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ORIGINAL RESEARCH

Early Clinical Outcomes After the Mix-and-Match Approach of Trifocal and Non-Diffractive EDOF IOL

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Purpose: To evaluate early postoperative visual performance following cataract surgery using the mix-and-match approach with Clareon PanOptix diffractive trifocal and Clareon Vivity non-diffractive extended depth of focus (EDOF) intraocular lenses (IOLs).

Patients and Methods: This single-center, retrospective study was conducted between April 2024 and April 2025 and included 27 patients (54 eyes). Each patient underwent bilateral cataract surgery with implantation of a PanOptix IOL in one eye and a Vivity IOL in the fellow eye. Postoperative outcomes were evaluated for up to 1 month after surgery of the second eye. Monocular (PanOptix and Vivity) and binocular (mix-and-match, M-M) uncorrected visual acuity (UCVA) from 5 m to 30 cm, defocus curves (+2.0 D to −4.0 D), mesopic contrast sensitivity with and without glare, and subjective evaluation of photic phenomena (halo) using the ViSU-L Halo & Glare Simulator were assessed.

Results: In the M-M group, 73% of patients achieved UCVA of ≤ 0.1 logarithm of the minimum angle of resolution (logMAR) across all distances (5 m to 30 cm). Binocular defocus curves showed visual acuity of ≤ 0.1 logMAR from 0 D to −3.0 D. Area under the log contrast sensitivity functions with or without glare was significantly higher in the M-M group compared to both monocular groups (all $P < 0.05$). The percentage of patients reporting no halo was highest in the Vivity group (77.8%), followed by the M-M (55.6%) and PanOptix groups (40.7%), and the M-M group showed a significantly higher rate than the PanOptix group ($P = 0.0455$).

Conclusion: Although limited by a short follow-up duration, the combination of PanOptix and Vivity IOL provided a favorable balance between visual acuity, contrast sensitivity, and photic phenomena. Our findings suggest that this mix-and-match approach may serve as a viable option for enhancing visual quality beginning in the early postoperative period.

Keywords: mix-and-match approach, clareon PanOptix, clareon vivity, contrast sensitivity, visual acuity

Introduction

Conventional monofocal intraocular lenses (IOLs) provide only one focal point, requiring many patients to wear spectacles after cataract surgery.[1] Recently, multifocal IOL development has improved post-surgery vision quality, providing good uncorrected visual acuity (UCVA) for various distances and high spectacle independence.[2] However, diffractive IOLs widely used in multifocal IOLs cause halos and glare due to light scattering from optical diffractive structure, and reduced contrast sensitivity, decreasing patients' night visual acuity.[3–5] These drawbacks particularly affect patients who drive at night or perform precise tasks in low light.[6–8]

The "mix-and-match approach" reduces visual disturbance and contrast sensitivity loss while maintaining vision range. This technique improves postoperative vision by utilizing different IOLs' characteristics in each eye while compensating for their shortcomings. Studies report results of combining similar-design IOLs with different add powers or combining different designs, such as monofocal and extended depth of focus (EDOF) IOL, EDOF, and multifocal IOL.[9–14] EDOF and trifocal IOL combinations show promising results in balancing visual range and minimizing photic phenomena.[10,11,14–16] These reports indicate that visual disturbances are suppressed through binocular summation while maintaining good visual acuity.

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The Clareon PanOptix diffractive trifocal (PanOptix, Alcon Vision LLC, Fort Worth, TX, USA) IOL uses ENLIGHTEN Optical technology to optimize intermediate vision without compromising near and distance vision. Studies show excellent vision at far, intermediate (60 cm), and near (40 cm) levels, with high spectacle independence and patient satisfaction.[2,17] Recent results show that the contrast sensitivity of the Clareon-material PanOptix exceeds that of the AcrySof-material IOL.[18,19] However, due to its optical design, dysphotopsia, such as halo and glare, remains a challenge. The diffractive design employed in this lens relies on concentric steps (diffractive rings) on the lens surface to physically distribute incoming light to multiple specific focal points. While this approach can generate highly sharp uncorrected near visual acuity at the designated focal peaks, light allocated to the out-of-focus focal peaks simultaneously creates blur or light scattering on the retina. This is the primary cause of halos, glare, and a slight reduction in contrast sensitivity, particularly at night or under mesopic conditions.

