Clinical Ophthalmology

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ORIGINAL RESEARCH

Visual, Refractive, Functional, and Patient Satisfaction Outcomes After Implantation of a New Trifocal Diffractive Intraocular Lens

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Purpose: To describe the visual, refractive, functional, and patient satisfaction outcomes of the Clareon® PanOptix® trifocal intraocular lens (IOL).

Patients and Methods: This was a prospective longitudinal descriptive study. Patients who underwent cataract surgery with implantation of Clareon® PanOptix® (Alcon Laboratories, Inc.) were included. Monocular refractive outcomes and visual acuity at distance, intermediate, and near were evaluated 1- and 6-months post-op. Binocular contrast sensitivity (M&S® Technologies), binocular defocus curve, and patient satisfaction with the IOL Satisfaction (IOLSAT) and Questionnaire for Visual Disturbance (QUVID) questionaries were assessed at 6-month post-op.

Results: Seventy-six Clareon® PanOptix® were implanted bilaterally in 38 patients. The mean age of the patients was 67.63±5.18 years. At 1-month post-op, the monocular Corrected Distance Visual Acuity (CDVA), CIVA and CNVA were 0.00±0.09, 0.02±0.17, and 0.12±0.12 LogMAR, respectively, and CDVA and CNVA were stable at 6-month post-op ($p>0.05$). No statistical differences were found in post-op spherical equivalent at 1 and 6 months (−0.08±0.27 D and −0.05±0.24 D; $p=0.351$). A 100% of eyes were within ±0.5 D at 1 month and 6-month post-op. Binocular defocus curve shows three peaks of maximum visual acuity (VA) at 0D (−0.04±0.08 LogMAR), at −1.50D, and −2.50 D (0.01±0.10 LogMAR and 0.03±0.07 LogMAR, respectively). Contrast sensitivity decreased at high spatial frequencies. In patient satisfaction, IOLSAT questionary reveals 78.94% patients "Never" or "Rarely" Needing Glasses and according QUVID questionnaire, 100% of patients report no hazy vision.

Conclusion: The PanOptix® IOL platform with the new material Clareon® provides good visual outcomes for distance, intermediate, and near vision, with adequate contrast sensitivity and low visual disturbances.

Keywords: cataract surgery, multifocal lens, vision restoration, phacoemulsification

Introduction

Cataract is the main cause of reversible blindness worldwide that is treated with surgery by removing the opaque crystalline lens and inserting an intraocular lens (IOL).[1] The first type of IOL was monofocal for far distance but prevalence of presbyopia and the importance of near and intermediate vision in modern society are the main reasons that have motivated the development of multifocal IOLs to compensate for this refractive condition.[2,3] Thus, the use of multifocal IOLs can improve uncorrected near vision and uncorrected distance visual acuity (VA) and thus reduce dependency on spectacles. The excellent refractive results obtained with this type of lens have favored their use in the correction of refractive errors since the fifth decade of life.[4]

Although multifocal IOLs can improve visual acuity at different distances, side effects need to be considered, such as halos, glare, and loss of contrast sensitivity.[5–8] In recent years, glistening and sub-surface nano-glistening (SSNG) have been reported with hydrophobic acrylic IOLs inserted for a long time.[9–16] Thereby, manufacturers are constantly improving IOL materials to maintain transparency. In this regard, Clareon® has recently entered the market and enhances transparency[17] and the development of glistening or microvacuoles compared with AcrySof® material.[18,19]

Received: 28 May 2024
Accepted: 20 September 2024
Published: 5 October 2024

This study aimed to assess the visual performance of the Clareon® PanOptix® (CNWT) multifocal platform IOL by analyzing the refractive results, defocus curves, and contrast sensitivity. In addition, refractive outcomes, visual acuity at different distances, and patient satisfaction were assessed.

Materials and Methods

Study Design

We performed a prospective, longitudinal, and descriptive study in patients who underwent uncomplicated bilateral cataract surgery and were implanted with a new trifocal CNWT (Alcon Laboratories Inc., Fort Worth, TX, USA) IOL. All the procedures complied with the ethical standards described in the 1975 Declaration of Helsinki and were revised in 1983. Research Ethics Committee approval was obtained from the IMO Miranza (PANCLA, 211214–200). In addition, the purpose of the study and policy on the protection of personal data were explained in detail to all participants, and informed consent was obtained.

Patient Population

Healthy patients with cataract surgery (ages between 60 and 80 years) were included in this study. Additionally, diabetic patients or those with retinal or neuro-ophthalmological pathology, glaucoma, or corneal astigmatisms greater than 1D were excluded.

