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ORIGINAL RESEARCH

Refractive and Visual Outcomes Using a Trifocal, Diffractive, Hydrophobic Intraocular Lens in Japanese Eyes

Takayuki Akahoshi

Cataract and Refractive Surgery Department, Nihonbashi Cataract Clinic, Tokyo, Japan

Correspondence: Takayuki Akahoshi, Cataract and Refractive Surgery Department, Nihonbashi Cataract Clinic, 2-4-1, Nihonbashi Muromachi, Chuoku, Tokyo, Japan, Email eye@phaco.jp

Purpose: To report the refractive and visual outcomes after implantation of a trifocal, diffractive, hydrophobic intraocular lens (IOL) in Japanese eyes following cataract surgery.

Methods: A total of 45 eyes implanted with FineVision HP IOLs (Beaver-Visitec International, Inc. USA) were enrolled in this retrospective study. The clinical outcomes assessed after 3-months were refraction and monocular logarithm of the minimum angle of resolution (LogMAR) uncorrected distance visual acuity (UDVA), corrected distance visual acuity (CDVA), uncorrected intermediate visual acuity (UIVA), distance-corrected intermediate visual acuity (DCIVA) at 80 and 66 cm, uncorrected near visual acuity (UNVA), and distance-corrected near visual acuity (DCNVA) at 40 cm.

Results: 97.78% of the eyes were within ±0.50D of spherical equivalent and all of them were within ±1.00D (mean: −0.00±0.22 D, with 75.56% within ±0.13D), while 91.11% of the eyes had ≤0.50D residual astigmatism and all of them had ≤1.00D (mean: −0.08 ±0.24D, with 88.89% ≤0.25D). UDVA and CDVA showed mean values of −0.05±0.07 logMAR and −0.07±0.06 logMAR, respectively. 86.67% and 95.56% of the eyes had ≥20/20 UDVA and CDVA, respectively, with 100% achieving ≥20/25 for both UDVA and CDVA. At 80 cm, the mean monocular logMAR UIVA and DCIVA were 0.18±0.14 and 0.14±0.14, and at 66 cm the values were 0.20 ±0.15 and 0.19±0.15, respectively. At 80 cm 20% of the eyes had ≥20/25 DCIVA and 60% had ≥20/32 DCIVA. These values changed to 15.56% and 40% of the eyes at 66 cm. In terms of near vision, the mean monocular logMAR UNVA and DCNVA were 0.04±0.10 and 0.03±0.10, respectively. 53.33% of the eyes had ≥20/20 UNVA and DCNVA, with 86.67% achieving ≥20/25 UNVA and DCNVA.

Conclusion: The FineVision HP trifocal diffractive IOL provided accurate refractive outcomes with good visual acuity at different distances in Japanese eyes.

Keywords: trifocal, intraocular lens, cataract

Introduction

A recent meta-analysis comparing the outcomes of randomised clinical trials of bilateral presbyopia-correcting intraocular lenses (IOLs) used in clinical practice concluded that in patients considering a multifocal IOL because of presbyopia, bilateral implantation of a trifocal IOL might be optimal, without compromising distant visual acuity.[1] Comparative studies with other presbyopia-correcting IOLs have also highlighted their benefits. Specifically, a systematic review and meta-analysis comparing trifocal and enhanced depth-of-focus IOLs found that trifocal IOLs yielded improved postoperative refraction and near visual acuity compared to enhanced depth-of-focus IOLs, without any differences in terms of far and intermediate visual acuity.[2] Regarding other types of presbyopia-correcting IOLs, a review assessing the visual effects of trifocal and bifocal IOLs in cataract surgery in prospective comparative clinical trials concluded that patients may achieve better intermediate visual acuity with a trifocal IOL than with a bifocal IOL without any adverse effects in terms of their far or near visual acuity.[3] Thus, surgeons may consider the use of trifocal IOLs a good solution in cataract surgery patients that will also enable spectacle independence to see objects at different distances ranging from far to near.

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One trifocal, diffractive, hydrophobic, glistening-free IOL currently available on the market is the FineVision trifocal optic (POD F GF; FineVision HP, Beaver-Visitec International, Inc., USA). This lens has been evaluated in different clinical studies and has shown good refractive outcomes and visual performance at far, intermediate, and near distances.[4–10] Some of these studies were prospective or retrospective with different follow-up times and samples of eyes, although very few of them were conducted in Asian eyes.[5,6] It will be important to fully analyse possible differences between ethnicities related, for example, to varying visual demands or patient heights which could affect the visual performance of this lens in situ. Therefore, to provide more clinical evidence regarding the performance of this lens in Asian eyes in terms of refraction accuracy, as well as vision at different distances, the aim of this present clinical study was to evaluate the predictability, safety, and efficacy of this product in a cohort of Japanese eyes diagnosed with cataracts after implantation of the FineVision HP trifocal, diffractive IOL.

Patients and Methods

Study Design and Patient Population

We retrospectively examined 45 eyes in 29 patients at the Akihabara Cataract Clinic and the Nihonbashi Cataract Clinic in Tokyo (Japan) between December 2023 and January 2024. The study was carried out in accordance with the tenets of the Declaration of Helsinki and was approved by the Review Board at both centres. Due to the retrospective nature of the study the data was anonymized. All patients signed an informed consent to undergo the surgical procedure and agreed to use their de-identified data for statistical analysis and research purposes. The inclusion criteria were the presence of cataracts, patient age of at least 40 years, implantation with the FineVision HP trifocal, diffractive IOL, and patient interest in no longer wearing any form of spectacles to correct far, intermediate, or near vision. The exclusion criteria were previous ocular surgery and a history of prior ocular disease that may have affected the postoperative visual outcome.