Clareon Vivity (Vivity, Alcon Vision LLC) IOL is the first non-diffractive EDOF IOL achieving an extended focal range with a visual disturbance profile similar to monofocal IOLs. Using X-WAVE technology, which features a slightly elevated (~1 μm) plateau and a small curvature change over the central 2.2-mm optical zone, it does not split light into multiple discrete focal points, thereby utilizing nearly 100% of the total light energy to generate a continuous, elongated focal range.[20] Studies show that the Vivity IOL delivers superior intermediate and functional but limited near vision, while maintaining comparable CDVA and visual disturbances to the SN60WF monofocal IOL.[21] By eliminating the overlapping of far and near images on the retina, this non-diffractive design effectively prevents halos, glare, and starbursts while preserving photopic and mesopic contrast sensitivity without the light energy loss inherent to diffractive optics.

Currently, few studies have shown the postoperative results of combining PanOptix trifocal and Vivity non-diffractive EDOF IOLs, and none have evaluated contrast sensitivity and sufficiently compared monocular and binocular outcomes in the same patients.[10,14] This study aimed to retrospectively evaluate the early postoperative monocular and binocular visual function and contrast sensitivity, which are directly linked to patients' early return to daily activities and satisfaction, in patients who underwent PanOptix and Vivity IOLs insertion using the mix-and-match method.

Materials and Methods

Design

This single-center, retrospective study was conducted between April 2024 and April 2025. Each patient underwent bilateral cataract surgery with implantation of a PanOptix IOL in one eye and a Vivity IOL in the fellow eye. Postoperative outcomes were evaluated for up to 1 month after surgery of the second eye. Eligible patients had bilateral cataracts and expressed a desire for postoperative spectacle independence. Eye dominance was determined preoperatively using the Miles test, and the Vivity IOL was implanted in the dominant eye and the PanOptix IOL in the non-dominant eye. However, if the dominant eye had astigmatism greater than 1.0 diopter (D), the PanOptix IOL was implanted in the dominant eye and the Vivity IOL in the non-dominant eye. Regarding astigmatism correction, only non-toric models were used for the Vivity IOL, whereas a toric model was selected for the PanOptix IOL when the preoperative corneal astigmatism was 0.75 D or greater, using the Clareon PanOptix toric IOL starting from the T2 model.

This study was approved by an external, independent ethics committee, the Tokushukai Group Central Ethics Committee (approval number: TGE02773-969) and was conducted in accordance with the ethical principles of the Declaration of Helsinki. Since this was a retrospective study, patient consent was obtained using an opt-out informed consent process.

The inclusion criteria were: patients ≥ 50 years with age-related cataracts, who underwent IOL implantation targeting emmetropia in both eyes, patients in whom both IOLs were properly implanted within the capsular bag, and patients with a postoperative CDVA of 0.15 logarithm of the minimum angle of resolution (logMAR) or better in both eyes. Additionally, when implanting the Vivity IOL, the preoperative astigmatism in the selected eye was required to be ≤1.0 D. The exclusion criteria included the presence of corneal abnormalities (eg, history of corneal transplantation, corneal opacity, or irregular astigmatism); pre-existing ocular diseases that could affect postoperative visual prognosis; history of refractive or intraocular surgery; and any condition deemed inappropriate by the attending physician.

Surgical Procedure

All surgeries were performed by a single experienced surgeon (AE.) using the standard small-incision phacoemulsification technique. Prior to surgery, the pupils were dilated, and a 2.0 mm conjunctival incision was made. A continuous curvilinear capsulorhexis was created, followed by removal of the crystalline lens using the CENTURION Vision System (Alcon Vision LLC, Fort Worth, TX, USA). During surgery, the VERION Image Guided System (Alcon Vision LLC, Fort Worth, TX, USA) was used to guide the incision location and IOL axis alignment. Additionally, the Optiwave Refractive Analysis System (ORA, Alcon Vision LLC, Fort Worth, TX, USA) was used to confirm the IOL power and toric axis in real time. The final IOL selection was based on a comprehensive assessment of preoperative calculations using the Barrett Universal II formula and the Barrett Toric Calculator, along with intraoperative measurements obtained via ORA. Bilateral surgeries were completed within a maximum interval of 2 weeks. Postoperatively, the patients received topical antibiotics and corticosteroids that were tapered over several weeks.

