

Targeting Anterior Corneal Astigmatism With Topography-Guided Ablation Ignores Ocular Residual Astigmatism, Resulting in Inferior Outcomes

We read with interest “Comparison of Wavefront-Optimized Ablation and Topography-Guided Contoura Ablation With LYRA Protocol in LASIK” by Ozulken et al.¹ Eyes with 0.75 diopters or greater magnitude difference between clinically measured manifest refractive astigmatism and Contoura-measured anterior corneal astigmatism (ACA) and 10° or less axis difference received Contoura treatment (WaveLight Contoura; Alcon Laboratories, Inc., Fort Worth, TX), whereas contralateral eyes without these criteria were excluded from Contoura treatment and received wavefront-optimized (WFO) treatment. This methodology led to Contoura eyes having lower ocular residual astigmatism (ORA) compared to contralateral WFO eyes with higher ORA. The authors do not report on this preoperative ORA difference between groups, nor do they discuss the potential impact on outcomes and conclusions. Furthermore, the study design did not investigate one single independent variable.¹ The technologies being compared (Contoura versus WFO) had differing modalities of astigmatism treatment (ACA vs refractive astigmatism).¹ The Contoura group targeted plano ACA and the WFO group targeted plano refractive astigmatism, whereas both used the same outcomes measure of postoperative refractive astigmatism. Therefore, the refractive astigmatism-treated WFO group would be expected to yield superior refractive astigmatism outcomes. Did these groups have equivalent outcomes because the refractive and topographical cylinder had minimal discrepancy in the Contoura (low ORA) group as per study design, and/or did the bias of higher ORA in the WFO group decrease those outcomes?

ACA-treated eyes with low ORA, those selected for this study’s Contoura group,¹ are reported to have good outcomes.² ACA-treated eyes with higher ORA, which were excluded from the Contoura group,¹ have poorer outcomes, particularly in eyes with greater discrepancy.² Without examining higher discrepancy (higher ORA) eyes, and with only 32 eyes per group,¹ the conclusion that treating the Contoura-measured ACA (LYRA protocol) had “statistically similar visual outcomes” to WFO treating the manifest refractive astigmatism¹ is not supported for all myopic virgin eyes treated with laser in situ keratomileusis.

The study¹ attempts to report on astigmatism outcomes without an Alpins analysis. The postoperative refractive astigmatism graph shows less than 70% of eyes within ± 0.50 diopters of cylinder in the

Contoura group,¹ whereas this rate ranges between 86% and 96% in the Contoura literature.² Despite the inferior refractive astigmatism outcomes, an exceptionally high 20/20 uncorrected distance visual acuity rate (96%) is reported.¹ We would ask the authors to reconcile these data. A 432-eye study reported opposite findings of lesser outcomes in ACA-treated Contoura versus refractive astigmatism-treated WFO eyes.³ We recently discussed how poorer outcomes are expected in ACA-treated eyes that ignore ORA, unrelated to a comparison of WFO versus Contoura technology.⁴

Much of the study’s discussion is a repetition of the research of Motwani, who first described the LYRA protocol. Ozulken et al. state: “Motwani showed that HOAs [higher order aberrations] interacting with lower order astigmatism is the main reason for the differences between manifest refraction,”¹ but they do not discuss our mathematical three-dimensional quantification that shows that his theory is not valid.⁵ Furthermore, the following statement is incorrect: “the magnitude and axis of astigmatism used in the Contoura with LYRA protocol is the magnitude and axis of the astigmatism that needs to be corrected after the treatment of corneal HOAs.”¹ This only holds true if ACA and anterior corneal HOAs are the only sources of refractive astigmatism. One cannot ignore the existence of other clinically significant sources of astigmatism such as posterior corneal astigmatism, lenticular astigmatism, and cortical perception.²

Ozulken et al. state: “According to Motwani’s hypothesis, the incidence of residual astigmatism posterior to the cornea is much less than expected, and the largest and most important part of the correction is the anterior corneal surface.”¹ There is ample evidence in the literature to show that the posterior cornea cannot be neglected.⁵ The authors state: “The LYRA protocol determines the connection between HOAs and lower order aberrations with the use of Contoura measurements” and “Contoura software can successfully model the cornea to determine the remaining astigmatism after removing corneal HOAs.”¹ These statements are inaccurate because this is not what the technology does.⁵ The Contoura topography-guided software determines the anterior corneal HOAs and the ACA from a high-resolution Placido disc topographer. The Contoura-measured ACA does not consider the manifest refractive astigmatism and does not measure or supply information on how anterior corneal HOAs impact lower order astigmatism. We thank the authors for their contribution to this important topic.

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Reply

We would like to thank Wallerstein et al. for their continued contributions to the dialogue around topography-guided ablation and refractive surgery, and their persistence in advocating their positions.