Intraocular Lenses

All the eyes had been implanted with FineVision HP IOLs (POD FT 49P). This lens type is made of a hydrophobic, glistening free, acrylic material called GFY which has a refractive index of 1.53 and an Abbe number of 42. The optical surface is aspheric, biconvex, and diffractive and creates 2 additions: one for intermediate (+1.75 D) and one for near vision (+3.50 D). The lens is available with a spherical power from +10.0 D to +35.0 D (in 0.50 D steps). It also has an ultraviolet and blue light filter and overall diameter of 11.40 mm and optical diameter of 6.00 mm. The haptic design consists of a double C-loop platform with Ridgetech® and posterior angulated haptic. It has 5 degrees of angulation with a spherical aberration induction of −0.11 µm for a 6.0 mm pupil. The lens is implanted using Medicel Accuject 2.0 injection systems for IOL powers up to 24.5 D and 2.1/2.2 systems for IOL powers up to 35 D.

The surgical procedure involved a phacoemulsification technique using the Centurion Phacoemulsification device (Alcon Labs, Fort Worth, TX, USA) through a 2.2 mm clear corneal incision with topical anaesthesia by an experienced surgeon (TA) using Phaco Prechop technique.[7]

Preoperative and Postoperative Eye Examinations

The medical records of eyes with cataracts that met the inclusion and exclusion criteria were considered in this present analysis. All the included eyes underwent a full preoperative ophthalmological assessment that included biomicroscopy, intraocular pressure measurement and fundoscopic examination, manifest refraction measurement (sphere, cylinder, and axis), and optical biometry using a IOLMaster 700 device (Carl Zeiss Meditec A.G., Germany) to collect biometric characteristics for the IOL calculation. These characteristics were keratometry, anterior chamber depth, lens thickness, white-to-white, and axial length. Specifically, in our cohort, the Universal II formula was used to calculate the required IOL power and the targeted refraction was emmetropia in all cases.

At 3-months post-cataract surgery, the following parameters were measured using Sloan standardised Early Treatment Diabetic Retinopathy Study (ETDRS) tests (Precision Vision, Woodstock, Ill, USA): manifest refraction (sphere, cylinder, and axis), monocular uncorrected distance visual acuity (UDVA), monocular corrected distance visual acuity

(CDVA), monocular uncorrected intermediate visual acuity (UIVA), and monocular distance-corrected intermediate visual acuity (DCIVA) at 80 and 66 cm; and monocular uncorrected near visual acuity (UNVA) and monocular distance-corrected near visual acuity (DCNVA) at 40 cm. Visual acuities were recorded on a logarithm of the minimum angle of resolution (logMAR) scale. The double-angle plot tool[8] was used to analyse the astigmatism vector, considering the preoperative corneal astigmatism obtained from the optical biometer and postoperative refraction obtained 3 months after implantation of the FineVision HP IOL. Any complications or adverse events during the surgery and follow-up were also recorded.

Analysis

The different parameters obtained from the patient medical records were analysed using Microsoft Excel software (2019, version 16.43, Microsoft Corporation, Redmond, WA, USA), reporting the measurements as the mean ± the standard deviation and ranges. Standard graphs were plotted for the refractive (histograms of the spherical equivalent [SE] refraction and refractive cylinder) and visual acuity outcomes (percentage of difference in visual acuity lines and cumulative visual acuity at different distances) for refractive surgery with an IOL.[9]

Results

Demographics

We considered 45 eyes from 29 patients with a mean age of 68.52 ± 9.98 years who had undergone standard cataract surgery with implantation of the FineVision HP IOL. The mean intraocular pressure was 14.93 ± 2.06 mmHg, with a range of 11 to 20 mmHg. The mean spherical IOL power was 17.37 ± 3.78 D, ranging from 10.50 to 24.00 D. Specifically, Table 1 shows the biometric characteristics of the eyes included in this study. There were no surgical complications or adverse events during the follow-up.

Refractive Accuracy

Figure 1A shows the refractive outcomes as the distribution of the post-operative SE refractions. Almost all the eyes (n = 44, 97.78%) were within ± 0.50 D and all of them (n = 45, 100%) were within ± 1.00 D. The largest group of eyes, 75.56% (n = 34), were in the ± 0.13 D range, followed by 13.33% (n = 6) in the +0.14 to +0.50 D range. The mean sphere was 0.03 ± 0.13 D (ranging from −0.50 D to 0.50 D), the mean cylinder was −0.08 ± 0.24 D (ranging from 0 to −1.00D), and the mean SE was −0.01 ± 0.22 D (ranging from −1.00 to 0.50 D). Figure 1B shows the distribution of the postoperative refractive cylinder, with 91.11% of the eyes (n = 41) with 0.50 D or less residual astigmatism, and all of

Table 1 Demographics and Characteristics of the Eyes Included in This Study, Shown as Means, Standard Deviations (SDs), and Ranges

	FineVision HP IOL
Patients (*n*)	29
Age (y)	68.52±9.98 (33 to 80)
Eyes (*n*)	45
Intraocular pressure (mmHg)	14.93±2.06 (11 to 20)
K1 (D)	43.58±1.35 (40.50 to 45.75)
K2 (D)	43.98±1.38 (40.50 to 46.11)
Corneal astigmatism (D)	0.40±0.17 (0 to 0.77)
Axial length (mm)	24.71±1.26 (23.01 to 27.39)
Anterior chamber depth (mm)	3.36±0.40 (2.62 to 4.11)
Lens thickness (mm)	4.35±0.32 (3.66 to 5.02)
White-to-white (mm)	12.04±0.35 (11.40 to 12.60)
IOL power (D)	17.37±3.78 (10.50 to 24.00)

Abbreviations: K, keratometry; IOL, intraocular lens; D, dioptres.