Outcome Measures

Postoperative outcomes were evaluated at 1 month and included the following endpoints: UCVA at 5 m, 3 m, 1 m, 60 cm, 40 cm, and 30 cm; refraction; defocus curves ranging from +2.0 D to −4.0 D; contrast sensitivity; and subjective evaluation of photic phenomena (halos) using the halo and glare simulation system. All endpoints were assessed binocularly (mix-and-match, M-M group) and monocularly (Vivity and PanOptix groups). For halo assessment, halo size, halo intensity, and the percentage of patients reporting "no halo" were also evaluated.

UCVA and Defocus Curve

1 month postoperatively, UCVA was measured using a decimal visual acuity chart at distances of 5 m, 3 m, 1 m, 60 cm, 40 cm, and 30 cm in the M-M, Vivity, and PanOptix groups, respectively. Defocus curves were evaluated under distance-corrected conditions by adding lenses at +2.0, +1.0, 0, −1.0, −1.5, −2.5, −3.0, and −4.0 D. All visual acuity data were converted to logMAR values for analysis.

Contrast Sensitivity

1 month postoperatively, contrast sensitivity was measured at 5 m under mesopic conditions in the M-M, Vivity, and PanOptix groups using a CGT-2000 device (Takagi Seiko Co., Ltd., Japan). The measurements were performed with and without glare illumination. The test included six spatial frequencies [0.64–6.3 degrees (deg)] and 14 contrast levels (0.0071–0.64 deg). The area under the log contrast sensitivity function (AULCSF) was calculated from these results.

ViSU-L Halo & Glare Simulator

Subjective evaluation of the halos was performed 1 month postoperatively using the ViSU-L Halo & Glare Simulator (ViSU-L GmbH, Hamburg, Germany). Patients were shown simulated images of halo appearance and were asked to rate the halo intensity and size on a scale of 0 to 100. The percentage of patients who reported no halo (both intensity and size rated 0) was also calculated.

Statistical Analysis

All statistical analyses were performed using JMP Statistical Software (SAS Institute Inc., Cary, NC, USA). Descriptive statistics were calculated for logMAR visual acuity, contrast sensitivity, halo size, and intensity obtained from the ViSU-L Halo & Glare Simulator, and the percentage of patients reporting no halo. Paired t-tests were used for comparisons between two groups. For comparisons among the three groups (monocular PanOptix, monocular Vivity, and binocular M-M), repeated-measures analysis of variance (ANOVA) was applied to properly account for the within-subject correlation within the same patients. The Bonferroni correction was used for multiple comparisons. McNemar's test was used to compare proportions between two groups, and Cochran's Q test was used for comparisons among three groups. Statistical significance was defined as $P < 0.05$.

Results

Preoperative Characteristics

The preoperative characteristics are summarized in Table 1. A total of 27 patients (54 eyes) were enrolled in this study, each undergoing bilateral implantation of PanOptix and Vivity IOLs in the opposite eye. The mean age was 67.72 ± 8.21 years, and the cohort included 5 males and 22 females. In 24 eyes, the Vivity IOL was implanted in the dominant eye, whereas in the remaining three eyes, the PanOptix IOL was implanted in the dominant eye.

The types of IOLs used were as follows: in the Vivity group, 27 eyes received non-toric lenses; in the PanOptix group, 21 eyes received non-toric lenses; toric lenses were used in six eyes (T2: one eye, T3: two eyes, T4: two eyes, T5: one eye). At 1 month postoperatively, the mean subjective refractive spherical equivalent was −0.26 ± 0.52 D in the Vivity group and −0.25 ± 0.35 D in the PanOptix group (P = 0.8484). The mean residual cylinder was −0.31 ± 0.41 D in the Vivity group and −0.23 ± 0.35 D in the PanOptix group. There was no significant difference (P = 0.2901).

Visual Acuity

The M-M group demonstrated better UCVA across all distances than the Vivity and PanOptix groups (Table 2). Furthermore, in the M-M group, 73% of patients achieved UCVA of 0.1 logMAR or better, and 88% achieved 0.2 logMAR or better across all distances from 5 m to 30 cm.

