# Good Flap, Bad Flap: Key Issues for LASIK Success

Complications unique to LASIK can be directly or indirectly related to the flap.

**BY VIKENTIA KATSANEVAKI, MD, PhD**

LASIK has several advantages for the correction of ametropia in comparison with corneal surface ablation procedures. LASIK treatments offer faster visual recovery, less discomfort after surgery, and more predictable wound healing.

The LASIK flap, while it conveys certain advantages to the procedure, can be a potential source of disadvantage. Complications unique to LASIK, whether related directly to the flap (eg, flap decentration, irregularity of the cut) or indirectly (eg, diffuse lamellar keratitis), can have a detrimental effect of the visual outcome of the surgery.

## DIRECT IMPLICATIONS OF THE FLAP

Since the era of the Automated Corneal Shaper microkeratome (Chiron/Adatomed) in the 1990s, considerable improvements in surgical instrumentation for preparing corneal flaps have contributed to the explosive growth of refractive surgery. The femtosecond laser became available for LASIK flap creation approximately 10 years ago. Corneal flaps created with the femtosecond laser tend to be more uniform

**Figure 1. An eye complicated with central corneal scaring 3 months after central buttonhole with the use of a mechanical microkeratome.**


**Figure 2. A 35-year-old woman underwent LASIK for correction of a refraction of +5.00 -1.00 X 180º (20/20). The procedure was complicated with a central full thickness buttonhole; (A) the surgical cannula is shown penetrating through the central flap hole; (B) the buttonhole left a central irregularity on the stroma to be ablated. The procedure was completed with the laser ablation aiming for emmetropia enhanced with intraoperative use of mitomycin C for 1 minute. Six months after the procedure, the patient's UCVA was 20/20 and the cornea is transparent. (C) The topography difference map, before and after the procedure.**

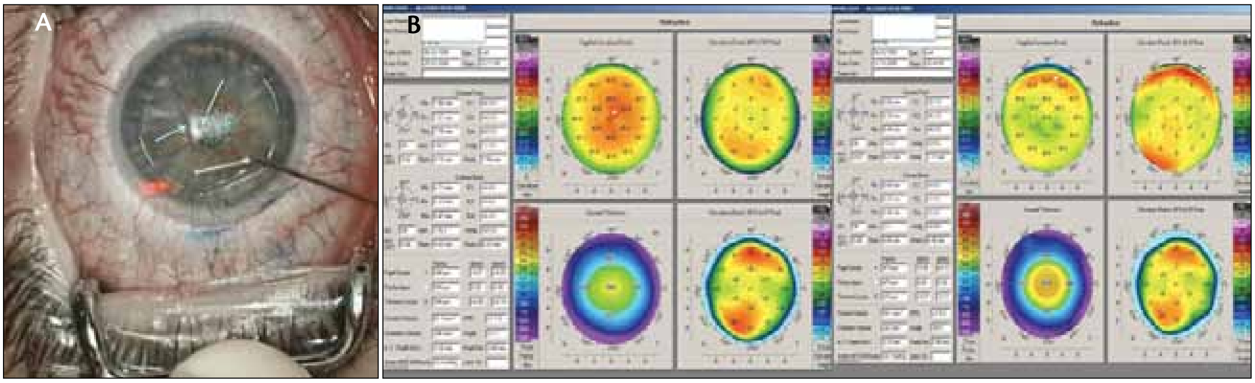

Figure 3. A 20-year-old woman was scheduled for SBK for correction of a refraction of -3.75 -0.75 X 170º (20/12). (A) The procedure was complicated with a paracentral remaining strip of Bowman membrane in the ablation zone (arrows); there was no epithelial defect. The procedure was completed with intraoperative use of mitomycin C for 1 minute. At 1 year postoperative, the patient's UCVA in this eye was 20/12. (B) The patient's corneal topographies before and after the procedure.