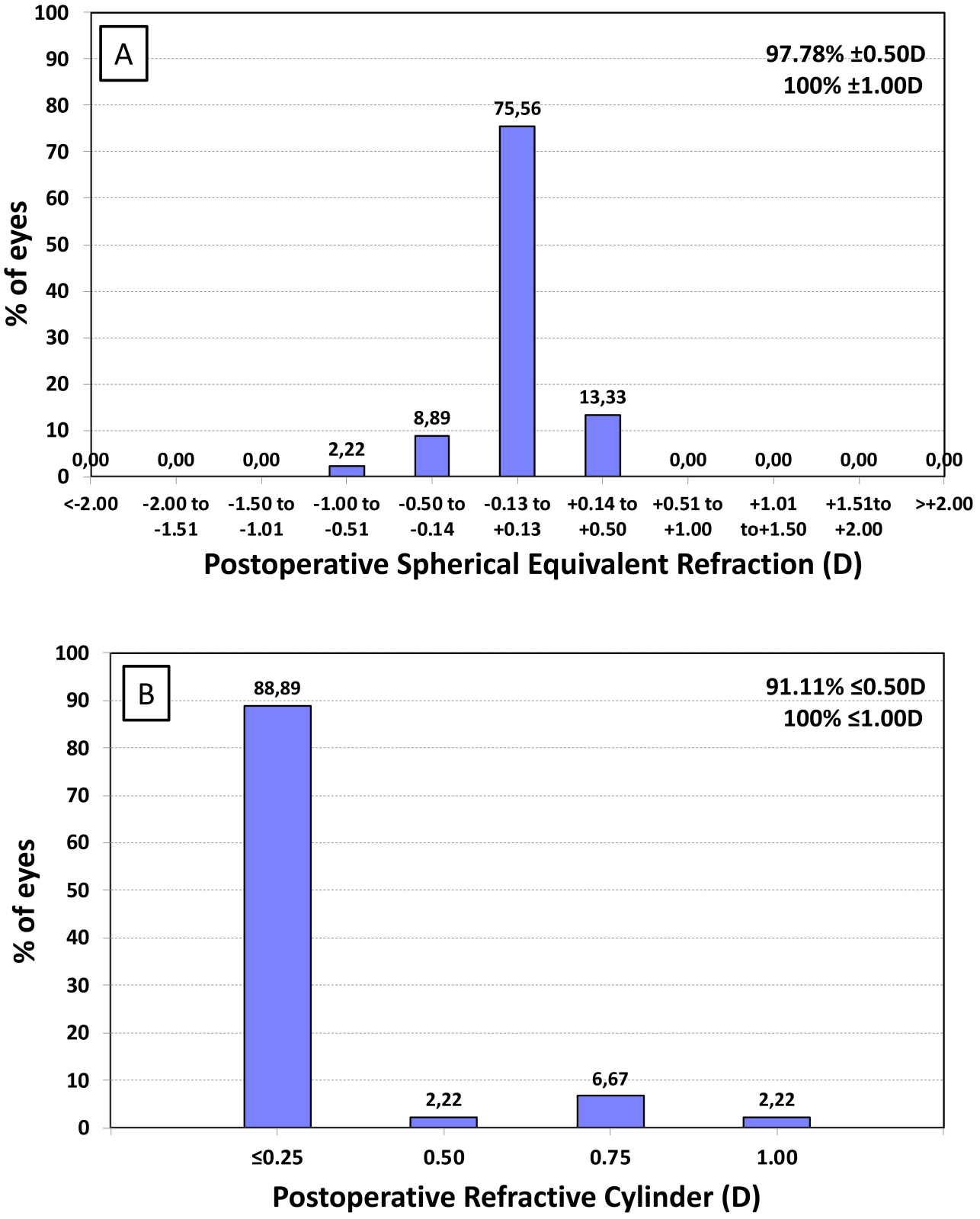

Figure 1 Distribution of postoperative spherical equivalent refraction (**A**) and refractive cylinder (**B**) 3-months after FineVision hydrophobic intraocular lens implantation.

them (n = 45) with 1.00 D or less. Note that 88.89% (n = 40) of the eyes showed a postoperative refractive cylinder of 0.25 D or less. Figure 2 shows the plot of the outcomes of the astigmatism vector analysis. It shows the double-angle plots of the preoperative corneal astigmatism and postoperative refractive astigmatism at 3-months after implantation of

