

# Functional Outcomes and Reading Performance After Combined Implantation of a Small-Aperture Lens and a Segmental Refractive Bifocal Lens

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## ABSTRACT

**PURPOSE:** Clinical evaluation of the visual outcomes after implantation of a small-aperture extended depth of focus (EDOF) intraocular lens (IOL) and a segmental refractive bifocal lens.

**METHODS:** In this prospective study, 13 patients with cataract received a small-aperture IC-8 IOL (AcuFocus, Irvine, CA) in one eye and a segmental-refractive Lentis Mplus LS-313 MF20 IOL (Oculentis, Berlin, Germany) in the fellow eye. The clinical examination included measurements of uncorrected (UDVA) and corrected (CDVA) distance visual acuity, uncorrected (UIVA) and distance-corrected (DCIVA) intermediate visual acuity, and uncorrected (UNVA) and distance-corrected (DCNVA) near visual acuity. Additionally, a defocus curve was obtained from +2.00 to -5.00 diopters (D) and a Salzburg Reading Desk was used to assess the patients' reading acuity at intermediate and near distances. A halo and glare simulator was used to evaluate the postoperative perception of dysphotopsia.

**RESULTS:** At 5 months postoperatively, the mean binocular visual results demonstrated UDVA, UIVA, and UNVA values of  $-0.04 \pm 0.11$ ,  $0.00 \pm 0.10$ , and  $0.11 \pm 0.08$  logMAR, respectively. The binocular distance-corrected reading performance test also confirmed the improved visual function, with an intermediate reading acuity of 0.12 logMAR at 69.21 cm and a near reading acuity of 0.19 logMAR at 41.63 cm. The mean halo size was  $32.54 \pm 22.38$ , mean halo intensity was  $34.46 \pm 21.95$ , mean glare size was  $9.00 \pm 17.47$ , and mean glare intensity was  $9.92 \pm 16.84$ .

**CONCLUSIONS:** The new concept of a combined implantation of a small-aperture IOL and a segmental-refractive bifocal lens showed good results in far and intermediate distances and functional results at near distance, while causing minimal photic phenomena.

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There are currently numerous different multifocal intraocular lens (IOL) models available in the market. Some are bifocal or trifocal, whereas recent ones claim to generate a so-called extended depth of focus (EDOF), which describes the ability of the lens to provide a continuous range of vision across multiple distances. Typically, multifocal lenses are implanted bilaterally. Alternatively, surgeons can “mix-and-match,”

a technique that describes an asymmetrical implantation of two different IOL models as an attempt to reinforce their advantages and thereby improve the visual outcomes.<sup>1,2</sup> Numerous studies have reported visual results after mixing and matching different multifocal IOLs.<sup>3-7</sup> In this study, we present the clinical outcomes after asymmetrical implantation of an EDOF IOL and a segmental-refractive bifocal lens.

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## PATIENTS AND METHODS

### STUDY DESIGN

In this prospective study, 26 eyes of 13 patients undergoing cataract surgery were included. All patients were adequately informed and signed the informed consent form prior to study inclusion. The study adhered to the tenets of the Declaration of Helsinki and was approved by the local ethics committee. The inclusion criteria were bilateral cataract for which standard phacoemulsification is planned and estimated postoperative distance visual acuity of +0.10 logMAR or better. Exclusion criteria included preoperative corneal astigmatism of 1.50 diopters (D) or higher, previous ocular surgery, glaucoma, pupil abnormalities (eg, aniridia, non-reactive, fixed, or abnormally shaped pupils), corneal abnormalities, degenerative visual disorders (eg, macular degeneration or other retinal disorders), use of systemic or ocular medication that may affect vision, and conditions associated with increased risk of zonular rupture, including capsular and zonular abnormalities that may lead to IOL dislocation (eg, pseudoexfoliation, trauma, or posterior capsule defects).

### IOLs

The IC-8 (AcuFocus, Irvine, CA) is a single-piece, hydrophobic acrylic lens with a central black "mask." The 3.23-mm wide mask is 5- $\mu$ m thick and features 3,200 microperforations (Figure A, available in the online version of this article). It is composed of polyvinylidene fluoride and carbon nanoparticles and has a 1.36-mm pinhole in the center that is intended to increase the depth of focus. The total diameter of the lens measures 12.5 mm with an optic size of 6 mm. It is available for dioptric powers from +15.50 to +27.50 D in 0.50-D increments.

