· Clinical Research ·

# Maximizing extend visual outcomes with extend focus intraocular lens in eyes with axial length shorter than 24 mm

*Yuan-Fei Zhu*[1,2], *Li-Zhen Chen*[3], *Tie-Ying Zhao*[2], *Shao-Chong Zhang*[1]

[1]Shenzhen Eye Hospital, Jinan University, Shenzhen Eye Institute, Shenzhen 518000, Guangdong Province, China
[2]Shenzhen Huaxia Eye Hospital, Huaxia Eye Hospital Group, Shenzhen 518000, Guangdong Province, China
[3]C-MER (Shenzhen) Dennis Lam Eye Hospital, Shenzhen 518000, Guangdong Province, China
**Co-first Authors:** Yuan-Fei Zhu and Li-Zhen Chen
**Correspondence to:** Tie-Ying Zhao. Shenzhen Huaxia Eye Hospital, Huaxia Eye Hospital Group, Shenzhen 518000, Guangdong Province, China. zhaotieying2007@hotmail.com; Shao-Chong Zhang. Shenzhen Eye Hospital, Jinan University, Shenzhen Eye Institute, Shenzhen 518000, Guangdong Province, China. zhangshaochong@gzzoc.com
Received: 2024-07-06 Accepted: 2025-06-11

## Abstract
● **AIM:** To evaluate the efficacy of the Tecnis® Symfony® ZXR00 lens in achieving optimal visual outcomes for cataract surgery patients with axial length (AL) shorter than 24 mm.
● **METHODS:** A total of 21 subjects (37 eyes) were submitted to cataract surgery and implantation of Tecnis® Symfony® ZXR00 lens (Johnson & Johnson Vision) was assessed. Patients were examined at 5 m, 80 cm, and 40 cm for uncorrected distance visual acuity (UCDVA) and corrected distance visual acuity (CDVA), uncorrected intermediate (UCIVA), and uncorrected near visual acuity (UCNVA). Further, based on the optimal distance correction, the monocular defocusing curve in the range of +0.5 to -3.5 D was investigated. A simple patient-reported spectacle independence questionnaire (PRSIQ) was used to evaluate subjects' subjective feelings about their dependence on glasses at various distances. Multiple linear regression was employed to examine the association amony intraocular lenses (IOLs) diopter, AL, corneal curvature, anterior chamber depth, mean manifest refractive spherical equivalent, pupil, pupil/scan, target refraction, and near vision (logMAR).
● **RESULTS:** The study demonstrated enhanced UCNVA alongside comparable distant vision and UCIVA outcomes in eyes with AL shorter than 24 mm. Mean post-operative UCDVA significantly improved from preoperative levels 0.530±0.406 ($P$=0.000). Notably, 83.3% of eyes achieved 0.01 logMAR in UCNVA. Five unilateral cases with blended IOL implantation also showed satisfactory visual acuity and satisfaction. The 90.5% (19/21) achieved spectacle independence. The average score for self-reported spectacle-independence on the PRSIQ was 3.52 with a standard deviation of 0.98. The results of the regression analysis revealed that one predictor, the pupil/scan accounted for 27.6% of the variation in near vision [logMAR; $F(1,35)=13.33$, $P<0.01$].
● **CONCLUSION:** The results affirm the effectiveness of the Tecnis® Symfony® ZXR00 lens in enhancing visual outcomes for cataract surgery patients with AL shorter than 24 mm. Additionally, the pupil/scan emerges as a critical factor influencing postoperative near vision.
● **KEYWORDS:** extended depth-of-focus; near vision; axial length; pupil; cataract surgery
**DOI:10.18240/ijo.2025.11.08**

**Citation:** Zhu YF, Chen LZ, Zhao TY, Zhang SC. Maximizing extend visual outcomes with extend focus intraocular lens in eyes with axial length shorter than 24 mm. *Int J Ophthalmol* 2025;18(11):2073-2078

## INTRODUCTION
In response to a growing demand for freedom from glasses, cataract surgery has undergone a transformative shift from solely restoring vision to also addressing spectacle independence for full distance range of vision[1]. This evolution has led to the adoption of advanced technologies, such as extended depth-of-focus (EDOF) intraocular lenses (IOLs)[2], aimed at optimizing visual outcomes and enhancing postoperative quality of life.