Preoperative and Postoperative Eye Examinations

All patients underwent a complete preoperative examination prior to surgery. A single observer performed all preoperative tests for all patients, including uncorrected visual acuity (UCVA); corrected visual acuity at distance (6 m), intermediate (66 cm), and near (40 cm); subjective refraction; MS-39 anterior segment optical coherence tomography (AS-OCT) (CSO, Firenze, Italy); biometry with OA-2000 (Tomey, Japan); infrared mesopic pupillometry (Colvard pupillometer, Oasis Medical Inc., Glendora, CA, USA), and macular and retinal nerve fiber layer measurements (DRI OCT Triton, Topcon Corp, Tokyo, Japan). Slit-lamp biomicroscopy, Goldmann applanation tonometry (CT-80; Topcon, Tokyo, Japan), and fundoscopy were also performed. At the 1-month postoperative review, the following variables were measured by an experienced optometrist: monocular uncorrected and corrected visual acuity at three distances (6m, 66, and 40 cm) and subjective refraction. Finally, at 6 months postoperatively, the same visual tests as in the month's review, binocular defocus curves, binocular contrast sensitivity (M&S® Technologies, Niles, IL, USA), and patient satisfaction were assessed through two validated tests,[20,21] IOL Satisfaction (IOLSAT) and Questionnaire for Visual Disturbance (QUVID). The IOLSAT assesses glass independence and patient satisfaction at various distances and light conditions, and the QUVID evaluates photopic phenomenon rates.

IOL calculations were performed using biometric parameters provided by the OA-2000 and Barrett II Universal formula. The IOLs were implanted and targeted for emmetropia. In all cases, the IOL power chosen was the one yielding myopic value closer to zero. A-constant used was at 119.1.

Intraocular Lens

The CNWT is a hydrophobic acrylic lens that is created using the cast molding method. It has a full 6.0-mm optic diameter and a 13.0-mm overall length. Patented Enlighten® optical technology redirects light energy from the 120 cm focal point. This is how the CNWT trifocal IOL design was obtained with focal points for distance, intermediate distances at 66 cm, and near 40 cm. PanOptix® transmits 88% of the available light to the retina, 50% to the distance vision, 25% to the intermediate vision, and 25% to the near vision. A crucial element in assisting surgeons in maximizing their refractive outcomes is exclusive Stableforce® haptics, which offers proven axial stability for maximum refractive predictability. Clareon® material was launched by Alcon in 2020 as an update of AcrySof®. This offers several benefits including enhanced clarity due to a material that does not glistening, a precision edge made to reduce edge-associated glare, and posterior capsular opacification (PCO).

Surgical Procedure

All surgeries were performed by two experienced surgeons (J.M. and I.M-S.) in the same way at Miranza Begitek (Donostia – San Sebastián, Spain). Surgical procedures with IOL implantation were performed with a difference of 7 days between eyes.

All patients underwent cataract surgery using phacoemulsification (Centurion®, Alcon Laboratories Inc., Fort Worth, TX, USA) according to regular clinical practice procedures under local anesthesia through a micro-incision of 2.2 mm.

Statistical Analysis

The data were collected using Microsoft Excel spreadsheet. Descriptive statistics were expressed as mean ± standard deviation (SD). Statistical analysis was performed using SPSS software (version 22.0 SPSS Inc. Chicago, IL, USA). When continuous variables were parametric, the Student's *t*-test was used to compare the surgical values. The Wilcoxon test was used for non-parametric analysis. Differences were considered statistically significant at $p < 0.05$.

Results

Demographics

Seventy-six CNWT were implanted bilaterally in 38 patients, of whom 26 were women (68.42%) and 12 were men (31.58%). The mean age of sample was 67.63±5.18 years. The mean power of the implanted IOL was 21.59±3.84 D. The average axial length before surgery was 23.48±1.38 mm. The remaining preoperative biometric values are shown in Table 1. All surgeries were uneventful, and no adverse events (glistening, posterior capsular opacification, early IOL-capsular bag complex dislocation, dysphotopyc phenomena, Irvine-Gass syndrome, or endophthalmitis) were recorded for any patient during the study visits.

Table 1 Preoperative Biometric and Refractive Values from the Right Eye

	K1 (D)	K2 (D)	Pupil (mm)	AXL (mm)	WTW (mm)	ACD (mm)	LT (mm)	Sph (D)	Cyl (D)	SE (D)	CDVA (LogMAR)
Mean	43.45	44.20	4.85	23.48	12.05	3.20	4.57	0.09	−0.72	−0.27	0.13
SD	1.64	1.64	1.07	1.38	0.35	0.30	0.32	3.07	0.52	3.13	0.16

Note: Values are shown as mean and standard deviation (SD).
Abbreviations: AL, Axial Length; ACD, anterior chamber depth; CDVA, Corrected Distance Visual Acuity; Cyl, Cylinder; D, Diopters; K, Keratometry; LT, Lens Thickness; SD, Standard Deviation; SE, Spherical Equivalent; Sph, Sphere; WTW, White-To-white.

