Since its inception, excimer laser refractive surgery has evolved full circle. Early practitioners used a surface ablation approach, PRK, but this technique can be accompanied by postoperative pain, prolonged recovery time, and frequent development of postoperative corneal stromal haze. LASIK soon supplanted PRK as the leading refractive surgery technique. However, with the increasing adoption of LASIK, concerns grew regarding postoperative keratectasia.

The past few years have witnessed renewed interest in surface ablation with two so-called advanced surface ablation techniques: (1) LASEK, in which the epithelium is removed with alcohol, and (2) epi-LASIK, in which the epithelium is mechanically lifted without adjunctive agents. In both procedures, laser photoablation is performed just above the Bowman layer.

Although the rate of visual recovery may be slower in surface ablation than in LASIK, surface ablation is effective for surgical correction of low to moderate myopia; its utility for the correction of high myopia is limited. With the introduction of thin and ultrathin flaps using femtosecond lasers and newer mechanical microkeratomes, indications for the two surgical modalities are becoming less distinct.

In 2004, during the annual meeting of the American Society of Cataract and Refractive Surgery (ASCRS), Dr. Carriazo reported a biomechanical response of the cornea after corneal flap creation. A correlation was seen between flap thickness and the degree of aberrations induced. Flaps thinner than 130 µm induced much less optical aberration than flaps thicker than 140 µm. This finding suggests that a difference exists between traditional LASIK, with flaps averaging 170 ±30 µm, and thin-flap LASIK, with flap thickness averaging 110 ±20 µm.

We have proposed naming this thin-flap approach laser anterior-stromal keratomileusis (LASAK). In LASAK, the ablation depth lies between those used in surface techniques and those used in LASIK, combining the advantages of both techniques and, for the most part, avoiding the associated adverse events.

The advent of ocular wavefront measurement and customized correction to reduce significant higher-order aberrations (HOAs) has introduced another dimension to the debate regarding surface ablation and LASIK. Wavefront analysis has shown that conventional refractive laser techniques were far from ideal, with aberrations induced by conventional algorithms and by the LASIK flap cut. Therefore, it has been suggested that surface ablation procedures may be better suited for customized correction, as they avoid the induction of aberrations related to the flap and interface, although this has not been proven clinically.

It has also been suggested that creation of the corneal flap in LASIK can induce further HOAs, especially coma-like aberrations. This may be particularly relevant to thinner flaps, which may have a higher incidence of flap striae than thicker flaps. The clinical relevance of these flap-induced HOAs, especially in relation to newer microkeratomes and femtosecond lasers and the effects of flap thickness, requires further investigation.

For patients who do not require customized treatments to reduce HOAs, new ablation profiles have been introduced, such as aspheric profiles aimed at maintaining the normal prolate shape of the cornea or at maintaining the preexisting aberrations of the eye. The Schwind Aberration-Free profile (Schwind eye-tech-solutions) is one such aberration-neutral aspheric profile; it aims to maintain HOAs at preoperative levels.

Aspheric ablation profiles are designed to preserve preexisting HOAs. The optical quality of the postoperative
Retinal image is, thus, similar to the patient’s preoperative best corrected retinal image to preserve the visual print and minimize the need for neural adaptation.12-14

CHOOSING THE BEST TECHNIQUE

At our center, the decision of whether to perform alcohol-assisted LASEK or LASAK (LASIK with a 90- or 110-µm microkeratome head) is based on the patient’s preoperative central corneal thickness, measured by ultrasonic pachymetry (DGH-550 Pachette 2; DGH Technologies), and the predicted depth of ablation. LASEK is performed on all patients with central pachymetry less than 500 µm. Eyes with central pachymetry greater than 500 µm are assigned to either LASEK or LASAK, depending on the central pachymetry and the estimated depth of ablation. The decision is based on the attempt to limit the ablation to the anterior one-third of the cornea, so as to achieve a residual stromal bed thickness of at least two-thirds of the preoperative pachymetry. If a patient does not meet the two-thirds condition, he or she is assigned to LASEK. Other operative considerations are outlined in Table 1.