Recent advancements in cataract surgery have introduced EDOF IOLs as a promising solution to achieve a broader range of vision. While traditional mono-focal lenses offer clear vision at a single focal point, multi-focal lenses (MIOLs) can induce visual disturbances such as glare and halos. In contrast, EDOF technology extends the depth of focus, providing enhanced distance and intermediate vision with reduced photic phenomena compared to MIOLs[2-4]. And unlike MIOLs, EDOF IOLs tend to retain contrast to the similar level of mono-focal IOLs[5]. But challenges remain in achieving satisfactory near vision with EDOF lenses, prompting exploration of strategies such as mini-monovision[6] or mix-and-match approaches with low-add lenses. However, using the mini-monovision may cause decrease in far vision and additional halos from the low myopia in the contralateral eye[7].

Here, we unveil a remarkable finding: the use of the EDOF lens (Tecnis® Symfony® ZXR00) in eyes with axial length (AL) shorter than 24 mm resulted in an unprecedented achievement of exceptional near vision, maximizing extend visual outcomes with EDOF lenses in cataract surgery, complementing the already impressive distance and intermediate vision outcomes. This new discovery represents a novel advancement in the field, as such full distant range of vision has not been previously reported in EDOF lenses.

## PARTICIPANTS AND METHODS

**Ethical Approval** This study was approved by the Huaxia Eye Hospital Group Xiamen Eye Center Ethics Committee (Approval No.XMYKZX-LW-2025-023) and adhered to the Declaration of Helsinki. Informed consent was obtained from all participants prior to their inclusion in the study.

**Patient Enrolment** This retrospective, non-comparative clinical trial was conducted from April 2021 to February 2024. Patients were recruited from the outpatient clinic. All participants were diagnosed with cataracts and expressed a desire for presbyopia correction. All patients underwent phacoemulsification cataract surgery with or without femoto-second laser assisting. Ocular biometry and corneal astigmatism measurement was performed with iTrace (Tracey, US), Scheimpflug corneal topographer (CSO, Italy) and iMaster 700 (Carl Zeiss, Germany). IOL power was calculated using the Barrett Universal II formula for all patients. All patients were targeted for plano.

Inclusion criteria were as follows: 1) AL less than 24.0 mm; 2) angle kappa no more than 0.5 mm; 3) estimate post-operative corneal astigmatism within 3.0 mm zone no more than 1.5 diopters; 4) corneal endothelial cell count no less than 1500/mm$^2$.

Exclusion criteria were as follows: 1) ocular comorbidities that would influence postoperative visual acuity; 2) traumatic cataract; 3) unstable posterior capsule or loose zonular fibers; 4) severe systemic diseases that would disable the cooperation with postoperative examinations. Surgical procedures were performed by a single experienced surgeon, with meticulous preoperative assessments.

**Intraocular Lenses** Tecnis Symfony ZXR00 (Johnson & Johnson Vision, Santa Ana, California, USA) is a hydro-phobic UV-filtering C-loop IOL. With an overall diameter of 13.0 mm and an optic diameter of 6.0 mm[8], the acrylic acid IOL is a biconvex. Its anterior surface is designed to provide a negative spherical aberration of 0.27 μm. Its posterior surface is composed of an achromatic design and an echelette, a special type of diffraction grating[9], to extend the range of vision. The refractive area within the 9 rings of diffractive zone has a diameter of 1.7 mm. Its light utilization ratio is 92%.