Visual Acuity Outcomes

Only the right eye was included in the visual acuity and refractive outcome analysis. Thus, in terms of monocular VA outcomes, the mean monocular Uncorrected Distance Visual Acuity (UCDVA) at 1 month (0.07±0.10 LogMAR) and 6 months (0.06±0.11 LogMAR) were similar (p=0.834). Also, the monocular Corrected Distance Visual Acuity (CDVA) at 1 month (0.00±0.09 LogMAR) and at 6 months (−0.02±0.08 LogMAR) was similar (p=0.388) (Table 2).

Table 2 Monocular Visual Acuity During 6 Months of Follow-Up

	1 Month Post-OP Mean ± SD (Range)	6 Months Post-OP Mean ± SD (Range)	p value
UCDVA (LogMAR)	0.07±0.10 (−0.10, 0.26)	0.06±0.11 (−0.14, 0.30)	0.834
UCIVA (LogMAR)	0.01±0.17 (−0.34, 0.48)	0.12±0.14 (−0.18, 0.44)	0.000*
UCNVA (LogMAR)	0.13±0.12 (−0.10, 0.46)	0.18±0.12 (0.00, 0.56)	0.007*
CDVA (LogMAR)	0.00±0.09 (0.24, 0.38)	−0.02±0.08 (−0.16. 0.18)	0.388
CIVA (LogMAR)	0.02±0.17 (−0.30, 0.56)	0.11±0.14 (−0.20, 0.46)	0.005*
CNVA (LogMAR)	0.12±0.12 (−0.10, 0.64)	0.15±0.11 (−0.10, 0.44)	0.079

Notes: Values are presented as mean, standard deviation (SD), and range. (*) $p<0.05$ was considered statistically significant at $p < 0.05$.
Abbreviations: CDVA, Corrected Distance Visual Acuity; CIVA, Corrected Intermediate Visual Acuity; CNVA, Corrected Near Visual Acuity; UCDVA, Uncorrected Distance Visual Acuity; UCIVA, Uncorrected Intermediate Visual Acuity; UCNVA, Uncorrected Near Visual Acuity.

Thus, one month after surgery, 13 eyes (34.21%) achieved a monocular UCDVA better than 0 LogMAR (Figure 1, graph A), 34 eyes (89.47%) achieved a monocular UCIVA equal to or better than 0.2 LogMAR and 31 eyes (81.58%) achieved a monocular UCNVA equal to or better than 0.2 LogMAR. The remaining cumulative distribution of VA at 1-month is presented in Figure 2 graphs A to C. 6-month post-operatively, similar results were obtained compared with 1 month in all VA, as shown in graphs D to E in Figure 2 and in graph E in Figure 1. A 100% of the eyes achieved 20/40 UCDVA and CDVA.

