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RESPONSE TO LETTER

The Importance of HOA Reduction Measurements to Improving Refractive Surgery Result Outcomes [Response to Letter]

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Dear editor

We thank Dr. Motwani for his valuable comments on our recent report: Kanellopoulos AJ, Maus M, Bala C, Hamilton C, Lemonis S, Jockovich ME, Khoramnia R. International Multicenter, Myopic and Myopic Astigmatism Femto LASIK, Customized by Automated Ray-Tracing Ablation Profile Calculation: A Postmarket Study. Clin Ophthalmol. 2024 Feb 20: 18: 525–536. Of interest, customized excimer laser approaches were initially introduced to treat complex irregular corneal conditions, including post-laser vision correction eyes.[1–3] The improvement of corneal higher-order aberrations indeed holds the promise of enhancing both the quality and quantity of vision. Improving the quantity of vision in terms of distance uncorrected visual acuity is evident when comparing preoperative corrected visual acuity to postoperative uncorrected visual acuity.

The current standard of care for customized ablations has shifted away from purely wavefront-guided treatments towards topography-guided treatments, a reason likely indeed for the more reproducible topography measurements and predictable outcomes. For years, we have advocated that topography-guided treatments may offer improved visual outcomes even in naïve myopic eyes in terms of acuity, and high order aberrations measured via aberrometry, and functionally via contrast sensitivity, by more effectively addressing higher-order aberrations, mainly coma (C7, C8) that have corneal refractive origin. These treatments, although measured by subjective manifest refraction, were treated topography-guided with cylinder adjustment to that of the amount and axis measured by the topography. This concept was based on the attempted alignment of corneal symmetry to the visual axis-this may be significantly disparate depending on angle kappa, which we introduced in 2015 through the concept of Topography Modified Refraction (TMR).[4] TMR uses the anterior reflection topography (Vario, Topolyzer, Alcon, Wavelight, Erlangen, Germany) to provide high-accuracy and reproducible topography data, as well as angle kappa measurements, so treatment data are calculated and applied via the Contura software and applied by the EX500 excimer by Alcon/Wavelight.

In treating virgin myopic and myopic astigmatic cases with Contura, we have noted that the cornea is reshaped to be more symmetric towards the vertex, which functionally represents the visual axis. Consequently, the topographic data regarding the magnitude and axis of astigmatism may provide better visual outcomes than those obtained using the most commonly used subjective manifest refraction.[5] TMR has since found broader clinical practice in the US, Europe and Australia with its subsequent integration into an automated software: Phorcides (Phorcides LLC, St. Paul, Minnesota, USA). Based on the same principle, raytracing automated customized treatments were designed to also include not just

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corneal but additionally whole eye aberrations. Although these treatments may not seem different from wavefront-guided treatments, in essence, they are:

The combined data from Scheimpflug tomography imaging and Hartmann-Shack wavefront sensing are used to retrace 2000 theoretical rays towards and from the eye. The "towards-the-eye" tracing is performed using Scheimpflug tomography data, while the "from-the-eye" tracing utilizes wavefront data, plotted virtually through a customized three-dimensional, unique for each eye studied, model. This 3D model is generated from axial length measurements captured by a single diagnostic device (eg, the Alcon WaveLight's Sitemap, a modification of the Pentacam HR Wave AXL device by Oculus, Germany). The raytracing algorithm developed by Alcon WaveLight also includes calculations besides low order aberrations (myopia with or without astigmatism) based on epithelial healing, taking into account the amount of spherical correction planned, as well as expected biomechanical changes related to the planned correction. It also additionally measures and attempts to correct tilt, between the cornea and the lens, as optical systems.

In our multi-center study, we report, for the first time, data from several international centers in Europe and Australia, regarding visual outcomes of myopic raytracing customized LASIK. We conclude that the exceptional outcomes, mainly in regard to lines of vision gained, and relatively low higher-order aberrations postoperatively, and a very high index of patient satisfaction underline the safety and efficacy of this novel automated customised approach. It should be noted that in the study, cases were treated without any manual adjustment by the surgeon on the values provided by the automated raytracing software. Years before this study, we reported similar outcomes when this technology when it first became clinically available in the European Union and demonstrated its significant benefit even in highly aberrated eyes, such as those with corneal distortion related to keratoconus.[6–10]

The comment regarding pursuit of reducing higher-order aberrations is well taken. However, the measurement of all these aberrations, even the ones induced by LASIK may remain elusive, as the human eye functions dynamically with fluctuating total aberrations and there are several parameters involved in postoperative corneal remodelling following LASIK. An absolute standard and reproducible total measurement may not yet be feasible. A more realistic approach appears to focus on aberrations related to coma, trefoil, spherical aberration expected and other forms of possible distortion related to corneal biomechanics and/or corneal epithelial remodelling.[9] In our study, while there was a slight increase in higher-order aberrations measured, the overall number was considered very low when compared to the global experience of cornea-based laser vision correction with any current platform standard and/or customized. Additionally, we reported improved contrast sensitivity across all spatial frequencies following the procedure, marking indeed a significant improvement in the quality of vision following the use of ray-tracing technology in myopic LASIK.[10]

Disclosure

MM has received consulting fees from WaveLight (a subsidiary of Alcon; Erlangen, Germany) and equipment or other services from Alcon and is a board member of the Refractive Surgery Alliance. CB has received grants, consulting fees, and fees for education events from Alcon; grants from Johnson & Johnson (Irvine, CA, USA); and consulting fees from Hoya (Tokyo, Japan). CH, SL, and MEJ are employees of, and stockholders in, Alcon. RK has received grants, lecture fees, and travel support from Alcon and Johnson & Johnson; has received lecture fees from Carl Zeiss (Oberkochen, Germany), Heidelberg Engineering (Heidelberg, Germany), Bausch + Lomb (Bridgewater, NJ, USA), and Oculus (Wetzlar, Germany); and is an unpaid board member of DGII. All authors report no other conflicts of interest in this communication.

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