flaps, however, is an ongoing issue (Figure 1A). Although I cannot claim that I have solved OBL as a problem in general, I seldom see it with the FS-200 (Figure 1B).

The advantage of thin-flap LASIK is a reduction in the biomechanical instability of the cornea as well as the area of the corneal surface that is affected during the LASIK procedure.

Creating a smaller flap reduces biomechanical instability of the cornea as well as the area of the corneal surface that is affected during the LASIK procedure.

Figure 1. (A) Opaque bubble layer is visible; (B) no noticeable opaque bubble layer is visible with the FS-200 flap.

A
B

Figure 1. (A) Opaque bubble layer is visible; (B) no noticeable opaque bubble layer is visible with the FS-200 flap.
A large angle kappa is relatively rare in myopic eyes in comparison with hyperopic eyes. However, not all myopic eyes have minimal angle kappa. Occasionally a myopic eye will have significant angle kappa, and in these cases the flap must be centered on the visual axis and not the pupillary center. The easiest way to double-check angle kappa in myopic patients is to use Placido-disc-based topography. If the pupil image is decentered from the central Placido reference disc, then significant angle kappa is present. This can be used as a quick reference guide for the busy LASIK surgeon; when the red light goes off on angle kappa, there is the potential for centration issues with a LASIK procedure, even in a myope. Our personal preference for years, which is currently submitted for publication, is to use the topography-guided platform of the WaveLight Allegretto (Alcon Laboratories, Inc.), as it automatically corrects on the visual axis (Figure 2).

There are a few caveats for a thin, small-diameter LASIK flap. Always check for corneal scars, especially in contact lens wearers, as past sterile ulcerations can disrupt Bowman membrane, creating a faint scar that may provoke vertical gas breakthrough during the flap-making process. This can trigger a buttonhole. Therefore, careful slit-lamp evaluation must be performed prior to the procedure. If a corneal scar is identified, a thicker flap should be created to avoid vertical gas breakthrough.

In addition to selecting the right flap parameters, handling of the flap must also be considered. I prefer to use disposable instruments, including a disposable irrigating cannula (Figure 3) to lift and reposition the flap (no hook or special autoclavable spatula is required). At the end of the procedure, I use a Johnston applanator (Rhein Medical, Inc.; Figure 4) to iron out the potential kinks in the flap over the myopic ablation. Adding this step has greatly improved flap adhesion and patients’ postoperative quality of vision.

I use a drop of steroid suspension at the end of the procedure to delineate the flap gutter and to ensure that the flap is centered (Figure 5). If the gutter of the flap is thinner on any one side, this indicates that the flap is skewed either to the left or to the right, and if the inferior gutter is thicker than the side gutters, this is a sign that fluid is trapped under the flap, usually near the hinge.

A particular advantage of flap creation with the FS-200 is the chimney: This is an initial passage, from the limbus into the lamellar portion of the flap, which allows venting of the intrastromal gas created by the laser (Figure 6). The chimney reduces the occurrence of OBL and avoids the need to create a pocket to vent this gas.

A large angle kappa is almost the rule rather than the exception in hyperopic eyes. For more than 8 years now, I have performed topography-guided treatment in hyperopic eyes. In hyperopic cases, the flap diameter is 9.5 mm. The larger flap diameter means more cutting time is required; it takes approximately 12 seconds for the FS-200 to create a 9.5-mm flap. Therefore, I increase the flap depth to 130 µm. If there is patient movement, loss of suction, or any other abnormality during the
longer procedure, the laser activity will be deeper in the cornea, and I will have the room and ability to redo the flap. This would be more difficult if a 100-μm flap was planned.

A deeper flap requires a steeper and wider sidecut (my preference is 70º), posing a barrier to epithelial ingrowth, which is more likely in hyperopic eyes than in myopic eyes. The FS-200 allows the (intentional) decentration of the flap toward the visual axis, thus corresponding with the decentration of the ablation toward the visual axis, which is usually decentered nasally in hyperopic patients.

OTHER CONSIDERATIONS

I evaluate all flaps with the online pachymeter of the EX-500 excimer laser (Alcon Laboratories, Inc.). Many other modern laser platforms have similar functions. All flaps are created with a femtosecond laser, avoiding the need for complicated calculations and the risk of producing a flap that is too thick or thin. Our experience now includes more than 4,000 cases performed with femtosecond laser flap creation, all with pristine results.

