· Clinical Research ·

A comparative study of extended depth of focus, bifocal intraocular lenses and their mix-and-match

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Abstract

● **AIM:** To compare the visual performances of extended depth of focus (EDOF) lenses, diffractive bifocal intraocular lenses (IOLs) and their combination.

● **METHODS:** This was a prospective, consecutive observational comparative study performed from Dec 2020 to Dec 2021. Cataract patients who meet the indications for multifocal IOLs implantation were divided into three groups, including binocular diffractive bifocal IOL (Human Optics Diff-aAY) implantation group, binocular EDOF IOL (Tecnis Symfony ZXR00) group and mix-and-match group (Symfony in one eye and Diff-aAY in the other). Follow-ups were scheduled at 1d, 3d, 2wk, and 6mo. Visual acuities (VA) at different distances were examined at every follow-up. At 6mo, optic path difference (OPD) scans, and questionnaire answers were evaluated.

● **RESULTS:** Thirty patients (60 eyes) were included in the binocular Diff-aAY group [age 63 (59-68), 11 males], 29 patients (58 eyes) in the binocular Symfony group [age 62 (56.75-68), 15 males] and 27 patients in mix-and-match group [age 65 (51-71), 11 males]. There was no significant difference in binocular uncorrected distance VA, uncorrected intermediate VA, or uncorrected near VA among the three groups (P=0.082, 0.151, and 0.703, respectively) at the last follow-up. The mix-and-match group had a superior Strehl ratio (SR; P=0.025) and modulation transfer function (MTF; P<0.05) and an inferior root mean square (RMS; P<0.05) in OPD scan. The three groups reported comparable level of postoperative satisfaction (P=0.141) and spectacle independence (P=0.278). Mild subjective dysphotopsia was more common (22.22%) in mix-and-match group (P=0.030).

● **CONCLUSION:** Bilateral Symfony, bilateral Diff-aAY, and the combination of these two IOLs are all remarkable regarding all range vision, objective visual quality, and spectacle independence.

● **KEYWORDS:** diffractive bifocal; extended depth-of-focus; intraocular lenses; mix-and-match; visual performance

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INTRODUCTION

The extended depth-of-focus (EDOF) intraocular lens (IOL) is an emerging technology that is designed to improve range of vision, especially at intermediate distances[1]. A recent bibliometric analysis of 1801 IOLs studies over 20y further confirmed that EDOF IOLs, together with trifocal and Toric IOLs, have become the core research hotspots in the field—owing to their ability to provide continuous visual range and reduce photic disturbances compared with traditional multifocal IOLs (MIOL)[2]. Bilateral EDOF IOL implantation has been shown to provide excellent distance and intermediate visual acuities (VA) but has some limitations for near vision[3-4]. The Diffractiva-aAY (Diff-aAY, HumanOptics AG, Germany) MIOL is an aspheric bifocal IOL with a +3.50 D addition power and can provide good vison at near and far distances[5-6]. Theoretically, the two IOLs can cover their own weaknesses. With the need for vision at all distances, there have been modifications in implantation techniques such as implantation with monovision and mix-and-match implantation[7-11]. This study aims to evaluate visual outcomes and patient satisfaction after the implantation of bilateral Symfony, bilateral Diff-aAY or mix-and-match lenses.

PARTICIPANTS AND METHODS

Ethical Approval The study was approved by the Ethics Committee of Eye and ENT Hospital of Fudan University

Table 1 Optical features of the bifocal (Diff-aAY) and EDOF (Symfony) IOLs

Parameters	Diff-aAY	Tecnis Symfony
Design	One-piece biconvex	One-piece biconvex
Addition, D	+3.5	+1.75
Overall diameter, mm	12.5	13.0
Optical diameter, mm	6.0	6.0
Optical design	Central 3.5-mm diffractive zone and an outer refractive zone (the first 3 steps are of the same height and a gradual decrease in the 6 remaining step heights)	Echelette design
Refractive index	1.46	1.47
Spherical aberration, μm	0	-0.27
Range	+10.0 to +30.0 D in 0.5 D steps	+5.0 to +34.0 D in 0.5 D steps
Material	Hydrophilic acrylic	Hydrophobicity acrylic
Edge design	360° sharp square	360° sharp square

EDOF: Extended depth of focus; IOLs: Intraocular lenses; D: Diopter.

