

Commentary: Corneal biomechanical assessment following refractive surgery: Past, present, and future

Topographic and tomographic changes of keratoconus and postrefractive surgery ectasia are expected to be preceded by a corneal biomechanical weakening.^[1] The field of corneal biomechanics has been gaining interest in the last couple of decades for the early detection of keratoconus and postrefractive surgery ectasias, among several other reasons, which include assessment of different cross-linking techniques and myopia progression in children.

The assessment and interpretation of corneal biomechanics depends on the device used. Ocular response analyzer (ORA) and corneal visualization Scheimpflug technology (CORVIS ST) are the two main devices used clinically to study biomechanics *in vivo*. ORA has been reported to have lesser sensitivity and specificity in detecting biomechanical weakening, and in recent years, most studies are performed using CORVIS ST.

The main research questions when it comes to the field of refractive surgery are i) Which procedure is biomechanically stronger, ii) Differentiating normal corneas postrefractive surgery from postrefractive surgery ectasia, and iii) Predicting postrefractive surgery ectasia earlier.

Before we delve into the individual questions, we need to understand certain basics while interpreting CORVIS ST biomechanical outputs. i) Several two-dimensional univariate values measuring biomechanics such as DA, A1, and A2 are prone to be affected by CCT (corneal thickness) and IOP;

just because a cornea is thinner or has a lower distending IOP, the tissue may be interpreted as weaker despite the strength being normal. Therefore, we must choose to utilize multivariate indices which are independent of CCT and IOP. ii) Interpretation of corneal biomechanics should not consider only the corneal center, but the whole of the cornea and the influence of whole globe biomechanics as well. For example, biomechanics of the corneal center may not reflect a peripheral corneal ectasia earlier and likewise, a weaker or stronger scleral wall is known to influence the deformation amplitude of the cornea. Finite element modelling (FEM)-based index such as Stress Strain Index (SSI) is the first in this right direction.^[2] SSI is not influenced by CCT or IOP and represents the actual strength of the cornea in lay man terms.

1. Which procedure is biomechanically stronger?

There have been several studies done using ORA and CORVIS to study biomechanical changes post LASIK, PRK, and SMILE. Though earlier studies using ORA have shown that LASIK has a greater biomechanical weakening compared to SMILE,^[3] recent studies using CORVIS ST have variable conclusions.^[4,5] When LASIK and SMILE are matched for the changes in CCT, they have shown similar biomechanical weakening.^[6] There is only one study now showing SSI changes in early postoperative time following LASIK.^[7] There are more studies needed using the novel SSI and CBI-LVC with longer-term follow ups and also involve the effects of long-term wound healing to check how LASIK differs from SMILE.

2. Differentiating normal corneas postrefractive surgery from post refractive surgery ectasia

Though several univariate indices provided by CORVIS ST have been variably successful in differentiating normal corneas from postrefractive surgery ectatic ones in the past,

the best index as on date is the CBI-LVC, with sensitivity and specificity over 90% for a cutoff of 0.20.^[8] For all corneas postrefractive surgery, surgeons must use this index which is different from CBI to build a larger database, so that this index can be further tested and refined.

3. Predicting postrefractive surgery ectasia earlier:

The existing indices from CORVIS ST can help differentiate a cornea which is biomechanically weaker from a normal cornea, adjusting for CCT and IOP. However, they cannot predict how much a laser refractive procedure can weaken a particular cornea. There is a relatively newer published work on predictive modelling using FEM,^[9] and also a software called "AcuSimX" which can help predict the level of biomechanical weakening a cornea undergoing a specific form of refractive surgery develops. This tool needs to be studied and compared with the actual measured long-term biomechanical weakening postrefractive surgery, denoted by CBI-LVC and SSI. This can be a significant value addition in the field of refractive surgery, which can let the surgeon know the risk of ectasia preoperatively itself.

Finally, there are newer devices, which are not commercially available until now, such as polarization sensitive OCT,^[10] which can visualize the collagen distribution within the cornea and identify weakening. Results from these devices, when studied and interpreted along with the advancements above, are likely to revolutionize our understanding of corneal biomechanics in the near future.

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Conflicts of interest

There are no conflicts of interest.

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