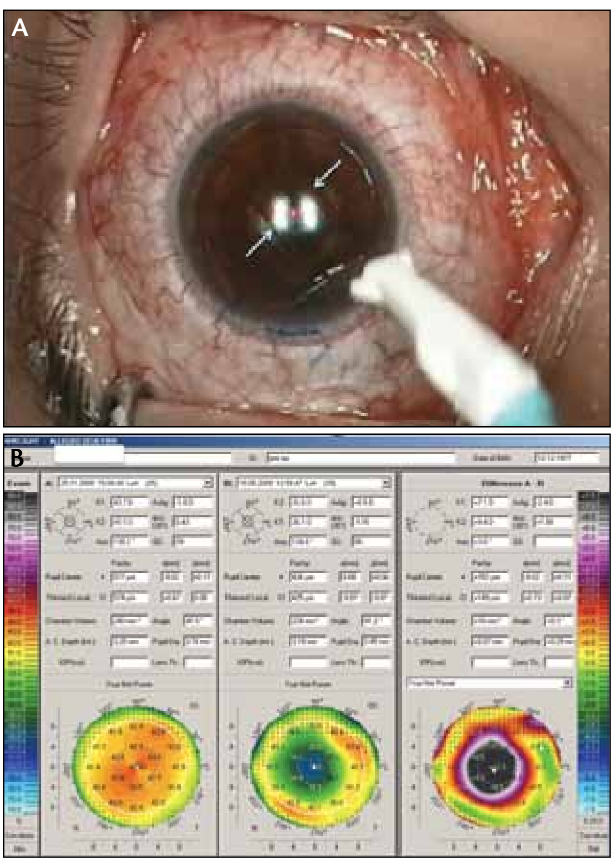

Figure 4. A 31-year-old man was scheduled for SBK for correction of a refraction of -8.75 -2.25 X 140º (20/25). (A) Flap creation was complicated with a wide central strip of Bowman membrane in the visual axis (arrows). The procedure was completed with intraoperative use of mitomycin C for 1 minute. At 8 months postoperative the patient's UCVA was 20/20, and the cornea is clear. (B) Topography difference map shows a well-centered ablation.

in thickness from the center to the periphery than microkeratome flaps, thus minimizing the risks for buttonhole perforations.[1] The laser also allows customization of flap parameters.

A central buttonhole is historically one of the worst-case scenarios during flap creation. It can be related to central scarring, especially if the procedure is completed with the laser ablation performed at the same session (Figure 1). Thankfully, the use of sub-Bowman keratomileusis (SBK)—ie, the LASIK procedure performed under a very thin flap—along with intraoperative mitomycin C, seems to minimize the risks of central corneal scarring, especially if the irregularity concerns a remaining strip of Bowman membrane without a concurrent epithelial defect.

Figures 2 through 4 are clinical images and topography maps of representative eyes with different refractive errors that were complicated by a strip of Bowman membrane remaining after the flap lift. The procedures were completed at the same session with additional use of mitomycin C 0.2% applied for 1 minute.

Although rare, buttonholes may also occur with the use of femtosecond lasers as the result of vertical subepithelial gas breakthrough. This may occur when gas bubbles escape into the epithelial space, usually when thin flaps are attempted (Figure 5).[2] In such cases, it is best to allow the opaque bubble layer to clear completely and then recut the flap at a level somewhat deeper than the initial attempt. If the surgeon aims more superficially for the recut, there is a tendency for the laser pulses to find the initial lamellar cut and for the complication to recur.

Another problem that may occur during flap creation is suction loss. Among other possible causes, loss of vacuum may be due to eyelid squeezing, tight orbits or inadequate positioning of the suction ring on the eye. An advantage of femtosecond lasers over microkeratomes is that, in many

**Figure 5. Peripheral flap hole as result of vertical gas breakthrough (arrow).**

such cases, the suction ring can be reapplied and the treatment repeated. If the suction is lost during the sidecut, the laser can be programmed to repeat only the sidecut, again after the suction ring is placed in the same position it occupied during the initial cut, making a smaller diameter flap.[3,4]

In the event of incomplete flap creation with a mechanical microkeratome, although a second pass to complete the case has been reported (Figure 6),[5] this can be risky. Most mechanical microkeratomes are programmed to stop once vacuum is lost. This feature minimizes the risk of creating multilevel or irregular cuts.

Using a mechanical microkeratome, the diameter of the flap is a function of corneal power, with steeper corneas having wider diameter flaps and flatter corneas having smaller diameter flaps. Femtosecond flaps are reported to be more accurate in achieved flap diameter and flap thickness than microkeratome flaps.[6] The tendency is to aim for flaps with the largest possible diameter, thus compensating for any decentration. Especially for eyes with a large angle kappa, the surgeon should aim for a nasally decentered flap (Figure 7).

## INDIRECT IMPLICATIONS OF THE FLAP

Corneal wound healing after refractive surgical procedures is a complex process and a major determinant of the efficacy and safety of surgery.[7] The introduction of femtosecond laser platforms with faster pulse rates has markedly reduced the total energy delivered to the cornea during flap creation; therefore, the levels of inflammation and associated complications with the latest-generation femtosecond lasers have been minimized.

