SMILE Blinks!

To the Editor:

Hjortdal et al. recently reported the outcomes of femtosecond laser small-incision lenticule extraction (SMILE) in which two independent femtosecond laser cuts intersect to create a three-dimensional intrastromal lenticule that is accessed and extracted from one or two 3- to 5-mm side-cut incisions. The traditional “cut and ablate/evaporate” thus changes to “cut, cut, and remove.”

This is a paradigm shift. There is no flap; rather, there is a cap and the immediate advantages are evident. Surface violation is minimized; instead of a circumferential LASIK incision of 20 to 25 mm, there is a 4-mm side-cut 100 to 120 microns deep, which induces little if any astigmatism. This means improved biomechanical integrity and least corneal denervation and dysfunctional tear film, which are the two major challenges of conventional LASIK. Interestingly, surgical time and laser energy are independent of the degree of correction, and the average 1.5 J/diopter energy expenditure in classic LASIK is reduced to 0.6 J for any amount of correction. Also, the fact that a single laser platform is used potentially improves cost-effectiveness.

Successful correction in refractive surgery necessitates a valid measurement of the refractive error of the eye, proper calculation of a treatment profile and its reliable delivery onto the corneal surface, and “fidelity” to achieve the intended new shape. SMILE has theoretical advantages in terms of fidelity because it does not have some of the fundamental weaknesses of phototherapeutic keratectomy—versus intrastromal excision/extraction. Femtosecond laser re-fractive “surface peeling”—a hypothetical counterpart of excimer laser surface ablation—versus intrastromal excision/extraction would circumvent the “cap-bed” mismatch.

The most mysterious aspect of this technique is perhaps the “cap-bed mismatch.” Striae are well-known complications of LASIK; they are common in deep and highly toric ablations and result from flap–bed mismatch. The phenomenon has alternatively been documented as induced higher-order aberrations. It is well established that LASIK induces more higher-order aberrations than surface ablation and this has been attributed to the LASIK flap. Similarly, it is simplistic to expect the cap and bed to be a fit match after the lenticule is removed. Folds and lacuna in the interface are inevitably formed, anterior and posterior surfaces of the cornea possibly undergo molding, and the long-term remodeling determines the refractive outcome. This implies a long recovery time during which biomechanical factors and intraocular pressure may modify the course of refractive stability. Posterior surface changes have been suggested in LASIK. So, until proven otherwise, we should expect more optical irregularities and less optical quality by SMILE. Femtosecond laser refractive surgery is highly applicable to SMILE, and we should probably incorporate biomechanics to optimize the nomograms.

In recent years, we have increasingly regarded the corneal biomechanics from a safety perspective. But biomechanical factors may also influence efficacy because they define tissue response and remodeling that translates into the final refractive result. This concept seems highly applicable to SMILE, and we should probably incorporate biomechanics to optimize the nomograms.

Available femtosecond laser platforms are highly varied in terms of applied suction, spot size, pulse energy level, track spacing and spot separation, scanning pattern, and pulse repetition rate and duration. The balance between tissue separation and the achieved cut quality can be contradictory at times; the former needs higher energy, which results in a coarser cut. To complicate things further, applying higher energy causes more gas breakthrough and collateral dissection, which may also compromise laser scanning and tissue separation. In this regard, indices such as energy density (energy/area) better predict surface smoothness and cut quality. It should be emphasized that the
cuts in intrastromal lenticule excision form refractive surfaces that must be smooth. Theoretically, we can attain a smoother surface by femtosecond lasers than excimer lasers because the spot size is much smaller, but this is not the reality at the moment. Epithelial integrity would be extremely important, and docking should be meticulously orchestrated. Even the scanning pattern and the cut direction have been shown to affect tissue separation.7,8 The other feature that may influence cut quality is suction pressure. We know that femtosecond laser platforms use lower pressures than microkeratome suction rings, which applanate the cornea prior to microkeratome pass. Some femtosecond laser machines applanate less and some practically “accurvate” the cornea, a feature that in turn increases the risk of suction loss.

Laser keratorefractive excision has the potential to overtake laser keratorefractive ablation methods but we should work further to improve laser cut quality and address the associated new challenges.

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REFERENCES

Reply
We thank Drs. Mohammadi and Vakilian for their interest in SMILE and our recently published article,1 and agree that all femtosecond laser techniques such as SMILE may become the preferred treatment in the future.

The SMILE technique is new and there are many issues that remain to be studied further. Publications from our group suggest that SMILE treatment for moderate and high myopia and low astigmatism is predictable, efficient, and safe,1,2 and that femtosecond lenticule extraction seems superior to femtosecond–LASIK and induce less corneal spherical aberration than this procedure.3 We are performing prospective studies of femtosecond lenticule extraction compared with SMILE covering evaluation of optical quality, corneal biomechanics, corneal sensitivity, nerve density, tear production, and osmolarity. These and other studies will be continued to further validate all femtosecond laser corneal refractive surgical techniques over the short and long term.

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