In our study,¹ we used topography-modified refraction values in accordance with the LYRA protocol and found that topography-guided Contoura ablation with LYRA protocol treatment (WaveLight Contoura; Alcon Laboratories, Inc., Fort Worth, TX) produced slightly better outcomes. Similarly, in a study of 100 eyes of 50 patients, Kanellopoulos² reported that topography-guided treatment using topography-modified refraction values yielded better results than the treatment using manifest refraction. In addition, in their study comparing wavefront-optimized (WFO) and topography-guided treatment methods, Kim et al.³ used topography-modified refraction values in the topography-guided treatment group and reported that topography-guided laser in situ keratomileusis induced fewer higher order aberrations (HOAs) and significantly reduced ocular trefoil, corneal total HOAs, and coma. On the contrary, Wallerstein et al.⁴ have long advocated the use of manifest refraction with topography-guided ablation, and this viewpoint

would have us believe that the removal of light scatter via corneal HOA reduction has no effect on the measurable astigmatism whatsoever and that the hand-measured, post-cortical processing-derived astigmatism number is sacrosanct and the correct way to treat.

In our study, because we applied WFO treatment in eyes that were not suitable for topography-guided Contoura ablation with LYRA protocol, Wallerstein et al. claim that there is bias in the method part of our study. We do not think so because, as Motwani stated previously, residual astigmatism value posterior to the cornea is much less than expected. In other words, we argue that both WFO and topography-guided Contoura ablation with LYRA protocol treat not only corneal astigmatism, but also whole refractive astigmatism. Therefore, we did not look for preoperative residual astigmatism in both groups. If the hypothesis of Wallerstein et al., which is that topography-guided Contoura ablation with LYRA protocol only treats anterior corneal astigmatism, was correct, we would have expected better results in the WFO-treated group. However, in our study we found slightly better visual outcomes in the group treated with the topography-guided Contoura ablation with LYRA protocol.

Furthermore, much of what Wallerstein et al. point to as proof is circular, and we believe analytically flawed. They put an enormous amount of emphasis on Alpíns analysis, but in their study,⁴ they set arbitrary parameters in their Alpíns analysis of data. We believe this has led to a flawed statistical analysis and diagnostic conclusions. This is reflected in their position that a larger difference between manifest refraction and Contoura-measured anterior corneal astigmatism (ACA) in magnitude or axis leads to a worse result when treated with the LYRA protocol (which uses the full amount of Contoura-measured ACA). That is the exact opposite of our and Motwani's clinical experience for almost 4 years now. These results have demonstrated that the patients who have the largest difference in Contoura-measured ACA and manifest refraction are those who have the greatest distortion and scatter of light from their corneal HOAs. We have a large group of patients with a marked difference from manifest astigmatism in magnitude and axis. These patients not only show excellent visual results, but some have shown other positive effects, such as elimination of chronic headache and pressure and debilitating glare. We attribute this to the decreased need for cortical processing of light scatter and distortion.

Alpíns analysis is not the only way to determine the reduction of astigmatism. Dr. Motwani demonstrated that the C3 and C5 Zernicke polynomials were reduced by the use of the LYRA protocol. Furthermore, there is a clinical result not only as 20/20 or 20/15 visual acuity,

but also in the quality of vision. Moreover, good results have been reported in studies using the Refractive Status and Vision Profile patient satisfaction surveys.

Wallerstein et al. cited mainly their own studies in this letter to the editor. Their clinical research letter,⁵ which Motwani responded to in *Clinical Ophthalmology*, is the basis for their claim that there is ample evidence for the significance of posterior astigmatism. In this research letter, Wallerstein et al. essentially claimed that the theories behind the LYRA protocol⁵ could not be correct because they disagree with past theories of the significance of posterior astigmatism. Wallerstein et al. never directly address or explain in this research letter the published clinical results from the use of the LYRA protocol, which works in direct opposition to their assertions.

Wallerstein et al. also cited a study by Zhang and Chen.⁶ They did not mention that this group did not use the WaveLight Topolyzer Vario, but a completely different topographic device for topography-guided ablation corrections. We have been careful to point out that the LYRA protocol has not been tested with any other system except the WaveLight Contoura system, which uses the Topolyzer Vario. This study cannot be used in comparison because we simply are not familiar with the topography device being used.

Wallerstein et al. also stated that the clinical visual results were not the same as other studies, and this is because our study represented 1-month outcomes. These outcomes improve over 3 and 6 months, which have been reported in the past. We reconciled the data of our study and we did not detect any errors, but we should state that the small differences in the data of the patients affected the percentage values due to the small number of patients. Also, patients with corneal aberration removal using the LYRA protocol will often still see 20/20 postoperatively even if they have a measurable refraction. Treating the refraction often increases visual acuity to 20/15 and improves patient satisfaction.

Furthermore, Wallerstein et al. stated without evidence that somehow the Contoura system did not model the cornea in software, and therefore could not determine the astigmatism. The Contoura software

does a best-fit sphere to the cornea after corneal HOA removal, which is how it determines the Contoura-measured ACA.

Although we deeply appreciate Wallerstein et al.'s input as part of a continued dialogue concerning the best outcomes for patients, it is critical that scientific fact and clinical outcomes be used to further the debate. At the end of the day, the goal is not to satisfy some analysis, but to provide the patient with the best possible visual outcomes. We are open to further discussion of this issue, and agree there is still much to investigate in providing the best possible patient outcomes.

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