**Surgical Technique** All surgeries were performed by a single experienced surgeon using standardized phacoemulsification techniques. After topical anesthesia, a 2.4 mm clear corneal incision was made, followed by continuous curvilinear capsulorhexis. The cataract was removed using phacoemulsification, and the Tecnis® Symfony® ZXR00 lens was implanted in the capsular bag. Femtosecond laser assistance was used to enhance precision in capsulotomy and lens fragmentation if it was chosen. Postoperative care included topical antibiotics and anti-inflammatory medications for four weeks.

**Patient Examinations** Patients were examined one day, one week, and one to two months after surgery. Visual acuity was measured using Snellen chart at 5 m for distance vision, 80 cm for intermediate vision, and 40 cm for near vision. All measurements were performed under standardized lighting conditions. Monocular uncorrected distance visual acuity (UCDVA), corrected distance visual acuity (CDVA), uncorrected intermediate visual acuity (UCIVA), and uncorrected near visual acuity (UCNVA) were recorded. Monocular defocus curves from +0.5 to -3.5 D were also measured based on the best distance-corrected status. Visual acuity was converted to the logarithm of the minimum angle of resolution (logMAR) scale for statistical analysis.

The evaluation of patients' independence from spectacles across different distances utilized a concise version of the patient-reported spectacle independence questionnaire (PRSIQ)[10]. This tool employs a scale from 0, indicating constant discomfort without glasses, to 4, signifying complete comfort without them. Those categorized as either "almost always" or "always" comfortable without glasses were deemed spectacle independent. Additionally, an assessment of photic phenomena was conducted during the final postoperative consultation, which occurred one to two months following the surgical procedure.

**Statistical Analysis** The study employed statistical methods to systematically evaluate demographic profiles, visual and refractive metrics, and responses from administered questionnaires. We presented all mean figures as mean±standard deviation to facilitate clarity and precision in data interpretation. To assess the relationships and differences within the data, we utilized Student's $t$-test and linear regression techniques where they were deemed suitable. Our analyses were conducted on the SPSS platform (Version 29.0.1.0, IBM Corp 2023), ensuring the use of robust software tools for accurate analysis. Outcomes yielding $P$ values less than 0.05 were identified as statistically significant, underscoring the reliability of our findings.

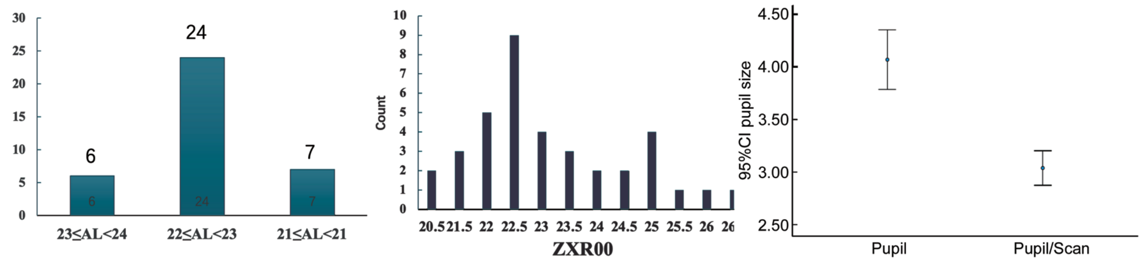


**Figure 1 The distribution of axial length (AL), ZXR00 diopters, pupil and pupil/scan.**

## RESULTS

Overall, 37 eyes (21 patients) were implanted with ZXR00 IOLs. Ten patients (47.6%) were female. The average age was 70.2±8.3y. Sixteen patients underwent bilateral cataract surgery, while the remaining 5 patients opted for unilateral procedures. Among the 5 patients, one patient had previously received a mono-focal IOL in the fellow eye, while another patient, dissatisfied with near vision, chose a bifocal IOL in the fellow eye, and three opted not to undergo lens exchange surgery due to good visual acuity in fellow eyes. All cataract surgery proceeded uneventfully in all cases.

