ARTICLE

Comparison of 3-month visual outcomes of a spherical and a toric trifocal intraocular lens

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Purpose: To evaluate visual outcomes and satisfaction after implantation of 2 trifocal intraocular lenses (IOLs): a spherical IOL and a toric IOL.

Setting: IOA Madrid Innova Ocular, Madrid, Spain.

Design: Prospective, controlled clinical trial.

Methods: Patients (>50 years) were implanted bilaterally with either a trifocal spherical hydrophilic IOL (FineVision POD F) if corneal astigmatism was 1.0 diopter (D) or less or with a trifocal toric hydrophilic IOL (FineVision POD FT) if astigmatism was more than 1.0 D. Outcomes analyzed 3 months after surgery included monocular and binocular visual acuities at distance, near and intermediate, both uncorrected and corrected. Defocus curves, contrast sensitivity and patient satisfaction were also assessed.

Results: There was no statistically significant difference between groups in monocular uncorrected distance (UDVA) (P = .38), monocular corrected distance (CDVA) (P = .22), or distance-corrected intermediate (DCIVA) (P = .95) visual acuities; however, the distance-corrected near visual acuity (DCNVA) was slightly better in the spherical IOL group (P = .008). The UDVA was 20/25 or better in 89% of eyes in the spherical IOL group and 93% in the toric IOL group. The DCIVA was 20/32 or better in 92% of eyes in the spherical IOL group and 93% in the toric IOL group at 80 cm (Radner Vissum chart), and 20/32 or better in 100% of eyes in both groups at 63 cm (Colenbrander chart). The DCNVA (Radner chart) was 20/32 or better in 89% of eyes in the spherical IOL group and 90% of eyes in the toric IOL group. There was no difference between the groups in contrast sensitivity, defocus curves, cylinder, or satisfaction results.

Conclusion: Patients had significant improvement in visual acuity and gained functional uncorrected visual acuity across all distances in both groups. Satisfaction was high with both IOLs.

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The advent of multifocal intraocular lenses (IOLs) has enabled correction of not only spherocylindrical refractive errors, but also for presbyopia. Multifocal IOLs aim to improve uncorrected vision at near and intermediate distances[1] without compromising uncorrected distance visual acuity (UDVA).[2,3] Multifocal IOLs have also been shown to improve visual rehabilitation, in particular, in providing patient independence for different working distances as well as reducing spectacle dependence.[4,5] However, halos, glare, and reduced contrast sensitivity continue to be reported with presbyopia-correcting IOLs.[6,7]

Multifocal IOLs can be broadly categorized based on their design: either concentric focal zones (alternating for near, intermediate, or far) or segmented, two zones (bifocal) with one zone for distance and the other for near. One known issue with these designs is a reduced visual acuity at intermediate distances.[8–10] To overcome this, trifocal IOLs were developed to provide improved vision at intermediate distances.

This is achieved with a diffractive surface with three foci, including the addition of intermediate vision at +1.75 diopters (D).[11–13] In addition, the FineVision (Physiol S.A.) design results in the lens becoming distance-dominant when the pupil reaches 4.5 mm. This design evolution is expected to result in higher patient satisfaction compared with patients who have monofocal or bifocal IOLs implanted.[14] The potential for an increase in halos because of the addition of a third focal point was a concern; however, photic phenomena and contrast sensitivity reduction are minimized as a result of the relatively low energy that is dedicated to intermediate vision when compared with distance and near vision foci.[15]

The FineVision POD F (Physiol, S.A.) is a diffractive trifocal spherical hydrophilic IOL that provides an intermediate focus at 1.75 D and a near focus at 3.5 D at the IOL

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plane. The FineVision POD FT (Physiol, S.A.) is trifocal toric hydrophilic IOL with astigmatic correction with cylindrical correction up to −6 D.

The goal of this clinical study was to evaluate visual performance at the 3 working distances—far, intermediate, and near—as well as patient satisfaction outcomes of the spherical IOL (POD F) and the toric IOL (POD FT) in patients with preexisting corneal astigmatism. Patients with 1.00 D or less of corneal astigmatism were implanted bilaterally with the spherical IOL, whereas those with more than 1.00 D of corneal astigmatism received the toric IOL, bilaterally.

PATIENTS AND METHODS

Study Design

This was a prospective comparative cohort study of patients who had cataract surgery between September 2014 and December 2016 at IOA Madrid Innova Ocular, Madrid, Spain. All patients provided written informed consent before enrollment. This study was approved by the local ethical committee and was performed in accordance with the Declaration of Helsinki and its subsequent revisions.

Patients were grouped 1:1 to have binocular implantation of either the trifocal spherical IOL (POD F) or the trifocal toric IOL (POD FT), depending on the amount of preexisting corneal astigmatism.

Patients

Eligible patients were at least 50 years of age, with cataractous eyes and no comorbidities. Specific inclusion criteria were regular corneal astigmatism of 1.00 D or less for the spherical IOL and more than 1.0 D of regular corneal astigmatism for the toric IOL. Other inclusion criteria included the desire for spectacle independence after surgery with realistic expectations and availability and willingness to comply with examination procedures.

Key exclusion criteria were irregular astigmatism, ocular comorbidities, history of ocular trauma or previous ocular surgery including refractive procedures, acute or chronic disease or illness that would increase risk or confound study results, capsule or zonular abnormalities that might affect postoperative centration or tilt of the lens (eg, pseudoexfoliation syndrome, chronic uveitis, Marfan syndrome), and patients with pupil abnormalities.

Preoperative Assessment

Before surgery, patients had an extensive ophthalmologic examination. This included uncorrected and corrected monocular visual acuities testing at far, intermediate, and near distances. Visual acuity was measured under photopic lighting conditions with a chart luminance of approximately 85 candelas (cd)/m^2. Distance was measured at 4.0 m (Early Treatment Diabetic Retinopathy Study [ETDRS], Precision Vision), intermediate at 80 cm (Radner Vissum, NeuMed AG, AT, Precision Vision) and 63 cm (Colenbrander, Precision Vision), and near at 40 cm (Radner Vissum, NeuMed AG, AT, Precision Vision). Topography was performed using a high-resolution rotating Scheimpflug device (Pentacam HR, Oculus Optikgeräte GmbH). Refraction, slitlamp evaluation, spectral-domain optical coherence tomography (OCT) (Cirrus, Carl Zeiss Meditec AG), and fundoscopy were also performed.

The corneal keratometry, axial length, and anterior chamber depth were measured with swept-source OCT (IOLMaster 700, Carl Zeiss Meditec AG). Once the corneal power was estimated, the required IOL power was computed using either the Barrett II Universal formula[A] or the Barrett Toric formula[B] with an optimized constant (119.02). The target refraction was calculated with the simulated keratometry value, considering the surgically induced astigmatism (SIA). In all cases, the target was emmetropia.