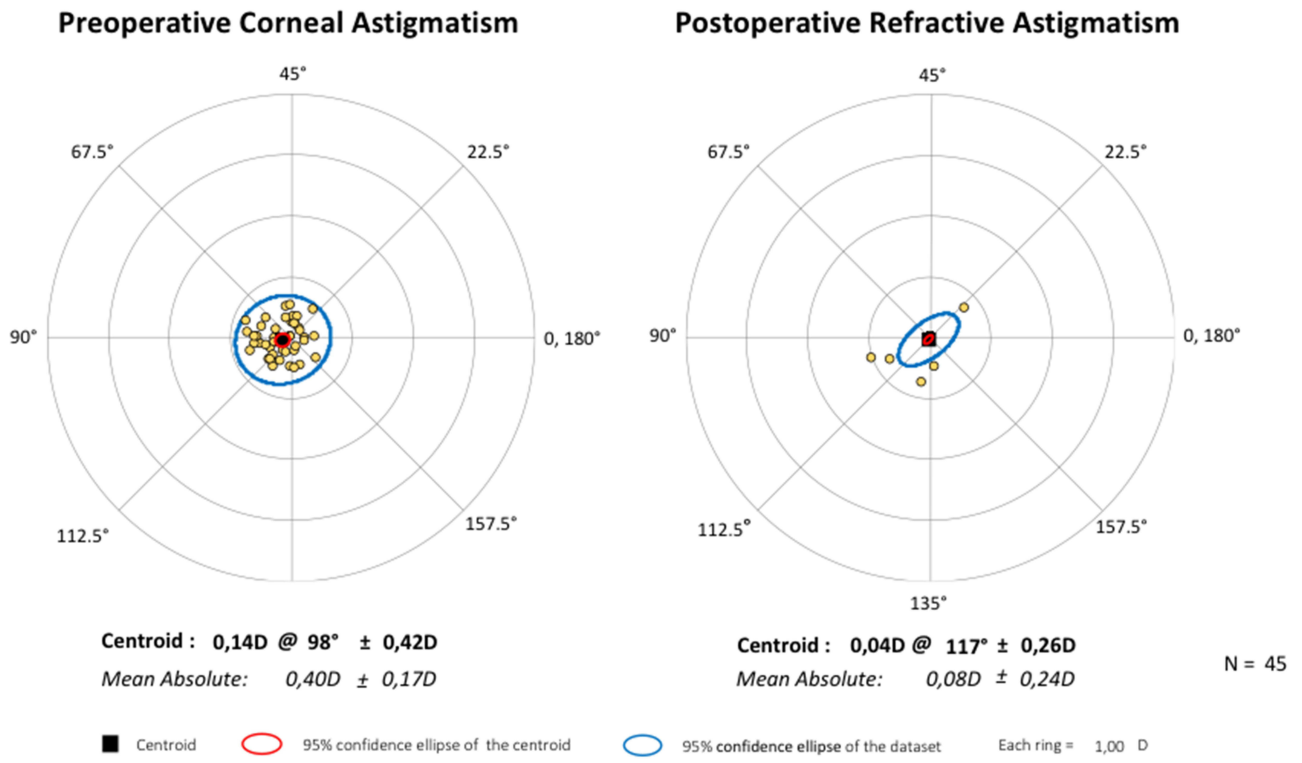

Figure 2 Double-angle plots for preoperative corneal astigmatism and postoperative refractive astigmatism 3-months after FineVision hydrophobic intraocular lens implantation. The centroid and mean absolute values with standard deviations are shown.

the FineVision HP IOL. The centroid of the corneal astigmatism before surgery was 0.14 ± 0.42 D at 98 degrees and that of the refractive astigmatism was 0.04 ± 0.26 D at 117 degrees after surgery. The mean absolute value was reduced from 0.40 ± 0.17 D before the surgery to 0.08 ± 0.24 D 3 months after the FineVision HP IOL implantation.

Visual Acuity Outcomes

Table 2 shows the mean monocular logMAR visual acuity outcomes recorded 3 months postoperatively. For distance vision, the mean UDVA and CDVA were good with values better than 20/20 (−0.05 ± 0.07 logMAR and −0.07 ± 0.06 logMAR, respectively). Figure 3 shows the difference in monocular UDVA and CDVA 3 months after FineVision HP IOL implantation; 88.89% of the eyes (n = 40) showed a UDVA that was the same or better than the CDVA, and 95.56% (n = 43) of the eyes had an UDVA within 1 line of the CDVA. Figure 4A shows the plot of the cumulative proportion of eyes with a given postoperative UDVA and CDVA. Three months after implantation of the FineVision HP IOL, 86.67% (n = 39) and 95.56% (n = 43) of the eyes had 20/20 or better UDVA and CDVA, respectively, with 100% (n = 45) achieving 20/25 or better both for UDVA and CDVA. At 80 cm, the mean monocular logMAR UIVA and DCIVA was 0.18 ± 0.14 and 0.16 ± 0.14, respectively, and at 66 cm, the values were 0.20 ± 0.15 and 0.19 ± 0.15, respectively (see Table 2).

The cumulative proportion of eyes with a given postoperative UIVA and DCIVA at both distances is shown in Figure 4B. Specifically, at 80 cm, 3 months after the FineVision HP IOL implantation, 20% (n = 9) of the eyes had 20/25 or better DCIVA and 60% (n = 27) had 20/32 or better DCIVA. These values changed to 15.56% (n = 7) and 40% (n = 18) of eyes for DCIVA at 66 cm. At near vision (40 cm), the mean monocular logMAR UNVA and DCNVA showed mean values of approximately 20/20: 0.04 ± 0.10 and 0.03 ± 0.10, respectively (Table 2). Figure 4C shows the cumulative proportion of eyes with a given postoperative UNVA and DCNVA 3 months after implantation of the FineVision HP IOL; 53.33% (n = 24) of the eyes had 20/20 or better UNVA and DCNVA, with 86.67% (n = 39) achieving 20/25 or better UNVA and DCNVA.

Table 2 Monocular Visual Acuity Outcomes Logarithm of the Minimum Angle of Resolution (logMAR) of Eyes Implanted with a FineVision Hydrophobic Intraocular Lens Shown as Means, Standard Deviations (SDs), and Ranges at a 3-Month Follow-Up

	FineVision HP IOL
UDVA	−0.05±0.074 (0.10 to −0.10)
CDVA	−0.07±0.06 (0.10 to −0.10)
UIVA (80 cm)	0.18±0.14 (0.60 to 0.00)
DCIVA (80 cm)	0.16±0.14 (0.50 to −0.10)
UIVA (66 cm)	0.20±0.15 (0.60 to −0.10)
DCIVA (66 cm)	0.19±0.15 (0.60 to −0.10)
UNVA (40 cm)	0.04±0.10 (0.30 to −0.10)
DCNVA (40 cm)	0.03±0.10 (0.30 to −0.10)

Abbreviations: UDVA, uncorrected distance visual acuity; CDVA, corrected distance visual acuity; UIVA, uncorrected distance intermediate visual acuity; DCIVA, distance corrected intermediate visual acuity; UNVA, uncorrected distance near visual acuity; DCNVA, distance corrected near visual acuity; IOL, intraocular lens.

Discussion

This study describes the refractive and visual outcomes obtained after implantation of the trifocal, diffractive, hydrophobic FineVision IOL in Japanese eyes after cataract surgery. The results of this study demonstrated that this lens provides good visual performance at different distances with excellent refractive accuracy. As already mentioned, previous studies have shown that this lens performed well in different cohorts.[4–10] Table 3 shows the main characteristics of these studies with a summary of the measurements carried out in their respective clinical trials.