**General Outcomes** Mean preoperative AL was 22.6±0.6 mm, mean corneal curvature was 44.8±1.5, mean anterior chamber depth (ACD) was 2.7±0.3 mm, mean pupil/scan from iTrace was 3.0±0.5 mm, mean manifest refractive spherical equivalent (MRSE) was 1.2±1.7. Mean implanted ZXR00 power was 23.1±1.5 (Figure 1).

**Visual Acuity, Refractive Error Outcomes and Defocus Curve** Mean post-operative UCDVA (logMAR) was 0.018±0.067, significantly improved from pre-operative UCDVA (logMAR) 0.530±0.406 ($P$=0.000). Mean post-operative UCIVA (logMAR) was 0.045±0.075, mean post-operative UCNVA (logMAR) was 0.105±0.093. Mean post-operative CDVA (logMAR) was 0.399±0.423, significantly improved from pre-operative CDVA (logMAR) 0.003±0.031 ($P$=0.000). Mean MRSE changed from 1.2±1.7 preoperatively to -0.21±0.26 postoperatively. Mean target refraction was-0.03±0.24. At the visual acuity threshold of 0.20 logMAR (or better) the defocus curve ranged from +0.5 to -2.5 D (Figure 2).

**Sub-group (AL≤23, ACD≤3, Corneal Curvature≥44)** Eighteen eyes exhibiting characteristics of AL≤23 mm, ACD≤3 mm, and corneal curvature ≥44 achieved improved near vision, with comparable distant and intermediate vision outcomes. The preoperative spherical equivalent was 1.40±1.57. The mean IOL power used was 23.1±1.5. Mean UCDVA (logMAR) was 0.011±0.065. Mean UCIVA (logMAR) was 0.040±0.070, mean UCNVA (logMAR) was 0.079±0. 080. The 83.3% (15/18) of eyes achieved 0.01 logMAR in UCNVA (Figure 3). The 83.3% (15/18) of eyes had pupils no larger than 3 mm (Figure 2).

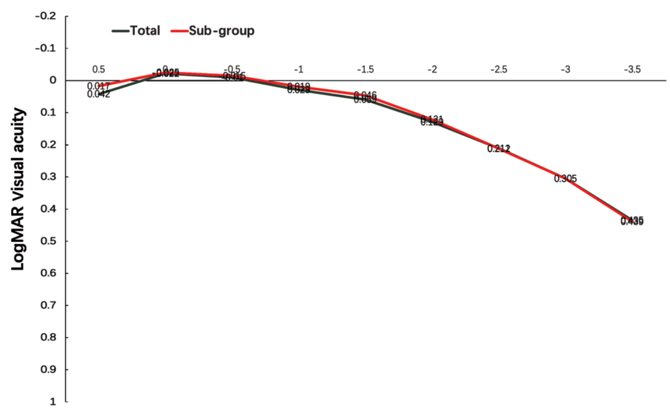


**Figure 2 Defocus curve from whole group *vs* sub-group.**

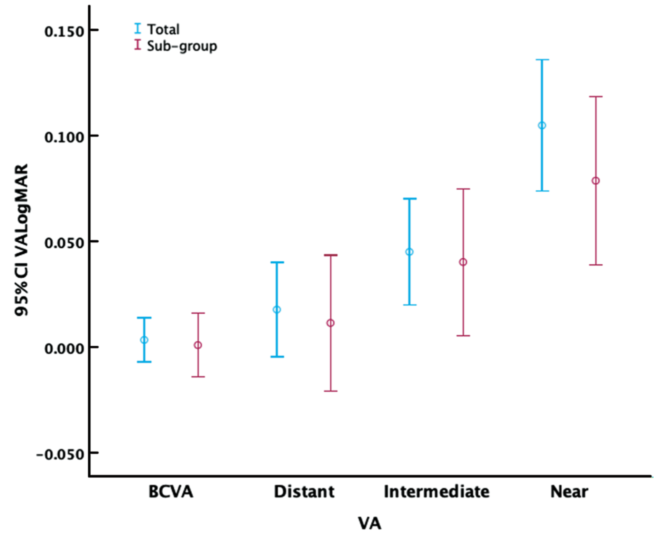


**Figure 3 Comparison of VA logMAR between whole group and subgroup** VA: Vasual acuity; BCVA: Best-corrected visual acuity.