The Amaris Total Tech laser system (Schwind eye-tech-solutions) is the platform used at our center for excimer laser ablation. The Carriazo-Pendular microkeratome (Schwind eye-tech-solutions) with a 90- or 110-µm head is used for creation of corneal flaps in patients undergoing LASAK.

SURGICAL TECHNIQUE

For corneal and conjunctival anesthesia, two drops of proparacaine HCl 0.5% are instilled three times before the patient is moved to the operating room.

In eyes assigned to LASAK, ultrasonic pachymetry of the stromal bed is performed before and after flap creation. A flap with a superior hinge is made using the Carriazo-Pendular microkeratome with a 90- or 110-µm head. Excimer laser ablation is performed, followed by repositioning of the epithelial flap.

In eyes undergoing LASEK, 19% alcohol is applied for 30 seconds to facilitate creation of the epithelial flap. An 8- or 9-mm diameter epithelial flap is made after incising the corneal epithelium with a trephine. Excimer laser ablation is performed, followed by repositioning of the epithelial flap. A contact lens is applied at the end of surgery in all LASEK-treated eyes.

Postoperatively, for patients who have undergone LASAK, we prescribe topical TobraDex (tobramycin/dexamethasone ophthalmic suspension; Alcon) three times daily for 1 week along with preservative-free artificial tears for the first 3 months. For patients treated with LASEK, lomefloxacin 0.3% and pranoprofen 0.1% are prescribed prior to epithelial healing. A bandage contact lens is applied in all LASEK patients for 5 to 7 days until epithelial healing is complete. Afterward, preservative-free artificial tears are given along with Efemoline (fluorometholone 0.1%, naphazoline HCl 0.025%; Novartis Ophthalmics) eye drops three times daily for 3 months. The steroids are gradually tapered every month to once daily in the last month.

Patients treated with LASAK are examined on the first postoperative day and at 1, 3, and 6 months. Those treated with LASEK are examined on the first postoperative day, at 1 week, and at 1, 3, and 6 months.

CLINICAL EXPERIENCE

In our clinical experience with more than 4,000 eyes (more than 3,000 LASAK and more than 1,000 LASEK), the surgical approach used does not affect the extent of change in HOAs. This may indirectly indicate that the creation of the ultrathin, nearly planar LASAK flaps with the Carriazo-Pendular microkeratome does not induce clinically relevant HOAs.

We have found treatment with an aspheric ablation profile to be safe, efficacious, and predictable, irrespective of the surgical approach utilized. There are no significant differences among the surgical modalities of LASEK or LASAK regarding safety, efficacy, or refractive predictability.

Analysis of induced HOAs suggests that the aspheric ablation profile is successful in preventing significant change in the levels of HOAs relative to preoperative levels, except for a slight change in spherical aberration. This is proportional to the achieved refractive correction.

Further analysis of induced spherical aberration reveals that the change in spherical aberration is similar between LASIK and LASAK groups and comparatively less than that reported in other studies.11,15-17 The induced spherical aberration per 1.00 D of spherical correction is approximately

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TABLE 1. CONSIDERATIONS IN CHOICE OF LASAK OR LASEK

<table>
<thead>
<tr>
<th>LASAK</th>
<th>LASEK</th>
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<tbody>
<tr>
<td>Aspheric ablation volume</td>
<td>Aspheric ablation volume</td>
</tr>
<tr>
<td>Compensate for biomechanics, flap cut, IOP, etc.</td>
<td>Compensate for biomechanics, IOP, etc.</td>
</tr>
<tr>
<td>Large flap discs (&gt;9 mm)</td>
<td></td>
</tr>
<tr>
<td>Thin flaps to minimize the cutting of corneal nerves</td>
<td>Intraoperative pachymetry to assess bed thickness</td>
</tr>
<tr>
<td>Intraoperative pachymetry to assess actual flap thickness</td>
<td>Avoiding ablation of outer disc and edges</td>
</tr>
<tr>
<td>Avoiding ablation of hinge, inner face of the lenticule, and flap edges</td>
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0.03 µm in eyes undergoing LASEK and 0.02 µm in eyes undergoing LASAK; both are comparatively lower than the 0.10 µm per diopter reported in other studies.16,18