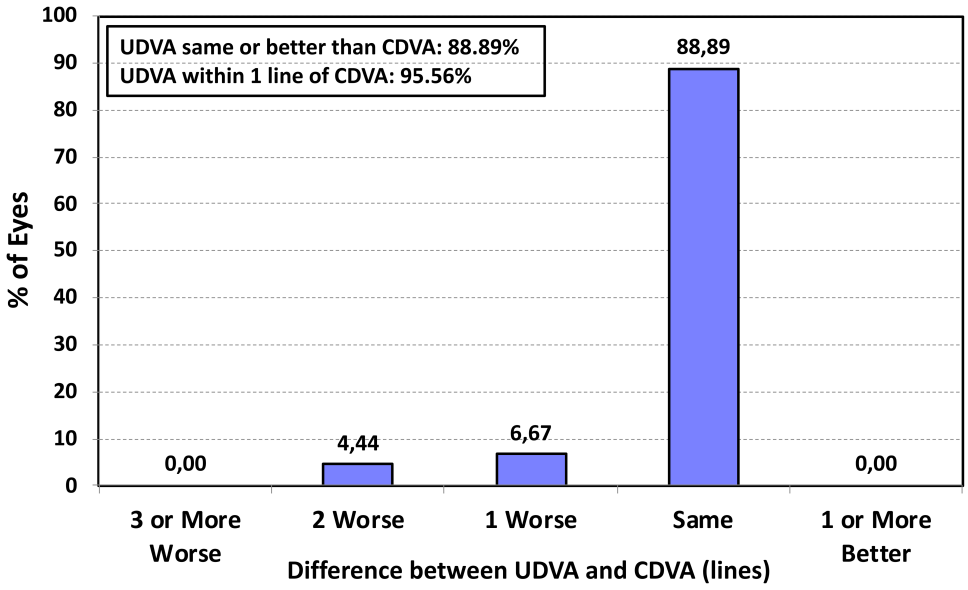

Figure 3 Difference in monocular uncorrected distance visual acuity (UDVA) and best-corrected distance visual acuity (CDVA) 3-months after FineVision hydrophobic intraocular lens implantation.

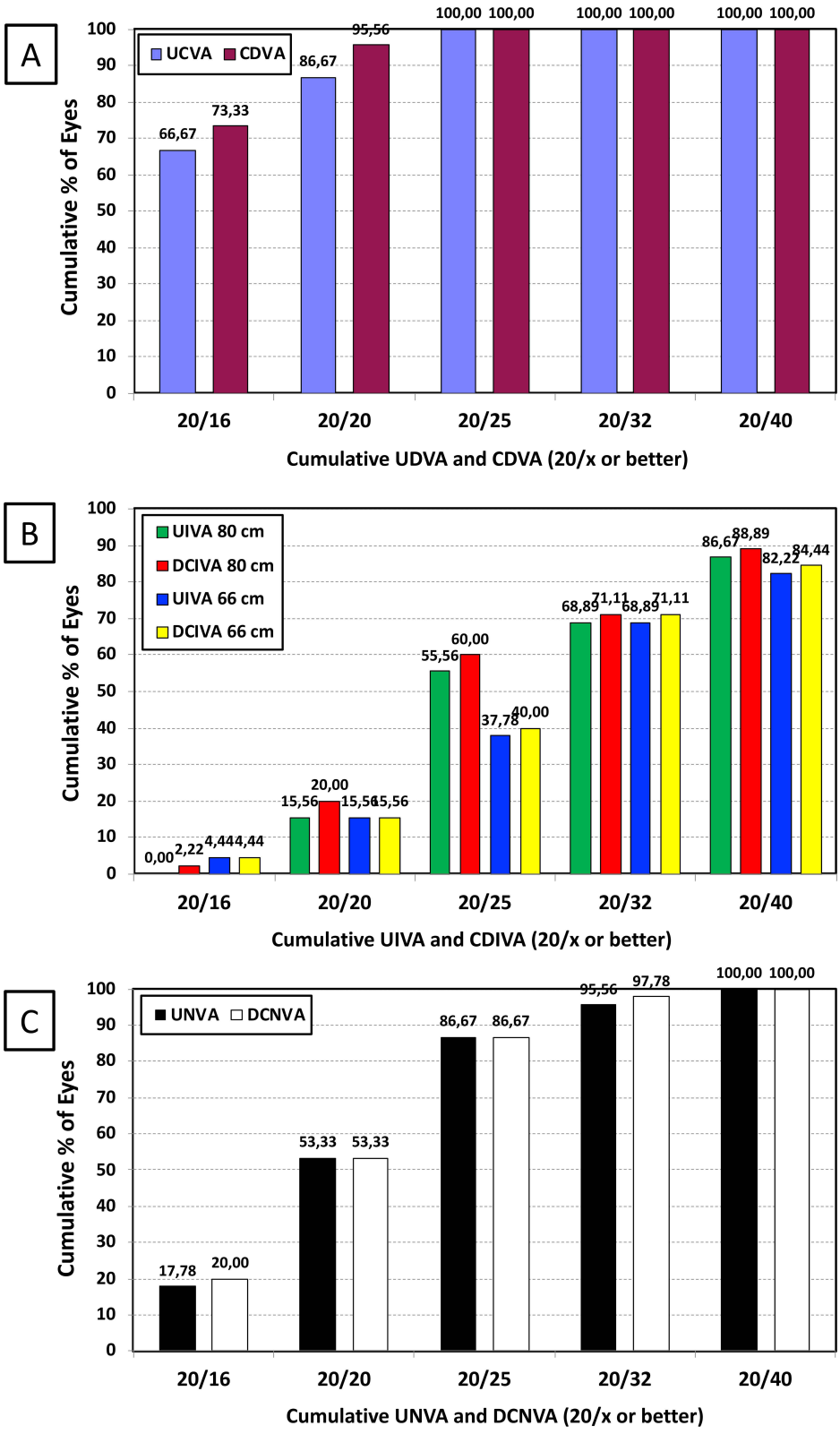

Figure 4 Cumulative proportion of eyes 3-months after FineVision hydrophobic intraocular lens implantation with a given postoperative uncorrected distance visual acuity (UDVA) and corrected distance visual acuity (CDVA) (**A**); uncorrected distance intermediate visual acuity (UIVA) and distance corrected intermediate visual acuity (DCIVA) at 80 and 66 cm (**B**); and uncorrected near visual acuity (UNVA) and distance corrected near visual acuity (DCNVA) at 40 cm (**C**).