(No.2022133). All research was conducted in accordance with the Declaration of Helsinki. Informed consent was obtained from all individual participants included in the study.

Study Design and Participants This prospective, comparative study included patients who underwent cataract surgery in both eyes between December 2020 and December 2021. The inclusion criteria for MIOL implantation were bilateral cataracts, corneal astigmatism lower than 1.50 D and strong desire for spectacle independence. The exclusion criteria were retinal abnormalities, amblyopia, glaucoma, previous intraocular surgery, pupillary abnormalities and dysfunction, corneal astigmatism higher than 1.50 D, and axial length (AL) shorter than 20 mm or longer than 27.0 mm. Patients who refused to participate in follow-up examinations were also excluded.

The choices of first eye's IOL were made referring to patients' lifestyle, working habits, and visual demands. Patients who had definite requirement on intermediate vision [such as television (TV) watching, computer working, and household duties] were implanted with Symfony, while those who required definite near vision (such as reading, writing, and using smartphones) were implanted with Diff-aAY. Patients with needs of both intermediate and near vision had a combined implantation of Symfony and Diff-aAY. The first-eye's postoperative feedbacks were also taken into consideration when choosing IOL for the fellow eye. Therefore, three groups of patients were formed, including the Binocular Diff-aAY (Bi-Diff-aAY) group, the Binocular Symfony (Bi-Symfony) group and the mix-and-match Symfony with Diff-aAY group. This non-randomized approach reflects real-world practice, where personalized IOL selection is prioritized to optimize patient-centred outcomes. Baseline characteristics were rigorously compared across groups to minimize selection bias.

The main features and parameters of the two IOLs were presented in Table 1. It is explained here that due to the access restrictions of hospital on different types of IOLs, we had to choose two different brands of IOLs to mix.

Surgical Approach All surgeries were performed by the same experienced surgeon (Luo Y) under the assistance of a real-time intraoperative navigation system (Callisto Eye or Verion system). The diameter of manual continuous curvilinear capsulorhexis was 5.5 mm, and the centre of the IOL was positioned according to the centre of the limbus. For all enrolled patients, a main 2.2 mm clear cornea incision, phacoemulsification and IOL implantation were performed. Simultaneous femtosecond laser-assisted cataract surgeries with arcuate keratotomy (AK) were performed on patients with the need for astigmatic correction. Specifically, 12 patients (24 eyes) underwent AK for astigmatism correction. The criteria for AK were: 1) preoperative corneal astigmatism ≥0.75 D (measured by IOL Master 700); 2) patient preference for minimizing residual astigmatism; 3) no contraindications for laser keratotomy. AK was planned using the intraoperative navigation system to target a residual astigmatism of ≤0.50 D.

IOL Master 700 (Carl Zeiss Meditec AG, Jena, Germany) biometry was optimized for IOL power calculations. The Barret Universal II formula was used to calculate IOL power for all patients, as it is validated across a broad range of AL and minimizes refractive prediction error. Target refraction was set as emmetropia for Diff-aAY, while micromonovision was applied for Symfony (dominant eye: -0.25 D; fellow eye: -0.5 D).

Patient Follow-up and Outcomes All patients underwent ophthalmologic examinations at 1, 3d, and 2wk after surgery to confirm the healing process and determine the surgical plan for the second eye. Approximately 6mo after the binocular surgeries, the monocular and binocular uncorrected distance visual acuity (UDVA), uncorrected intermediate visual acuity (UIVA; 80 cm), and uncorrected near visual acuity (UNVA, 40 cm) were measured with Early Treatment of Diabetic Retinopathy Study (ETDRS) charts under photopic conditions.

At the last follow-up, the binocular defocus curve was measured at defocus levels from +2.00 to -5.00 D in 0.50 D increments using ETDRS charts on synthetical optometry.