Five unilateral cases showed good results and tolerance with different blended IOL implantation (Table 1).

**Spectacle Independence, PRSIQ Questionnaire and Photic Phenomena** According to the PRSIQ questionnaire completed at least one month after surgery, 90.5% (19/21) achieved spectacle independence. The mean PRSIQ score for subjective reported spectacle-independence was 3.52±0.98, respectively. If ruled out 2 patients developed macular degeneration and myopic shift, PRSIQ score was 3.79±0.42. Two patients showed outstanding near vision to be able to do needle work, one of which implanted bilaterally, the other one unilaterally. Both is subgroup with pupil/scan 2.5 mm.

**Table 1 Five unilateral Tecnis® Symfony® ZXR00 implantation cases with various fellow eye blends**

| Fellow eye | UCDVA (logMAR) | UCIVA (logMAR) | UCNVA (logMAR) | MRSE of fellow eye |
|---|---|---|---|---|
| Mono-focal | 0.097 | 0.097 | 0.097 | -0.75 |
| Bifocal | 0.000 | 0.000 | 0.222 | 0 |
| Nature lens | 0.000 | 0.000 | 0.097 | 1.875 |
| Nature lens | 0.046 | 0.000 | 0.097 | 0.875 |
| Nature lens | -0.079 | 0.097 | 0.222 | 2 |

UCDVA: Uncorrected distance visual acuity; UCIVA: Uncorrected intermediate visual acuity; UCNVA: Uncorrected near visual acuity; MRSE: Manifest refractive spherical equivalent.

The 8.1% ($n$=3/37) of patients reported photic phenomena (halos, starburst, glare). Only 1% ($n$=1/37) found these photic phenomena bothersome, also diagnosed with dry eye syndrome and strabismus postoperatively.

Multiple linear regression was employed to examine the association between IOL diopter, AL, corneal curvature, ACD, MRSE, pupil size, pupil/scan ratio, target refraction, and near vision (logMAR). The results of the regression analysis revealed that one predictor, the pupil/scan ratio, accounted for 27.6% of the variation in near vision [logMAR; $F(1,35)=13.33$, $P<0.01$].

## DISCUSSION

Our findings highlight the extending near vision for the EDOF IOL in patients with short AL. The success of this approach underscores the importance of personalized IOL selection[11]. Factors such as corneal curvature, pupil size, and preoperative refractive status play crucial roles in determining postoperative visual outcomes and should be carefully considered in clinical decision-making.

The EDOF IOL is an emerging technology that is designed to improve range of vision[12]. ZXR00 is known for excellent visual quality in distant and intermedia visual acuity[13-14] and fewer photic phenomena[15], but inadequate quality of near vision[15-17]. Mini-monovision is a common strategy to improve near vision for EDOF users. However, there are still concerns in photic phenomena and loss of stereopsis by using a dioptric power difference between two eyes[6]. To our knowledge, this is the first report to achieve distant, intermedia and near vision without compensation or blend implantation of MIOLs, which demonstrate ideal candidate for ZXR00 application by overcoming the shortcoming of ZXR00.

This study adds several novel insights. First, it demonstrates the unprecedented achievement of exceptional near vision using EDOF lenses in cataract surgery patients with short AL (AL≤24 mm). Second, it highlights that the use of EDOF lenses in a subgroup of eyes with AL≤23 mm, ACD≤3 mm, and corneal curvature ≥44 D maximizes extended visual outcomes, complementing the existing advantages in distance and intermediate vision. Third, it identifies pupil/scan size, as measured by iTrace, as a critical factor influencing improvements in near vision; specifically, larger pupil/scan sizes (over 3 mm) may be associated with weaker near performance. Fourth, it addresses a gap in knowledge by providing evidence of a full distant range of vision with EDOF lenses, a feature not previously well-documented. Finally, it offers valuable guidance for personalized IOL selection based on individual ocular characteristics to optimize postoperative visual outcomes.