Table 3 Peer-Reviewed Publications Using FineVision Hydrophobic, Trifocal, Glistening-Free (POD F GF) Intraocular Lenses

Authors	Year	Eyes [patients]	Type	Follow-up (months)	Age (y)	IOL power (D)	Axial length (mm)	Measurements
Nagy et al[4]	2019	25 [25] One eye with a POD F GF IOL and the contralateral eye with a POD F IOL.	Prospective	6	58.8±7.8 (43 to 78)	NR	NR	Monocular photopic (85 cd/m^2) and mesopic (3.5 cd/m^2) UDVA, CDVA, UIVA (70 cm), DCIVA (70 cm), UNVA (35 cm), and DCNVA (35 cm), photopic and mesopic CS (3 months), and defocus curve (3 months).
Vinas et al[10]	2020	20 [10]	Prospective	1	64.56±3.52 (53 to 71)	23.15±1.42 (21 to 26)	NR	Longitudinal chromatic aberration, refraction, UDVA, and CDVA.
Poyales et al[11]	2020	50 [25]	Prospective	1–3	66±6.9 (52 to 83)	22.6±2.0 (17 to 26)	23.28±0.77 (21.81 to 25.08)	UDVA, CDVA, DCIVA, DCNVA, refraction, negative dysphotopsia, optical quality of vision, photopic and mesopic CS, halometry, and PROQ (NEI VFQ-25).
Mayer et al[12]	2022	2 [1] 1 eye combined with Customflex	Prospective	3	56	27	NR	UDVA, CDVA, UIVA and UNVA, and defocus curve.
Garzón et al[13]	2022	48 [48]	Prospective	1	67.7±7.1 (NR)	NR	NR	Refraction, UDVA, and CDVA.
Benyoussef et al[14]	2022	42 [21]	Prospective	1	57.81±6.31 (44 to 70)	23.40±3.56 (NR)	23.04±1.08 (20.34 to 25.29)	Reading speed, monocular and binocular UDVA and CDVA, UIVA and DCIVA (70 cm), UNVA and DCNVA (35 cm), defocus curve, photopic CS, halometry, and PROQ (NEI VFQ-25).
Kim et al[6]	2022	Mix-and-match 212 [106] FineVision Triumf/FineVision HP	Retrospective	6–10 weeks	57.5±5.8 (42 to 70)	21.1±2.00 (NR)*	23.64±0.79 (NR)*	Monocular UDVA and CDVA, UNVA (40 cm), monocular and binocular defocus curves, and PROQ.
Mori et al[5]	2022	46 [23]	Prospective	6	71.3±5.9 (56 to 82)	20.54±3.68 (10 to 26)	23.66±1.04 (22.15 to 26.68)	Monocular and binocular UDVA, CDVA, UIVA and DCIVA (80 cm), UNVA and DCNVA (40 cm), binocular defocus curve, binocular photopic CS, and PROQ (VFQ-J11)
Current	2024	45 [29]	Retrospective	3	68.52±9.98 (33 to 80)	17.37±3.78 (10.50 to 24)	24.71±1.26 (23.01 to 27.39)	Refraction, monocular UDVA, CDVA, UIVA and DCIVA (80 and 66 cm), and UNVA and DCNVA (40 cm).

Notes: Values reported as the mean ± standard deviation (range). *including eyes implanted with the Triumf IOL.

Abbreviations: D, dioptres; IOL, intraocular lens; UDVA, uncorrected distance visual acuity; CDVA: corrected distance visual acuity; UIVA: uncorrected distance intermediate visual acuity; DCIVA, distance corrected intermediate visual acuity; UNVA, uncorrected near visual acuity; DCNVA, distance corrected near visual acuity; CS, contrast sensitivity photopic (85 cd/m^2) and mesopic (3.5 cd/m^2); PROQ, patient-reported outcomes questionnaire; NR, not reported; POD F: FineVision trifocal optic; GF, glistening-free; NEI VFQ-25, National Eye Institute 25-item Visual Function Questionnaire; VFQ-J11, Japanese 11-item Visual Function Questionnaire.

The refractive accuracy measured in our cohort was excellent, given that the mean SE value was −0.01 D and almost all the eyes were within ± 0.50 D (97.78%, Figure 1A). The percentages of cylinder ≤ 0.50 D and ≤ 1.00 D were algo high (91.1% and 100%, Figure 1B), with a minimum mean cylinder of −0.08 D. Interestingly, our mean SE value was the same as that obtained by Kim et al[6] in a mix-and-match retrospective study, which was slightly better than previous reports in both cases (see Table 4 for a detailed analysis comparing different study outcomes). However, more eyes were ±0.50 D or ±1.00 D in our study compared to the other trials we considered. For astigmatism, we obtained better outcomes both for the mean value and percentages of eyes with a cylinder ≤ 0.50 D and ≤ 1.00 D.

Specifically, compared to those found in our work, in a sample of 46 Japanese eyes 6 months post-surgery, Mori et al obtained lower percentages of SE (74%[5] vs 97.78% for ±0.50 D) and cylinder (82%[5] vs 91.11% for ≤ 0.50 D) than those reported in our sample. These differences could perhaps be explained by the different follow-up periods and sample characteristics (ie, age, IOL power, and axial length) or the use of SRKT/ Barrett Universal II formulas to calculate IOL power. Nevertheless, both studies reported excellent outcomes both for the spherical and cylindrical components, providing further evidence for the good accuracy of this lens when implanted in Japanese eyes.