The Lentis Mplus LS-313 MF20 (Oculentis, Berlin, Germany) is a segmental-refractive, rotationally asymmetric, low-add bifocal IOL with a +2.00 D near addition. The lens is composed of HydroSmart (HydroSmart Inc., Elk River, MN) copolymer of hydrophilic acrylate with hydrophobic surface properties. The lens is 11 mm in diameter and has a 6-mm large optic. It is available for dioptric powers from -10.00 to -1.00 D in 1.00-D increments and from 0.00 to +36.00 D in 0.50-D increments.

### PREOPERATIVE AND POSTOPERATIVE EXAMINATION

Preoperatively, all patients underwent a full ophthalmological assessment including manifest refraction, visual acuity, biometry (IOLMaster; Carl Zeiss Meditec, Jena, Germany), slit-lamp examination of both anterior and posterior segments, and Goldmann applanation tonometry. Follow-up visits were scheduled 5 months postoperatively and included evaluation of the postoperative refraction, uncorrected

(UDVA) and corrected (CDVA) distance visual acuity at 4 m, uncorrected (UIVA) and distance-corrected (DCIVA) intermediate visual acuity at 80 cm, and uncorrected (UNVA) and distance-corrected (DCNVA) near visual acuity at 40 cm. Visual acuity was measured with an Early Treatment Diabetic Retinopathy Study chart under photopic conditions. In addition, defocus curves were obtained from +2.00 to -5.00 D.

The reading visual acuity at intermediate and near distances was assessed using the Salzburg Reading Desk. The measurement principles of this device had been extensively described in our previous studies.<sup>8-10</sup> Furthermore, the subjective perception of photic phenomena was evaluated using a computer-based software Halo and Glare Simulator (Eyeland Design Network GmbH, Vreden, Germany). The measurement method of this simulator has also been explained in detail in a previous study.<sup>11</sup> Patients are asked to select the type of halo and glare that they perceive in daily life and must define its size and intensity on a scale from 0 (none) to 100 (very disturbing). The perceived halo can be classified into three different types: H1 (classic halo with a diffuse ring), H2 (starburst type), and H3 (multiple thin concentric rings encircled by a thicker outer ring). Glare can be classified into two different types: G1 (concentric glare) and G2 (eccentric glare).

### SURGICAL PROCEDURE

The target refraction for the eye with the IC-8 IOL was -0.50 D, whereas the target refraction for the fellow eye with LS-313 MF20 IOL was emmetropia. The IC-8 IOL was implanted into the non-dominant eye. The dioptric IOL power was calculated using the A-constants as suggested by the manufacturer and using the SRK-T formula. Two surgeons (RK, GUA) performed all surgeries using a standard sutureless technique under general or topical anesthesia. The IC-8 IOL was implanted via a 3.5-mm incision size, whereas the LS-313 MF20 was implanted via a 2-mm incision size. As recommended by the manufacturer, the LS-313 MF20 IOL was placed in the capsular bag vertically with the haptic position at 90° and 270°. Postoperative topical medication included a combination of an antibiotic and a steroid.

### STATISTICAL ANALYSIS

All measured data were computed into an Excel database (Microsoft Office 2010; Microsoft Corporation, Redmond, WA). A Wilcoxon rank-sum test was performed using the MedCalc statistical software for Windows (version 15; MedCalc Software, Ostend, Belgium) to assess the statistical significance between paired samples. A *P* value of .05 or less was considered statistically significant.

TABLE 1  
Preoperative and Postoperative Visual Acuity Results<sup>a</sup>

Parameter	IC-8	LS-313 MF20	P
Preoperative			
CDVA (logMAR)	0.22 ± 0.10 (0.02 to 0.38)	0.19 ± 0.11 (0.04 to 0.44)	.4413
Postoperative			
UDVA (logMAR)	0.07 ± 0.12 [-0.12 to 0.30]	0.01 ± 0.13 [-0.26 to 0.26]	.2937
CDVA (logMAR)	-0.06 ± 0.10 [-0.20 to 0.20]	-0.04 ± 0.10 [-0.26 to 0.12]	.4965
IOL power (D)	24.2 ± 1.84 (21.5 to 27.5)	20.8 ± 1.81 (18.0 to 24.0)	.0004 <sup>b</sup>

CDVA = corrected distance visual acuity; UDVA = uncorrected distance visual acuity; IOL = intraocular lens; D = diopters  
<sup>a</sup>Values are presented as mean ± standard deviation [range].  
<sup>b</sup>Statistically significant (P < .05).  
The IC-8 is manufactured by Acufocus, Irvine, CA, and the LS-313 MF20 is manufactured by Oculentis, Berlin, Germany.