The optic path difference (OPD) Scan III aberrometer (Nidek, Japan) provided objective optical quality data, including the modulation transfer function (MTF), root mean square (RMS), and point spread function (PSF). A metric for the MTF was provided as the area ratio value, that is, the ratio of the area under the MTF curve of the actual eye and the area under the curve of a perfect optical system. The MTF derived from OPD scans quantifies the optical system's ability to preserve contrast at different spatial frequencies, serving as an objective indicator of potential contrast-related performance. Similarly, RMS values reflect total optical aberrations, where lower RMS indicates reduced light scattering and better preservation of contrast. Together, these metrics provide indirect insights into contrast sensitivity (CS), a key aspect of visual quality for MIOL. The PSF was analysed using the Strehl ratio (SR) value, which is defined as the ratio of the peak of the ocular optical system's image intensity from a light-point source compared to the maximum attainable intensity for an ideal optical system. All the above-mentioned measurements were reported at 4-mm pupil diameters.

The objective visual quality outcomes were evaluated by a questionnaire including spectacle independence, dysphotopsia (such as glare and halo) and overall satisfaction, *etc*. Based on the VF-14 Visual Function Related Quality of Life Scale[12] and the visual characteristics after MIOL surgery, questionnaire was simplified including questions such as: 1) whether walking or driving, looking at road signs or signs are clear, and whether glasses are needed; 2) Is it clear to watch TV or movies, and do you need to wear glasses; 3) Is it clear to look at mobile phones and reading newspapers, and is it necessary to wear glasses; Answer options: a) Very clear, no need to wear glasses; b) Clear, occasionally wearing glasses; c) Fair, often wearing glasses; d) Blurred, non-removable mirror. 4) Do you feel glare or halo under natural light; 5) Do you feel glare or halo at night. Answer options: a) I don't feel anything at all; b) I have a slight feeling and can accept it; c) Obvious feeling, sometimes distressed; d) Great interference, very distressing. 6) Score the overall satisfaction with postoperative visual quality. a) Very satisfied; b) Satisfied; c) Generally; d) Very dissatisfied. Patients with different types of IOL implantation in both eyes are required to complete two survey questionnaires with eye types indicated. The collected questionnaire results were quantified and statistically analysed.

Statistical Analysis Our sample size calculation indicated that to detect a difference in binocular VA of 0.05 logMAR between groups, with a power of 80% and a 95% confidence interval (CI; α=0.050) and a standard deviation (SD) of 0.07 logMAR, a minimum of 25 patients per group was needed. The data were analysed by SPSS 20 software (IBM, USA). The quantitative values are reported as the mean and SD; the qualitative values were converted into percentages. Prior to analysis, the normality of continuous variables was assessed using the Shapiro-Wilk test. Variables meeting the assumption of normality (*e.g.*, MTF-Total) were analysed using one-way analysis of variance (ANOVA) for intergroup comparisons. Variables violating the normality assumption (*e.g.*, logMAR VA, RMS, and patient-reported outcomes) were analysed using nonparametric tests: Kruskal-Wallis for overall group differences, with pairwise comparisons performed using the Mann-Whitney *U* test with Bonferroni correction to adjust for multiple comparisons. Baseline characteristics, including AL, were compared across groups. Where relevant, AL was included as a covariate in adjusted analyses to account for potential confounding effects. All statistical tests were two-tailed, and *P* values less than 0.05 were statistically significant.

RESULTS

Patient Characteristics The study enrolled 172 eyes of 86 patients with bilateral cataract and corneal astigmatism under 1.5 D. AL was 23.59±0.87 mm, 24.39 (23.63-25.74) mm and 23.43 (22.99-24.27) mm in the Bi-Diff-aAY, Bi-Symfony, and mix-and-match (*P*<0.001) groups, respectively. There was no significant difference in preoperative UDVA, CDVA, simulated keratometry value, total corneal refractive power, and angle kappa (*P*>0.05; Table 2). There were no intraoperative or other complications. None of the IOLs had to be explanted.

Postoperative refractive outcomes were consistent with target refractions. The mean spherical equivalent (SE) at 6mo was -0.15±0.22 D in the Bi-Diff-aAY group, -0.32±0.25 D in the Bi-Symfony group, and -0.21±0.20 D in the mix-and-match group. The mean absolute error between achieved and target SE was 0.18±0.10 D across all groups, indicating precise refractive control.