Diffuse lamellar keratitis as a unique early complication of otherwise flawless LASIK procedures can significantly affect the final visual outcome (Figure 8). Operated eyes should always be evaluated on the first postoperative

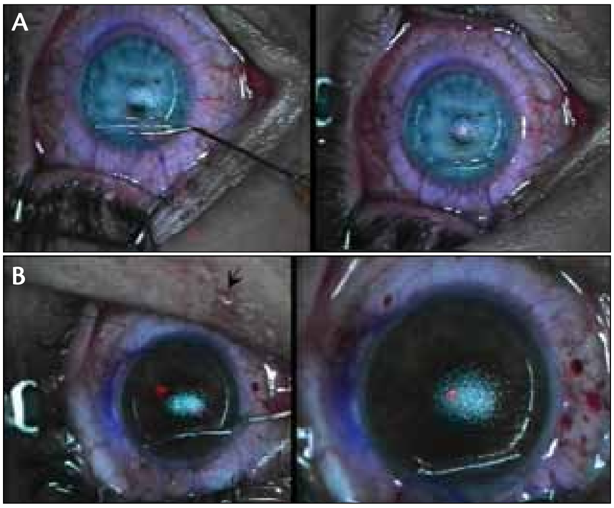


**Figure 6. Two cases (A and B) successfully completed with a second pass of a mechanical microkeratome at the same session after initial incomplete flap creation.**

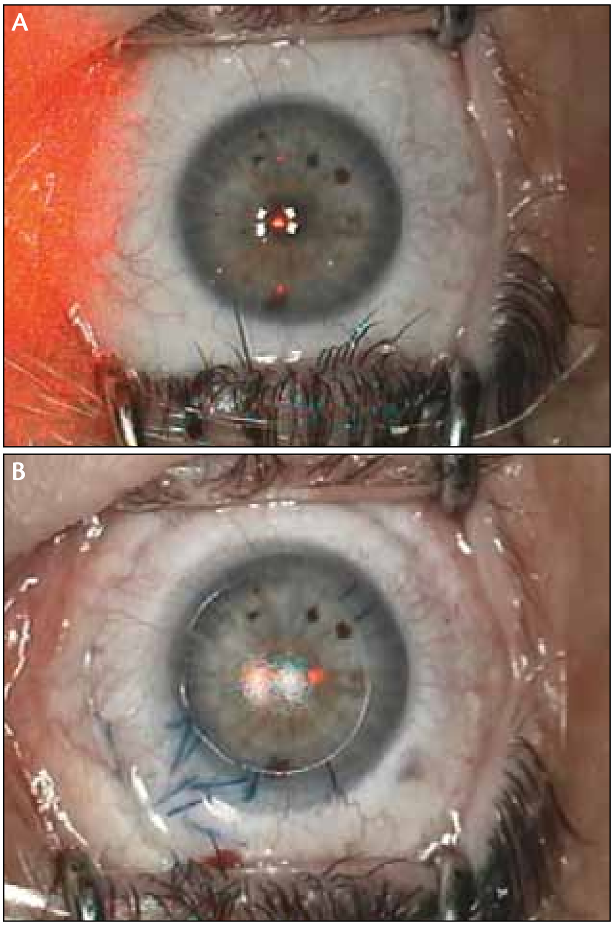


**Figure 7. Eye with large angle kappa. (A) The red spot indicates the visual axis. (B) Hyperopic LASIK treatment of the eye necessitated an intentionally decentered flap.**

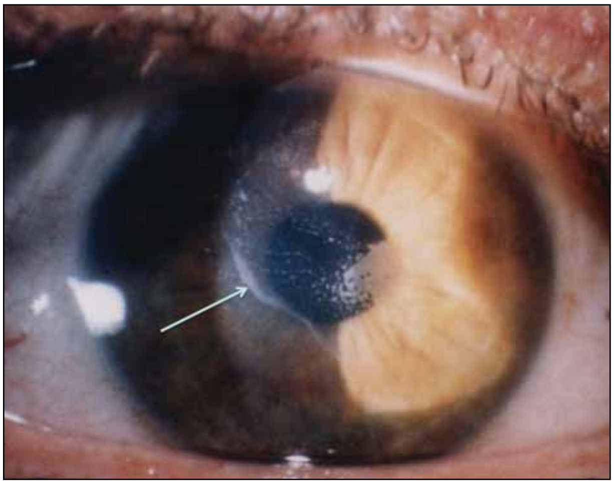

**Figure 8. Clinical photo of an eye complicated with stage 4 diffuse lamellar keratitis following uncomplicated LASIK surgery for myopia. The prolonged inflammation resulted in partial flap melt (arrow) and extensive epithelial ingrowth.**

**TAKE-HOME MESSAGE**

- Flap decentration and irregularity of the cut are complications directly related to the flap; diffuse lamellar keratitis is indirectly related.
- A central buttonhole is one of the worst-case scenarios during flap creation.
- Corneal wound healing is a major determinant of the efficacy and safety of the surgery.

day and treated properly if corneal edema is not resolved after the first few postoperative hours.

## CONCLUSION

After 20 years of continued effort and clinical research and development, LASIK has evolved to what it is today. As a safe and efficient surgical procedure, LASIK remains the indisputable leader in refractive corrections. ■

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