Regarding the IOL material, we want to point out the study by Nagy et al that prospectively compared hydrophobic and hydrophilic lenses in 25 patients in a contralateral eye study (25 eyes with the POD F GF IOL and 25 eyes with PDO F IOL).[4] After 6 months, these authors concluded that both lenses provided equally good refractive outcomes but mentioned that the additional benefit of the hydrophobic lens was its reduced risk for postoperative glistening and posterior capsule opacification. This finding was also supported by Poyales at al. who compared both IOL models in two groups of patients, one with each lens type.[11] Importantly, using the GF material helped preserve the advantages of hydrophobic acrylic materials in terms of bio-adhesiveness and low posterior capsule opacification rate.[15]

In relation to the visual acuity outcomes obtained in our study, the postoperative far, intermediate, and near vision was good. Table 2 shows both the uncorrected and corrected mean values for all the distances. To aid the comparison of our results with other studies, we created Table 5 which shows the mean logMAR monocular visual acuity outcomes obtained at far, intermediate (80, 70, and 66 cm), and near (40 and 35 cm) distances in previous studies. Of note, one study[11] reported binocular rather than monocular mean values. At distance, our results were similar to those reported by other cohorts (a CDVA ranging from 0.01 to −0.07 logMAR), and specifically for Japanese eyes, we found slightly worse CDVA and DCIVA (at 80 cm) and better DCNVA than Mori et al[5] although the maximum difference was 0.14 logMAR at 80 cm (about 1 line of the chart). It is also worth noting that our mean axial length was 1.66 mm, which was longer than that of Mori et al (23.66[11] vs 24.71 mm) and therefore, the mean IOL power implanted was different between these two studies (17.37 vs 20.54 D[5]).

Table 4 Refraction Outcomes Obtained in Peer-Reviewed Publications Using Hydrophobic Trifocal FineVision Intraocular Lenses

Authors	Mean ± SE (D)	SE ± 0.50 D (%)	SE ± 1.00 D (%)	Mean Cylinder (D)	Cylinder ≤ 0.50 D (%)	Cylinder ≤ 1.00 D (%)
Nagy et al[4]	0.05±0.21	100	100	−0.18±0.41	88	96
Vinas et al[10]	–	55	100	–	80	100
Poyales et al[11]	0.23±NR	90	92	–	–	–
Garzón et al[13]	0.09±0.42	–	–	−0.28±0.34	–	–
Benyoussef et al[14]	0.14±0.64	73	92	–	–	–
Kim et al[6]	−0.01±0.30	–	–	−0.25±0.27	–	–
Mori et al[5]	−0.22±0.38	74	98	–	82	100
Current study	−0.01±0.22	97.78	100	−0.08±0.24	91.11	100

Note: Values reported as the mean and standard deviation.
Abbreviations: D, dioptres; SE, spherical equivalent; –: not reported.

Table 5 The Monocular Visual Acuity Logarithm of the Minimum Angle of Resolution (logMAR) Outcomes at Different Distances Obtained in Peer-Reviewed Publications Using Hydrophobic Trifocal FineVision Intraocular Lenses

Authors	UDVA	CDVA	UIVA (80 cm)	DCIVA (80 cm)	UIVA (70 cm)	DCIVA (70 cm)	UIVA (66 cm)	DCIVA (66 cm)	UNVA (40 cm)	DCNVA (40 cm)	UNVA (35 cm)	DCNVA (35 cm)
Nagy et al[4]	0.00 (0.07)	−0.04 (0.08)	–	–	0.04 (0.09)	0.04 (0.09)	–	–	–	–	0.06 (0.08)	0.04 (0.07)
Vinas et al[10]	0.06 (0.16)	−0.03 (0.09)	–	–	–	–	–	–	–	–	–	–
Poyales et al[11]*	0.01 (0.08)	−0.03 (0.03)	–	0.08 (0.10)	–	–	–	–	–	0.13 (0.11)	–	–
Garzón et al[13]	0.08 (0.09)	0.01 (0.03)	–	–	–	–	–	–	–	–	–	–
Benyoussef et al[14]	0.09 (0.14)	−0.05 (0.07)	–	–	0.04 (0.10)	−0.03 (0.07)	–	–	–	–	0.12 (0.10)	−0.04 (0.09)
Kim et al[6]	0.03 (0.04)	0.01 (0.02)	–	–	–	–	–	–	0.04 (0.06)	–	–	–
Mori et al[5]	−0.03 (0.08)	−0.11 (0.02)	0.07 (0.11)	0.02 (0.08)	–	–	–	–	0.08 (0.09)	0.06 (0.09)	–	–
Current	−0.05 (0.07)	−0.07 (0.06)	0.18 (0.14)	0.16 (0.14)	–	–	0.20 (0.15)	0.19 (0.15)	0.04 (0.10)	0.03 (0.10)	–	–

Note: Values reported as the mean and (standard deviation).

Abbreviations: UDVA: uncorrected distance visual acuity; CDVA: corrected distance visual acuity; UIVA: uncorrected distance intermediate visual acuity; DCIVA: distance corrected intermediate visual acuity; UNVA: uncorrected near visual acuity; DCNVA: distance corrected near visual acuity; –: not reported; *binocular visual acuities.

At near vision (40 cm), our results showed a mean monocular DCNVA of 0.03 ± 0.10 logMAR, which was better than that reported by Poyales et al who found a mean value of 0.13 ± 0.11 logMAR in a prospective study of 50 eyes 1–3 months post-surgery, (although this latter value was binocular).[11] Our results were more comparable to those reported by Nagy et al, who found a similar monocular DCNVA to us at a nearer distance (35 cm, 0.04 ± 0.07 logMAR),[4] and were much better than the findings reported by Benyoussef et al with a mean value of −0.04 ± 0.09 logMAR for DCNVA at 35 cm at 1 month follow-up in a prospective study.[14] Interestingly, compared to our cohort, the mean age of the population in the latter study was younger (57.81^9 vs 68.52 years) and had a shorter axial length (23.04^9 vs 24.71 mm). We believe that the aforementioned dissimilarities in the sample characteristics of these cohorts may be the responsible for these differences.

Another metric that supports the good visual acuity outcomes of this IOL was the analysis of the percentage of cumulative visual acuity at far, intermediate, and near distances, as shown in Figure 4. For distance vision, we obtained a CDVA ≥ 20/20 in 95.56% of the eyes, with all of them achieving ≥ 20/25. In Table 6, these results are compared with those from other studies in terms of the percentage of cumulative monocular visual acuity ≥ 20/16, ≥ 20/20, ≥ 20/25, and ≥ 20/32 obtained at far, intermediate (80, 70, and 66 cm), and near (40 and 35 cm) distances. Of note, a couple of studies[5,11] reported binocular rather than monocular cumulative percentages.

