Nonwavefront-Guided Presby Reversal Treatment Targeting a Monofocal Cornea After Bi-asperic Ablation Profile in a Patient Intolerant to Multifocality

Michiel H. A. Luger, MHA, MD; Tobias Ewering, Dipl-Ing (FH); Samuel Arba-Mosquera, PhD

ABSTRACT

PURPOSE: To analyze distance and near vision after a nonwavefront-guided Presby reversal treatment targeting a monofocal cornea in a patient intolerant to multifocality in the dominant eye.

METHODS: Case report.

RESULTS: An originally myopic patient treated for correcting distance ametropia and simultaneously alleviating presbyopic symptoms resulted in intolerance to the induced multifocality. Twenty-one months after the bi-asperic multifocal treatment, the patient was treated with PresbyMAX reversal (SCHWIND eye-tech-solutions, Kleinostheim, Germany) to remove the previously induced multifocality. Original corrected distance visual acuity (CDVA) was -0.1 logMAR (20/16 Snellen) with +0.8 logMAR (J12) uncorrected near visual acuity (UNVA) and changed to CDVA +0.1 logMAR (20/25 Snellen) with +0.2 logMAR (J4) UNVA before the Presby reversal procedure (all monocularly). Three months after the reversal treatment, uncorrected distance visual acuity and CDVA were both -0.1 logMAR (20/16 Snellen), and the patient was emmetropic and had no further visual complaint for distance, but at the cost of losing the UNVA.

CONCLUSIONS: Nonwavefront-guided Presby reversal treatments targeting a monofocal cornea after bi-asperic ablation profile were successful.


Surgical correction of presbyopia continues to be one of the greatest challenges for refractive surgeons. There is increasing interest in achieving pseudo-accommodative corneas for the alleviation of presbyopic symptoms, which can be performed with the PresbyMAX (SCHWIND eye-tech-solutions, Kleinostheim, Germany). One of the major concerns about induced corneal multifocality is the reversibility of the procedure, or how easy it is to regain a monofocal cornea in case of dissatisfaction with a surgically induced multifocal cornea. Such multifocal optical systems cannot be fully corrected with conventional spectacles or contact lenses. In the case of multifocal ablation, it also remains inconclusive whether multifocal corneas (characterized by extreme high levels of aberrations, particularly spherical aberrations), can be resolved by Placido-based topography or Hartmann-Shack aberrometry and reverted back to normal corneas using a wavefront-guided approach.

To the best of our knowledge, we present the novel use of a nonwavefront-guided Presby reversal treatment targeting a monofocal cornea after bi-asperic ablation profile applied to a patient intolerant to multifocality and wishing to have a monofocal cornea again.

CASE REPORT

An originally myopic patient (49 years old at the time of the initial treatment) simultaneously treated for correcting distance ametropia and alleviating presbyopic symptoms resulted in intolerance to the induced multifocality in the dominant (right) eye.

Refration values and visual acuities can be found in Table 1. The original refraction was mild myopic astigmatism with normal corrected distance visual acuity (CDVA). The bi-asperic multifocal treatment (Figure 1A) resulted in low myopic astigmatism close to the target of approximately -0.5 diopters sphere (DS), but CDVA decreased by two lines. After the 3-month follow-up was completed, a corneal wavefront-guided treatment was performed (Figure 1B) in an attempt to improve distance visual acuity. With this treatment, refraction shifted to low hyperopic astigmatism, but CDVA did not improve and the patient was still dissatisfied with the result.

Due to the persistent dissatisfaction, a nonwavefront-guided PresbyMAX reversal treatment was planned (Figure 1C). This treatment was prepared using the SCHWIND PresbyMAX treatment planning module in Presby reversal mode. This reversal treatment analytically counterbalances the aberration induction of the PresbyMAX profile in an attempt to correct residual refraction and to remove all or some of the multifocality induced by a previous PresbyMAX treatment.