One of the promises of the femtosecond laser, performing ultra-thin flaps, has not come to fruition. Any time I have created a flap under 90 μm, I have seen late haze resembling the haze observed after PRK. Perhaps 90 μm is too close to Bowman membrane, exciting keratocyte activity in that location and leading to subepithelial haze. Therefore, in my opinion, the gold standard for myopic LASIK is the 100-μm flap, given that the femtosecond laser to be used can reproducibly create flaps with this thickness; alternatively, I would move toward 110- to 120-μm flaps, especially during the learning curve with a new femtosecond laser. On a sidenote, I have increased the minimum thickness of the residual stromal bed to about 340 μm, and a thinner flap allows me to do that.

It may sound like an extreme prerequisite to have a residual bed thickness of 340 μm for LASIK cases, but practicing in an area where keratoconus is rampant, and treating a lot of patients under the age of 30 who may appear topographically normal but may not in fact be normal, a residual stromal bed of 340 μm is safe. If I cannot confirm this thickness, I prefer to implant a phakic IOL such as the AcrySof Cachet (Alcon Laboratories, Inc.) or the Artiflex (Ophtec).

CONCLUSION

In my practice, LASIK is still the premiere refractive procedure for the correction of myopia up to 10.00 D and for hyperopia up to 6.00 D. My preferred parameters for myopia are an 8-mm flap diameter and 100-μm flap thickness; for hyperopia, it is for a 9.5-mm diameter, 130-μm thick flap centered on the patient’s visual axis (usually infranasally).

A. John Kanellopoulos, MD, is the Director of the LaserVision.gr Eye Institute in Athens, Greece, and is a Clinical Professor of Ophthalmology at New York University School of Medicine. Dr. Kanellopoulos is also an Associate Chief Medical Editor of CRST Europe. He states that he has no financial interest in the products or companies mentioned. He may be reached at tel: +30 21 07 47 27 77; e-mail: ajkmd@mac.com.
Refractive surgery has gained significant popularity in the past 2 decades by eliminating the need for spectacles or contact lenses. I have come to realize that hyperopia is not just the opposite of myopia. Hyperopic patients have several distinct differences:

1. They are almost always undercorrected. This is due to variable degree of accommodating spasm, resulting in common “regression” following LASIK, and second and third treatments to be necessary.

2. They have large amounts of angle kappa. As we will expand herein, the visual axis of hyperopes is usually 0.5 to 1.5 mm off the geometric center of the pupil. This is in stark contrast to myopes and needs special attention during laser correction.

3. In our population of Southern Mediterraneans, PRK appears to be a poor option for hyperopic correction, even of small amounts, due to the increased regression percentages (up to 35%) and the invariable scarring associated with it, despite MMC use. LASIK therefore becomes the only laser correction option in my opinion in our patient population.

4. The mean age of the hyperope corrected in our practice is near or over the presbyopic age making overcorrection in the non-dominant eye a serious consideration in our practice to be discussed and demonstrated by contact lenses in all hyperopes as will be discussed below.

These are the basic reasons of why I feel hyperopic laser corrections with LASIK deserve a special chapter.

While the lasers and software that drives them become more sophisticated, there are still alignment errors during photoablation that could lead to decenteration and nonhomogenous ablation patterns. Decentered ablations can lead to negative visual effects including irregular astigmatism, reduced best-corrected visual acuity, glare, etc. Thus, proper centration of the ablation zone during refractive procedures is an essential goal. However, a large angle kappa, which is defined as the difference between the primary line of sight and the pupillary axis, may cause alignment errors during photoablation. This issue is more important in hyperopic patients who tend to have larger angle kappas. Because of this, some refractive surgeons prefer to alter the location of the ablation to take into account a large angle kappa. However, there are few data in the literature concerning the normative values of angle kappa in healthy subjects.

