Comments on "Biomechanical Properties of Human Cornea Tested by Two-Dimensional Extensiometry Ex Vivo in Fellow Eyes"

We read with great interest the article by Spiru et al.[1] published in the June 2018 issue. The topic of the theoretical superiority, in terms of preservation of the corneal biomechanical behavior, of "cap" versus "flap" procedures (ie, small incision lenticule extraction [SMILE] vs laser-assisted in situ keratomileusis [LASIK]) is a controversial issue, mainly based on theoretical assumptions. Early postoperative ectasia cases have been described after SMILE performed to correct low myopia.[2] These findings represent a challenge to the aforementioned hypothesis that a cap behaves much better than a flap in the preservation of the corneal rigidity. This hypothesis is mainly based on the theoretical assumption that a cap behaves as an "untouched" anterior corneal stroma, in contrast with a LASIK flap.

An interesting fact in Spiru et al.'s article is that the model they use is based on assumptions that are biologically plausible (ie, that an increase in the intraocular pressure [IOP] [stress] will induce a forward deformation of the cornea [strain]). This model has been successfully used to evaluate the increase in the corneal rigidity induced by corneal cross-linking in porcine eyes by Kling et al.[3,4] Spiru et al.[1] used a spherical indenter to induce a load on the cornea (stress) and the displacement of the corneal sample (strain) is recorded simultaneously, as described by Hammer et al.[5]

We agree that by using this model many of the disadvantages of other ways to detect changes in the corneal rigidity are avoided, and thus that the results obtained should be closer to reality. Nevertheless, the authors found significant differences between SMILE and LASIK only when the load (IOP) was higher than 20 or even 40 kPa (roughly 150 or 300 mm Hg), and the differences were more marked when the load was increased to 160 kPa (1,200 mm Hg) as shown in Figure 2A.[1] In other words, the conclusion of the study should be that for the range of IOP that a cornea would need to withstand in normal life conditions both procedures seem to behave in a similar way and that a cap would behave better than a flap in terms of rigidity only for very high IOP levels unseen in real life.

When SMILE to correct myopia is performed, the cap has to move backward to reach the residual stromal bed surface, thus experiencing a "relaxation" that will disappear (and thus the cap will recover its original resistance) only when the stroma suffers a forward deformation ("ectasia-like") equal, in microns, to the maximum lenticule thickness that the resected stroma had. This is what probably happened when the corneal samples analyzed by Spiru et al.[1] suffered a high load (stress).

We believe that the available evidence suggests that until the stromal bed becomes significantly ectatic, the cap will offer no significant biomechanical benefit over a flap, at least in the first months postoperatively.

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Reply

Our experiment was a short-term experiment aiming to produce changes similar to those occurring over a long period of time. Under given conditions (see Methods) of the experiment on fellow ex vivo eyes, small incision lenticule extraction (SMILE) has favorable results. Hence, we stated in our conclusions: "Further prospective noninferiority clinical studies matched by refraction, treatment zone, age, and sex may be envisaged once more sensitive in vivo techniques for the measurement of the corneal biomechanics become available (pp. 422-423)."

REFERENCE

1. Spiru B, Kling S, Hafezi F, Sekundo W. Biomechanical properties of human cornea tested by two-dimensional extensiometry ex vivo in fellow eyes: femtosecond laser–assisted LASIK versus SMILE. *J Refract Surg.* 2018;34(6):419-423. doi:10.3928/1081597X-20180402-05.

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