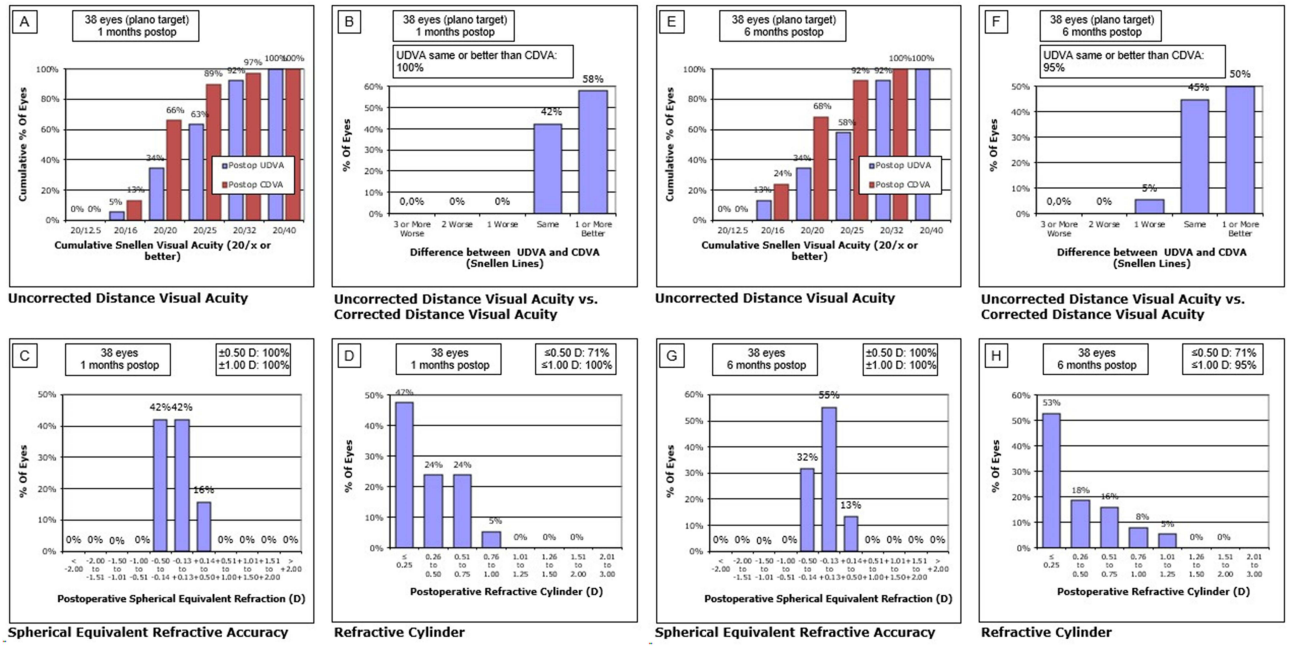

Figure 1 Monocular refractive outcomes at 1-and 6-month post-op. (**A**–**D**) correspond with 1-month outcomes, and (**E**–**H**) correspond with 6-month outcomes.

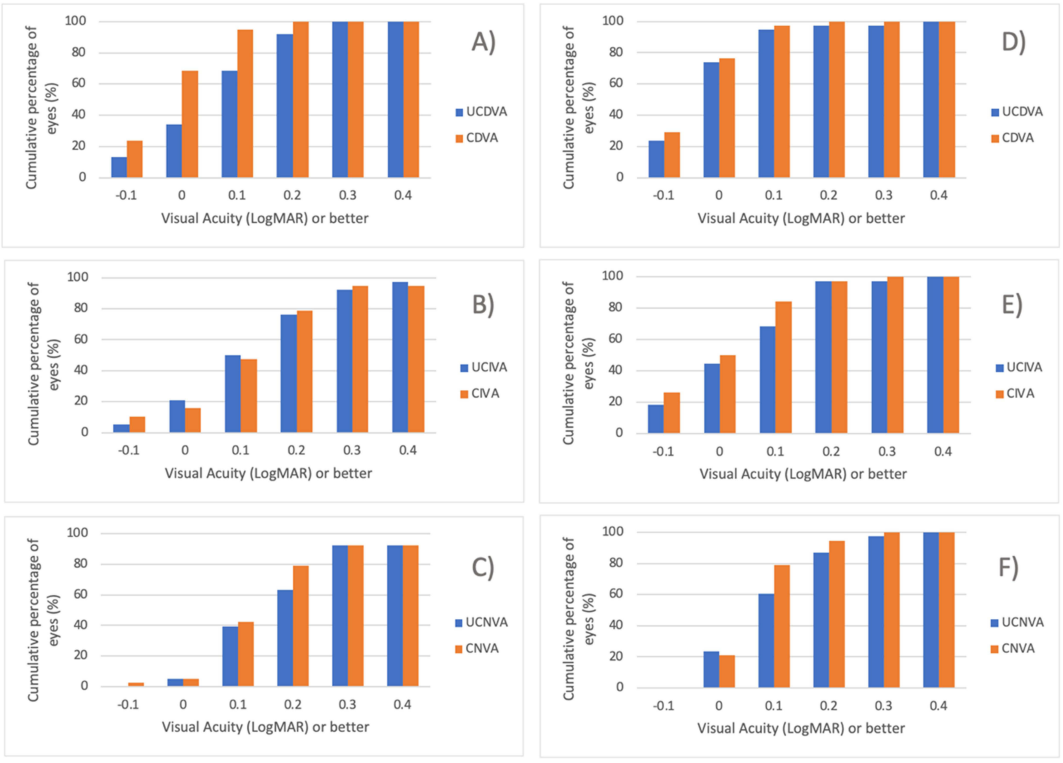

Figure 2 Cumulative distribution of visual acuity at 1 month and 6-month post-op at all distances. (**A**–**C**) correspond to monocular visual acuity at 1 month post-op; and (**D**–**F**) correspond to monocular visual acuity at 6-month post-op.

In this sense, at 1-month post-op that 22 eyes (57.89%) won one or more lines, 16 eyes (42.11%) obtained the same difference, and 0 eyes lost one or more lines (Figure 1, graph B). At 6-month post-op, 19 eyes (50%) had one line or more, 17 eyes (44.74%) showed the same difference, and only 2 eyes (5.26%) lost one or more lines (Figure 1, graph F). The overall efficacy index (postoperative UCDVA / preoperative CDVA) at 1 month was 1.02 and at 6 months it was 1.04. The safety index (ratio of postoperative CDVA to preoperative CDVA) at 1 month was 1.20 and at 6 months was 1.23.

