Thin-Flap LASIK: How Thin Should We Go?

I use the femtosecond laser to create a 100-µm flap.

BY MICHAEL KNORZ, MD

In the early days of LASIK, thin flaps were considered the gold standard. However, after the appearance of complications, including flap folds and irregularities, the trend was toward thicker flaps in the hopes of reducing postoperative side effects.[1] Microkeratome-related complications subsequently decreased; however, they continued to cause surgical complications.

Over the last 2 years, we have begun to see a resurgence of the thin flap, which has been driven by the growing need to preserve the stroma for both higher correction capabilities and safety reasons, such as avoiding keratectasia. The precision of modern laser keratomes, including the IntraLase femtosecond laser (Advanced Medical Optics, Inc., Irvine, California), have enabled us to consistently cut flaps as thin as 90 µm. This begs the question: How thin should we go to promote the safest results for our patients?

BIOMECHANICS

To adequately answer this question, we must first consider corneal biomechanics. According to Marshall et al,[2] the first 160 µm of corneal stroma is much stronger than the deeper stroma. Additionally, the mid-periphery (8–12 µm) is stronger than the central region (6 µm) of the cornea. Therefore, we must ensure we are creating the flap cut as superficially as possible—especially in the mid-periphery—to maintain the integrity of the cornea.

TAKE-HOME MESSAGE

- The thin flap has once again become popular for LASIK because it preserves the stroma.
- A superficial flap cut maintains the corneal integrity.
- A steeper sidecut weakens the cornea more than an inverted steeper sidecut.

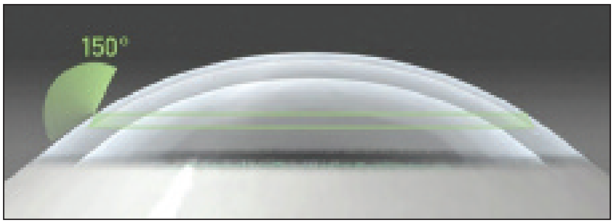


Figure 1. Schematic drawing of an inverted sidecut.

Microkeratomes create a meniscus-shaped flap, deriving the thickness from the stronger, mid-periphery of the cornea; alternatively, femtosecond lasers generate planar flaps that are uniformly thick across the cornea.[3] Generally speaking, planar flaps cut by the femtosecond laser minimize corneal weakening.

Tran et al[4] confirmed that planar flaps have less biomechanical effect on the cornea compared with mechanical microkeratome-created flaps. The incidence of measurable spherical aberrations was noted in patients treated with the Hansatome microkeratome (Bausch & Lomb, Rochester, New York); however, no aberrations were seen in patients treated with the IntraLase.

SIDECUT DESIGN

Femtosecond lasers raise another question regarding post-LASIK corneal function: sidecut design. For instance, the iFS Advanced Femtosecond Laser (Advanced Medical Optics, Inc.) customizes the sidecut for each individual patient. But does the sidecut angle matter clinically? According to the latest research, it does.

Marshall et al[5] found that a steeper (70º) versus inverted (150º; Figure 1) sidecut weakened the cornea more. One explanation is that the beveled edge of the flap is tucked under the lip of the peripheral stroma in case of an inverted sidecut (Figure 1), preserving the strongest part of the cornea. Marshall concluded that shallow sidecuts weaken the cornea because supportive superficial fibers are severed; however, inverted sidecuts at 150º inflict less biomechanical change. Marshall's findings have since been replicated (see *How Can We Influence Flap Healing*?).[6]

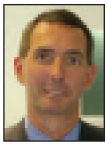
MAKING A THINNER FLAP

We have established: (1) the mid-periphery of the cornea must stay as intact as possible, (2) femtosecond lasers create planar flaps that promote corneal stability, and (3) inverted sidecuts maximize corneal strength. Now, we can discuss how to make a thinner flap.

No studies have tested the efficacy of thin versus thick flaps; however, two retrospective studies speculate that 100-µm flaps provide visual quality as good as or better than thick flaps.[7,8] Thin flaps also (1) weaken the cornea less, (2) make less biomechanical impact, and (3) leave more stroma for ablation. Thick flaps are more stable and have less of tendency to form microfolds; however, they are also more harmful to the cornea and limit higher corrections.

If we consider the epithelium (approximately 50 µm to 60 µm) and Bowman's layer (10 µm), we could theoretically create a flap as thin as 70 to 80 µm; however, the thickness of the epithelium varies between individuals, and applanation cones have a certain variability, too. For this reason, using a flap thickness of 100 µm provides a margin of safety with which I am comfortable.

In comparison to today's standard flap thickness (range, 130–160 µm), I recommend 100-µm flaps cuts made with the femtosecond laser. I believe a femtosecond laser is mandatory when performing thin-flap LASIK because it creates predictable, uniform, planar flaps. The inverted sidecut may also enhance thinner flaps. Lastly, to prevent flap folds that result from overstretching, laser energy should be set accordingly to achieve easy flap separation. ■



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HOW CAN WE INFLUENCE FLAP HEALING?

By Michael Knorz, MD

In a recent animal study, we investigated the effect of three variables on the strength of flap adhesion: (1) flap technology, (ie, mechanical microkeratome versus femtosecond laser), (2) sidecut design, and (3) sidecut energy.[1]

A total of 17 New Zealand white rabbits underwent LASIK with either a mechanical microkeratome (Amadeus II; Ziemer Group AG, Port, Switzerland) or a femtosecond laser (iFS; Advanced Medical Optics, Inc.). The latter group was further divided into three groups. Two of these groups received 70º sidecuts, one at the standard 0.8 mJ and the other at 1.6 mJ; and one group received inverted 150º sidecuts at 0.8 mJ.

After 75 days, the animals were sacrificed and the epithelium was removed. After gluing an acrylic lens onto the flap, a tension meter was used to dehisce the flaps, and the force required to accomplish dehiscence was recorded.

Overall, the femtosecond laser created flaps with stronger adherence than the mechanical microkeratome. In both 70º sidecut flap groups and the inverted 150º sidecut flap group, an average of 492 g, 444 g, and 687 g of force, respectively, were needed. The inverted flaps were nearly 1.5 times stronger than the 70º flaps; consequently, sidecut energy did not have a significant effect on adherence. Flaps produced with the Amadeus II dehisced on average under only 210 g of force. The difference in flap adhesion strength between the mechanical microkeratome group and all three femtosecond laser groups was statistically significant.

In this study, we learned that flap adhesion is approximately 2.5 times stronger with iFS-created flaps compared with Amadeus II-created flaps. Additionally, sidecut energy did not appear to influence the strength of adhesion. Lastly—and most importantly—an inverted 150º sidecut yielded a stronger flap adhesion (1.5 times) compared with the normal 70º sidecut.