Intraocular Lenses

The trifocal spherical IOL (POD F) combines 2 diffractive structures adjusted to offer +3.5 D addition for near vision and +1.75 D addition for intermediate vision. This corresponds to a nominal intermediate addition of approximately +1.2 D and near addition of about +2.4 D at the corneal plane, depending on the geometry of the eye. The optic is biconvex aspheric (−0.11 µm spherical aberration) diffractive. The lens is 26% hydrophilic acrylic with an ultraviolet and blue light blocker and an optic body diameter of 6.00 mm, overall diameter of 11.40 mm, refractive index of 1.46, angulation of 5 degrees, and power from +6.0 D to +35.0 D.

The trifocal toric IOL (POD FT) has the same design and material as the trifocal spherical IOL, with the possibility of correcting astigmatism up to 6.0 D at the IOL plane because of the toric posterior lens surface geometry.

Surgical Technique

All surgical procedures were performed by the same experienced surgeon (F.P.) under topical anesthesia and aided by a computer-assisted cataract surgery system (Callisto Eye, Zeiss Cataract Suite Markerless, Carl Zeiss Meditec AG). For the cataract procedure, a 2.2 mm angled 45 degree, bevel-up surgical knife (Xstar Safety Slit Knife, Beaver-Visitec International) was used to create a 2.2 mm self-sealing clear corneal incision at 180 degrees (temporal) in right eyes and at 90 degrees (superior) in left eyes and approximately 1.00 mm anterior to the limbus. Next, a continuous curvilinear capsulorhexis measuring approximately 5.5 mm in diameter was created. Two ophthalmic viscosurgical devices (OVDs)—cohesive sodium hyaluronate 1.0% (Healon (Johnson & Johnson Vision Care, Inc.) and dispersive sodium hyaluronate 1.2% (Amvisc, Bausch & Lomb, Inc.)—were used during the surgery. The chosen IOL was then implanted in the capsular bag with a single-use injection system (Accujet, Medicel AG) and positioned using the computer-assisted cataract surgery system. According to the clinical center's protocol on premium IOLs, a capsular tension ring (CTR) was inserted in all eyes undergoing cataract surgery. In all cases, after IOL insertion, all traces of OVD were removed.

After insertion of the trifocal toric IOL, the lens was rotated until the IOL markings agreed with the alignment marking.

Postoperative Assessment

The patients had follow-up visits at 1, 7, 30, and 90 days postoperatively. All examinations were performed by a single optometrist (N.G.). Uncorrected monocular and binocular distance visual acuities were measured at all visits.

Uncorrected and corrected distance visual acuities as well as uncorrected and distance-corrected intermediate and near visual acuities were measured at the 3-month visit. Intermediate visual acuity was tested at 80 cm (Radner) and 63 cm (Colenbrander). Near visual acuity was tested at 40 cm (Radner). Binocular defocus curve testing was performed using a 100% contrast ETDRS chart at 4.0 meters under photopic lighting conditions. The patients were defocused with −4.0 D spherical correction from their best distance correction in both eyes. Minus power was decreased in 0.5 D increments, and visual acuity was recorded for each defocus step. The patients were subsequently defocused with +1.5 D spherical correction from their distance correction, and plus power was decreased in 0.5 D increments, with logarithm of the minimum angle of resolution (logMAR) acuity recorded for each defocus.

Contrast sensitivity was measured binocularly with correction in place at spatial frequencies of 3, 6, 12, and 18 cycles per degree (cpd) under photopic conditions at 85 cd/m2, and under mesopic

conditions at 6 cd/m2 using a contrast sensitivity tester (CST 1800 Digital, Vision Sciences Research Corp.).

Patient Satisfaction

Patient satisfaction and quality of life were determined by means of an ad hoc questionnaire completed by patients at the 3-month visit. Questions included satisfaction about adaption between photopic and mesopic conditions, ability to find the correct distance, night driving, vision during the day, halos, and adaption between far and near vision and vice versa, as well as general satisfaction for far vision, near vision, and intermediate vision, and overall satisfaction. The last question was to ask patients whether they would undergo surgery with implantation of the IOL again. Each subscale score was converted to a score between 0 and 5, with higher scores indicating better results.

Statistical Analyses

Statistical analyses were performed using an integrated statistics software package (Stata 13.1 (Statacorp LLC). For comparison of baseline demographics and clinical characteristics between groups, categorical data were analyzed using the chi-square test. For all quantitative variables, summary tables containing mean, standard deviation, and range values were developed.

A repeated measure analysis of variance (ANOVA) was computed to compare the 2 types of multifocal IOLs for visual and refractive data with more than 2 timepoints with post hoc Tukey-Kramer test if the ANOVA results showed statistical significance between groups. In the case of a simple timepoint, a Student *t* test or Welch test was performed. A two-way ANOVA was performed to analyze the difference between IOLs in defocus curves and contrast sensitivity with post hoc Tukey-Kramer test. Results from the questionnaire were analyzed using a Student *t* test or the Welch test with a Cronbach $\alpha \geq 0.86$ to compare the differences between groups. A *P* value less than 0.05 was considered statistically significant.

Standards graphs for reporting cataract surgery outcomes were used as per published recommendations.[16] Error bars reflect the standard deviation. A vector analysis of the change in astigmatism was performed according to previously published standards on astigmatic analysis.[17]

RESULTS

Patients

This clinical trial enrolled 126 cataractous eyes (42 female and 21 male) with a mean age of 62.5 years ± 10.4 (SD). The spherical IOL group consisted of 33 bilateral patients (66.7% women) with a mean age of 63.0 ± 7.9 years and the toric IOL group consisted of 30 bilateral patients (66.7% women) with a mean age of 62.0 ± 12.8 years.

The mean spherical power of the implanted in the spherical IOL group was 21.55 ± 3.56 D (range 11.0 to 29.0 D) and 19.81 ± 5.79 D (range 9.5 to 32.5 D) in the toric IOL group; the mean cylindrical power in the toric IOL group was 2.43 ± 1.24 D (range 1.0 to 6.0 D). Of the 30 patients in the toric IOL group, 29 completed the 90-day follow-up.

Efficacy

Table 1 shows the visual acuity values at all distances in both IOL groups at 3 months postoperatively.

Distance Visual Acuity There was no statistically significant difference between the 2 IOL groups in the mean monocular UDVA at 3 months postoperatively ($P = .38$). The binocular UDVA was good and slightly better than monocular UDVA in both groups. The binocular UDVA was statistically significantly better in the spherical IOL group than in the toric IOL group ($P = .034$); however, the difference was only between 1 and 2 letters. Both groups had UDVA better than 20/20 at 3 months.

There was no statistically significant difference between the 2 IOL groups in the mean monocular corrected distance visual acuity (CDVA) at 3 months postoperatively ($P = .22$). The binocular CDVA also improved compared with monocular CDVA. It was statistically and significantly better in the spherical IOL group than in the toric IOL group ($P = .038$); however, the difference was only between 1 and 2 letters.

Table 1. Overview of 3-month postoperative visual acuity outcomes in logMAR, and comparison between the 2 IOL groups.