To meet and exceed patient expectations, a holistic approach is critical to optimize outcomes for patients. The IOL selection process for patients requires objective assessment of patient-specific ocular characteristics[11].

The mean AL was 22.6±0.6 mm. Among them, the eyes with the characteristic of short AL, shallow ACD and high corneal curvature achieved the better result than others. The result of the characteristics is relatively higher IOL power. When you have a higher IOL power, adding on the addition of +1.75 D at the IOL plane, this may be the main reason for better near vision than previous study[1,3,16], in our opinion. Also, majority of these patients are hyperopic, they had great difficulty in near vision preoperatively, so it was also a big improvement when target plano accomplished.

Another common feature in the excellent near vision candidates was small pupil, which demonstrated on iTrace as pupil/scan smaller than 3 mm. Two patients with pupil/scan 2 mm achieved excellent near vision to be able to do sewing work for near vision. Łabuz *et al*[18] also reported that its optical performance through a 3 mm pupil was minimally better than that of the other EDOF IOLs. These observations are clinically confirmed by the defocus curve in our study. The effects of EDOF IOLs were achieved based on the principles of echelette diffractive ring (Tecnis Symfony ZXR00), spherical aberration induction (SIFI MiniWell), or pinhole effect (Acu-Focus IC-8)[19-20]. The pinhole effect is another phenomenon which allows obtaining greater depth of focus. From the equation presented by Campbell[21] over 50 years ago, it can be deduced that with increasing pupil size, the depth of field decreases (and so does the depth of focus). Therefore, application of ZXR00 in small pupil eyes enhance EDOF lens effect with two mechanisms. Another theory is pseudo-accommodation.

Key factors enhancing pseudo-accommodation primarily encompass corneal and IOL wavefront aberrations, astigmatism, and reduced pupil diameter[22].

UCDVA was 0 logMAR or better in 78.4% of patients, at intermediate distance, UCIVA was 0.1 logMAR or better in 91.9% of patients and UCNVA was 0.2 logMAR or better in 94.6% or 0.1 logMAR or better in 73.0%.

Implanting EDOF lenses in both eyes of patients with short AL and setting the target to plano resulted in excellent postoperative vision, surpassing that of unilateral candidates. This dual implantation approach provides perfect full-range vision.

In our study, the defocus curve exhibited a smoother slope, demonstrating a gradual decrease in visual acuity across the defocus range (Figure 2). We observed that a visual acuity of 0.2 logMAR or better was achieved between -2.5 and +0.5 D, surpassing the outcomes reported in previous studies[6,23-26].

It's noteworthy that there may be a slight myopic shift postoperatively in eyes with a shallow anterior chamber and high corneal curvature, from preoperative target refraction 0.06±0.20 to postoperative MRSE -0.15±0.23 ($P$=0.005). Before recognizing this pattern, we initially selected an IOL power of -0.14 as routine for one patient, who subsequently experienced a myopic shift (-0.75) one month after the operation. Fortunately, she had a mono-focal IOL implanted in the fellow eye, which also experienced a similar myopic shift. As a result, she maintained satisfactory near vision and achieved good distance vision with the use of spectacles. Biocular Defocus Curve with spectacles Figure 4.

