Femtosecond LASIK Flaps: Excellent, but Superior?

J. Bradley Randleman, MD

As 2012 begins, femtosecond lasers have been used for more than a decade to create LASIK flaps.1 Starting with a single model, these lasers have gone through multiple iterations, and now multiple competing technologies are available in the marketplace worldwide. In the United States, recent surveys demonstrate continued increasing market share. Now more than half of all LASIK procedures are performed using femtosecond lasers, suggesting that there is some real or perceived superiority of these devices over mechanical microkeratomes. This increased utilization has occurred despite the increased cost of performing LASIK using a femtosecond laser; the absolute cost may vary from practice to practice, but invariably femtosecond LASIK is more costly for surgeons to perform.

So, at this time when femtosecond lasers have surpassed microkeratomes in utilization and are making inroads into cataract procedures, again at increased expense but with the promise of superiority over current techniques, it seems reasonable to compare the perception to the data regarding femtosecond lasers and modern mechanical microkeratomes in the most relevant variables, including visual acuity and refractive outcomes, flap thickness parameters and reproducibility, and potential complications.

VISUAL ACUITY AND REFRACTIVE OUTCOMES

In this issue, Chen and colleagues2 performed a meta-analysis comparing the IntraLase femtosecond laser (Abbott Medical Optics, Santa Ana, California) to a variety of mechanical microkeratomes, specifically focusing on uncorrected and corrected distance visual acuity, spherical equivalent and cylinder correction, and flap thickness. In short, the authors found no significant differences between technologies except for flap thickness predictability. These results mirror another meta-analysis performed by a separate group who utilized randomized controlled trials only.3 These results and methodology will surely be thoroughly scrutinized; however, the data appear to be a compelling report of equivalence between technologies.

FLAP THICKNESS, VARIABILITY, AND ARCHITECTURE

Chen and colleagues2 did find significant differences in flap thickness predictability between the IntraLase and mechanical microkeratomes included in their analysis—a difference that has been echoed by numerous authors. The preponderance of evidence suggests that femtosecond lasers create thinner, more predictable flaps than most mechanical microkeratome units.4-7 However, flap thickness variability certainly exists with femtosecond lasers as well as microkeratomes,7 and at least some modern mechanical microkeratomes appear equivalent to their femtosecond laser counterparts in creating thin, reproducible flaps to their femtosecond laser counterparts. A recent study by my colleagues8 demonstrated that the Amadeus microkeratome (Ziemer Ophthalmic Systems AG, Port, Switzerland) creates nearly planar flap architecture with flap thickness mean and variability equivalent to femtosecond lasers. The SCHWIND Carriazo-Pendular (SCHWIND eye-tech-solutions, Kleinostheim, Germany)9,10 and Moria M29 (Moria, Antony, France) also have been found to produce thin, reproducible, nearly planar flaps. Thin flaps provide biomechanical advantages to the cornea postoperatively, and most surgeons are moving to creating thinner flaps for all cases. However, flaps that are “too thin” appear more prone to complications, whether they are created by microkeratomes or femtosecond lasers.

COMPlications

Overall complication rates appear extremely low with femtosecond laser flap creation,11 with suction loss the most prevalent complication. In this issue, Tomita and colleagues12 report successful immediate lamellar recut in all cases in their series of eyes with suction loss. Some controversy surrounds the rationale for immediate recut, as other authors have demonstrated the potential for creating new cleavage planes if immediate recut is undertaken.13

Free caps and flap buttonholes occur rarely but
continue to be a concern during LASIK. These almost always occur in the second eye with a thinner flap in mechanical microkeratomes.\textsuperscript{14,15} Femtosecond laser flaps are also prone to similar complications of variable severity,\textsuperscript{16-18} albeit usually from a different mechanism: vertical gas breakthrough. In this issue, Tomita and colleagues\textsuperscript{19} report a series of eyes undergoing LASIK with anterior stromal opacities, finding that the Femto LDV (Ziemer Ophthamlic Systems AG) created significantly thinner flaps without experiencing vertical gas breakthrough, whereas the IntraLase FS 60 had equal acuity outcomes but a significantly higher number of vertical gas breakthrough cases. In all of these eyes, flaps were successfully lifted without apparent effect on final visual acuity.

There may be a barrier to how thin femtosecond laser flaps can be safely attempted, as cases of haze have been reported with ultrathin femtosecond laser flaps.\textsuperscript{20,21} In this issue, Vaddavalli and colleagues\textsuperscript{22} report vertical gas breakthrough that resulted in corneal haze; the authors provide evidence via high-resolution optical coherence tomography that this haze is caused by focal epithelial basement membrane and Bowman layer disruption.

**VERSATILITY**

Although the aforementioned studies demonstrate more similarities than differences with modern mechanical microkeratome and femtosecond laser flaps, there is no question that the femtosecond laser brings a new level of versatility to LASIK flap creation. Flap parameters, side-cut angles, and other variables can be controlled like never before. This likely has clinical relevance, with reduced epithelial ingrowth rates postulated as being related to femtosecond flap edge parameters.\textsuperscript{23-25} Epithelial ingrowth is more prevalent for enhancements than for primary procedures. In this issue, Coskunseven and colleagues\textsuperscript{25} describe a technique of using the femtosecond laser to create a side cut only within the original LASIK flap to prevent or reduce epithelial ingrowth. This technique simply cannot be performed with a mechanical microkeratome. As we move forward, there may be other femtosecond laser–specific techniques that evolve to further refine LASIK flap creation.

So, as we begin 2012, femtosecond lasers have proven themselves to be excellent devices for LASIK. But are they superior to modern mechanical microkeratomes? That will be left for our readers to decide and for our authors to provide robust, compelling data to the discussion.

**REFERENCES**