The final treatment plan was +0.33 DS -0.60 diop ters cylinder (DC) × 1° and reversed addition -0.75 D in an optical zone of 6.50 mm and with a pupil-to-vertex offset of 0.13 mm at 190° (with both identical to the original PresbyMAX treatment) (Figure 1C).
TABLE 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Preoperative</th>
<th>After PresbyMAX Before CW</th>
<th>After CW Before PresbyMAX Reversal</th>
<th>After PresbyMAX Reversal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative follow-up time (mo)</td>
<td>-</td>
<td>3</td>
<td>18</td>
<td>3</td>
</tr>
<tr>
<td>UDVA (logMAR [Snellen])</td>
<td>+1.7 (20/1000)</td>
<td>+0.3 (20/40)</td>
<td>+0.1 (20/25)</td>
<td>-0.1 (20/16)</td>
</tr>
<tr>
<td>CDVA (logMAR [Snellen])</td>
<td>-0.1 (20/16)</td>
<td>+0.1 (20/25)</td>
<td>+0.1 (20/25)</td>
<td>-0.1 (20/16)</td>
</tr>
<tr>
<td>UNVA (logMAR [Jaeger])</td>
<td>+0.8 (J12)</td>
<td>0.0 (J1)</td>
<td>+0.2 (J4)</td>
<td>Not measured</td>
</tr>
<tr>
<td>DCNVA (logMAR [Jaeger])</td>
<td>+0.2 (J4)</td>
<td>+0.1 (J2)</td>
<td>+0.2 (J4)</td>
<td>Not measured</td>
</tr>
<tr>
<td>CNVA (logMAR [Jaeger])</td>
<td>+0.1 (J2)</td>
<td>0.0 (J1)</td>
<td>0.0 (J1)</td>
<td>Not measured</td>
</tr>
<tr>
<td>SE (D)</td>
<td>-4.00</td>
<td>-0.75</td>
<td>+0.38</td>
<td>0.00</td>
</tr>
<tr>
<td>Astigmatism (D)</td>
<td>0.50</td>
<td>0.25</td>
<td>0.25</td>
<td>0.00</td>
</tr>
<tr>
<td>Ksteep (D)</td>
<td>42.50</td>
<td>39.00</td>
<td>38.25</td>
<td>38.25</td>
</tr>
<tr>
<td>Kflat (D)</td>
<td>42.00</td>
<td>38.75</td>
<td>37.75</td>
<td>38.25</td>
</tr>
<tr>
<td>Corneal thickness (μm)</td>
<td>514</td>
<td>457</td>
<td>435</td>
<td>424</td>
</tr>
</tbody>
</table>

CW = corneal wavefront-guided treatment; UDVA = uncorrected distance visual acuity; CDVA = corrected distance visual acuity; UNVA = uncorrected near visual acuity; DCNVA = distance corrected near visual acuity; CNVA = corrected near visual acuity; SE = spherical equivalent; D = diopters; Ksteep = steep keratometry; Kflat = flat keratometry

PresbyMAX is manufactured by SCHWIND eye-tech-solutions, Kleinostheim, Germany.

Eighteen months after the corneal wavefront re-treatment, the patient was treated with a Presby reversal ablation to remove the previously induced multifocality. Original CDVA was -0.1 logMAR (20/16 Snellen) with +0.8 logMAR (J12) uncorrected near visual acuity (UNVA) and changed to CDVA +0.1 logMAR (20/25 Snellen) with +0.2 logMAR (J4) UNVA before reversal. Three months after the reversal treatment, the patient achieved both -0.1 logMAR (20/16 Snellen) uncorrected distance visual acuity (UDVA) and CDVA, ending up emmetropic and without any further visual complaints for distance, but at the cost of losing the UNVA.

Corneal spherical aberration at 6 mm was +0.191 μm preoperatively, -0.118 μm before corneal wavefront-guided treatment, and -0.081 μm before reversal. Ocular spherical aberration at 6 mm was -0.169 μm preoperatively, -0.108 μm before corneal wavefront-guided treatment, and -0.168 μm before reversal. Three months after the reversal treatment, corneal spherical aberration at 6 mm was +0.172 μm and ocular spherical aberration at 6 mm was +0.041 μm (Figure A, available in the online version of this article).