Refractive Outcomes

The percentage of eyes with a postoperative refractive spherical equivalent of ±0.25 D at 1-month post-op was 71.05% (27 eyes) and at 6-month post-op was 78.95% (30 eyes). The percentage of eyes in ±0.5 D and ±1.00 D were 100% (38 eyes) and 100% (38 eyes), respectively, at 1 month and 6-month post-op (Graph C and G in Figure 1). The 71% of eyes had a post-operative refractive cylinder ≤ −0.50 D at 1 month and 6 months. The remaining postoperative refractive cylinder outcomes are presented in graphs D and H of Figure 1.

The refractive stability (Table 3) measured as the mean change of the SE between the 1- and 6-month post-op was 0.04±0.24 D (p=0.351) and this stability of SE during the period of follow-up is shown in Figure 3.

Table 3 Monocular Refractive Outcomes During 6 Months of Follow-Up

	1 Month Post-OP Mean ± SD (Range)	6 Months Post-OP Mean ± SD (Range)	p value
Sphere (D)	0.11±0.26 (−0.50, 0.50)	0.14±0.28 (−0.50, 0.75)	0.419
Cylinder (D)	−0.38±0.34 (−1.00, 0.00)	−0.38±0.40 (−1.25, 0.00)	0.903
Spherical Equivalent (D)	−0.08±0.27 (−0.50, 0.50)	−0.05±0.24 (−0.50, 0.50)	0.351

Note: Values are presented as mean, standard deviation (SD), and range.
Abbreviation: D, Diopters.

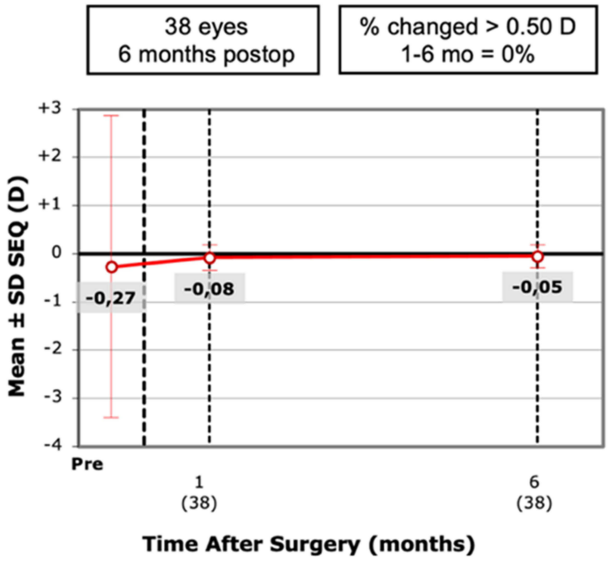

Figure 3 Spherical equivalent refraction stability during the follow-up.

Defocus Curve and Contrast Sensitivity Function

Figures 4 and 5 illustrate the defocus curves and contrast sensitivity in photopic conditions, respectively, at 6-month as the mean values of visual acuity and contrast sensitivity. The binocular defocus curve shows a peak of maximum VA at 0 D (−0.04±0.08 LogMAR) that corresponds to distance vision (6 m) and a more elongated and smoother peak of VA at the intermediate (66 cm or −1.50 D) and near (40 cm or −2.50 D) distance (0.01±0.10 LogMAR and 0.03±0.07 LogMAR respectively). Regarding the binocular contrast sensitivity curve, at short spatial frequencies (3 and 6 cpg) a high and expected performance is evident (−2.20±0.24 LogMAR and −2.19±0.22, respectively); however, at high spatial frequencies (12 and 18 cpg), a decrease (−1.68±0.32 Log and −1.30±0.34 Log, respectively) was observed.

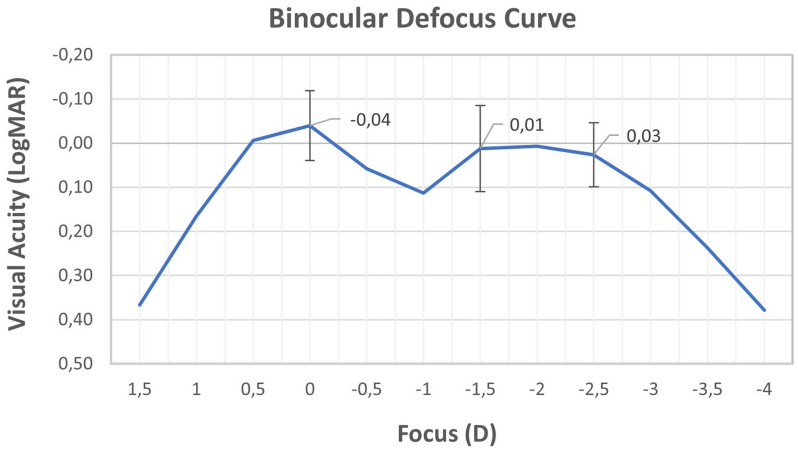

Figure 4 Binocular defocus curve at 6 months post-op in photopic conditions.