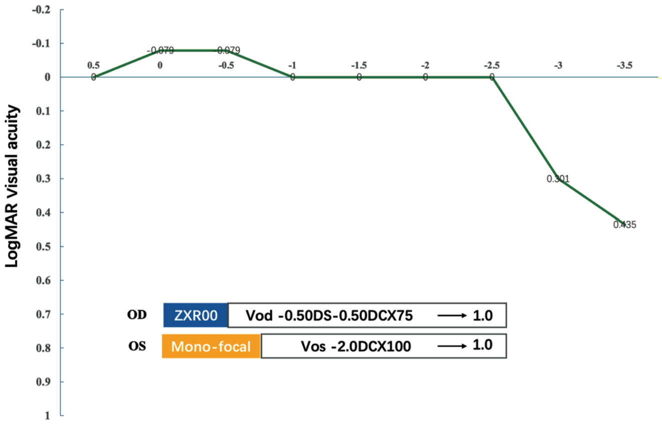


**Figure 4 Biocular defocus curve with myopic correction following unilateral ZXR00 implantation and myopic shift** DS: Diopter sphere ; DC: Diopter cylinder.

**Sub-group (AL≤23, ACD≤3, Corneal Curvature ≥44)** The subgroup analysis for patients with AL≤23 mm, ACD≤3 mm, and corneal curvature ≥44 yielded even more promising resultIn the subgroup, our study observed better near vision and higher satisfaction levels compared to the overall cohort. The mean IOL power used (23.1±1.5) was consistent with the total cohort (23.1±1.5). However, the preoperative spherical equivalent (1.40±1.57) was more hyperopic compared to the total cohort (1.2±1.7). The mean pupil size/scan (scotopic; 2.96±0.36) was smaller than that of the total cohort (3.0±0.5).

We employed a multiple linear regression model to analyze preoperative factors, including IOL diopter, AL, corneal curvature, ACD, MRSE, pupil size, pupil/scan ratio, and target refraction, in relation to near vision (measured in logMAR). The results indicate that one predictor, the pupil/scan, accounts for 27.6% of the variance in near vision [logMAR; $F(1,35)$=13.33, $P$<0.01]. This suggests that the pupil/scan significantly influences changes in near vision, while the impact of other factors may be less pronounced. This finding could be crucial for preoperative assessment and surgical decision-making, as it implies that pupil/scan size is a key factor affecting improvements in near vision.

It's important to note that one patient with a pupil size/scan larger than 3 mm exhibited lower near vision than the subgroup average. Additionally, despite achieving a near vision of 0.1 logMAR, another patient with preoperative myopia expressed less satisfaction.

**Excellent Tolerance for the Blended Implantation of IOLs**

The ZXR00 IOL has previously demonstrated better tolerance to IOL tilt in myopic eyes[27]. Consistently, the ZXR00 not only showed good tolerance with myopic shift but also demonstrated good tolerance in blended implantation. In our study, five unilateral cases with different blends achieved good visual acuity and satisfaction.

In conclusion, our study highlights the effectiveness of the Tecnis® Symfony® ZXR00 lens in achieving superior visual outcomes for cataract surgery patients with short AL. Through the utilization of advanced technologies and patient-centered approaches, we can optimize visual outcomes and improve the overall quality of life for individuals undergoing cataract surgery.

The limitations of this study include a relatively small sample size, which may limit the generalizability of the findings to a broader population. Additionally, the study's retrospective design may introduce inherent biases and confounding variables that were not accounted for in the analysis.

## ACKNOWLEDGEMENTS

**Authors' Contributions:** Conception, design and data collection: Zhu YF; Conceptualization, project administration: Zhao TY; Analysis and writing: Chen LZ; Supervision: Zhang SC.

**Conflicts of Interest: Zhu YF,** None; **Chen LZ,** None; **Zhao TY,** None; **Zhang SC,** None.

## REFERENCES

1 Gil MÁ, Varón C, Cardona G, *et al*. Far and near contrast sensitivity and quality of vision with six presbyopia correcting intraocular lenses. *J Clin Med* 2022;11(14):4150.

2 Chang DH, Janakiraman DP, Smith PJ, *et al*. Visual outcomes and safety of an extended depth-of-focus intraocular lens: results of a pivotal clinical trial. *J Cataract Refract Surg* 2022;48(3):288-297.