Table 1 Patient Demographics

Demographics			
Patients (eyes)	27 (54)		
Age (years) (mean ± SD)	67.72 ± 8.21		
Sex (female/male)	22/5		
IOL implanted in the dominant eye (eyes)	Vivity 24/PanOptix 3		
Types of IOL used (IOLs: eyes)	Vivity non-toric: 27 PanOptix non-toric: 21 PanOptix toric T2: 1, T3: 2, T4: 2, T5: 1		
Parameters (mean ± SD)	**Vivity**	**PanOptix**	**P value**
Pupil size (mm)	3.66 ± 0.96	3.74 ± 0.95	0.2148
Axial length (mm)	24.11 ± 1.28	24.06 ± 1.22	0.2777
Preoperative DCVA (logMAR)	0.05 ± 0.13	0.04 ± 0.16	0.8456
Preoperative UCVA (logMAR)	0.48±0.42	0.45±0.43	0.4822
Preoperative SE (D)	−0.56±2.54	−0.74±2.68	0.4708
Preoperative cylinder (D)	−0.77±0.60	−0.82±0.63	0.7945

Abbreviations: IOL, intraocular lens; SD, standard deviation; SE, spherical equivalent; logMAR, logarithm of the minimum angle of resolution; D, diopter; DCVA, distance corrected visual acuity; UCVA, uncorrected visual acuity.

Table 2 Monocular and Binocular UCVA at 1 Month Postoperatively (Mean ± SD)

Measured Distance	**Binocular**	**Monocular**		**P value***	**P value****	**P value†**
	M-M Group	**PanOptix**	**Vivity**			
5 m	−0.07 ± 0.05	0.00 ± 0.09	−0.01 ± 0.10	0.0003	0.0012	1.0000
3 m	−0.05 ± 0.05	−0.01 ± 0.09	−0.02 ± 0.09	0.0204	0.1746	1.0000
1 m	0.00 ± 0.05	0.02 ± 0.08	0.02 ± 0.09	0.2646	0.3669	1.0000
60 cm	0.02 ± 0.06	0.05 ± 0.09	0.05 ± 0.06	0.0765	0.0051	1.0000
40 cm	0.03 ± 0.07	0.04 ± 0.07	0.21 ± 0.13	1.0000	0.0003	0.0003
30 cm	0.07 ± 0.08	0.08 ± 0.10	0.41 ± 0.18	0.7587	0.0003	0.0003

Notes: * Compared M-M with PanOptix. ** Compared M-M with Vivity. † Compared Vivity with PanOptix.
Abbreviations: UCVA, uncorrected visual acuity; SD, standard deviation; M-M, mix and match.

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At 1 month postoperatively, both the M-M group and the PanOptix group achieved UCVA of 0.1 logMAR or better at all measured distances (5 m to 30 cm). The M-M group showed significantly better visual acuity than the PanOptix group at 5 and 3 m (P = 0.0003 and P = 0.0204, respectively). In the Vivity group, UCVA of 0.1 logMAR or better was achieved from distance to intermediate ranges (5 m to 60 cm). However, compared with the M-M group, the visual acuity at 60, 40, and 30 cm was significantly lower (P = 0.0051, P = 0.0003, and P = 0.0003, respectively). Compared to the PanOptix group, the Vivity group also showed significantly lower visual acuity at 40 and 30 cm (P = 0.0003 for both).

Defocus Curve

Figure 1 shows the monocular and binocular distance-corrected defocus curves. In the M-M group, visual acuity consistently improved across all defocus steps. This group achieved visual acuity of 0.0 logMAR or better from 0 D to −2.5 D, and 0.1 logMAR or better from 0 D to −3.0 D.

Compared to the Vivity group, the M-M group demonstrated significantly better visual acuity across the range from 0 D to −4.0 D (P < 0.05). When compared to the PanOptix group, the M-M group showed significantly better acuity from +1.0 D to −1.5 D (P < 0.05). Additionally, the PanOptix group exhibited significantly better near vision than the Vivity group in the range from −2.5 D to −4.0 D (P < 0.001).