**Angle Kappa**

Angle kappa is determined by the intersection between the line of sight and the pupillary axis. Because the fovea lies slightly temporal to the point at which the pupillary axis intersects with the posterior pole of the globe, the normal angle kappa is slightly positive. Evaluation of angle kappa before refractive surgery has gained significant importance because ablation zone centration during refractive surgery is a critical step. Uozato and Guyton asserted that centering on the pupil is the proper method of centration because the photoreceptors are aimed toward the center of a normal pupil; their method has
since become the standard practice. However, Pande and Hillman stated that the optimal centration is the corneal intercept of the visual axis because this is the line joining the fovea to the fixation point. They have concluded that coaxially sighted corneal reflex was nearest the corneal intercept of the visual axis. Recently Nepomuceno and colleagues performed hyperopic LASIK with the ablation centered on the coaxially sighted corneal light reflex. They have concluded that the traditional centering method based on the entrance of the pupil could lead to decentration in the presence of a large angle kappa, especially in hyperopic patients. There are various methods that measure the amount of angle kappa. Synoptophore is one of the most widely used methods in the clinical practice. It measures angle kappa depending on the corneal reflection methods. Recently, newer devices such as Orbscan II (Orbtek Inc., Bausch + Lomb, Rochester, NY) have become commercially available and can be used in the evaluation of angle kappa. But, there are no published data evaluating the reliability of Orbscan in measuring angle kappa. We have reported the significance and magnitude of angle kappa when studying a normal hyperopic population. Other authors have also underlined the importance of angle Kappa in refractive surgery. We have also previously reported our experience in hyperopic LASIK utilizing a mechanical microkeratome (Moria M2) and the Wavelight Allegretto excimer laser.

In a Journal of Refractive Surgery article in 2007 titled “Measurement of angle kappa with synoptophore and Orbscan II in a normal population” by Basmak, Sahin, Yildirim, Papakostas, and Kanellopoulos, we found that there is a significant correlation between positive refractive errors and large positive angle kappa values. Refractive surgeons must take into account angle kappa especially in hyperopic patients in order to avoid complications related to decentration of ablation zone (Figures 21-1 and 21-2).

The LASIK flap may need to be de-centered as well to accommodate the angle kappa. This is challenging for the surgeon (Figures 21-3 and 21-4).

We have presented our experience in comparing hyperopic standard to topography-guided LASIK (AAO, 2007) (Figure 21-5). Topography-guided femto-LASIK and standard LASIK appear to be both safe and effective for hyperopia. Topography-guided femto-LASIK appears be superior in regard to regression, residual astigmatism, contrast sensitivity, and estimated ablation decentration in regard to the visual axis. Hyperopic LASIK utilizing the topography-guided WaveLight Allegretto excimer laser appears to be safe and effective in the correction of low, moderate, and high hyperopia and/or hyperopic astigmatism. The results appear to be safe and predictable for the low and moderate hyperopia groups; they appear to carry similar promise in the high hyperopia/high cylinder group. The topography-guided platform appears to better center the ablation to the visual axis vs the pupillary center with high level of reproducibility in all cases, and compared to our previously published results with standard hyperopic treatments with this laser.

**Measurements**

We currently use as our treatment values the dilated (with one drop of mydriacyl 1%) pupil measurements and not cycloplegic measurements as we feel that they do not represent a physiologic condition. We make...
it an effort to try contact lenses on all hyperopic patients prior to LASIK in order to appreciate the proposed correction better. This is the point that we showcase to them—overcorrecting the non-dominant eye by 0.5 D and how well they can tolerate this. This is well-tolerated by the majority and offers a great near advantage up to ages of 55!

We use placido disk topography along with the Pentacam, a tool that better illustrates the degree of angle kappa.

As with most hyperopic measurements, the dilated pupil measurement is usually 0.5 to 1 D more hyperopic. We use an optical zone of 6.5 mm (the treatment zone is 6.5 to 8.5 mm) and use the upper limit of 6 D of spherical equivalent—meaning up to +6 of hyperopia or up to +6 in spherical equivalent for mixed astigmatism (it is possible to treat a +7 -2.5 D astigmatism as this would be the equivalent of +4.5 +2.5 D of astigmatism). We treat with these parameters, but discuss with patients prior to their surgery the fact that they may be myopic 0.5 to 1 D 1 to 3 weeks following the femto-LASIK, until their accommodative spasm relaxes. We have a 3% re-treatment rate with this protocol, a fact that greatly reinforces this approach. We have to share though the fact the hyperopes become extremely anxious during this 1- to 3-week myopic interval, and they require ample reassurance and plenty of discussion time.

We feel that correcting for angle kappa gives more accurate results and prohibits the induction of astigmatism, a common occurrence with hyperopic corrections due to the “eccentric” placement of the ablation on the pupillary center and not on the visual axis.

We have had the opportunity to enhance our hyperopic femtoLASIK treatments these last 12 months with the new Alcon/WaveLight refractive suite platform. This platform utilizes the FS200 femtosecond laser with a distinct advantage for hyperopes: a very large applannation area on the cornea allowing for comfortable “nasal” decentration of the flap in order to accommodate the angle kappa-corrected ablation center.