Visual Acuity	Mean ± SD		*P* Value
	Spherical IOL Group	Toric IOL Group	
UDVA (ETDRS chart)			
Monocular	0.03 ± 0.08	0.05 ± 0.08	.380
Binocular	−0.04 ± 0.06	−0.01 ± 0.05	.034
CDVA (ETDRS chart)			
Monocular	0.00 ± 0.03	0.02 ± 0.03	.220
Binocular	−0.06 ± 0.04	−0.03 ± 0.05	.038
DCIVA @ 80 cm (Radner Vissum chart)			
Monocular	0.12 ± 0.09	0.12 ± 0.09	.947
Binocular	0.09 ± 0.11	0.08 ± 0.08	.656
DCIVA @ 63 cm (Colenbrander chart)			
Monocular	0.04 ± 0.06	0.08 ± 0.14	.030
Binocular	−0.01 ± 0.06	−0.01 ± 0.05	.162
DCNVA @ 40 cm (Radner Vissum chart)			
Monocular	0.13 ± 0.10	0.17 ± 0.09	.009
Binocular	0.07 ± 0.08	0.11 ± 0.07	.036

CDVA = corrected distance visual acuity; DCIVA = distance-corrected intermediate visual acuity; DCNVA = distance-corrected near visual acuity; ETDRS = Early Treatment Diabetic Retinopathy Study; IOL = intraocular lens; logMAR = logarithm of the minimum angle of resolution; UDVA = uncorrected distance visual acuity

Figure 1, *A*, shows the distribution of monocular UDVA and CDVA in the spherical IOL group and Figure 1, *B*, in the toric IOL group. At 3 months postoperatively, 59 (89%) of 66 eyes in the spherical IOL group and 56 (93%) of 60 eyes in the toric IOL group had 20/25 or better UDVA, with 65 eyes (98%) and 58 eyes (97%) achieving 20/32 or better UDVA, respectively.

Figure 2, *A*, shows the distribution of binocular UDVA and CDVA in the spherical IOL group and Figure 2, *B*, in the toric IOL group. At 3 months postoperatively, 60 (91%) of 66 eyes in the spherical IOL group and 52 (86%) of 60 eyes in the toric IOL group had 20/20 or better UDVA, with 64 eyes (97%) and 60 eyes (100%) achieving 20/25 or better UDVA, respectively.

Intermediate Visual Acuity There was no statistically significant difference between the 2 IOL groups in mean monocular postoperative distance-corrected intermediate visual acuity (DCIVA) ($P = .95$) (Table 1). The DCIVA was assessed at 80 cm and 63 cm. There was no statistically significant difference between the 2 IOL groups in mean binocular DCIVA at 80 cm ($P = .66$). Using the Colenbrander chart, the DCIVA was slightly better at 63 cm than at 80 cm. The mean monocular DCIVA at 63 cm was statistically and significantly better in the spherical IOL group than in the toric IOL group ($P = .030$); however, the difference was only 2 letters. The binocular DCIVA at 63 cm was not statistically different between the 2 groups ($P = .162$).

Figure 3, *A*, shows the distribution of monocular DCIVA at 80 cm in both groups and Figure 3, *B*, shows the distribution of binocular DCIVA in both groups. At 3 months postoperatively, 31 (92%) of the 33 patients in the spherical IOL group and 28 (93%) of the 30 patients in the toric IOL group could see 20/32 or better uncorrected monocularly at 80 cm. Binocularly, 30 (91%) of the 33 patients in the spherical IOL group and 30 (100%) of the 30 patients in the toric IOL group could read 20/32 at 80 cm. Figure 3, *C*, shows the distribution of monocular DCIVA at 63 cm in both IOL groups, and Figure 3, *D*, shows the distribution of binocular DCIVA at 63 cm in both groups.

Near Visual Acuity The mean monocular postoperative distance-corrected near visual acuity (DCNVA) at 40 cm was statistically and significantly better in the spherical IOL group than in the toric IOL group ($P = .009$) (Table 1). Again, the difference was only 2 letters. The binocular DCNVA at 40 cm was also statistically and significantly better in the spherical IOL group ($P = .036$).

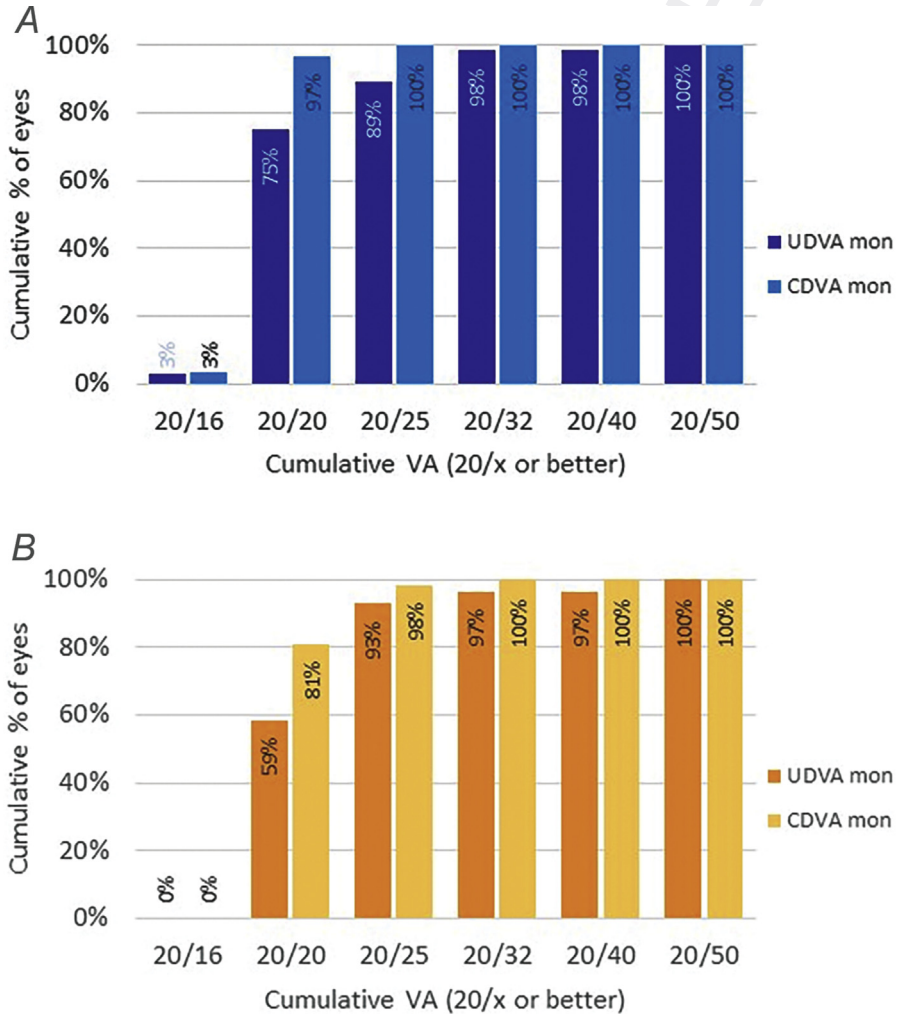

Figure 1. *A*: Monocular UDVA and CDVA in the spherical IOL group. *B*: Monocular UDVA and CDVA in the toric IOL group (CDVA = corrected distance visual acuity; IOL = intraocular lens; mon = monocular; UDVA = uncorrected distance visual acuity; VA = visual acuity).