Contrast Sensitivity

Contrast sensitivity was evaluated under mesopic conditions, with and without glare, in the monocular and binocular groups. Monocular spatial frequency measurements were conducted in all 27 patients (Figure 2A and B). The Vivity and PanOptix groups demonstrated contrast sensitivity values within the normal range. Without glare, the Vivity group demonstrated a significantly higher contrast sensitivity at 0.64, 1.0, 1.6, 2.5, and 4.0 deg (P = 0.0091, P = 0.0126, P = 0.0090, P = 0.0001, and P = 0.0067, respectively). With glare, a significant difference was observed only at 1.6 deg, with the Vivity group outperforming the PanOptix group (P = 0.0186).

AULCSF was calculated for both monocular and binocular measurements. For the AULCSF analysis, binocular data were available for 14 patients. Due to the retrospective nature of this study, binocular records were missing for the remaining patients, and they were pairwise excluded from this specific analysis. Therefore, the comparative analysis among the three groups (Vivity, PanOptix, and M-M) was performed using this subset of 14 patients (Figure 3A and B). Under glare-off conditions, the AULCSF was 1.51 ± 0.13 in the Vivity group, 1.31 ± 0.11 in the PanOptix group, and 1.54 ± 0.16 in the M-M group. The M-M group demonstrated significantly higher contrast sensitivity than both

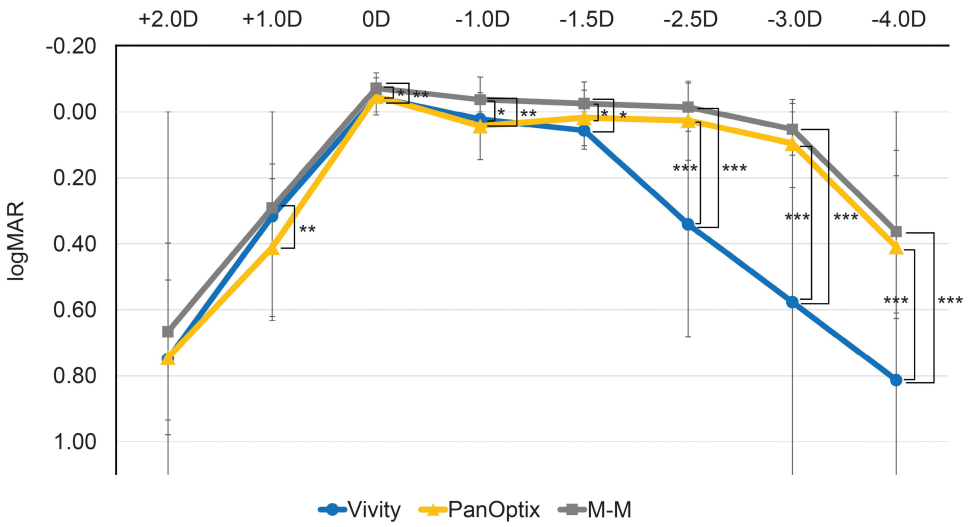

Figure 1 Monocular and binocular defocus curves from +2.0 D to −4.0 D (n = 27). Statistical comparisons were performed using repeated-measures ANOVA followed by Bonferroni post-hoc tests. *P < 0.05, **P < 0.01, ***P < 0.001.
Abbreviations: logMAR, logarithm of the minimum angle of resolution; D, diopter; M-M, mix and match.

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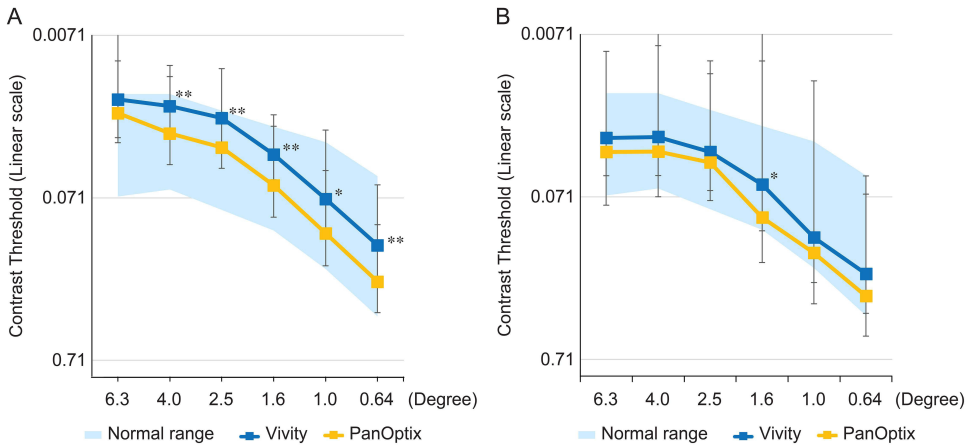