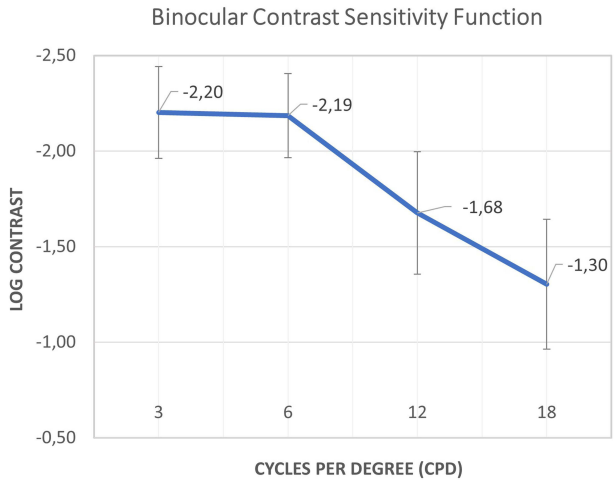

Figure 5 Binocular contrast sensitivity curve (M&S® Technologies) at 6 months post-op in photopic conditions.

Patient Satisfaction

Table 4 summarizes the QUVID questionnaire outcomes for different vision problems and the qualitative scales. A 100% of patients stated that they had no concerns about hazy vision in terms of frequency, severity, or discomfort. An 89% of the patients (34 patients of 38) reported having no shadows or in frequency, severity, or botherness. Only 5.26% and 13.16% of patients showed "Something" glare and halos botherness, respectively.

Table 4 QUVID Questionary Results at 6 Months Post-op

Botherness							
	Glare	**Halos**	**Starbursts**	**Blur Vision**	**Diplopia**	**Hazy Vision**	**Shadow Area**
Nothing	47.37 (18)	28.95 (11)	86.84 (33)	42.11 (16)	84.21 (32)	100.00 (38)	89.47 (34)
A Bit	28.95 (11)	34.21 (13)	7.89 (3)	39.47 (15)	7.89 (3)	0.00 (0)	10.53 (4)
Something	5.26 (2)	13.16 (5)	5.27 (2)	10.53 (4)	2.63 (1)	0.00 (0)	0.00 (0)
Quite	18.42 (7)	15.79 (6)	0.00 (0)	7.89 (3)	5.27 (2)	0.00 (0)	0.00 (0)
A Lot	0.00 (0)	7.89 (3)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Severity							
	Glare	**Halos**	**Starbursts**	**Blur Vision**	**Diplopia**	**Hazy Vision**	**Shadow Area**
None	50.00 (19)	26.32 (10)	84.21 (32)	42.11 (16)	86.85 (33)	100.00 (38)	89.48 (34)
A Bit	15.79 (6)	15.79 (6)	10.53 (4)	26.32 (10)	5.26 (2)	0.00 (0)	5.26 (2)
Mild	15.79 (6)	26.32 (10)	5.26 (2)	23.68 (9)	5.26 (2)	0.00 (0)	5.26 (2)
Moderate	18.42 (7)	31.57 (12)	0.00 (0)	7.89 (3)	2.63 (1)	0.00 (0)	0.00 (0)
Severe	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Frequency							
	Glare	**Halos**	**Starbursts**	**Blur Vision**	**Diplopia**	**Hazy Vision**	**Shadow Area**
Never	47.37 (18)	26.32 (10)	84.21 (32)	42.11 (16)	86.85 (33)	100.00 (38)	89.48 (34)
Rarely	10.53 (4)	15.79 (6)	13.16 (5)	23.68 (9)	5.26 (2)	0.00 (0)	5.26 (2)
Sometimes	28.95 (11)	26.32 (10)	2.63 (1)	28.95 (11)	5.26 (2)	0.00 (0)	5.26 (2)
Most of the time	7.89 (3)	15.79 (6)	0.00 (0)	5.26 (2)	2.63 (1)	0.00 (0)	0.00 (0)
Always	5.26 (2)	15.79 (6)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)

Note: Results are expressed in % (n patients).