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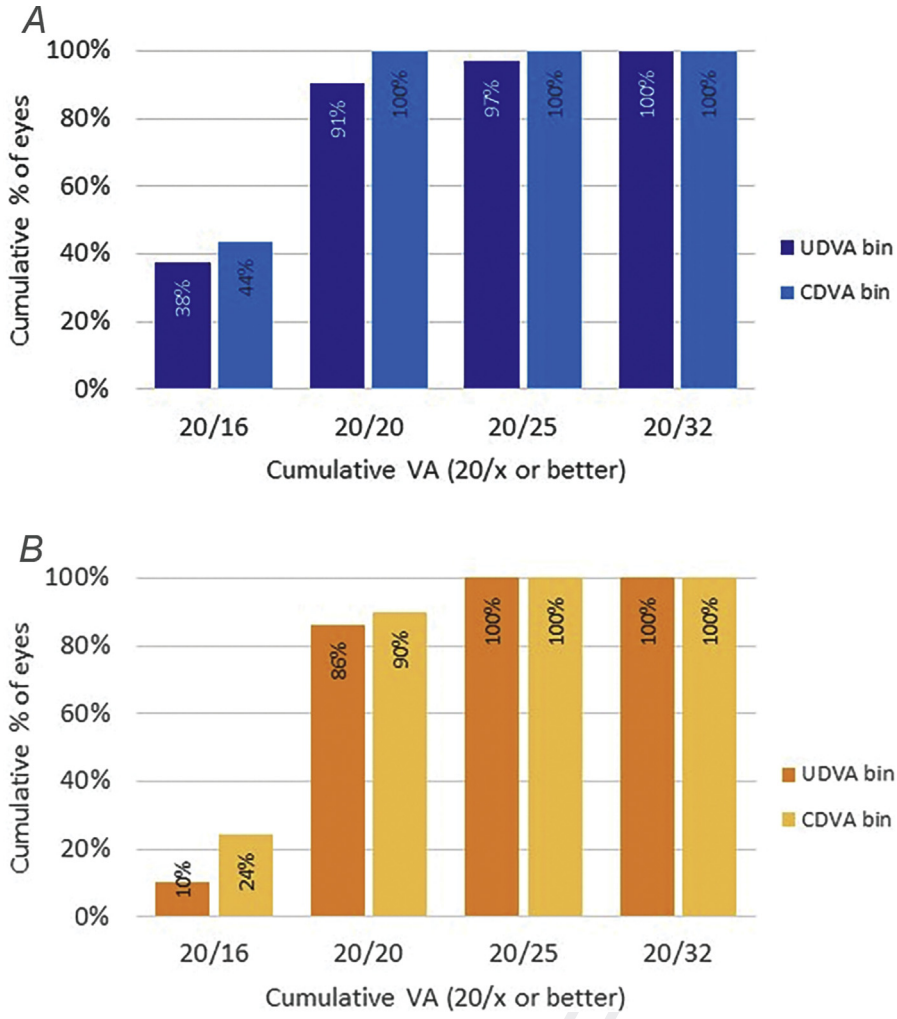

Figure 2. *A*: Binocular UDVA and CDVA in the spherical IOL group. *B*: Binocular UDVA and CDVA in the toric IOL group (bin = binocular; CDVA = corrected distance visual acuity; IOL = intraocular lens; UDVA = uncorrected distance visual acuity; VA = visual acuity).

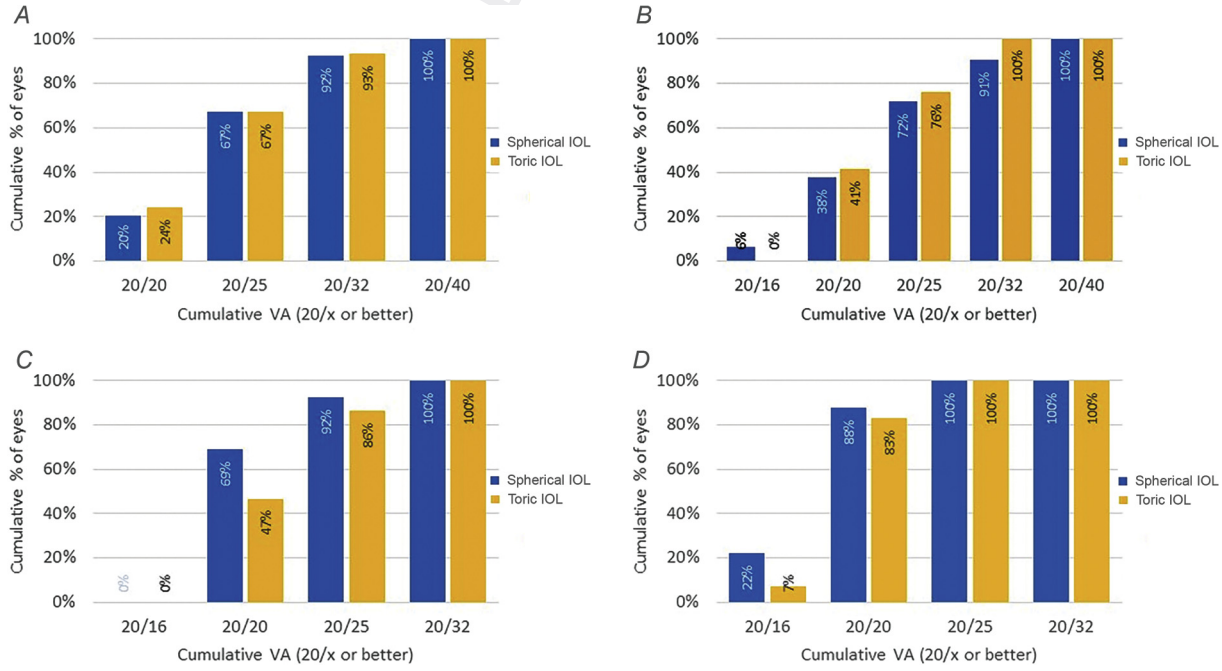

Figure 3. *A*: Monocular DCIVA at 80 cm. *B*: Binocular DCIVA at 80 cm. *C*: Monocular DCIVA at 63 cm. *D*: Binocular DCIVA at 63 cm (DCIVA = distance-corrected intermediate visual acuity; IOL = intraocular lens; VA = visual acuity).