Figure 2 (**A**) Contrast sensitivity determined under mesopic conditions without glare (n = 27). Statistical comparisons were performed using the paired *t*-test. *P < 0.05, **P < 0.01. (**B**) Contrast sensitivity determined under mesopic conditions with glare (n = 27). Statistical comparisons were performed using the paired *t*-test. *P < 0.05.

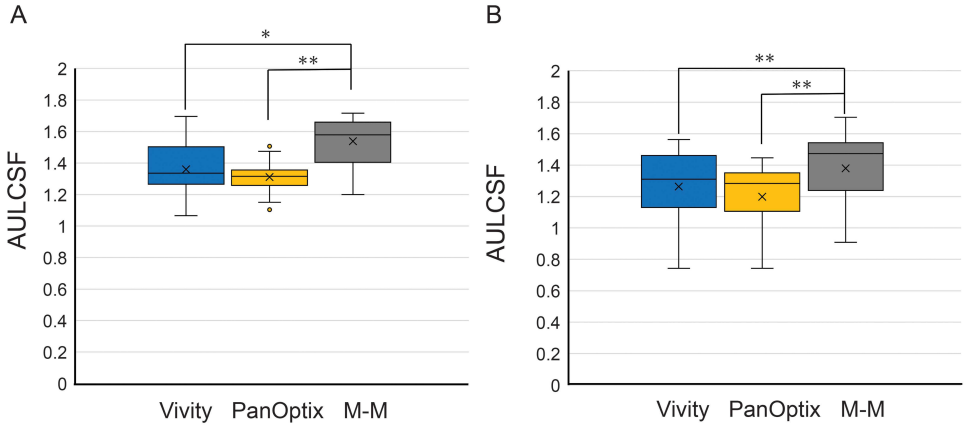

Figure 3 (**A**) AULCSF under mesopic conditions without glare (n = 14). Statistical comparisons were performed using repeated-measures ANOVA followed by Bonferroni post-hoc tests. *P < 0.05, **P < 0.01. (**B**) AULCSF under mesopic conditions with glare (n = 14). Statistical comparisons were performed using repeated-measures ANOVA followed by Bonferroni post-hoc tests. **P < 0.01. In the boxplots, the horizontal line inside each box represents the median, the cross represents the mean, and the small circles represent outliers.

Abbreviations: AULCSF, area under the log contrast sensitivity function; M-M, mix and match.

monocular groups (P = 0.0145 vs Vivity, P = 0.001 vs PanOptix). With glare, the AULCSF was 1.26 ± 0.26 in the Vivity group, 1.20 ± 0.21 in the PanOptix group, and 1.38 ± 0.23 in the M-M group. The M-M group also showed significantly higher contrast sensitivity under the glare-on condition than both monocular groups (P = 0.0047 vs Vivity, P = 0.0004 vs PanOptix).

Photic Phenomena (Halo)

Halo perception was assessed using the ViSU-L Halo & Glare Simulator under both monocular and binocular conditions. Average halo size and intensity in the Vivity group that reported the halo were 41.6 ± 20.0 and 46.0 ± 19.0, respectively. In the PanOptix group, these values were higher, at 50.9 ± 19.3 for size and 56.0 ± 21.0 for intensity. The M-M group showed an intermediate halo size of 43.5 ± 20.9 and an intensity of 56.5 ± 22.1. Furthermore, halo perception under binocular vision (M–M) was analyzed in 12 patients who reported no halos in the Vivity-implanted eye but reported halos in the PanOptix-implanted eye. As a result, four patients reported no halos, while eight patients reported "halos present". In the group that reported no halos, the mean halo size and intensity of PanOptix were 34.0 ± 22.6 and 50.0 ± 0.0, respectively. Contrastingly, in the group that reported halos, the mean halo size and intensity of PanOptix were 49.0 ± 14.1 and 62.4 ± 21.3, respectively.