The IOLSAT questionnaire is divided into four sections: Section 1 assesses how frequently the wearer is required to use glasses under various lighting and distance conditions; Section 2 assesses how well the wearer can see without using glasses under various conditions; Section 3 asks what the wearer expected from their cataract surgery; and Section 4 asks about their satisfaction with their vision following cataract surgery. Table 5 presents the IOLSAT outcomes summary for

Table 5 IOLSAT Questionary Results at 6 Months Post-op

Condition		**Percentage of Subjects That "Never" or "Rarely" Needing Glasses**	**Percentage Reporting "Good" or "Very Good" Vision without Glasses**
Overall		78.94 (30)	–
General	**Distance ("Far Away")**	84.21 (32)	–
	Intermediate ("Arm's length")	89.47 (34)	–
	Near ("Up Close")	76.31 (29)	–

(*Continued*)

Table 5 (Continued).

Condition		Percentage of Subjects That "Never" or "Rarely" Needing Glasses	Percentage Reporting "Good" or "Very Good" Vision without Glasses
Bright Light	**Distance ("Far Away")**	84.21 (32)	92.10 (35)
	Intermediate ("Arm's length")	94.73 (36)	97.36 (37)
	Near ("Up Close")	94.73 (36)	92.10 (35)
Dim Light	**Distance ("Far Away")**	81.57 (31)	92.10 (35)
	Intermediate ("Arm's length")	89.47 (34)	89.47 (34)
	Near ("Up Close")	71.05 (27)	71.05 (27)

Note: Results are expressed in % (n patients).

Sections 1 and 2. In section 3, in response to question "How often did you think you would need near (question 18), intermediate (question 19) or far (question 20) glasses after your cataract surgery?", the percentage of subjects that "Never or Rarely Needing Glasses" were 92.10% (35 patients) for the three distances. In Section 4, the question "What has been the degree of satisfaction with your vision after cataract surgery?" 36 patients, or 94.73% of the total, responded "Satisfied or Very Satisfied".

Discussion

PanOptix® design was the first quadrifocal diffractive C-loop 1-piece IOL introduced in clinical practice, although one of its diffractive steps has been eliminated and it works as a trifocal lens. This intraocular lens was first developed using AcrySof® (TFNT). IOLs based on AcrySof® material may cause glistening or surface scattering.[22,23] Recently, the manufacturer released a new material Clareon® that can increase the clarity of the IOL.[24] In the material composed of the previous phenylethyl acrylate-phenylethyl methacrylate copolymer, PEMA was replaced with 2-HEMA, a hydrophilic polymer[17] and the water content and the clarity were increased and solves long-term problems, such as glistening and surface haze.[18,19,25]

To our knowledge, only one previous study has retrospectively evaluated CNWT for up to 2-months postoperatively.[26] However, our prospective study with 6-months of follow-up focused more on the refractive, functional, and patient satisfaction evaluations of this new intraocular lens. Owing to the various patient characteristics and methods used to measure visual acuity, comparisons with other studies describing the visual outcomes of trifocal IOLs are challenging. Therefore, we reported visual acuity and refractive outcomes monocularly (right eye when both were eligible), and defocus curve and contrast sensitivity binocularly. Thus, at 1-month post-op the monocular UCDVA, UCIVA and UCNVA was 0.07±0.10, 0.01±0.17, and 0.13±0.12 LogMAR, respectively, visual outcomes were similar than those reported by Lee at al. in far distance with CNWT[26] and better than García-Perez et al with TFNT[27] at intermediate and near distances (0.20±0.18 and 0.08±0.11 LogMAR) at 1-month post-op and agrees with previous studies.[28,29] In terms of vision stability, both the uncorrected and distance-corrected VA in our study were generally stable over the follow-up period monocularly (Table 2), similar to previous study.[30]

Our study has demonstrated excellent refractive stability and postoperative refractive refraction outcomes at 6 months follow-up. We achieved 100% of the eyes were within ±0.50D and ±1.00D in post-op SE during all follow-up, better than Chang et al who obtained 77% and 98% of the eyes within ±0.50D and ±1.00D.[31] Also, our sphere (0.11±0.26 D vs 0.14 ±0.28 D) and SE (−0.08±0.27 D vs −0.05±0.24 D) were similar compared with Lee et al[26] and considered clinically stable over the follow-up period (1 month vs 6 month, $p>0.05$) as has been shown in the previous studies when TFNT IOL was analyzed.[32–34]

Multifocal IOLs have more than one focal point to provide vision over a variety of distances, reducing the frequency of spectacle dependence and offering a wide field of vision, from close to intermediate to far distances.[35] Defocus curves

are frequently tested binocularly in order to simulate real-world conditions and shows the performance of the IOLs through different distances. Taking this into account, our binocular defocus curve exhibits a maximum VA (−0.04±0.08 LogMar) peak at 0 D, corresponding to far vision. For intermediate (−1.50 D) and near (−2.50 D) vision CNWT showed a good VA (0.01±0.10 LogMAR and 0.03±0.07 LogMAR, respectively). The binocular defocus curve in our study did not differ from the previously published TFNT and CNWT defocus curves.[26,31,35] With the increased use of mobile devices and computers in daily life, patient demand for functional intermediate vision has increased. In this sense, the CNWT in our study has a very broad intermediate and near range of vision (0.01±0.10 LogMAR and 0.03±0.07 LogMAR, respectively) with VA values close to 0 LogMAR which allows a good vision at these distances.