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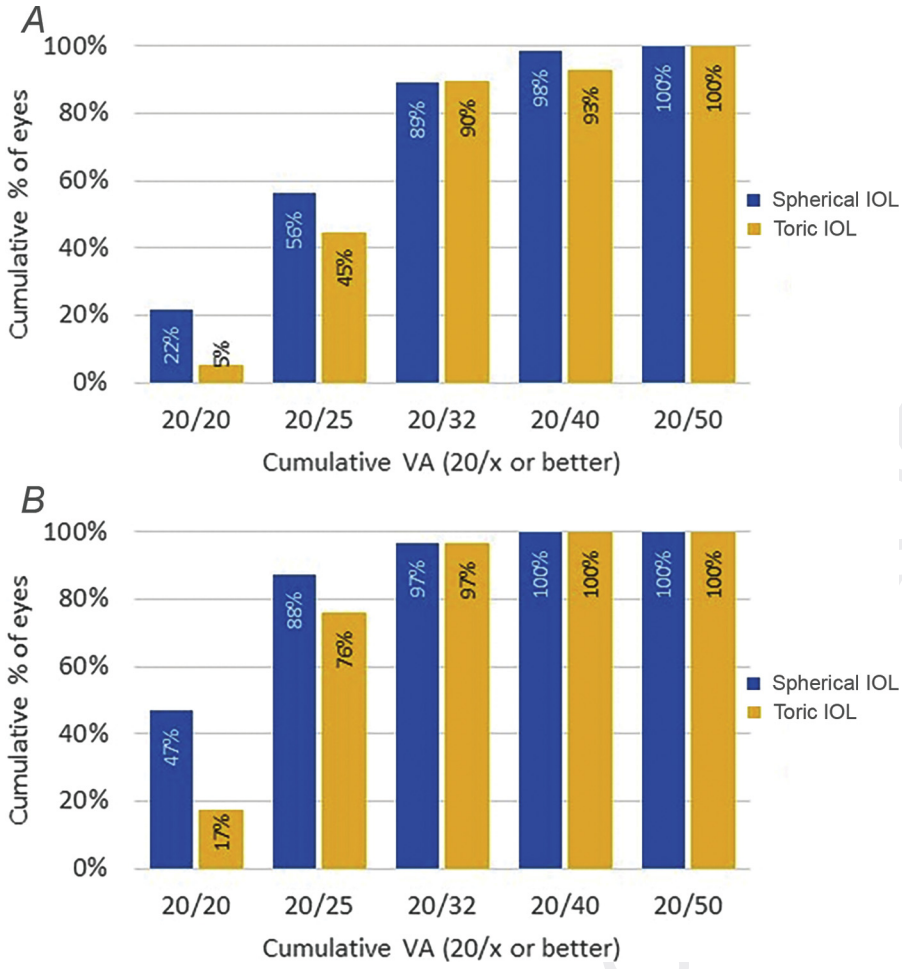

Figure 4. *A*: Monocular DCNVA at 40 cm. *B*: Binocular DCNVA at 40 cm (DCNVA = distance-corrected near visual acuity; IOL = intraocular lens; VA = visual acuity).

Figure 4, *A*, shows the distribution of monocular DCNVA at 40 cm in both groups, and Figure 4, *B*, shows the distribution of binocular DCNVA in both groups. At 3 months postoperatively, 29 (89%) of 33 patients in the spherical IOL group and 27 (90%) of 30 patients in the toric IOL group could see 20/32 uncorrected monocularly. Binocularly, 61 (97%) of all 63 patients could read 20/32.

Refraction

At 3 months postoperatively, the mean sphere was −0.01 ± 0.22 D (range −0.75 to +0.50 D) and 0.00 ± 0.27D (range −1.00 to +0.75 D), the mean cylinder was −0.14 ± 0.31D (range −1.25 to 0.0 D) and −0.19 ± 0.36 D (range −1.5 to 0.0 D), and the manifest refraction spherical equivalent (MRSE) was −0.08 ± 0.21 D

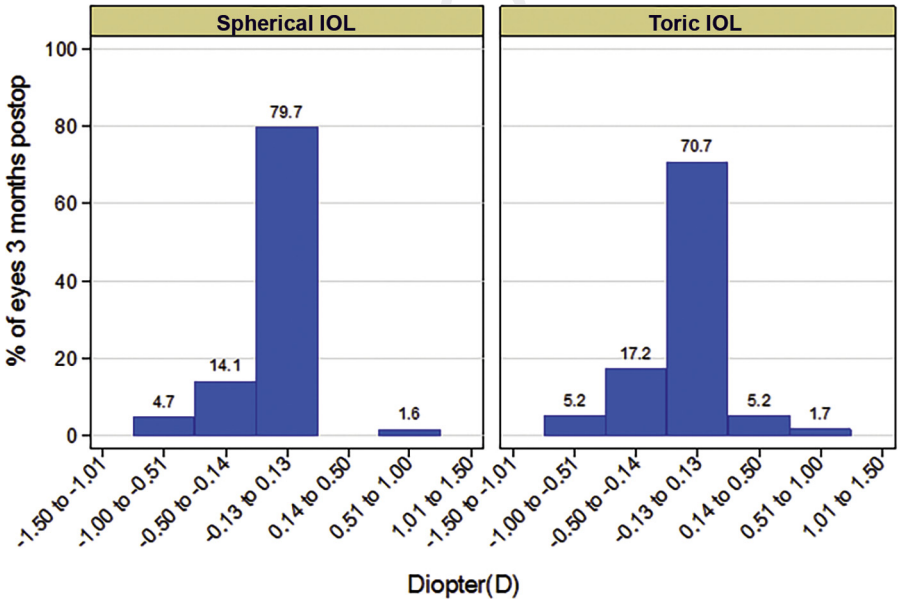

Figure 5. Spherical equivalent refraction accuracy by IOL (IOL = intraocular lens).

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(range −0.75 to 0.5 D) and −0.09 ± 0.27 D (range −1.0 to 0.5 D) in the spherical IOL group and the toric IOL group, respectively.

Figure 5 shows the distribution of the MRSE at 3 months postoperatively; 62 (94%) of the 66 eyes in the spherical IOL group and 56 (93%) of the 60 eyes in the toric IOL group were within ±0.5 D of the target refraction and 100% of eyes were within ±1.0 D of the target refraction in both groups.

Figure 6 shows the distribution of the refractive cylinder at 3 months postoperatively in both IOL groups; 59 (89%) of the 66 eyes in the spherical IOL group and 52 (86%) of the 60 eyes in the toric IOL group had 0.50 D or less of residual astigmatism.

Figure 7 shows the planned astigmatic correction (target-induced astigmatism [TIA] vector analysis [7, *A*]); the SIA is shown in 7, *B*, whereas 7, *C*, shows the vectorial difference between the preoperative target and the SIA changes. The mean difference vector was 0.15 D at 97 degrees, which indicates an effective correction of cylinder.