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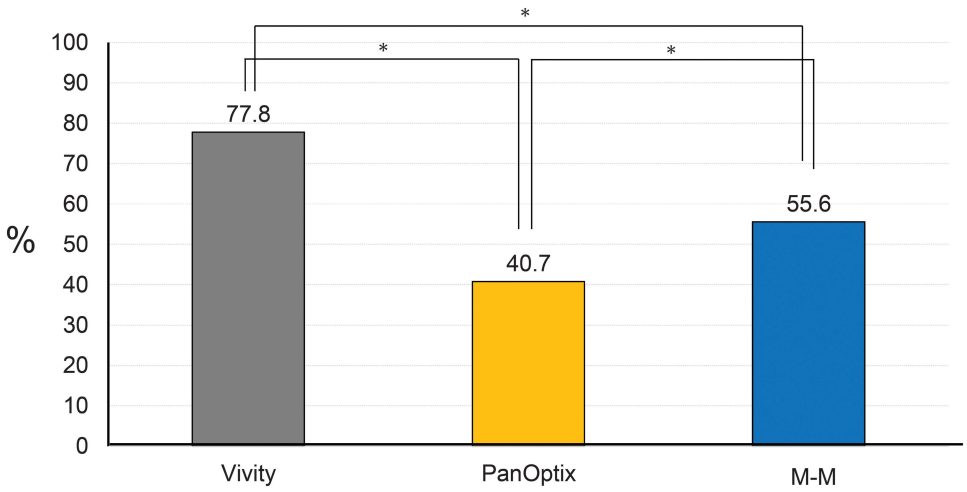

Figure 4 Percentage of patients who reported no halo (n =27). Proportions were compared using Cochran's Q test. *P < 0.05.
Abbreviation: M-M, mix and match.

The percentage of patients who reported no halo was highest in the Vivity group (77.8%) (Figure 4). In contrast, only 40.7% of patients in the PanOptix group reported no halos. The M-M group showed an intermediate result, with 55.6% of the patients reporting no halo. Statistically, the M-M group had a significantly lower rate of no halo compared to the Vivity group (P = 0.0339), but a significantly higher rate than the PanOptix group (P = 0.0455). Furthermore, the Vivity group demonstrated a significantly higher percentage of patients reporting no halo than the PanOptix group (P = 0.016).

Discussion

Previous reports on mix-and-match using Clareon PanOptix trifocal IOL and Vivity non-diffractive EDOF IOL are limited, particularly regarding contrast sensitivity data. This study addresses this gap by providing novel insights into the impact of binocular integration through intra-individual comparison of two different optical designs. We evaluated early postoperative visual function 1 month after surgery in patients who received PanOptix and Vivity IOL in opposite eyes, including UCVA across distances, defocus curves, contrast sensitivity, and halo perception. Our results showed that the M-M group demonstrated better visual range, defocus curves, and contrast sensitivity than monocular PanOptix and Vivity groups, with reduced halo perception.

Our findings align with previous reports on mix-and-match approaches. Zhou et al[14] demonstrated excellent binocular visual outcomes 3 months after implanting Clareon PanOptix and Vivity IOLs, showing good vision at all distances. Notably, 90% of patients achieved 20/25 or better at near distance (40 cm). Similarly, Labiris et al[10] reported favorable results with the same IOL combination, noting better near visual acuity at 40 cm in the mix-and-match group versus the bilateral PanOptix group. Although near visual acuities at 40 and 30 cm in the Vivity IOL group were significantly reduced compared to the PanOptix group in the current study, binocular visual acuity with the mix-and-match approach compensated for the Vivity IOL's near vision weakness, resulting in near vision comparable to the PanOptix group. This demonstrates the merit of combining PanOptix trifocal and Vivity EDOF IOL.

In terms of defocus curves, previous studies showed that combining PanOptix and Vivity IOLs provides a wide, smooth visual acuity distribution, maintaining 0.1 logMAR or better from 0 D to −3.0 D.[10] Similarly, our defocus curves showed consistent improvement across all defocus steps, likely due to binocular summation.