Visual Acuity The binocular VA of the three study groups at 6mo after surgery were presented in Table 3. There was no significant difference in binocular UIVA, UNVA, or CDVA (*P*=0.082, 0.151, and 0.703, respectively). The cumulative postoperative binocular VA of the three study groups showed the Bi-Diff-aAY group had the best UNVA (47% *vs* 38%, 37%). The Bi-Symfony group had the best UDVA (90% *vs* 73%, 70%). Additionally, the mix-and-match group had the highest percentage of patients with a binocular UIVA better than 0.1 (74%) but ranked last in patients with a binocular UNVA better than 0.1 (37%). All patients in the three study groups had binocular VA better than 0.5.

Binocular Defocus Curves The binocular defocus curve of the Bi-Diff-aAY group had obvious double peaks of maximum VA, while the Symfony and mix-and-match groups had one flatter peak (Figure 1). The Bi-Diff-aAY group had the best distance VA (0 D), while the mix-and-match group was the best in the intermediate VA (-1.0 to -1.5 D). The two groups

Table 2 Preoperative characteristics of the three study groups mean±SD or median (IQR)

Parameters	Bi-Diff-aAY	Bi-Symfony	Mix-and-match	*P*	Mix-and-match group		
					Symfony eyes	Diff-aAY eyes	*P*
Patients, *n*	30	29	27	-	27	27	-
Eyes, *n*	60	58	54	-	27	27	-
Age, y	63.00 (59.00-68.00)	62.00 (56.75-68.00)	65.00 (51.00-71.00)	0.428	65.00 (51.00-71.00)	65.00 (51.00-71.00)	-
Sex (male/female)	11/19	15/14	11/16	-	11/16	11/16	-
UDVA	0.70 (0.52-1.00)	0.70 (0.52-1.00)	0.70 (0.49-1.02)	0.839	0.81±0.43	0.70 (0.52-1.00)	0.986
CDVA	0.52 (0.30-0.70)	0.52 (0.30-0.73)	0.52 (0.30-0.70)	0.627	0.52 (0.30-0.70)	0.40 (0.30-0.70)	0.541
AL, mm	23.59±0.87	24.39 (23.63-25.74)	23.43 (22.99-24.27)	<0.001	23.66±1.32	23.36 (22.97-24.26)	0.917
SimK, D	0.6 (0.3-0.8)	0.7 (0.4-1.2)	0.7±0.3	0.159	0.6±0.3	0.8±0.4	0.081
TCRP, D	0.6 (0.4-0.8)	0.7 (0.5-1.2)	0.7 (0.4-1.1)	0.111	0.7±0.4	0.8±0.4	0.196
Angle kappa, degree	0.19 (0.12-0.26)	0.19 (0.13-0.27)	0.21 (0.14-0.24)	0.921	0.21 (0.15-0.23)	0.22 (0.14-0.25)	0.952
Target refraction, D	-0.13±0.12	-0.31 (-0.43 to -0.22)	-0.20 (-0.27 to -0.10)	<0.001	-0.18 (-0.26 to -0.07)	-0.21±0.14	0.232
IOL power, D	20.5 (18.0-22.5)	20.5 (18.9-21.5)	20.3±3.3	0.815	20.0±3.2	20.5±3.5	0.349

Bi-Diff-aAY: Binocular Diff-aAY group; Bi-Symfony: Binocular Symfony group; Mix-and-match: Symfony mix with Diff-aAY group; UDVA: Uncorrected distance visual acuity; CDVA: Corrected distance visual acuity; AL: Axial length; SimK: Simulated keratometry value; TCRP: Total corneal refractive power; IOL: Intraocular lens; SD: Standard deviation; IQR: Interquartile range.