Defocus Curve

Figure 8 shows the defocus curves in both groups. As would be expected, both IOLs performed similarly with a visual acuity peak at 0.00 D and an acuity of 20/20 or better in both groups. From +1.00 D to −3.0 D, visual acuity was 0.13 logMAR or better (20/27 or better) in both IOL groups, showing that a good visual acuity was maintained at all distances from far to near. In the near range, there was a peak at −2.5 D (corresponding to an approximate distance of 40 cm).

Contrast Sensitivity

Figures 9, *A* and *B*, show the photopic and mesopic contrast sensitivity at 1.5, 3, 6, 12 and 18 cpd in both IOL groups. The observed mean contrast sensitivity with both IOLs was within the normal band of the age group (56 to 75 years) for all spatial frequencies except for 12 cpd. Although it was not statistically significant ($P = .05$), a trend toward reduced contrast sensitivity with the spherical IOL versus the toric IOL was observed.

Patient Questionnaire

Table 2 shows results from the questionnaire in both IOL groups. There were no statistically significant differences between the groups, and both groups reported high levels of satisfaction. In the spherical IOL group, 30 (96.8%) of 31 patients indicated that they would have the same surgery again, and 25 (89.3%) of 28 patients in the toric IOL group said the same ($P = .337$; Fisher exact test).

Complications

There were no complications in either IOL group.

DISCUSSION

In this study, refractive and visual outcomes as well as quality of life outcomes were reported after bilateral implantation of 2 trifocal IOLs: a spherical IOL and a toric IOL. In general, both IOLs performed well with good quality of vision at distance, intermediate, and near; good refractive accuracy; and high levels of satisfaction from the patients.

The visual outcomes showed excellent unaided visual acuity for both spherical and toric models. Previously published studies have assessed visual outcomes after implantation of multifocal IOLs, including a recent metaanalysis by Rosen,[18] which examined published results of multifocal IOLs and reported a mean postoperative UDVA of 0.05 logMAR and a mean binocular UDVA of 0.04 logMAR. These findings are similar to our study, which showed a mean of 0.03 ± 0.08 logMAR in the spherical IOL group, and 0.05 ± 0.08 logMAR in the toric IOL group. However, in our study, binocular UDVA was improved by one line compared with monocular UDVA, and it was better than 20/20 in both groups: −0.04 ± 0.06 (20/18) in the spherical IOL group and −0.01 ± 0.05 (20/19) in the toric IOL group.

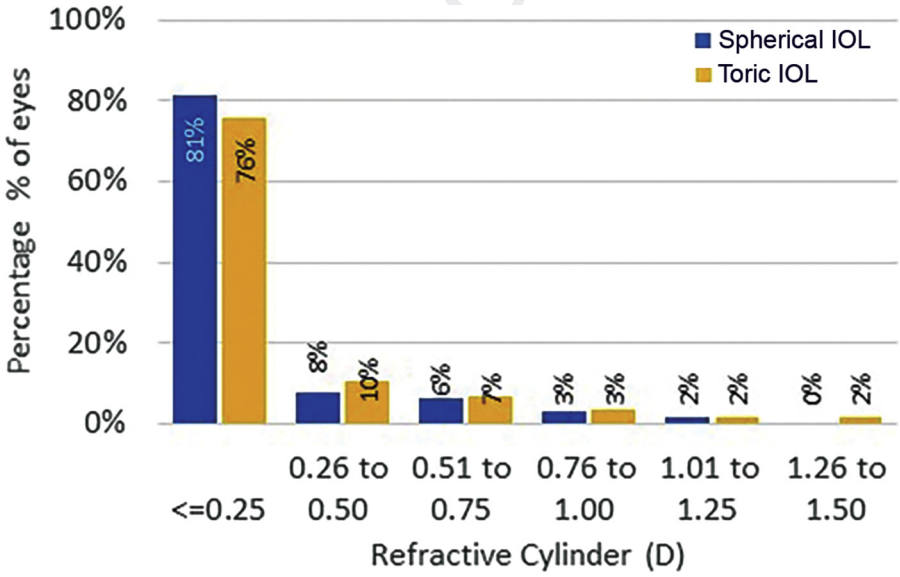

Figure 6. Refractive cylinder by IOL (IOL = intraocular lens).