The monocular Vivity group showed significantly higher contrast sensitivity than the monocular PanOptix group under both glare-off and glare-on conditions. This finding is consistent with the report by Yeo et al, which demonstrated that patients bilaterally implanted with AcrySof PanOptix or Vivity also exhibited superior contrast sensitivity with bilateral Vivity under both photopic and mesopic conditions[22] Observing the same trend in both intraindividual and interindividual comparisons suggests that Vivity IOL's advantage in contrast sensitivity is robust across different study designs Furthermore, the AULCSF was significantly higher in the M-M group than in

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the monocular groups. This improvement is largely attributable to the contribution of the non-diffractive optical design of Vivity, which minimizes light scattering and energy dispersion during binocular summation.[6,21]

Photic phenomena are among the most significant side effects associated with multifocal IOLs, and they can greatly impact postoperative patient satisfaction.[3–5] Based on our results, the halo intensity and size in eyes that reported halos tended to be lowest in the Vivity group. Halo intensity was similar between the PanOptix and M-M groups, whereas the halo size was smaller in the M-M group than in the PanOptix group. Furthermore, the percentage of patients who reported no halo was significantly higher in the M-M group than in the PanOptix group, indicating a reduction in halo perception. Similar trends have been documented in patient questionnaires in a previous study. For example, a patient questionnaire conducted after mix-and-match approach of Clareon PanOptix and Vivity IOLs reported that 58–64% of patients were "not bothered at all" by visual disturbances like halos, glare, and starbursts, and only a few patients were "bothered very much" by them (0–4%).[14]

Although the precise mechanism remains to be fully elucidated, one possible hypothesis is that the reduction in photic phenomena and improved contrast sensitivity under binocular vision might be partially attributed to a competitive mechanism similar to binocular rivalry, a phenomenon in which conflicting images presented to each eye alternate in perceptual dominance.[23–26] It could be speculated that the image from the Vivity eye, which provides higher contrast and fewer photic phenomena, might become perceptually dominant, thereby suppressing the visual artifacts from the PanOptix IOL. However, in our study, among the 12 patients with halos in the PanOptix eye but not in the Vivity eye, the eight who reported halos binocularly had larger halo size and intensity, and these were not completely suppressed. Additionally, one of the eight patients with high halo intensity requested an IOL exchange from PanOptix to Vivity IOL after the study duration. This also suggests that when halos are severe, neural adaptation and binocular integration may not reduce the symptoms to a tolerable level.

This study had several limitations, including its retrospective design, small sample size, and the absence of bilateral control groups. Additionally, although the Clareon IOL platform demonstrates excellent refractive stability as early as 1 month postoperatively,[27,28] this limited sample size and short follow-up period serve as limiting factors in detecting longer-term outcomes, and thus may not fully capture the complete process of neural adaptation. Therefore, caution should be exercised when interpreting the robustness and generalizability of these findings. Future prospective studies with longer follow-up periods and appropriate control groups are warranted to verify the long-term superiority of this mix-and-match approach.

Conclusion

The mix-and-match approach using the Clareon PanOptix and Clareon Vivity IOLs provided a favorable balance in binocular visual acuity from far to near distances in this short-term observation. By combining complementary optical designs, this strategy contributed to mitigating photic phenomena and yielding favorable contrast sensitivity. These findings suggest that this approach may serve as a viable option for providing a favorable balance between range of vision and visual quality beginning in the early postoperative period. However, these findings represent early outcomes, and further validation in larger, prospective studies is warranted to confirm these preliminary results.

Abbreviations

ANOVA, analysis of variance; AULCSF, area under the log contrast sensitivity function; CDVA, corrected distance visual acuity; D, diopters; DCVA, distance corrected visual acuity; deg, degree; EDOF, extended depth of focus; IOL, intraocular lens; logMAR, logarithm of the minimum angle of resolution; M-M, mix-and-match; SD, standard deviation; SE, spherical equivalent; UCVA, uncorrected visual acuity.

Data Sharing Statement

Data supporting the findings of this study are available from the corresponding author, A.E., upon reasonable request.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

Dr. A.E. has received lecture fees from HOYA Corporation, Alcon Vision LLC, Kowa Company, Ltd., Santen Pharmaceutical Co., Ltd., and Senju Pharmaceutical Co., Ltd. However, these lecture fees are not related to the present study. The other authors declare no conflicts of interest.

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