In Figures 21-6 and 21-7, the reader can appreciate the excimer treatment plan (the refractive suite utilizes the ultra-fast EX500 excimer that is linked to the Pentacam HD, called the Oculyzer II as a platform device) in reference to the pupil and can clearly understand the necessity of an equally nasally placed ablation. The actual 9.5-mm flap created by the FS200 femtolaser is noted in the second picture. As an additional safety feature, the refractive suite is inter-connected via its network not only between the...
Figure 21-6. The topography-guided treatment plan with the EX500 excimer laser by Alcon. The ablation is clearly decentered nasally in reference to the pupil, but centered to the visual axis.

Figure 21-7. This is the treatment report of the FS200 Femto laser by Alcon. A 9.5-mm diameter, 140 µm in depth flap was just completed. In anticipation of the above topography-guided hyperopic ablation, please note that the flap is intentionally decentered nasally (close to the limbus). The FS200 offers a great advantage to this purposes. The large applanated area on the cornea allows the surgeon to “move” the flap plan nasally, without limiting the flap diameter.
two lasers but additionally to the Pentacam device (the Oculyzer) for enhanced safety in data processing. The actual Pentacam scans of each eye of the patient are fed seamlessly to the EX500 and are processed by surgeon and staff. The treatment plan is viewed on the EX500 screen, but also superimposed over the femto flap planned on the relative flap-making process that precedes on the FS200 femtosecond laser. This is an extremely helpful tool for the learning curve of performing topography-guided hyperopic LASIK.

The picture below represents the final FS200 report documenting all flap parameters used, as well as the actual flap position at the termination of the side-cut. Please note the nasal (to the left) decentration of the flap in regard to the pupil.

A last consideration for hyperopes, especially the over 40 age group, is the increased incidence of narrow angles. We caution clinicians that hyperopes of over 3 D may have significantly narrow angles, a fact that needs to be evaluated thoroughly; especially when considering that the progressive cataract formation in these patients will further narrow the angle and potentially lead to angle closure attack(s). It is reasonable to consider premature cataract extraction in these patients and/or laser peripheral iridotomy as this approach may eliminate both the hyperopic correction and the phacomorphic danger of glaucoma.

REFERENCES


LASIK requires that a surgeon use a microkeratome to create a corneal flap. This has been the major deterrent in comparison to PRK and other surface ablations. As a cornea surgeon, I am generally comfortable operating this flap—as far as I keep close track of the equipment and parameters involved.

A portion of the flap remains attached to the eye (ie, as a hinge), while the remainder is gently lifted up and back to expose the inner cornea. This means that part of the corneal nerves are not affected, and the rest are incised within the flap and left to regenerate. LASIK is considered to be the refractive technique that induces the most dryness when compared with PRK. It is, though, unfair to compare dryness between PRK and LASIK in different refractive errors. Most PRKs are indicated for up to -5.00 D, whereas the average LASIK correction is for -5.00 D.

**ADVANTAGES**

Eyedrop medications—a significant advantage in LASIK—are used for up to 1 week, and the patient may typically resume most normal activities the following day and full activity within 1 week. Most of the healing process takes place within 1 week, except for dryness that reverses within 1 month to 3 months. There are several other advantages that make this procedure the most popular among refractive surgeons and patients. Below is my Top 10 list:

1. It can treat wide ranges of refractive error with great accuracy (ie, myopia from -0.50 D to almost -14.00 D; hyperopia from 0.50 D to 6.00 D; and astigmatism up to 6.00 D). This is not quite possible with PRK.

2. In contrast, surface ablations are generally not used in hyperopia, as they are invariably associated with regression and corneal haze—despite the use of mitomycin C. It is quite important to consider that (1) LASIK holds an advantage for all hyperopic corrections in a population that I have carefully studied over the last few years, and (2) LASIK may offer a similar rehabilitation in hyperopes as in myopes.

3. The visual rehabilitation is very rapid, and the risk for infection is less than 1 day. In contrast, surface ablations take 3 days to 6 days to offer reasonable visual function. It may take up to 2 weeks to reach the vision level of post-LASIK day 1. PRK is associated with risk of infection up to 3 days to 5 days (ie, until the epithelium completely heals).