The lower levels of induced spherical aberration with the aspheric Aberration-Free ablation profile are a result of the software’s attempt to compensate for factors that induce HOAs including peripheral energy loss due to corneal curvature, tissue removal, cyclotorsion, centration, and thinning of the cornea. Influences that are not compensated for by the ablation software include wound healing and biomechanical response of corneal stroma, spot-size limitations, and measurement errors.15,18-25 Factors such as corneal wound healing response are likely to vary among groups due to the difference in techniques of flap preparation. Because the induced aberrations are similar in LASEK and LASAK, these differences in wound healing are probably not significant enough to affect the level of induced aberrations between techniques.

Despite the fact that ocular spherical aberration increases from pre- to postoperative status, in our experience, postoperative contrast sensitivity improves from baseline. This may indicate that the increase in ocular aberrations is not clinically relevant and that removing the minification effect from the preoperative trial lenses is a reason for the improvement.26 The aspheric ablation profile is thus equally successful with both surface and intrastromal excimer ablation, minimizing the change in HOAs pre- to postoperatively.

RECOMMENDATIONS

We apply aspheric treatment when no symptomatic aberrations are present and when preoperative BCVA is 20/20 or better. Ocular wavefront-guided treatment is applied when symptomatic aberrations exist and in primary treatments when preoperative distance BCVA is worse than 20/20. Corneal wavefront-guided treatment is used when symptomatic aberrations are present in primary treatments in eyes with distance BCVA worse than 20/20, in small pupils, and in all retreatments in eyes with distance BCVA worse than 20/20.

For successful LASAK, we recommend the use of planar flap technologies such as the Carriazo-Pendular microkeratome or a femtosecond laser technology, creation of large flap disks (greater than 9-mm diameter), and use of a 9-mm marker to ensure perfect centration and allow objective measurement of the amount of applanation.

Aside from preexisting risk factors, low residual stromal bed thickness is the most important modifiable factor that increases the risk of iatrogenic post-LASIK ectasia.27 LASAK achieves a thicker residual stromal bed and, therefore, is believed to decrease the risk of post-LASIK ectasia.

For both LASEK and LASAK techniques, large optical zones with smart blending zones are mandatory to avoid edge effects. Although one should be mindful of maximizing the outcomes, minimizing tissue removal is also important.

Other recommendations include: opt for a nasal hinge to optimize outcomes or a superior hinge to maximize safety, and eventually a temporal hinge in hyperopic cases; attempt ultrathin flaps to reduce the severing of corneal nerves; perform intraoperative pachymetry to assess actual flap thickness; and avoid ablation of the hinge, the inner face of the flap disk, and the flap edges. The risks of complications and suggested management strategies are outlined in Table 2.

CONCLUSION

Although experience shows that surface ablation, traditional LASIK, and LASAK are all safe techniques, there are numerous reasons to choose LASAK. This technique combines the advantages of surface ablation and LASIK and minimizes the drawbacks of each procedure. The advantages of LASAK include faster visual function recovery (days rather than weeks); better visual acuity in the early postoperative period;
no significant effect on epithelial repopulation and, therefore, greater stability of correction; sparing of the Bowman layer; a smoother corneal surface for better optical quality; reduced risk of infection and need for steroids; a lower retreatment rate; extended treatment ranges; an easy healing process with a lower regression rate over time; a low ratio of adverse events; and minimal postoperative patient discomfort.

César Carriazo, MD, is the founder of the Carriazo Centro Oftalmológico in Barranquilla, Colombia. Dr. Carriazo states that he has a financial interest in the Carriazo-Pendular mechanical microkeratome. He may be reached at tel: +5753785858; e-mail: ccarriazo@carriazo.com.

Samuel Arba Mosquera, PhD, is an Optical and Visual Researcher at Schwind eye-tech-solutions in Kleinostheim, Germany.