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Disclosures: *L. van Vught, G.P.M. Luyten, and J.-W.M. Beenakker have a patent pending on the improved IOL design.*

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Comment on: Comparison of clinical outcomes between vector planning and manifest refraction planning in small-incision lenticule extraction for myopic astigmatism

Jun et al. should be congratulated on their important study comparing clinical outcomes between vector planning (VP) and conventional manifest refraction (MR) for the treatment of myopic astigmatism with small-incision lenticule extraction (SMILE).[1,2] The findings of this groundbreaking study demonstrated statistically significant better outcomes for the VP-treated patients for both refractive cylinder and corneal astigmatism as well as internal aberrations as quantified by ocular residual astigmatism (ORA) than those treated by conventional MR. Angle of error, correction index (CI), and linearity of slope of line of best fit between surgically induced astigmatism vector and target-induced astigmatism vector were also significantly better.

With such clear-cut superiority of the VP group, it is difficult to rationalize such a problematic conclusion recommending a requirement for a nomogram adjustment. A nomogram adjustment means that this Zeiss SMILE device is systematically over or under correcting astigmatism across ALL treatments—which is incorrect according to the results in this study in which the overall CI is very close to the ideal 1.0. The authors suggest a nomogram adjustment for the cylinder treatment of the MR group alone. If a nomogram adjustment was to be applied to the MR group, which has a CI of 0.88 by refraction, then the overcorrection by corneal values of 1.24 (arithmetic mean of 1.06 for both CI) would be further increased to cause adverse corneal outcomes for the MR group. When extended to the VP group, this would also adversely affect the excellent outcomes achieved, with the CIs of both refractive (1.04) and corneal (0.98) analyses (arithmetic mean 1.01) being optimal.

Just as treatment is shown to have benefit by an ideal balance between corneal and refractive astigmatism parameters, so too does the analysis postoperatively of nomogram adjustments benefit by both being taken into account as performed below.

CI analysis: (1) corneal measurements (from Table 3) MR 1.24 VP 0.98 (2) refractive measurements (from Supp. Table 2 calculated for zero target) MR 0.88 VP 1.04.

The statistically significant difference between MR and VP is not due to any nomogram adjustment being required, but rather the VP method of incorporating both corneal and refractive astigmatism parameters into the treatment profile, leading to beneficially reduced astigmatism, cylinder, and internal aberration outcomes.

Furthermore, the stated solution to resolve differences that exist between corneal and refractive values by repeating the MR with more care or accuracy belies the fact that care was likely taken with the first test and a significant proportion of eyes will still have ORAs greater than 0.75 diopters after retesting.

This study reconfirms the findings by Arbelaez et al. in demonstrating better outcomes for VP with less corneal astigmatism remaining postoperatively, compared with treatment using MR parameters.[3] This important benefit was achieved without compromising refractive cylinder outcomes. However, it seems the authors here may have misinterpreted the astigmatism analyses of their own study in suggesting a nomogram adjustment would provide benefit when in fact from their own published figures, as tabulated above, the Zeiss SMILE device without any correction adjustments is performing excellently by examining both corneal and refractive astigmatism parameter analyses.

With several studies now demonstrating the benefits of VP when treating astigmatism, consideration should be given to VP being adopted as the standard of care in refractive surgery for the treatment of myopic astigmatism.

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analysis of astigmatic correction. ASSORT holds trademarks and patents in vector planning.

Reply to comment on: Comparison of clinical outcomes between vector planning and manifest refraction planning in small-incision lenticule extraction for myopic astigmatism

We thank the author for this considered letter. As mentioned, a nomogram adjustment means that there is a systematic overcorrection or undercorrection across all treatments. The published evidence and anecdotal experience demonstrates the need for a cylinder nomogram in small-incision lenticule extraction for all treatments (both low and high ocular residual astigmatism [ORA]) as described in the article and supported by references.[1–5] Had a nomogram been applied to the manifest refraction (MR) group, this would be expected to reduce the undercorrection observed. In comparison, the major cause for ORA in the vector planning (VP) group was that the corneal toricity magnitude was higher than refractive cylinder, whereas the axis was within ±10 degrees for most eyes. Therefore, the VP approach increased the cylinder magnitude, which was similar to applying a nomogram but only in the VP group.

It was proposed that because the overall correction index (CI) was close to 1.0 for the MR group, this indicated that the nomogram was set correctly. We strongly disagree and believe that corneal astigmatism data should be given less weight than MR. There is considerably more scatter in corneal compared with refractive data; corneal astigmatism based on 3 mm data uses a limited amount of topography data available; simulated keratometry values can also be influenced by measurement centration, optical zone, and topographic asymmetry.

The high corneal astigmatism CI of 1.24 was an interesting finding that appeared to contradict the refractive CI of 0.88. However, the relatively low reliability of this analysis was addressed in the discussion. This was most likely influenced by bias toward low target-induced astigmatism (TIA) in the MR group. CI is the ratio of surgically induced astigmatism and TIA and is therefore a misleading metric for low corrections. TIA was less than 0.50 diopters (D) for 38% of eyes in the MR group. Low corrections are also more sensitive to other factors, including measurement error, alignment, and healing effects. Cylinder corrections of 0.50 D and below are often excluded from vector analysis for this reason.

We would also question the use of CI for nomograms because CI averages data across the treatment range, whereas TIA vs surgically induced astigmatism regression line accounts for magnitude. If the CI of 1.24 was used as a nomogram for the MR group, this would apply a smaller increase for low corrections than high corrections, which is opposite to what the corneal astigmatism data show, that there was an overcorrection for low cylinder.

To investigate this further, we analyzed optical path difference scan (Nidek) objective refraction, which excludes neural processing and is independent of ORA. Figure 1 shows there was an undercorrection for higher cylinder in the MR group, which confirms the MR results and weakens the interpretation of an overcorrection based on corneal astigmatism.

In summary, it is reasonable to conclude that had a nomogram been used, the MR group results may have improved. If the same nomogram had been used in addition to using VP, the VP group results may have changed. Therefore, we had proposed to repeat the study using a nomogram and compare this with VP. In our opinion, the CI should not be used for nomograms, and corneal astigmatism data should not be given the same weight as manifest or objective optical path difference refraction data.

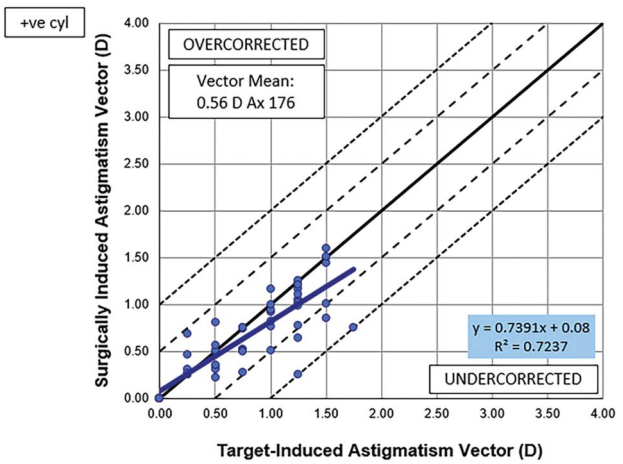

Figure 1. The relationship between TIA vs surgically induced astigmatism calculated using OPD scan data. OPD = optical path difference

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