TABLE 2  
Difference Between Target and Achieved Refraction for Each Eye<sup>a</sup>

IOL	Target Refraction (D)	Achieved Refraction (D)	Difference Target vs Achieved (D)
IC-8	-0.43 ± 0.18 [-0.62 to 0.05]	-0.43 ± 0.43 [-1.13 to 0.00]	-0.01 ± 0.48 [-0.60 to 0.74]
LS-313 MF20	-0.15 ± 0.16 [-0.49 to 0.08]	-0.32 ± 0.40 [-1.25 to 0.00]	-0.17 ± 0.47 [-0.24 to 1.26]

IOL = intraocular lens; D = diopters  
<sup>a</sup>Values are presented as mean ± standard deviation [range].  
The IC-8 is manufactured by Acufocus, Irvine, CA, and the LS-313 MF20 is manufactured by Oculentis, Berlin, Germany.

## RESULTS

This study evaluated 26 eyes of 13 patients with a mean age of 68.5 ± 10.8 years. There were 9 women (69.2%) and 4 men (30.8%). All patients underwent uneventful cataract surgery in both eyes and all IOLs were well-centered postoperatively. **Table 1** shows the preoperative and postoperative visual acuity values and refractive outcomes.

### REFRACTION

**Table 2** shows the difference between the target and achieved refractions for both IOLs. For the IC-8 IOL, 7 of 13 eyes (53.8%) were within ±0.50 D and 13 of 13 eyes (100.0%) were within ±1.00 D of the intended value. For the LS-313 MF20 IOL, 11 of 13 eyes (84.6%) were within ±0.50 D and 12 of 13 eyes (92.3%) were within ±1.00 D of the intended value. **Figure 1** shows the postoperative spherical equivalent and refractive cylinder results for each IOL.

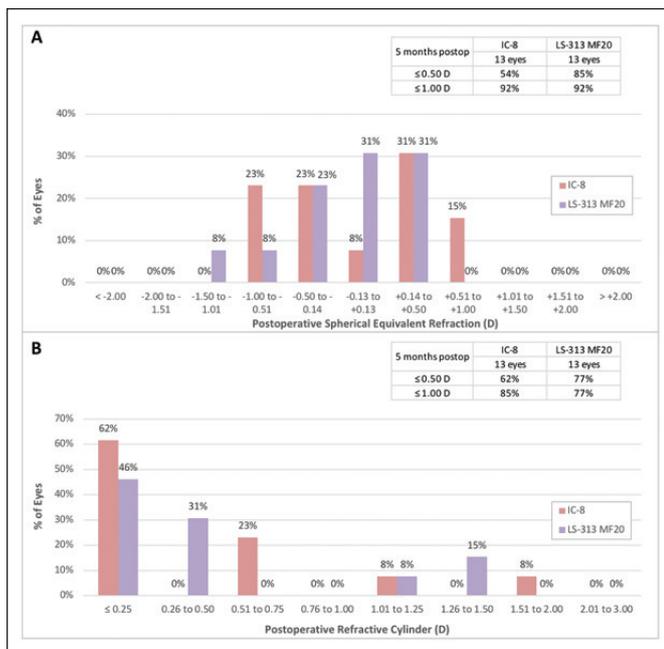
### VISUAL ACUITY

The IC-8 IOL led to statistically significant improvement of mean preoperative CDVA of 0.22 ± 0.10 logMAR to mean postoperative CDVA of -0.06 ± 0.10 logMAR (P = .00006). The same was the case for the MF20 IOL, with an increase of mean preoperative CDVA of 0.19 ± 0.11 logMAR to mean postoperative CDVA of -0.04 ± 0.10 logMAR (P = .00012). **Table 3** shows the mean 5-month

postoperative monocular and binocular visual acuity results at far, intermediate, and near distances. The differences between postoperative UDVA and CDVA results are demonstrated in **Figure 2**. The uncorrected binocular visual acuity was 0.20 logMAR or better for 100% of the eyes (n = 13 patients) at 4 m, for 100% of the eyes (n = 13 patients) at 80 cm, and for 100% of the eyes (n = 13 patients) at 40 cm. The cumulative Snellen visual acuity results are summarized in **Figure 3**. **Figure 4** shows the mean binocular distance-corrected defocus curve measured 3 months postoperatively.