In terms of CDVA, our results were better than those from Nagy et al.[4] Poyales at al.[11] and Benyoussef et al[14] especially for the highest visual acuity (≥ 20/16). Furthermore, our findings also broadly agree with those from the sample of Japanese eyes reported by Mori et al, who found practically the same percentages as us.[5] However, this latter study reported binocular visual acuity values rather than the monocular vales we report here. Therefore, we could extrapolate that we might have found better values in this current work if we had measured visual acuity under binocular conditions. In any case, both studies showed excellent percentages of cumulative CDVA.

Regarding visual acuity at intermediate distances, we found that 60% of the eyes had a DCIVA ≥ 20/25 at 80 cm, which decreased to 40% at 66 cm. These values were slightly worse than those reported by Poyales at al. at 80 cm[6] but could be explained by the fact that these authors measured visual acuity under binocular conditions while our values were monocular. We cannot compare our values obtained at 66 cm with other studies, although we can do this for near vision. Our values were good, with 86.67% and 97.7% of the eyes achieving ≥ 20/25 and ≥ 20/32 of DCNVA, respectively, with these findings being similar to those from Mori et al[5] and better than those reported by Poyales at al.[11] (see Table 6). Of note, the comparable percentage values reported by Nagy et al[4] and Poyales at al.[11] were found at a near distance of 35 cm.

Table 6 Percentage of Cumulative Monocular Visual Acuity (≥ 20/16, ≥ 20/20, ≥ 20/25, and ≥ 20/32) Outcomes at Different Distances Obtained in Peer-Reviewed Publications Using Hydrophobic Trifocal FineVision Intraocular Lenses

Authors	UDVA	CDVA	UIVA (80 cm)	DCIVA (80 cm)	DCIVA (70 cm)	UIVA (66 cm)	DCIVA (66 cm)	UNVA (40 cm)	DCNVA (40 cm)	DCNVA (35 cm)
Nagy et al[4]	16, 76, 100, 100	32, 96, 100, 100	–	–	12, 64, 88, 100	–	–	–	–	4, 60, 92, 100
Poyales et al[11]*	0, 62.5, 95.8, 95.8	0, 87.5, 100, 100	–	8.3, 29.2, 79.2, 100	4, 40, 88, 100	–	–	–	0, 16.7, 70.8, 87.5	4, 48, 88, 96
Benyoussef et al[14]	7, 29, 45, 88	38, 85, 98, 100	–	–	–	–	–	–	–	–
Mori et al[5]*	35, 96, 100, 100	74, 100, 100, 100	9, 74, 96, 100	4, 74, 100, 100	–	–	–	9, 52, 96, 96	9, 74, 96, 100	–
Current	66.6, 86.6, 100, 100	73.3, 95.5, 100, 100	0, 15.5, 55.5, 68.8	2.2, 20, 60, 71.1	–	4.4, 15.5, 37.7, 68.8	4.4, 15.5, 40, 71.1	17.7, 53.3 86.6, 95.5	20, 53.3, 86.6, 97.7	–

Notes: *Binocular visual acuities.
Abbreviations: UDVA: uncorrected distance visual acuity; CDVA: corrected distance visual acuity; UIVA: uncorrected distance intermediate visual acuity; DCIVA: distance corrected intermediate visual acuity; UNVA: uncorrected near visual acuity; DCNVA: distance corrected near visual acuity; –, not reported.

In general, the visual outcomes obtained with this type of IOL were good for all the populations considered, however, it was interesting that better values were obtained in Japanese eyes (Mori et al[5] and the present study). This is a pattern similar to that observed in Japanese eyes implanted with other types of trifocal IOLs[16,17] and so it has been suggested that differences in the study population or/and assessment centre could play a role in this variation. Interestingly, other visual performance metrics have been reported in other studies in patients implanted with FineVision POD F GF IOLs. For example, Nagy et al found that the contrast sensitivity was good and within the expected range for eyes after IOL implantation (with no significant differences observed between hydrophobic and hydrophilic models in both photopic and mesopic conditions).[4] This finding was also supported by Poyales at al. who compared both models in two different groups of patients and obtained similar contrast sensitivities under both lighting conditions.[11] Similarly, Mori et al also obtained binocular photopic values within the normal range.[5]

In terms of patient-reported outcomes, Poyales at al. used the National Eye Institute 25-item Visual Function Questionnaire to reveal that this lens type scored very highly across all the survey categories (with results comparable to those from the hydrophilic model).[11] These authors also measured photic phenomena, with halometry results showing that the optical design of this lens did not introduce additional problems to those reported by diffractive IOL designs. Using the same questionnaire, Benyoussef et al reported a satisfaction rate of 85.7%, with 95.2% of the patients in their cohort saying they would be willing to repeat the surgery.[14] Mori et al found that spectacle independence was achieved in 91.23% of their patients and according to the Japanese 11-item Visual Function Questionnaire, the total scores and sub-scores for far and near vision also improved postoperatively.[5] Regarding photic phenomena, 78.3% of patients had no symptoms of glare, 56.6% reported no halo, and 69.6% had no symptoms of light disturbance at night. As these authors indicated, their findings demonstrate that cataract surgery with this trifocal IOL increased patient quality of vision.

Finally, there were some limitations to our study. For example, we did not compare the performance of the FineVision HP IOL with other trifocal IOLs available on the market. Furthermore, we did not examine contrast sensitivity or outcomes from patient-reported quality of vision questionnaires with longer follow-ups. These problems should be addressed in future studies in order to confirm the early outcomes obtained in this present work and specifically, it would be useful to conduct a long-term analysis to assess posterior capsule opacification.

Conclusions

In conclusion, implantation of the FineVision HP trifocal, diffractive, IOL in Japanese eyes provided good visual performance at far, intermediate, and near distances. Moreover, the refractive accuracy of the procedure was excellent. Based on our findings, patients that wish to be spectacle-independent at different distances may benefit from implantation of this trifocal diffractive HP lens.

Disclosure

The author reports no conflicts of interest in this work.

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