**DISCUSSION**

PresbyLASIK treatment uses the principles of LASIK surgery to create a multifocal corneal surface aimed at reducing near vision spectacle dependence in presbyopic patients. The aim of PresbyMAX reversal is spectacle-free vision in daily situations but with the possibility of needed additives (ie, spectacles for reading or distance in case of special demands while focusing).

**Figure 1.** (A) Original PresbyMAX treatment (SCHWIND eye-tech-solutions, Kleinostheim, Germany). (B) Corneal wavefront-guided re-treatment. (C) PresbyMAX reversal treatment.
In this case report, the concern was the reversibility of the previously induced multifocality. The patient’s visual acuity could not be sufficiently improved with conventional spectacles or contact lenses, probably due to the high levels of spherical aberrations, making the patient intolerant to the multifocality in the dominant eye.

In a first attempt, we tried a corneal wavefront-guided treatment derived from Placido-based anterior corneal topography (Figure 1B). This treatment worked only partially and improved the refraction and UDVA, but it did not improve CDVA. Similarly, spherical aberrations changed only slightly. The patient’s complaints persisted. Our hypothesis is that the videokeratoscope did not effectively detect the levels of primary and secondary spherical aberrations induced. The patient remained dissatisfied with the vision after the corneal wavefront-guided treatment, probably because the dominant eye was affected. This emphasizes the importance of preoperative patient counselling prior to a corneal multifocal treatment, which will always compromise the contrast vision to some extent.

Planned refraction (+0.33 DS -0.60 DC x 11°) was different from manifest refraction (+0.50 DS -0.25 DC x 180°) because of the differences between keratometric values and measured refraction. Because CDVA was reduced, we estimated the postoperative refraction based on the original manifest refraction before PresbyMAX treatment and the differences in keratometric values from before PresbyMAX treatment to after corneal wavefront-guided treatment.

The planned reversal addition was lower (-0.75 D) than the originally planned addition (+1.33 D). The reasons for this are twofold: (1) a corneal wavefront-guided treatment had already been performed and part of the negative spherical aberrations may have been reduced (although not confirmed by the diagnostic devices) and (2) partly reducing induced multifocality may help the patient recover CDVA (and UDVA) while retaining a small part of the UNVA (and DCNVa).

The corneal spherical aberrations after reversal were similar to the status before PresbyMAX but the ocular spherical aberrations before PresbyMAX were dissimilar to 3 months after reversal (Figure A). Because all involved treatments were corneal ablations and we could not find a reason for the similar levels of corneal spherical aberrations without evidence of changes in internal optics, ocular spherical aberrations remained different.

The Presby reversal option is not recommended for planning all re-treatments after PresbyMAX. The patient’s complaints and expectations after previous multifocal ablation should be individually considered.

For a successful Presby reversal with this technique, surgeons need to know the original multifocal planning, particularly optical zone and pupil-to-vertex offset (along with near addition). Differences in optical zone will result in removing multifocality outside, where it was not induced (for optical zone reversal > optical zone PresbyMAX), or leaving some peripheral multifocality uncorrected (for optical zone reversal < optical zone PresbyMAX). Similarly, using different offsets would result in a multifocality removal shifted from an originally induced one, leading to coma aberration.

This case report shows that nonwavefront-guided Presby reversal treatments targeting a monofocal cornea after bi-aspheric ablation profile were successful in a patient intolerant to multifocality in the dominant eye. Further investigation is needed to improve our knowledge about the real advantages and disadvantages of the different procedures currently available for the treatment of presbyopia and its reversibility.

AUTHOR CONTRIBUTIONS
Study concept and design (MHAL, SA-M); data collection (MHAL); analysis and interpretation of data (TE, SA-M); drafting of the manuscript (SA-M); critical revision of the manuscript (MHAL, TE); statistical expertise (SA-M).

REFERENCES
Figure A. Ocular and corneal wavefront aberrations measured by the OPD-Scan II (Nidek, Gamagori, Japan). (A) Original preoperative aberrations. (B) Aberrations 3 months after PresbyMAX reversal treatment (SCHWIND eye-tech-solutions, Weinostheim, Germany).