### READING PERFORMANCE

The binocular best-corrected intermediate and near reading performance are shown in **Table 4**. For both intermediate and near reading acuity, there were no statistically significant differences between the reading acuity values measured at the fixed distance and those at the respective preferred distance. Regarding the tested distances, the difference between the fixed and preferred intermediate distances was statistically significant (P = .0012), whereas the difference between the fixed and preferred near distances was not statistically significant (P = .6818). In terms of the smallest letter size read, no statistically significant difference could be found between the measurements at the fixed and preferred distance for both intermediate (P = .4122) and near (P = .6101) examinations. The as-



**Figure 1.** Postoperative (A) spherical equivalent and (B) refractive cylinder results for each intraocular lens (IOL). The IC-8 is manufactured by Acufocus, Irvine, CA, and the LS-313 MF20 is manufactured by Oculentis, Berlin, Germany. D = diopters

assessments of reading speed and duration also did not reveal any statistical significance when compared between the values measured at the fixed distance and those at the respective preferred distance.

**PHOTIC PHENOMENA**

At 5 months postoperatively, 2 patients reported not perceiving any halo at all and 9 patients reported not perceiving any glare. The mean halo size was  $32.54 \pm 22.38$  (range: 0 to 68) and mean halo intensity was  $34.46 \pm 21.95$  (range: 0 to 79). Ten of 11 patients

(90.9%) reported seeing type 1 halo (classical type), whereas 1 patient indicated seeing type 2 halo (starburst type) (Figure 5B). The mean glare size was  $9.00 \pm 17.47$  (range: 0 to 60) and mean glare intensity was  $9.92 \pm 16.84$  (range: 0 to 50). All 4 patients reported perceiving G1 type glare (Figure 5C). Figure 5A shows an exemplary image obtained when the mean size and intensity values of halo and glare are computed.

**DISCUSSION**

In the current study, we assessed the visual performance after asymmetrical implantation of the IC-8 IOL, a small-aperture EDOF lens that uses the pinhole effect to provide an elongated field of vision, and the Lentis Mplus LS-313 MF20 IOL, which is a bifocal lens that is based on a rotationally asymmetric segmental-refractive optic. To our knowledge, this is the first study to report the clinical outcomes after mix-and-match implantation of these two IOLs.

Numerous studies have explored the visual outcomes after mixing and matching different multifocal IOL models.<sup>3-7</sup> In a prospective study by Black,<sup>12</sup> a diffractive EDOF Tecnis Symphony ZXR00 IOL was implanted in the dominant eye and a diffractive low-add bifocal Tecnis ZLB00 IOL with +3.25 D near addition in the non-dominant eye (32 patients, up to 3-month follow-up). The clinical results of this asymmetrical implantation showed excellent uncorrected visual acuities, with mean binocular UDVA (6 m), UIVA (66 cm), and UNVA (40 cm) values of  $-0.06 \pm 0.08$ ,  $0.00 \pm 0.07$ , and  $0.05 \pm 0.08$  logMAR, respectively. Similarly, de Medeiros et al.<sup>13</sup> compared the visual outcomes after bilateral implantation of a diffractive trifocal PanOptix TNFT00 IOL to visual results after blended implantation of the EDOF Tecnis Symphony ZXR00 IOL and a diffractive bifocal Tecnis ZMB00 IOL with +4.00