4. Regarding the preservation of normal corneal anatomy, LASIK preserves the epithelium and Bowman’s membrane. Both are removed during PRK, and therefore it is sometimes slow to heal. This results in reduced risk of light sensitivity with LASIK, while it may occur for 1 week to 2 weeks after PRK.

5. PRK—and generally all surface ablations—is often

---

**REFRACTIVE MINI FOCUS ON SURFACE ABLATION VS LASIK**

**LASIK: POINT**

**Why is LASIK My Preferred Refractive Surgery Procedure?**

PRK and other surface ablation techniques should only be used as an alternative for thin and irregular corneas.

**BY A. JOHN KANELLOPOULOS, MD**
associated with severe pain on postoperative day 1, and it may be associated with significant discomfort for up to 1 week. PRK patients usually take pain relief medication for approximately 1 day to 2 days postoperatively, because most pain fibers in the cornea are located in the surface portion. With PRK, these are affected and left “uncovered” during surgery and the healing process. This is a major deterrent for patients considering the procedure.

6. The ability to establish the final refractive outcome is approximately 1 month with LASIK, but lies between 3 months to 6 months with surface ablations. This makes it very difficult to retreat or to establish postsurgical results.

7. Inflammation is very rare with LASIK—with the exception of diffuse lamellar keratitis that has now become a rarity. Significant inflammation and haze is common in PRK, especially when attempting hyperopes and/or refractive errors more than -5.00 D. The cornea keratocytes may respond strongly to the intervention. Most surgeons use mitomycin C, and some surgeons anecdotally use frozen balanced salt solution on a week cell to reduce the possibility of haze. Although the use of highly diluted mitomycin C has become generally acceptable internationally, the use of freezing is—in my opinion—a dangerous practice, as freezing in vivo may affect not only keratocytes but also endothelial cells. Significant post-PRK haze poses a difficult problem, as it requires large and long treatment with corticosteroids (ie, significant risks for cataract genesis and/or glaucoma) and/or reoperation (Figure 1).

8. Humans are unique among mammals in that Bowman’s membrane is present in the cornea, and I share the theory that it may be needed as an important optical “accessory” in the needs of human visual function. Unfortunately, Bowman’s membrane is inadvertently removed in all surface ablative techniques including PRK. The Bowman-less cornea visual properties have not been well understood, and therefore have not been carefully evaluated. The future will determine whether this theory is of any importance.

9. In my opinion, flap problems have been the sole disadvantage of LASIK. With accrued experience, most are preventable and treated with good visual outcome. I have been a strong proponent of thin LASIK flaps (ie, 100 µm to 120 microns) and have been very consistent in establishing my goal in most cases. In the past, I used a highly customized algorithm with the Moria M2 microkeratome (Moria, Antony, France) and precalibrated blades. In my practice, beside infection, flap striae are the second-largest concern with LASIK. Nevertheless, I see this complication a couple times a year and treat it with immediate hypotonic water irrigation and ironing followed by seven interrupted tight 10-0 nylon sutures in a fashion similar to a penetrating keratoplasty. They are usually removed within the week, and the visual rehabilitation had been excellent and without problems. I still believe that these eyes are better off with the LASIK procedure versus PRK. I have not seen this problem yet in my Intralase-LASIK cases (Intralase Corp, Irvine, California).

10. The popularity of femtosecond lasers, and Intralase particularly, has minimized flap-related problems and further boosted the use of LASIK versus PRK. It is its ability to create a planar flap of a precisely desired thickness that this technology can now offer with very high levels of safety. Unfortunately, the costs involved are significant. So, though, was our transition from radial keratotomy to excimer laser refractive surgery. This means less chance of ectasia, less biomechanical change and response from the cornea, and rapid visual recovery.

It is for these reasons that I think that today, any refractive surgeon that has access to an Intralase will have LASIK as the preferred procedure and reserve PRK (or any other surface ablation technique) as an alternative for thin and irregular corneas.

A. John Kanellopoulos, MD, is a Corneal and Refractive Surgery Specialist. Dr. Kanellopoulos is Director of Laservision Eye Institute in Athens, Greece, and practices in New York. He is Attending Surgeon for the Department of Ophthalmology at the Manhattan Eye, Ear, and Throat Hospital, in New York, and Clinical Associate Professor of Ophthalmology at New York University Medical School. Dr. Kanellopoulos states that he has no financial interest in the products or companies mentioned. He is a member of the CRST Europe Editorial Board. He may be reached at +30 21 07 47 27 77, laservision@internet.gr.