Table 3 Visual acuity of the three study groups at 6mo after surgery mean±SD or median (IQR)

Visual acuity	Bi-Diff-aAY	Bi-Symfony	Mix-and-match	*P*
Binocular UDVA	0.10 (0.00-0.21)	0.00 (0.00-0.10)	0.10 (0.00-0.22)	0.082
Binocular UIVA	0.13±0.12	0.10 (0.00-0.15)	0.10 (0.00-0.15)	0.151
Binocular UNVA	0.15 (0.10-0.23)	0.20 (0.10-0.22)	0.18±0.11	0.703

Bi-Diff-aAY: Binocular Diff-aAY group; Bi-Symfony: Binocular Symfony group; Mix-and-match: Symfony mix with Diff-aAY group; UDVA: Uncorrected distance visual acuity; UIVA: Uncorrected intermediate visual acuity; UNVA: Uncorrected near visual acuity; SD: Standard deviation; IQR: Interquartile range. *P* values were calculated using analysis of covariance with axial length as a covariate.

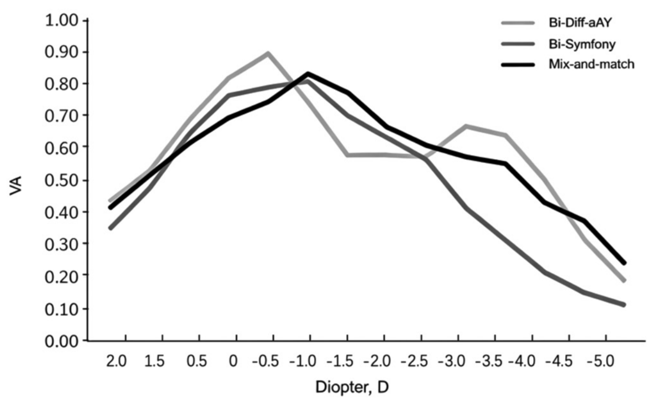

Figure 1 Comparison of binocular defocus curves among the three study groups at 6mo after surgery. Visual acuities (VA) were represented in decimal form. Bi-Diff-aAY: Binocular Diff-aAY group; Bi-Symfony: Binocular Symfony group; Mix-and-match: Symfony mix with Diff-aAY group.

performed similarly in the near VA (-2.5 D). The Bi-Symfony group had the worst vision at near distances. Overall, the mix-and-match of the two IOLs achieved satisfactory outcomes of VA at all distances.

Visual Qualities The postoperative visual qualities of the three study groups are presented in Table 4, it was showed the mix-and-match group had a superior SR (*P*=0.025) and higher-order MTF (MTF-HO; *P*=0.033) and an inferior RMS-Total (*P*=0.039) than the other two groups. The satisfaction rate was 96.66% in the Bi-Diff-aAY group, 93.10% in the Symfony group, and 92.59% in the mix-and-match group with no significant difference (*P*=0.141). The percentage of complete spectacle independence was 70.37% in the mix-and-match group, which was higher than that in the other two study groups (60.00% and 50.17%) but with no significant differences (*P*=0.278). However, 22.22% of patients in the mix-and-match group had mild dysphotopsia, such as glare and halo, after surgery, which was significantly higher than the other two groups.

DISCUSSION

Overall, the patients in this study achieved good visual effects. At six months postoperatively, binocular uncorrected VA was 0.00±0.05 for distance, 0.06±0.13 for intermediate, and 0.00±0.05 for near. Additionally, a total of 91.7% of patients were spectacle independent, and 92.59%-96.67% of patients reported very satisfied or satisfied, with a small subgroup (3.33%-7.41%) reporting neither satisfied nor dissatisfied and no patients reporting very dissatisfied. This confirms high but not universal satisfaction, with the minority neutral group potentially linked to mild dysphotopsia.

Table 4 Visual qualities at 6mo after surgery mean±SD or median (IQR)