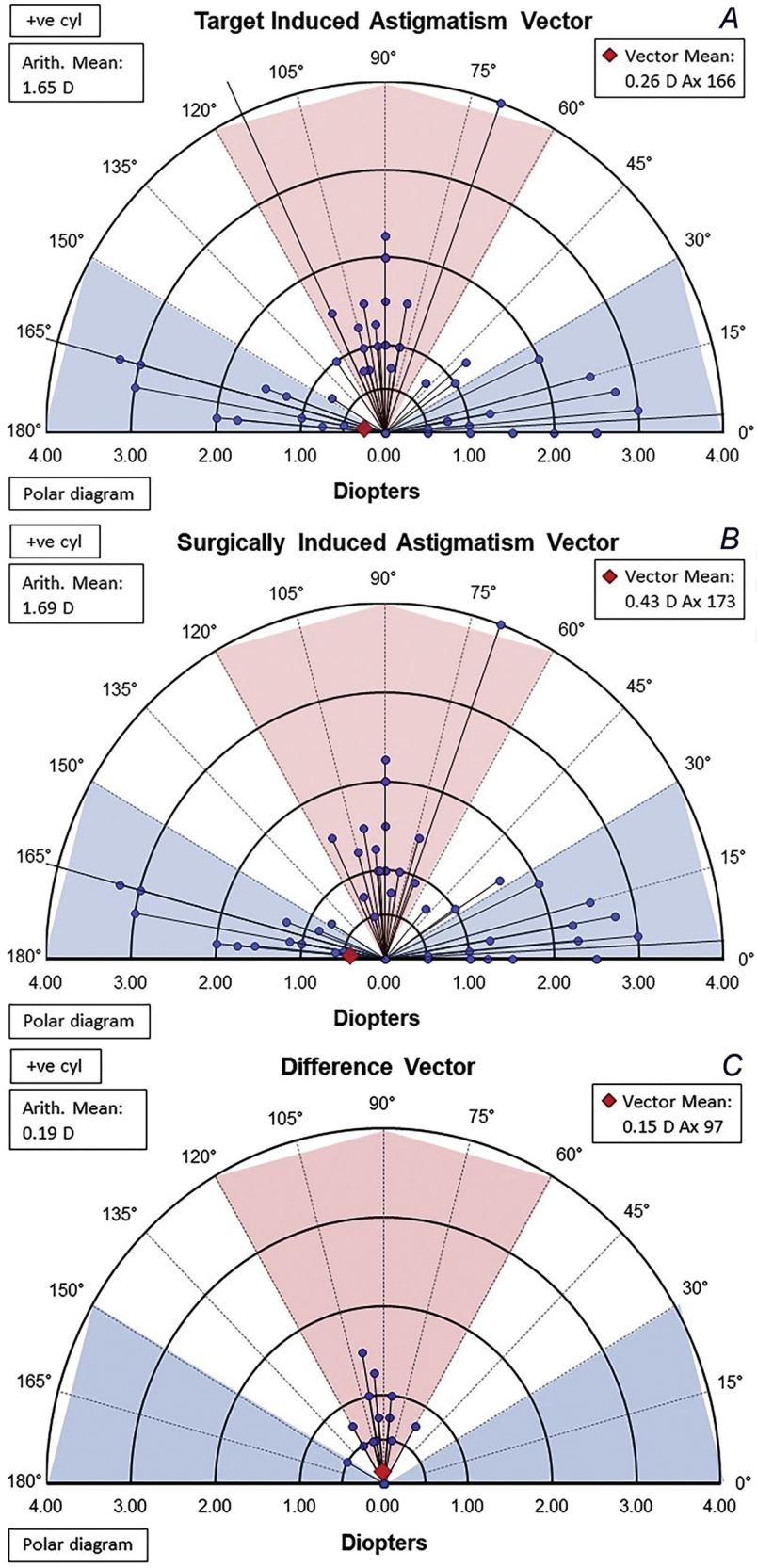

Figure 7. Standard graphs for reporting outcomes for astigmatism correction, based on the Alpins Method. Single-angle polar plots for the target-induced astigmatism vector (*A*), the **s**urgically induced astigmatism vector (*B*), and the Difference vector (*C*). The vector means are plotted as red diamonds, with the blue dots representing single point —with most eyes at 0 D, which demonstrates the tight cylindrical correction that was achieved.

Distance-corrected near and intermediate visual acuity were also excellent with both IOLs. A previous study on the FineVision toric IOL had already demonstrated improved intermediate vision with no loss of far and near vision.[15] Furthermore, comparison studies have demonstrated that a trifocal toric IOL also improved intermediate vision without negatively affecting near or distance visual acuity relative to a bifocal toric IOL, with good rotation

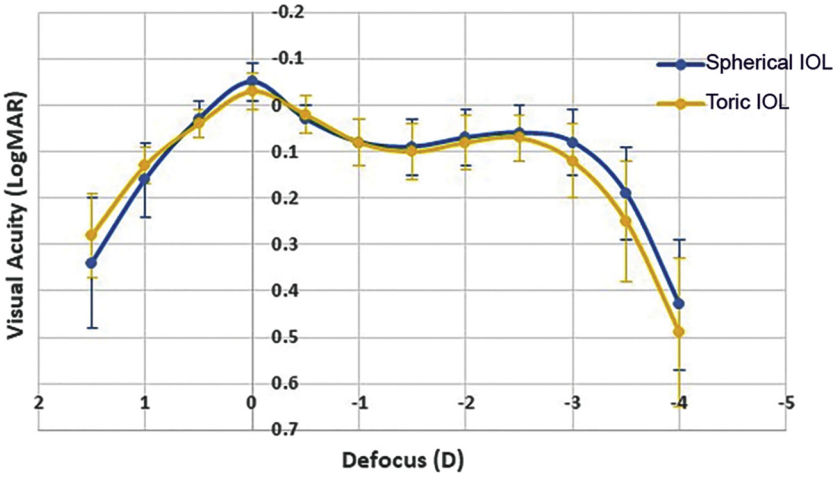

Figure 8. The defocus curve for both IOLs (IOL = intraocular lens; logMAR = logarithm of the minimum angle of resolution).

stability and low postoperative refractive astigmatism.[19] The mean monocular DCIVA was 0.09 logMAR in the spherical IOL group and 0.08 logMAR in the toric IOL group at 80 cm, which was better than the value of 0.20 logMAR achieved with the M-flex T multifocal toric IOL (Rayner Intraocular Lenses Ltd.), and also slightly better than previously reported values for the POD FineVision (0.15 logMAR).[20]

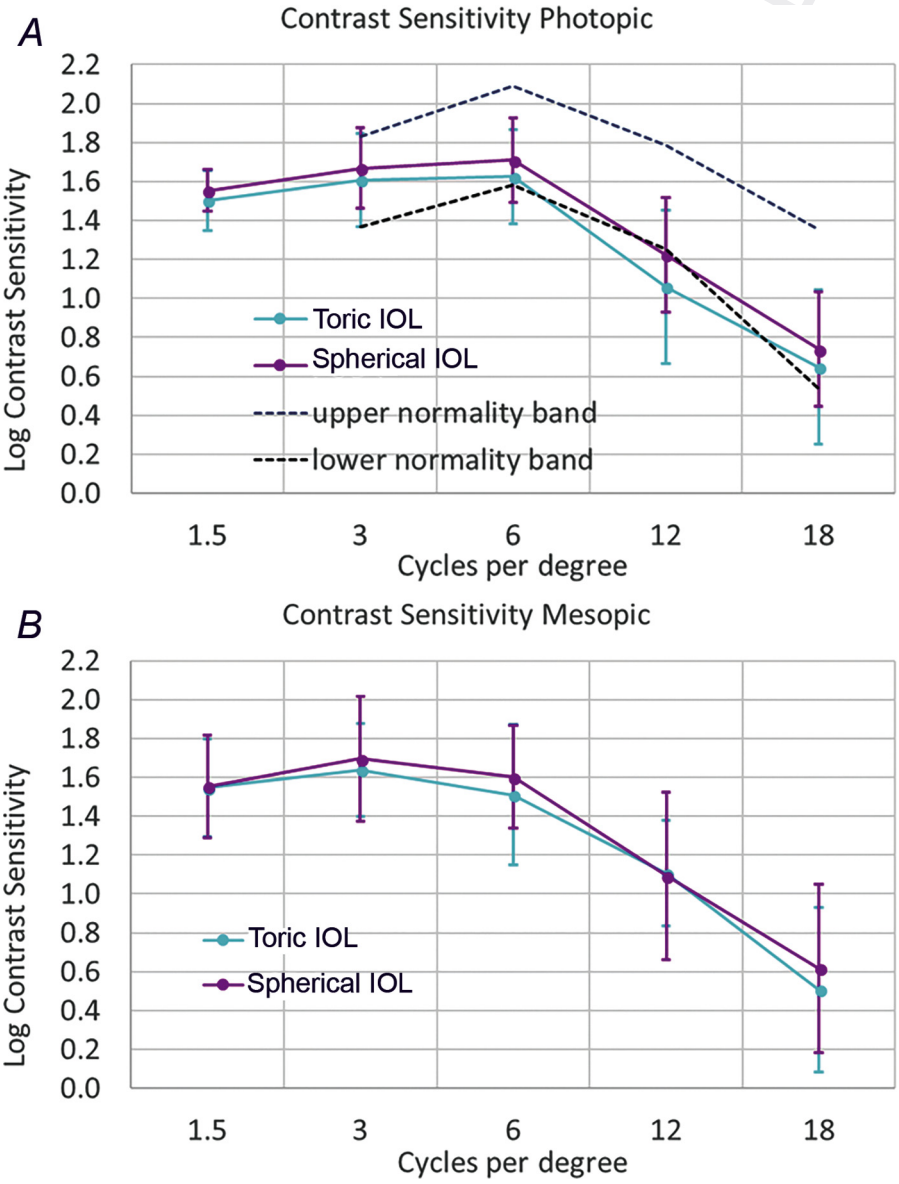

Figure 9. Photopic (*A*) and mesopic (*B*) contrast sensitivity (IOL = intraocular lens).