To assess the effect of the IOL more accurately in a scenario that is more representative of daily life and to make comparisons with earlier studies using other IOLs more easily, we measured the contrast sensitivity binocularly. Another point to keep in mind is that contrast sensitivity attenuation at high spatial frequencies, which causes more light dispersion at numerous focus positions, could be a disadvantage of diffractive IOLs.[33,36] This profile it can be seen at 12 and 18 cpg (−1.68 ±0.32 Log and −1.30±0.34 Log, respectively) and these results are similar to those published by Lee et al.[26]

Patients frequently express dissatisfaction with multifocal IOLs due to visual disturbances, which sometimes leads to the explanation of these devices sometimes.[37] Therefore, it is crucial to consider the patients' perspective on how bothered they are by the presence of such photic phenomena when estimating the prevalence of visual disturbances. CNWT IOL has demonstrated low rates of optical disturbances with QUVID and good patient satisfaction with the IOLSAT questionnaire. Only 13.15% of patients reported suffering from diplopia, most of them "Rarely" or "Sometimes" frequency. Only one patient (2.63%) reported having diplopia "Most of the time" but in overall, 86.85% of the patients "Never" had diplopia, 100% had no problems with hazy vision, and 89.48% had shadow areas on the QUVID questionnaire. Only the 13.15% of the patients (the sum of 7.89% and 5.26%) had glare symptoms "Most of the time" and "Always" in frequency section and the 18.42% patients had "Moderate" symptoms in severity section. Furthermore, when we consider the Clareon® material and its transparency benefits over its predecessor,[25] the QUVID test showed that no patient experienced hazy vision symptoms, which might validate the benefits of the Clareon® material. IOLSAT questionary showed a high percentage satisfaction outcome, in overall the 78.94% of patients "Never" or "Rarely" need glasses as well as at "Far Away" (84.21%) and "Arm's Length" (89.47%) distances. In bright light conditions from 92.10% up to 97.36% of patients stated have "Good" or "Very Good" vision without glasses in "Far Away", "Arm's Length" and near "Up Close" distances. These IOLSAT outcomes validate the PanOptix® platform's strong performance in terms of independence from glasses at any distance, regardless of the material.

However, our study had some limitations. One of these was the 6-months follow-up period. We understand that such monitoring may be sufficient to evaluate the results and refractive stability but insufficient when it comes to assessing the quality of the material and the absence of phenomena such as glistening or the incidence of capsular opacity. In the aforementioned 6 months follow-up, all lenses remained transparent, and we did not observe cases of PCO that required YAG capsulotomy. It is highly recommended to study these parameters in the long term, and more in-depth studies are needed in relation to the transmittance in an optical bench between the AcrySof® and Clareon® materials to demonstrate the high transparency of Clareon® and its possible benefits. Another limitation of the study is that we used a high-precision device to measure CSF and not-so-common patient satisfaction questionnaires. This means that by not using a "gold-standard" device or questionnaires, it may be more challenging to compare with future studies and draw more robust conclusions. Even so, the CSF and patient questionnaires employed in this study are validated for being used.

Conclusion

CNWT is a new presbyopia-correction IOL that can be expected to provide excellent refractive results and stability at the 6-months follow-up that we analyzed. It showed improved contrast sensitivity compared to the previous TFNT IOL. The quality of vision and life questions showed a high percentage of satisfaction outcomes, and no significant inconvenience/discomfort related to visual disturbances. In the 6-months follow-up, all lenses remained transparent, and we did not observe cases of capsular opacification or glistening.

Acknowledgments

The authors would like to thank Maider Arratibel Alkorta, Alazne Gainza Uranga, and Ane García Torre, optometrists at Miranza Begitek, for their assistance in measuring and collecting the variables for this study.

Funding

This study was partially supported by an Alcon grant (IIT No. 69445597). The results of the study and the revision of the manuscript were conducted independently of any influence from Alcon. Moreover, none of the authors have received payments from Alcon for this study.

Disclosure

Javier Mendicute is a consultant for Alcon, and an external researcher for Bausch and Lomb, Santem, Hoya, and Medicontur. The remaining authors have nothing to declare.

The authors have no financial or proprietary interests in the medical field or products involved in this manuscript.

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