Commentary: Comparison of changes in refractive error and corneal curvature following small-incision lenticule extraction and femtosecond laser-assisted *in situ* keratomileusis surgery

Femtosecond laser-assisted flap creation for laser *in situ* keratomileusis (LASIK) was first described in 2001.[1] Roughly a decade later, the evolution of refractive surgery witnessed the advent of small incision lenticule extraction.[2] Numerous studies have demonstrated the safety, efficacy, and refractive predictability of both techniques for correction of myopia and myopic astigmatism. Femtosecond LASIK entails the creation of a corneal flap, with subsequent excimer laser stromal ablation for refractive correction. ReLEx describes the creation of four sequential femtosecond cuts to fashion an intrastromal lenticule, which is subsequently separated from the surrounding stromal tissue and removed. The lenticule is either peeled off after raising a flap in FLEx or extracted through a 2-5 mm corneal side cut in SMILE. Do the variations in the surgical technique result in differences in corneal curvature and wound healing?

Zhang *et al*. demonstrated greater stability of corneal curvature and refractive outcomes following SMILE in comparison to femtosecond LASIK.[3] The myopic shift in the 3-month postoperative period following LASIK was attributed to the regression associated with the flap side cut, similar to a limbal relaxing incision. In addition, superior biomechanics following SMILE was considered to provide greater postoperative stability. The changes in corneal asphericity and wound healing response are other factors that influence surgical outcomes.

Sagittal curvature changes following SMILE better preserve the corneal asphericity, with a steeper center and flatter periphery.[4] Femtosecond LASIK, on the other hand, demonstrates an increase in the corneal curvature with greater corneal diameter. This, in turn, results in lower induction of spherical aberrations following SMILE.[5-7] Induced aberrations in FS-LASIK are secondary to stromal excimer ablation and are less dependent on the flap creation *per se*, as studies have demonstrated no significant differences in spherical aberration induction between FLEx and SMILE. In addition, the true optic zone is significantly larger in SMILE vis-à-vis LASIK.[8]

Corneal tissue inflammation and subsequent wound healing is another factor impacting the postoperative biomechanical stability. Earlier studies demonstrated delayed visual recovery in SMILE, with increased keratocyte activation and haze in comparison to LASIK up to 3 months postoperative. Addition of a second lenticule cut and increased surgical maneuvering for lenticule extraction were considered as the causative factors.[9]

Since then, numerous studies provide a contrarian view, demonstrating lower degree of keratocyte apoptosis, proliferation, and inflammation following SMILE in animal models.[10] The creation of an epithelial cut with the cap or flap facilitates the dispersion of inflammatory mediators at the interface through epithelial debris and tears. This epithelial trauma is lower in SMILE.[11] Excimer stromal ablation in FS-LASIK additionally causes photodecompensation, with resultant release of cytokines and chemokines. In addition, the laser energy delivered in SMILE is constant and independent of the refractive error. The same is not true for LASIK, where higher refractive errors entail deeper ablation and induce subsequently greater inflammation. Thus, obviating the need for excimer laser would intuitively elicit lower inflammatory response and wound healing reaction. However, comparable levels of keratocyte proliferation and apoptosis in the stromal bed were demonstrated in human *ex vivo* corneas following SMILE and FS-LASIK.[12] Fibronectin expression as a marker for stromal fibrosis appeared more pronounced after LASIK.

Bowman's membrane microdisortions, especially with thicker lenticule extractions, was another cause attributing to delayed visual recovery post SMILE.[13,14] However, the Bowman's Roughness Index following SMILE returns to preoperative levels within 6 months. Tissue healing in LASIK, on the other hand, is delayed, with persistent micro distortions postoperatively. This is attributed to the greater severance of helical collagen fibers secondary to a larger corneal incision.[15] Thus, a greater preservation of corneal asphericity and possibly reduced inflammation following SMILE may attribute to greater refractive stability in comparison to femtosecond LASIK.