Parameters	Bi-Diff-aAY	Bi-Symfony	Mix-and-match	*P*
SR	0.037±0.017	0.037 (0.027-0.044)	0.043 (0.035-0.051)	0.025
MTF-Total	34.1±6.2	32.8±6.5	40.0 (35.6-45.1)	0.091
MTF-HO	47.1 (42.2-51.5)	45.9 (42.3-48.7)	52.1 (47.3-57.6)	0.033
RMS-Total	0.701 (0.601-0.755)	0.766 (0.711-0.805)	0.527 (0.476-0.599)	0.039
RMS-HO	0.292 (0.241-0.346)	0.317 (0.292-0.432)	0.248 (0.217-0.284)	0.162
Overall satisfaction				0.141
Very satisfied	43.33%	58.62%	62.96%	
Satisfied	53.33%	34.48%	29.63%	
Neither satisfied nor dissatisfied	3.33%	6.90%	7.41%	
Dissatisfied	0	0	0	
Spectacle independence				0.278
Always	60.00%	55.17%	70.37%	
Most of time	33.33%	44.83%	22.22%	
Seldom	6.67%	0	7.41%	
Never	0	0	0	
Dysphotopsia				0.030
None	96.67%	96.55%	77.78%	
Mild	3.33%	3.45%	22.22%	
Moderate	0	0	0	
Severe	0	0	0	

Bi-Diff-aAY: Binocular Diff-aAY group; Bi-Symfony: Binocular Symfony group; Mix-and-match: Symfony mix with Diff-aAY group; SR: Strehl ratio; MTF-Total: Total modulation transfer function; MTF-HO: Higher-order modulation transfer function; RMS-Total: Total root mean square; RMS-HO: Higher-order root mean square; SD: Standard deviation; IQR: Interquartile range.

Mix-and-match implantation of diffractive MIOL with different additional power has already been reported to provide an excellent wide range of vision, as well as high levels of visual quality and patient satisfaction[13-14]. For example, a mix-and-match study found that the EDOF and trifocal IOLs group had the same postoperative visual quality and patient satisfaction outcomes as the EDOF only group, and better results in near VA were demonstrated in the mix-and-match group[15]. Therefore, this study mainly aimed to observe whether Diff-aA, which has good near vision, can compensate for Symfony's shortcomings in near range, and whether their mixed combination can achieve better full range vision and binocular visual quality.

There are few studies on Diff-aAY MIOL, but existing studies have confirmed its ability to provide good distance and near vision with only minimal visual disturbances at night[6]. This study additionally found that the visual performance of Diff-aAY was satisfactory at intermediate distances. Also, the mix-and-match group had the highest percentage of patients with a binocular UIVA better than 0.1 logMAR VA (74% *vs* 50% and 69%). But there was no significant difference in binocular UIVA, UNVA, or CDVA between either group. It was consistent with previous studies related to mix-and-match[16]. In another Symfony and bifocal mix-and-match study, there were no significant differences in UCVA for distance, intermediate, and near vision[17].

EDOF IOLs were designed to combine the advantages of both monofocal and MIOLs, hence providing a wider range of focus, more spectacle independence, and reduced dysphotopsia[18-19]. Symfony, as one type of EDOF IOL, can provide higher levels of subjective and objective depth of field than bifocal and trifocal IOLs, and can provide good VA from near to far distances, particularly in distant and intermediate ranges[3,19-20]. Although EDOF IOLs were unable to achieve excellent near vision, Symfony IOLs may attain better near vision if postoperative SE remains slightly negative, thus achieving spectacle independence that was similar to the proportion of patients with MIOLs[8]. In this study, the postoperative SE was -0.98±0.59 D in the Bi-Symfony group, and a high level of postoperative satisfaction was achieved. As the defocus curves showed in different study groups, the binocular defocus curve of the Bi-Diff-aAY group had obvious double peaks, while the Bi-Symfony group had a continuous and flatter peak. In the mix-and-match group, the defocus curve of Symfony eyes partly filled the gap between the two peaks of the Diff-aAY eyes' defocus curve. The Bi-Diff-aAY group had the best distance VA, with a peak VA at 0 D defocus. At the same time, the Bi-Symfony group was the best in the intermediate VA (-1.0 to -1.5 D), as the -1.25 D defocus corresponded to a visual distance of 80 cm. The two groups performed similarly between -2.5 and -3.5 D, which was equivalent to the near VA. However, the Bi-Symfony group had the worst VA at near distance. This indicated that the Bi-Symfony and mix-and-match groups had their own advantages in postoperative visual performance, and both were generally better than the Bi-Symfony group.