**TABLE 3**  
**5-Month Postoperative Visual Acuity Values<sup>a,b</sup>**

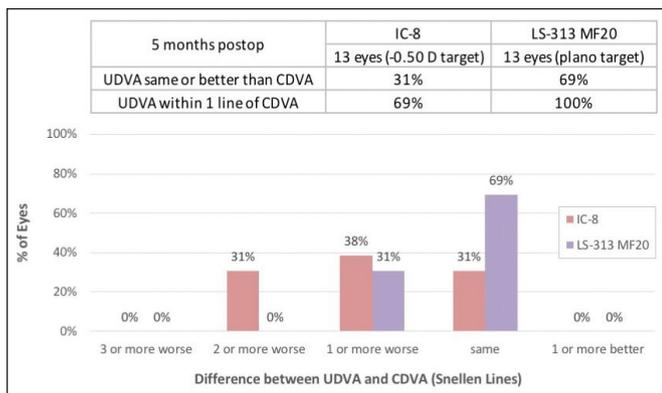
IOL	UDVA (4 m)	CDVA (4 m)	UIVA (80 cm)	DCIVA (80 cm)	UNVA (40 cm)	DCNVA (40 cm)
Monocular						
IC-8	0.07 ± 0.12 (-0.12 to 0.30)	-0.06 ± 0.10 (-0.20 to 0.20)	0.05 ± 0.13 (-0.14 to 0.30)	0.06 ± 0.13 (-0.12 to 0.36)	0.21 ± 0.10 (0.04 to 0.40)	0.27 ± 0.09 (0.16 to 0.40)
LS-313 MF20	0.01 ± 0.13 (-0.26 to 0.26)	-0.04 ± 0.10 (-0.26 to 0.12)	0.12 ± 0.14 (-0.08 to 0.44)	0.13 ± 0.15 (-0.02 to 0.54)	0.26 ± 0.15 (0.04 to 0.54)	0.33 ± 0.20 (0.08 to 0.80)
Binocular						
	-0.04 ± 0.11 (-0.26 to 0.12)	-	0.00 ± 0.10 (-0.14 to 0.14)	-	0.11 ± 0.08 (-0.08 to 0.20)	-

IOL = intraocular lens; UDVA = uncorrected distance visual acuity; CDVA = corrected distance visual acuity; UIVA = uncorrected intermediate visual acuity; DCIVA = distance-corrected intermediate visual acuity; UNVA = uncorrected near visual acuity; DCNVA = distance-corrected near visual acuity

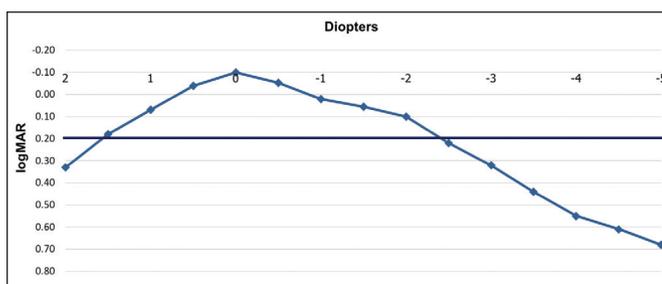
<sup>a</sup>5-month postoperative visual acuity values at far, intermediate, and near distances using Early Treatment Diabetic Retinopathy Study charts (measured in logMAR units).

<sup>b</sup>Values are presented as mean ± standard deviation (range).

The IC-8 is manufactured by Acufocus, Irvine, CA, and the LS-313 MF20 is manufactured by Oculentis, Berlin, Germany.



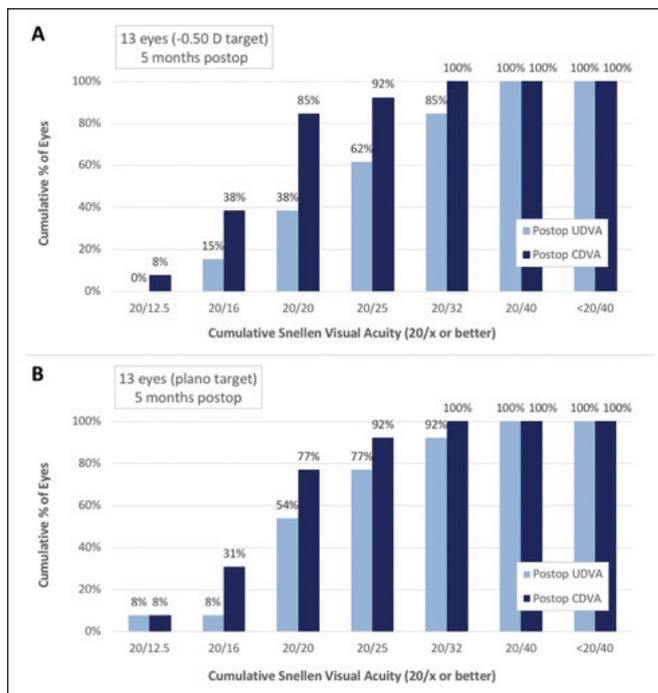
**Figure 2.** The difference between postoperative uncorrected (UDVA) and corrected (CDVA) distance visual acuity results for each intraocular lens (IOL). The IC-8 is manufactured by Acufocus, Irvine, CA, and the LS-313 MF20 is manufactured by Oculentis, Berlin, Germany. D = diopters