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References

1. Ratkay-Traub I, Juhasz T, Horvath C, Suarez C, Kiss K, Ferincz I, *et al.* Ultra-short pulse (femtosecond) laser surgery: Initial use in LASIK flap creation. Ophthalmol Clin North Am 2001;14:347-55, viii-ix.
2. Sekundo W, Kunert KS, Blum M. Small incision corneal refractive surgery using the small incision lenticule extraction (SMILE) procedure for the correction of myopia and myopic astigmatism: Results of a 6 month prospective study. Br J Ophthalmol 2011;95:335-9.
3. Zhang YL, Cao LJ, Chen HW, Xu XH, Li ZN, Liu L. Comparison of changes in refractive error and corneal curvature following small-incision lenticule extraction and femtosecond laser-assisted *in situ* keratomileusis surgery. Indian J Ophthalmol 2018;66:1562-7
4. Gyldenkerne A, Ivarsen A, Hjortdal JØ. Comparison of corneal shape changes and aberrations induced by FS-LASIK and SMILE for myopia. J Refract Surg 2015;31:223-9.
5. Ganesh S, Gupta R. Comparison of visual and refractive outcomes following femtosecond laser- assisted lasik with smile in patients with myopia or myopic astigmatism. J Refract Surg 2014;30:590-6.
6. Lin F, Xu Y, Yang Y. Comparison of the visual results after SMILE and femtosecond laser-assisted LASIK for myopia. J Refract Surg 2014;30:248-54.
7. Vestergaard A, Ivarsen A, Asp S, Hjortdal JØ. Femtosecond (FS) laser vision correction procedure for moderate to high myopia: A prospective study of reLEx(®) flex and comparison with a retrospective study of FS-laser *in situ* keratomileusis. Acta Ophthalmol 2013;91:355-62.
8. Liu M, Chen Y, Wang D, Zhou Y, Zhang X, He J, *et al.* Clinical outcomes after SMILE and femtosecond laser-assisted LASIK for myopia and myopic astigmatism: A prospective randomized comparative study. Cornea 2016;35:210-6.
9. Agca A, Ozgurhan EB, Yildirim Y, Cankaya KI, Guleryuz NB, Alkin Z, *et al.* Corneal backscatter analysis by *in vivo* confocal microscopy: Fellow eye comparison of small incision lenticule extraction and femtosecond laser-assisted LASIK. J Ophthalmol 2014;2014:265012.
10. Riau AK, Angunawela RI, Chaurasia SS, Lee WS, Tan DT, Mehta JS, *et al.* Early corneal wound healing and inflammatory responses after refractive lenticule extraction (ReLEx). Invest Ophthalmol Vis Sci 2011;52:6213-21.
11. Dong Z, Zhou X, Wu J, Zhang Z, Li T, Zhou Z, *et al.* Small incision lenticule extraction (SMILE) and femtosecond laser LASIK: Comparison of corneal wound healing and inflammation. Br J Ophthalmol 2014;98:263-9.
12. Luft N, Schumann RG, Dirisamer M, Kook D, Siedlecki J, Wertheimer C, *et al.* Wound healing, inflammation, and corneal ultrastructure after SMILE and femtosecond laser-assisted LASIK: A human *ex vivo* study. J Refract Surg 2018;34:393-9.
13. Yao P, Zhao J, Li M, Shen Y, Dong Z, Zhou X, *et al.* Microdistortions in bowman's layer following femtosecond laser small incision lenticule extraction observed by fourier-domain OCT. J Refract Surg 2013;29:668-74.
14. Luo J, Yao P, Li M, Xu G, Zhao J, Tian M, *et al.* Quantitative analysis of microdistortions in bowman's layer using optical coherence tomography after SMILE among different myopic corrections. J Refract Surg 2015;31:104-9.
15. Shetty R, Francis M, Shroff R, Pahuja N, Khamar P, Girrish M, *et al.* Corneal biomechanical changes and tissue remodeling after SMILE and LASIK. Invest Ophthalmol Vis Sci 2017;58:5703-12.

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