A Review of LASIK Flap Complications

Modern mechanical and laser devices make flap complications uncommon.

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A lamellar cut in the anterior cornea is the first surgical step of LASIK. This cut must be regular and well centered, it must have parallel sides and a sharp sidecut, and it should achieve the intended flap thickness. Its quality can strongly influence the final visual result. A perfect flap should not affect quality of vision, influence the final refractive result, or create optical aberrations. As with any surgical maneuver, however, LASIK flap complications can be occasionally observed. This article reviews common complications of the LASIK flap.

The rate of intraoperative complications reported in the literature varies from 0.16% to 15%,[1,2] and LASIK flap complications have been reported with both mechanical and laser cuts. Some complications are specifically associated with one technology or the other, such as epithelial defects with mechanical devices or opaque bubble layer formation with femtosecond lasers.

We must also remember that a cut in the cornea affects corneal biomechanics. The effect is supposedly less traumatic when the femtosecond laser is used to create a thinner flap, such as with sub-Bowman keratomileusis (SBK). However, for years we have been using mechanical microkeratomes that can produce the same thin flaps (100–110 µm) with very low and comparable standard deviations, with no problems related to corneal biomechanics. We believe that a cut is still a cut, and suspicious corneas should always be rejected for LASIK to avoid corneal ectasia, no matter the device used for flap creation.

INTRAOPERATIVE COMPLICATIONS

Common intraoperative complications include irregular, incomplete, or decentered flaps; buttonholes; and epithelial movement or defects. Some intraoperative complications are the results of suction loss during the cut and are generally associated with failure of the suction mechanism; a sudden and strong movement of the patient's head; or incomplete suction due to an obstacle such as the conjunctiva, eyelashes, or surgical materials. Many times, intraoperative complications can be prevented by using a Barraquer tonometer to ensure that intraocular pressure (IOP) is high enough (greater than 65 mm Hg). The surgeon can then check pupil dilatation and ask the patient if he or she is experiencing any loss of vision. Gentle movement of the suction device should also be assessed to confirm that the eye is firmly attached, and, with the assistance of a technician or nurse, the surgeon should also check the system's indicators and alarms to ensure that the proper levels of IOP have been obtained before initiating the cut.

Incomplete or irregular flaps. Any flap that is not completed as planned deserves careful examination under the microscope to confirm the diagnosis, rule out the presence of any kind of debris in the interface, and check for associated epithelial defects. Whenever possible, I recommend not lifting the flap but keeping it in place to facilitate future adhesion. In these cases, stromal ablation should always be postponed; with a mechanical microkeratome, a new (deeper) cut can be created a few weeks later, and with a femtosecond laser either a smaller flap within the original cut can be performed the same day or a new one can be created within the next few days using the original parameters. When using a mechanical microkeratome, I prefer to wait 3 months before performing the new cut. PRK is also an option in either situation. Again, I prefer to wait 3 months to perform PRK, applying mitomycin C 0.02% for 15 seconds after the stromal ablation to avoid haze formation.

Incomplete and irregular flaps can typically be prevented with proper set-up of the devices, by working with a trained team, and by keeping a wide and clean surgical field free of obstacles. Wet labs with the surgical team are useful before a new technology is introduced in the operating room.

Buttonholes. Mainly observed when mechanical

microkeratomes are used on steep corneas or when suction loss occurs, buttonholes are usually formed near the center of the corneal flap. With femtosecond lasers, vertical gas breakthrough can cause a similar complication, usually located in the periphery of the flap rather than centrally. After 10 years working with mechanical microkeratomes, I had never had a single buttonhole until 6 months ago when our group observed nine consecutive cases related to a possible failure of the suction mechanism. We have not observed buttonholes using the femtosecond laser, but our experience with this device is limited. Even though a recut can be performed in this situation, we have always managed it with PRK and mitomycin C, with good final results. A video demonstration is available at eyetube.net/?v=pihin.

Decentered flaps. Decentration of the LASIK flap can occur with either type of device. When decentration occurs, the flap should be lifted, and, using calipers, the stroma should be checked to ensure that enough stroma is exposed to guarantee a well-centered and complete excimer laser ablation. We have never had a flap decentered so much that it necessitated postponing treatment, but careful attention is mandatory for wavefront-guided ablations or in eyes with hyperopia or high astigmatism as a larger ablation area is needed in these situations.