**Figure 4.** Mean binocular best-corrected defocus curve measured at 4 m at 3 months postoperatively.

D near addition (20 patients, 30 to 180 days postoperatively). The authors reported that the blended group showed statistically significantly better mean binocular UDVA ( $-0.10 \pm 0.15$  logMAR) results than the bilateral group ( $0.01 \pm 0.04$  logMAR) when measured at 4 m. In contrast, the bilateral group showed statistically significantly better binocular UIVA (60 cm) and UNVA (40 cm) results, with mean values of  $0.14 \pm 0.05$  and  $-0.03 \pm 0.04$  logMAR, respectively, compared to mean UIVA and UNVA values of  $0.20 \pm 0.05$  and  $0.11 \pm 0.07$  logMAR, respectively, in the blended group.

The visual performance results obtained in our study were comparable to those of the aforementioned studies. Although we measured similar mean binocular UDVA (4 m) and UNVA (40 cm) values of  $-0.04 \pm 0.11$  and  $0.11 \pm 0.08$  logMAR, respectively, the asymmetrical implantation of the small-aperture EDOF lens and the segmental-refractive bifocal lens also provided excellent intermediate performance with mean binocular UIVA (80 cm) of  $0.00 \pm 0.10$  logMAR. The defocus curve confirmed this visual outcome, with a peak at the 0.00 D defocus and a visual acuity of 0.20 logMAR or better from +1.50 D to -2.00 D. The intermediate visual performance may have been further



**Figure 3.** Cumulative Snellen visual acuity results for (A) the IC-8 and (B) the LS-313 MF20 intraocular lenses (IOLs). The IC-8 is manufactured by Acufocus, Irvine, CA, and the LS-313 MF20 is manufactured by Oculentis, Berlin, Germany. D = diopters; UDVA = uncorrected distance visual acuity; CDVA = corrected distance visual acuity

boosted by the low +2.00 D near addition of the LS-313 MF20 IOL, because such “low-add” bifocal lenses have been reported to additionally increase the visual performance at intermediate distance.<sup>14-16</sup> However, it is important to note that our clinical results can only be compared to a limited extent due to the differences in the distance at which the visual acuity tests were performed between the studies.

Previous studies assessing the clinical performance of the IC-8 IOL were also in accordance with our results.<sup>13,17,18</sup> Dick et al.<sup>19</sup> found monocular uncorrected UDVA (4 m), UIVA (67 cm), and UNVA (40 cm) values of  $0.06 \pm 0.15$ ,  $0.08 \pm 0.12$ , and  $0.18 \pm 0.14$  logMAR, respectively (105 patients, 6-month follow-up). When combined with an aspheric monofocal IOL, the binocular distance-corrected defocus curve revealed a visual acuity of 0.20 logMAR or better ranging from +1.00 to -2.00 D.

Our results were also in agreement with a study by Calvo-Sanz and Sánchez-Tena,<sup>20</sup> who compared the optical performance of the LS-313 MF20 IOL to that of its higher-add counterpart LS-313MF30 IOL (10 patients in each group, 6 weeks postoperatively). The authors found that the former provided better visual outcomes in far and intermediate distances up to 50 cm, whereas the latter allowed superior vision at near distance up to 25 cm. The corrected defocus curve of

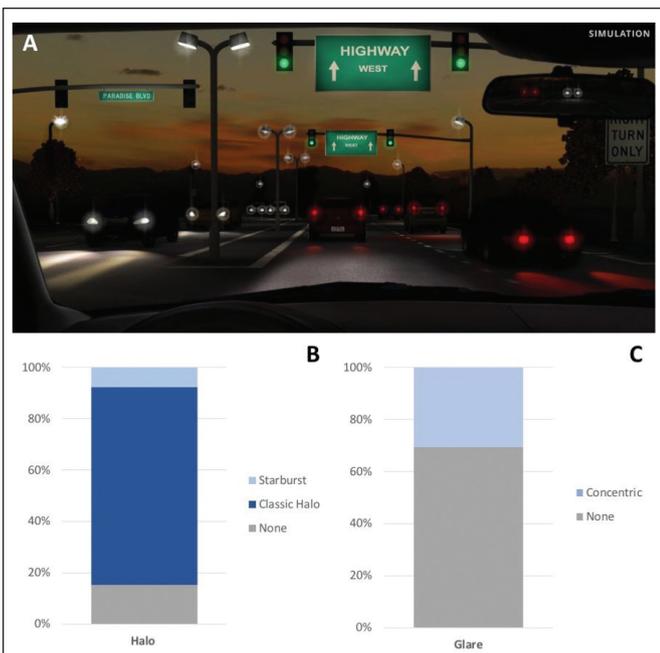
TABLE 4  
**Binocular Distance-Corrected Intermediate and Near Reading Performance Using the Salzburg Reading Desk (n = 26)<sup>a</sup>**