In the mix-and-match group, 22.22% provided feedback about experiencing mild dysphotopsia, such as glare and halo, while fewer patients reported glare and halo in the Bi-Symfony and Bi-Diff-aAY groups. An earlier study also found a higher incidence of glare and halo in the mix-and-match group than in the EDOF only group[21]. Although dysphotopsia was reported more frequently in the mix-and-match group in our study, the objective optical quality data of the mix-and-match group were significantly better than those of the binocular groups. This may be due to psychological factors of patients in the mix-and-match group who preferring to undergo binocular contrast. Additionally, patients in the three groups showed the same level of overall satisfaction and spectacle independence in this study. In another Symfony and bifocal mix-and-match study, on the contrary, the mixed group had a lower incidence of photic phenomena reported by patients and a lower reduction in CS for low illumination levels with the presence of glare[17]. So overall, it cannot be assumed that mix-and-match method may bring more visual interference than binocular MIOL.

This study is not without limitations. Due to the strict inclusion and exclusion criteria, the number of patients finally included in this study was not large enough. Future studies could evaluate a larger sample size and compare different kinds of mix-and-match IOLs as well. We acknowledge that variations in AL between groups could introduce bias. After accounting for AL statistically, most critical outcomes–including objective visual quality metrics (SR, MTF-HO, RMS-Total), VA at all distances, and patient-reported measures (satisfaction, spectacle independence, dysphotopsia) remained consistent. Future studies with matched baseline AL or larger sample sizes may further validate our findings. Another potential limitation is the non-randomized selection of IOL type based on patient preference, which may introduce selection bias. However, baseline characteristics were largely comparable between groups, and statistical adjustment for AL further reduced confounding. Future randomized controlled trials could validate these findings to enhance generalizability. While we present temporal trends in VA, other functional metrics (*e.g.*, spectacle independence, patient-reported satisfaction, OPD parameters) were only assessed at 6mo, as these are considered indicators of stable long-term outcomes. Future studies with comprehensive longitudinal assessments of all functional metrics would further clarify adaptation dynamics. Another limitation is the lack of CS testing, a key metric for evaluating functional vision in MIOL. CS can be affected by diffractive designs and provides critical insights into real-world visual performance, particularly in low-light conditions. Future studies including CS assessments would enhance the comprehensiveness of comparisons between these IOL strategies. Notably, the OPD-derived MTF and RMS metrics partially complement this limitation: MTF directly reflects the optical system's capacity to transfer contrast across spatial frequencies, while RMS indicates aberration-induced contrast degradation. These objective parameters offer relevant, albeit indirect, information about contrast-related visual performance. Additionally, while the 6-month postoperative follow-up duration of this study was longer than the 3-month follow-up used in most similar studies–sufficient to capture relatively stable visual performance outcomes–it still focused solely on endpoint data at the 6-month mark. However, as a recent study has highlighted, different types of IOLs exhibit distinct temporal trends in visual performance: for instance, EDOF IOLs stabilize at 1mo postoperatively, whereas diffractive MIOLs require 3mo to reach stability[22]. Incorporating dynamic assessments at multiple time points (*e.g.*, 1wk, 1, and 3mo postoperatively) to monitor changes in visual acuity and optical quality would further clarify the adaptation process of the mix-and-match IOL group, and this represents a key direction for future research. Nevertheless, despite the aforementioned limitation in follow-up design, this study remains innovative: to the best of our knowledge, this study is the first to compare the visual performance after implantation of EDOF and a bifocal IOL with a 3.5 D addition. It is well established that every MIOL has its benefits and limitations; thus, integrating the findings of this study with individual patient's needs and clinical conditions will be critical for selecting the most appropriate IOL to achieve optimal postoperative outcomes. Notably, the mix-and-match IOL strategy evaluated herein provides a new option for patients seeking spectacle independence, and its effectiveness was validated in our results.

Symfony and Diff-aAY are both remarkable in distance, intermediate and near vision. The mix-and-match approach for these two IOLs can also achieve good objective visual quality and spectacle independence with no more objective dysphotopsia but more subjective dysphotopsia compared to other two groups. This provides important reference information for patients who peruse high visual quality when choosing a plan.

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