Eye movement during suction makes centration more difficult and can be managed with gentle displacement of the suction ring in the opposite direction. I have found this movement more difficult to perform with the femtosecond laser unit, at least during an initial learning curve. In my experience, high astigmatism and short white-to-white measurements are risk factors for decentered flaps. I always center the flap using the pupil as a reference; in some eyes, however, the status of the pupil can simulate decentration.

Epithelial defects. This complication is almost obsolete with modern mechanical microkeratomes, as the amount of compression they exert on the surface of the eye has been reduced. As an additional preventive measure, I always stop the suction when the cut is completed, and the backward movement is then finished free of pressure.

Some eyes have risk factors for epithelial defects, such as a history of recurrent corneal erosion or basement membrane dystrophy. I prefer a surface approach in these situations, but the femtosecond laser is a nice alternative because it does not apply direct force to the cornea.

Once an epithelial defect is observed, careful examination should be performed to distinguish it from a buttonhole, which sometimes looks similar under the microscope. After the flap is lifted, it is safe to proceed with the refractive ablation and replace the flap and the loose epithelial zone; in some cases, it can be gently removed from the affected area. A bandage contact lens should be applied and the eye closely monitored for signs of diffuse lamellar keratitis and epithelial ingrowth.

POSTOPERATIVE COMPLICATIONS

Flap complications can also occur after surgery, with the most common being flap dislocation, folds or striae, and epithelial ingrowth.

Flap dislocation. A lack of adhesion can cause the flap to dislocate. This is typically observed at the first check-up after surgery and described by the patient as a loss of vision and foreign body sensation. The eye looks generally quiet and white; sometimes the dislocated area is covered by epithelium.

Risk factors for flap dislocation include anxiety, heavy blinking, dry eye, a thick flap, and a retracted sidecut with exposed stromal rim. We sometimes use intraoperative brimonidine in red eyes to avoid clearance of the anesthetic drops and to improve patient tolerance. However, we have had a few cases of flap dislocation, as the use of brimonidine, as shown by Muñoz and colleagues, can also be a risk factor.[3] I always place a bandage contact lens after surgery for the first 24 hours when any risk factors for flap dislocation are identified. I also instruct all patients to rest after surgery, to keep their eyes closed for the first 6 hours, and to blink as gently as possible. When dislocation is diagnosed, I send the patient back to the operating room, where I irrigate the affected area with balanced saline solution, remove ingrown epithelium to expose a clean stromal bed when necessary, and unfold and replace the flap with an irrigation cannula. A bandage contact lens is applied for at least 3 days. All these maneuvers can be performed at the slit lamp in some cases, but I generally prefer the safer ambience of the surgical theater.

Trauma, such as a deployed air bag during a car accident, a sports injury, or a domestic accident, can also trigger flap dislocation at any time after surgery.

TAKE-HOME MESSAGE

- No matter the device used for flap creation, suspicious corneas should be always rejected for LASIK to avoid corneal ectasia.
- The list of possible flap complications is similar for mechanical microkeratomes and femtosecond lasers, with the exception of epithelial defects (mainly observed with microkeratomes) and DLK (mainly observed with femtosecond lasers that work at low frequency levels).
- It is advisable to use a femtosecond LASIK approach in eyes with high astigmatism, hyperopia, or flat or steep corneas.

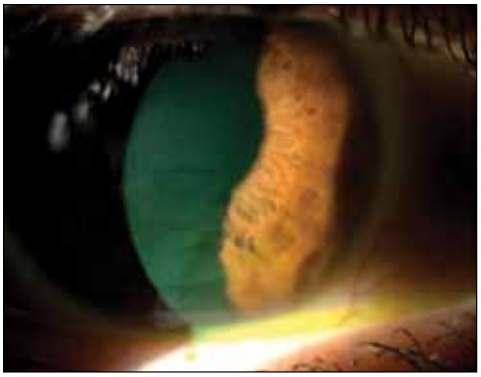

Figure 1. Striae after femtosecond LASIK were due to heavy blinking.

Figure 2. Epithelial ingrowth after femtosecond LASIK.