Parameter	Intermediate at 80 cm	Preferred Intermediate	P	Near at 40 cm	Preferred Near	P
Distance (cm)	78.03 ± 3.70 (69.80 to 82.60)	69.21 ± 6.41 (61.90 to 85.70)	.0012 <sup>b</sup>	40.85 ± 2.47 (37.50 to 46.70)	41.63 ± 5.94 (33.30 to 50.00)	.6818
Reading acuity (logMAR)	0.11 ± 0.07 (0.00 to 0.22)	0.12 ± 0.06 (0.01 to 0.22)	.7795	0.21 ± 0.14 (0.00 to 0.41)	0.19 ± 0.10 (0.08 to 0.37)	.7949
Letter size (log scale)	0.77 ± 0.21 (0.32 to 1.00)	0.83 ± 0.26 (0.32 to 1.25)	.4122	0.71 ± 0.33 (0.40 to 1.60)	0.73 ± 0.23 (0.40 to 1.25)	.6101
Reading speed (wpm)	115.23 ± 36.69 (84.00 to 219.00)	119.46 ± 35.79 (81.00 to 206.00)	.7795	138.00 ± 89.63 (88.00 to 424.00)	118.00 ± 39.34 (80.00 to 200.00)	.7566
Reading duration (seconds)	8.99 ± 2.19 (4.40 to 11.70)	8.45 ± 2.16 (4.40 to 11.10)	.5552	8.55 ± 1.87 (5.90 to 11.60)	9.40 ± 3.75 (4.80 to 19.00)	.5892

wpm = words per minute

<sup>a</sup>Values are presented as mean ± standard deviation [range] unless otherwise specified.

<sup>b</sup>Statistically significant ( $P < .05$ ).



**Figure 5.** Assessment of photic phenomena. (A) Exemplary image of mean size and intensity of halo and glare. (B) Perceived halo type. (C) Perceived glare type.

the LS-313 MF20 IOL showed 0.20 logMAR or better vision from 0.00 to -1.50 D and 0.30 logMAR or better vision from +0.50 to -2.50 D.

The assessment of the reading acuity at subjectively preferred distances is a good indicator of “real-life” clinical performance because merely testing at predefined distances may underestimate the patients’ actual reading ability. The Salzburg Reading Desk is a widely validated assessment device<sup>21-23</sup> that allows a standardized quantitative analysis of the patients’ reading performance at both fixed and preferred distances.

Currently, only a limited number of studies have assessed the reading acuity after implantation of different multifocal IOLs using this device.<sup>8-10,22,23</sup> Attia et al.<sup>10</sup> examined the reading ability after bilateral implantation of another EDOF lens, the Tecnis Symphony IOL, and found a distance-corrected intermediate reading acuity of 0.00 logMAR at a fixed distance of 80.1 cm and 0.08 logMAR at a subjectively preferred distance of 65.0 cm (15 patients, 2 to 6 months postoperatively). For near, the distance-corrected near reading acuity was 0.29 logMAR at a fixed distance of 40.6 cm and 0.16 logMAR at a subjectively preferred distance of 41.7 cm. Linz et al.<sup>9</sup> also evaluated the reading ability after implantation of the LS-313 MF30 IOL (18 patients, 12 to 36 months postoperatively), another bifocal lens with a segmental-refractive optic and +3.00 D near addition, and observed an intermediate distance-corrected reading acuity of 0.11 logMAR at a fixed distance of 79.9 cm and 0.15 logMAR at a preferred distance of 64.05 cm. The distance-corrected near reading acuity was 0.10 logMAR at a fixed distance of 39.9 cm and 0.10 logMAR at a preferred distance of 39.6 cm.