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Table 2. Results from the questionnaire evaluation to show the mean scores in the 2 IOL groups for various domains of satisfaction.

Evaluatory Parameter	Spherical IOL Group		Toric IOL Group		*P* Value
	Patients (n)	Mean Score ± SD	Patients (n)	Mean Score ± SD	
General satisfaction w/far vision	32	4.2 ± 0.6	28	4.4 ± 0.7	.348*
General satisfaction w/near vision	32	4.1 ± 0.8	28	3.9 ± 1.2	.418†
General satisfaction w/intermediate vision	32	4.2 ± 0.8	28	4.5 ± 0.6	.226*
Adaption between photopic and mesopic conditions	32	4.0 ± 1.0	28	4.5 ± 0.6	.087†
Ability to find the correct distance	32	4.9 ± 0.1	28	4.9 ± 0.2	.496†
Night driving	21	3.5 ± 0.7	14	3.7 ± 0.7	.461*
Vision during day	32	4.5 ± 0.8	28	4.2 ± 1.1	.212*
Halos	31	2.3 ± 1.1	28	2.5 ± 1.1	.624*
Adaption between far and near visual acuity and vice versa	32	4.5 ± 0.7	28	4.4 ± 0.6	.715*
Overall satisfaction	32	4.1 ± 0.7	28	4.3 ± 0.9	.320*

IOL = intraocular lens
*t test
†Welch test

Binocular DCNVA at 40 cm was good and similar between both IOLs: 0.07 ± 0.08 logMAR (20/23) in the spherical IOL group and 0.11 ± 0.07 logMAR (20/26) in the toric IOL group. This is also comparable to other multifocal IOLs. For example, the M-flex T IOL with +3.0 D add provided a mean DCVNA of 0.08 LogMAR.[15]

In comparing visual acuity performance between the 2 IOLs: POD F and POD FT, some statistically significant differences were found. However, the differences were always less than 0.05 logMAR or half a line of visual acuity, and therefore not considered clinically significant. The defocus curve results were in alignment with the visual acuity findings, confirming that visual acuity above 20/25 was maintained over a defocus range of 4 D from +1.00 D to −3.00 D, indicating good quality of vision from far to near distances of up to 33 cm. The defocus curves confirmed that there was no gap in vision at the intermediate distances.

In terms of refractive accuracy, both IOLs performed similarly, which was to be expected as the diffractive designs are identical. Over 93% of eyes were within ±0.50 D of the target refraction for both IOLs and all eyes were within ±1.00 D of the target refraction. The toric IOL was effective in correcting astigmatism, with 93% of eyes after surgery with 0.75 D or less of residual astigmatism. This was comparable to 95% of eyes with 0.75 D of residual astigmatism in the spherical IOL group. This demonstrated that the correction of astigmatism was accurate within the toric IOL group.

In this study, two tools were employed to aid in the postoperative outcome. In all eyes, a CTR was inserted before IOL insertion. Based on our experience, the use of a CTR reduces the likelihood of capsular folds and creases appearing in the posterior capsule. In other studies, a reduction of ocular wavefront errors because of better positioning of the IOLs are reported or a combination of using trifocal and bifocal lenses provided good efficacy, predictability, and safety and increased the intraocular optical performance.[20] Other reasons for use of a CTR are an increased stabilization of the capsular bag and reduced problems related to IOL decentration and tilt.[21,22] The second tool was the Callisto eye, which was used to guide the implantation of all IOLs, to ensure fixation over the patients' optical axis, as well as to place the toric IOL on the proper axis.

Loss of contrast sensitivity because of the distribution of total available light between several focal points in a refractive toric multifocal IOL is a known fact.[23] In this study, contrast sensitivity showed small differences under photopic conditions between the spherical IOL and the toric IOL, but no differences under mesopic conditions. The contrast sensitivity levels measured with POD F and POD FT were comparable to levels obtained from another published study that used an illuminated viewer system (CSV-1000, Vectorvision, Inc.) (1.56 ± 0.15 at 3 cpd, 1.80 ± 0.16 at 6 cpd, 1.50 ± 0.15 cpd, and 0.93 ± 0.25 at 18 cpd).[24] Previously, Marques and Ferreira[25] found no significant differences in contrast sensitivity between eyes implanted with the AT LISA tri IOL (Carl Zeiss Meditec AG) and a FineVision trifocal IOL, with the contrast sensitivity within the normal range, a finding that was confirmed by others.[6] This trend toward reduced contrast sensitivity results with toric trifocal IOLs in comparison to nontoric trifocal IOLs can be seen in clinical outcomes using an IOL with a very similar optic design (AT LISA tri and AT LISA tri toric). As with the investigated Physiol trifocal IOLs, the published literature by the authors on the Carl Zeiss Meditec AT LISA IOLs demonstrated a similar difference in contrast sensitivity between toric and nontoric IOL models.[26,27]

It is well recognized that assessment of subjective perception of vision is an important part of multifocal IOL assessment. In this study, patients reported high levels of satisfaction after surgery. It is interesting to note that patients were equally satisfied with the quality of their vision at distance, intermediate, and near distances. This confirms the objective visual acuity measurements and defocus curves demonstrating equal quality of vision at all distances. Quality of vision during the day, and the ability to find the correct distance were scored the highest by the study patients. Night driving problems, in particular halos, were reported as low by the patients. The appearance of halos is

one of the most common light phenomena reported by patients after multifocal IOL implantations and it was ranked the same for both the FineVision spherical and the toric models.[16,28–31] Furthermore, it has been shown previously that the incidence of symptoms tends to reduce with time, likely because of a neuroadaptation process. This will be the subject of a future study with a longer follow-up.

In conclusion, our study of the spherical POD F IOL and the toric POD FT IOL 3 months after surgery demonstrated good vision at a range of distances, with excellent accuracy and a high patient satisfaction rate. The toric POD FT offers the option of correcting astigmatism without compromising accuracy and quality of vision. Q6

WHAT WAS KNOWN

- Multifocal IOLs have been shown to improve uncorrected near visual acuity compared with monofocal IOLs, without compromising UDVA. However, halos, glare, and reduced contrast sensitivity remained compromises associated with multifocal IOLs.
- Several toric multifocal IOLs are available to correct for both astigmatism and presbyopia, including the FineVision POD FT IOL.

WHAT THIS PAPER ADDS

- The spherical POD F IOL and the toric POD FT IOL demonstrated excellent vision at a range of distances, with excellent accuracy and a high rate of patient satisfaction.
- The toric POD FT offers the option of correcting astigmatism without compromising accuracy and quality of vision.

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