Treatment is the same as described above. This complication has no consequences on the refractive result; final UCVA is generally not affected.

Folds and striae. These complications are commonly observed under retroillumination at the slit lamp. Typically there is no effect on visual acuity; however, some patients report a small degree of glare and halos, and folds and striae have a tendency to be less evident with time. When there is a significant effect on visual acuity or quality of vision due to increased higher-order aberrations (HOAs), I recommend lifting the flap and applying gentle traction perpendicular to the folds. A bandage contact lens is then applied for a few days.

I do not use hypertonic solutions, as I have similar results using standard balanced saline solution and I believe these solutions excessively damage the LASIK flap. Suturing with 10-0 nylon can also be helpful to provide extra traction against the striae and to keep the flap in place. This is a delicate maneuver because the needle passes can promote epithelial ingrowth. Folds and striae mainly occur with the use of mechanical microkeratomes, although I had an anecdotal case after using the femtosecond laser in a patient who displayed total absence of cooperation during and after surgery (Figure 1).

If a case also has associated refractive defects, I recommend first treating the flap problem. In many cases, the refractive change will disappear and refraction will go back to plano with an improvement in HOAs. When the refractive problem remains, a refractive enhancement can then be planned. In this situation, I wait for the refraction to stabilize (at least 3 months after the initial treatment for folds and striae) and plan on either a surface approach or again lifting the flap, depending on the status of the flap. In some cases, heavy folds can be initially managed with phototherapeutic keratectomy.

Epithelial ingrowth. When space remains at the sidecut that allows epithelial cells to colonize the interface, epithelial ingrowth can result. This complication is generally reported less often with femtosecond lasers (Figure 2) because of better quality of the flap edge, the option to modify its geometry, and stronger flap adhesion to the stromal bed. Epithelial ingrowth is managed by lifting the flap and cleaning the epithelial debris, removing it from the posterior face of the flap as well as the stromal bed. The flap edges should be especially well cleaned and a bandage contact lens applied. In some cases, sutures are helpful to close gaps that could promote epithelial regrowth.

MECHANICAL VERSUS FEMTOSECOND

Femtosecond lasers are replacing mechanical microkeratomes in many centers. The femtosecond laser uses infrared light (1,053-nm wavelength) to produce microcavitation bubbles in the corneal stroma. The nature of this technology is related to specific flap complications such as vertical gas breakthrough, opaque bubble layer, and transient light sensitivity syndrome.[4] However, these complications have been reduced with modern platforms that work at higher frequencies and therefore lower energy levels.

The laser is also not free of the types of complications that can occur with mechanical devices. The list of possible flap complications is shared by both systems, with the exception of epithelial defects (mainly observed with microkeratomes) and DLK (mainly observed with femtosecond lasers that work at low frequency levels).[5] The incidence and rate of complications vary between mechanical and laser cuts, and there are surgeons who have found insignificant differences between both systems and others who report fewer complications with lasers.[2] Flap dislocation is less frequent with femtosecond lasers due to the planar geometry of the flap and to its steeper sidecut angle that favors increased adhesion strength. In my experience, laser flaps are more transparent, they are more easily replaced, their sidecut edges close exactly, they are free of particles, and I feel much safer when cutting the cornea with the laser. I always recommend a femtosecond LASIK approach in eyes with high astigma-

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tism or hyperopia, and in flat or steep corneas. In standard cases, we use either mechanical or laser devices. I still perform many cases of surface ablation.

CONCLUSION

LASIK flap complications can occasionally be observed when using either mechanical microkeratomes or femtosecond lasers, and risk factors should be identified to avoid them. Some complications seem more common with microkeratomes (eg, epithelial defects) and others are mainly observed with lasers (eg, DLK).

Modern mechanical devices that exert less pressure on the surface of the eye, and new lasers that reduce the energy intensity applied into the stroma by increasing its frequency, will continue to reduce the already low incidence of these complications. Modern femtosecond laser units seem safer for flap creation in high-risk eyes with extremely steep or flat corneas, high astigmatism, or hyperopia. Although I use either technology in standard cases, I believe that femtosecond technology is a better approach for LASIK in high-risk cases, and it probably will replace mechanical devices in all LASIK cases in the forthcoming years. ■

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