Similarly, our results showed good intermediate reading performance with distance-corrected binocular reading acuity of 0.11 logMAR at a fixed distance of 78.03 cm and 0.12 logMAR at a subjectively preferred distance of 69.21 cm. Although the difference between the fixed and preferred intermediate distances was statistically significant ( $P = .0012$ ), the difference between the reading acuity values was not statistically significant ( $P = .7795$ ). We also found a comparable distance-corrected binocular reading ability at near distance with a reading acuity of 0.21 logMAR at a fixed distance of 40.85 cm and 0.19 logMAR at a subjectively preferred distance of 41.63 cm.

When analyzing the reading performance, it is also important to make sure the reading acuity was measured with a reading speed of at least 80 wpm, because this threshold demonstrates that the print size was read easily without effort.<sup>8</sup> In the current study, all reading acuity values were measured with a reading speed of at least 80 wpm (range: 81 to 424 wpm), suggesting the patients' ability to perform daily tasks at intermediate and near distances comfortably.

The perception of halo and glare is one of the main drawbacks of multifocal IOLs<sup>24</sup> and can even lead to a high dissatisfaction rate.<sup>25,26</sup> Our results showed low development of photic phenomena, with mean halo size and intensity values of  $32.54 \pm 22.38$  and  $34.46 \pm 21.95$ , respectively, and mean glare size and intensity values of  $9.00 \pm 17.47$  and  $9.92 \pm 16.84$ , respectively. In contrast, the assessment of dysphotopsia using the same halo and glare simulator after implantation of diffractive trifocal toric AT Lisa tri toric 939MP IOLs<sup>11</sup> showed mean halo size and intensity values of  $50.67 \pm 15.69$  and  $54.89 \pm 17.86$ , respectively, and mean glare size and intensity values of  $39.67 \pm 3.51$  and  $44.67 \pm 15.01$ , respectively (28 patients, 3 months postoperatively). Also, in another clinical study assessing the visual performance after implantation of the EDOF MiniWell IOL, Savini et al.<sup>27</sup> reported mean halo size and intensity values of  $34.80 \pm 22.08$  and  $38.50 \pm 16.47$ , respectively, and mean glare size and intensity values of  $4.40 \pm 8.69$  and  $15.70 \pm 26.33$ , respectively (22 patients, 4 to 8 weeks postoperatively). The low occurrence of photic phenomena observed in this study could be ascribed to two factors. First, the central mask embedded in the IC-8 IOL may function as an auxiliary pupil and help minimize the perception of halo and glare.<sup>28</sup> In a similar fashion, Warrak et al.<sup>28</sup> implanted the KAMRA corneal inlay, which also uses the principles of the small-aperture optics to elongate the depth of focus, in a patient who suffered from extreme photophobia secondary to traumatic mydriasis. One day postoperatively, the patient reported that the glaring symptoms have already been significantly reduced. Second, the LS-313 MF20 IOL is based on a segmental-refractive IOL design that is reported to reduce the loss of light to below 7%.<sup>9</sup> Such an attribute may have helped further decrease the incidence of optical side effects.

The mix-and-match implantation of the small-aperture EDOF IC-8 IOL and a rotationally asymmetric, segmental-refractive bifocal LS-313 MF20 IOL is an effective treatment option. Our results show that this combination can provide excellent visual performance at far and intermediate distances and functional visual acuity at near distances, while causing minimal photic phenomena. The

excellent visual outcomes were also confirmed by the good reading performance results, which suggest that this asymmetrical implantation strategy can enable patients to perform daily tasks at intermediate and near distances comfortably.

## AUTHOR CONTRIBUTIONS

Study concept and design (RK, GUA); data collection (H-SS, TMY, IB, GL); analysis and interpretation of data (H-SS, RK, TMY, IB, GUA); writing the manuscript (H-SS,); critical revision of the manuscript (RK, TMY, IB, GUA); statistical expertise (H-SS, TMY); administrative, technical, or material support (GUA); supervision (RK, IB, GUA)

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**Figure A.** Studied intraocular lenses (IOLs): the IC-8 (left) and the Lentis Mplus LS-313 MF20 (right). The IC-8 is manufactured by AcuFocus, Irvine, CA, and the LS-313 MF20 is manufactured by Oculentis, Berlin, Germany.