3 Farvardin M, Johari M, Attarzade A, *et al*. Comparison between bilateral implantation of a trifocal intraocular lens (Alcon Acrysof IQ® PanOptix) and extended depth of focus lens (Tecnis® Symfony® ZXR00 lens). *Int Ophthalmol* 2021;41(2):567-573.

4 Teus MA, Kohnen T, Ball J, *et al*. Visual and subject-reported outcomes of a wavefront shaping extended depth of focus intraocular lens implanted bilaterally with monovision. *J Cataract Refract Surg* 2025;51(7):549-556.

5 Pedrotti E, Bruni E, Bonacci E, *et al*. Comparative analysis of the clinical outcomes with a monofocal and an extended range of vision intraocular lens. *J Refract Surg* 2016;32(7):436-442.

6 Tomagova N, Elahi S, Vandekerckhove K. Clinical outcomes of a new non-diffractive extended depth-of-focus intraocular lens targeted for mini-monovision. *Clin Ophthalmol* 2023;17:981-990.

7 Megiddo-Barnir E, Alió JL. Latest development in extended depth-of-focus intraocular lenses: an update. *Asia Pac J Ophthalmol* (*Phila*) 2023;12(1):58-79.

8 Vukich J, Thompson V, Yeu E, *et al*. Evaluating the small aperture intraocular lens: depth of focus and the role of refraction and preoperative corneal astigmatism in visual performance. *J Cataract Refract Surg* 2024;50(11):1165-1172.

9 Miret JJ, Camps VJ, García C, *et al*. Analysis of the optical performance of intraocular lenses using profilometric measurements. *Graefes Arch Clin Exp Ophthalmol* 2025;263(2):451-465.

10 Morlock R, Wirth RJ, Tally SR, *et al*. Patient-reported spectacle independence questionnaire (PRSIQ): development and validation. *Am J Ophthalmol* 2017;178:101-114.

11 Yeu E, Cuozzo S. Matching the patient to the intraocular lens: preoperative considerations to optimize surgical outcomes. *Ophthalmology* 2021;128(11):e132-e141.

12 Zeilinger J, Kronschläger M, Schlatter A, *et al*. Comparing an advanced monofocal with a non-diffractive extended depth of focus intraocular lens using a mini-monovision approach. *Am J Ophthalmol* 2025;271:86-95.

13 Baartman BJ, Karpuk K, Eichhorn B, *et al*. Extended depth of focus lens implantation after radial keratotomy. *Clin Ophthalmol* 2019;13:1401-1408.

14 Gil MA, Varón C, Cardona G, *et al*. Visual acuity and defocus curves with six multifocal intraocular lenses. *Int Ophthalmol* 2020;40(2):393-401.

15 Kim JH, Eom Y, Park SY, *et al*. Rainbow halos occur less following implantation of extended range of vision one-piece intraocular lenses *vs* diffractive bifocal intraocular lenses. *Int J Ophthalmol* 2020;13(6):913-919.

16 Liu X, Song XH, Wang W, *et al*. Comparison of the clinical outcomes between echelette extended range of vision and diffractive bifocal intraocular lenses. *J Ophthalmol* 2019;2019:5815040.

17 Kanclerz P, Toto F, Grzybowski A, *et al*. Extended depth-of-field intraocular lenses: an update. *Asia Pac J Ophthalmol* (*Phila*) 2020;9(3):194-202.

18 Łabuz G, Son HS, Naujokaitis T, *et al*. Laboratory investigation of preclinical visual-quality metrics and halo-size in enhanced monofocal intraocular lenses. *Ophthalmol Ther* 2021;10(4):1093-1104.

19 Rocha KM. Extended depth of focus IOLs: the next chapter in refractive technology *J Refract Surg* 2017;33(3):146-149.

20 Auffarth GU, Łabuz G, Khoramnia R, *et al*. Overview of intraocular lenses with optics for correcting presbyopia. *Ophthalmologie* 2024;121(9):685-697.

21 Campbell FW. The depth of field of the human eye. *Optica Acta* 1957;4:157-164.

22 Nakazawa M, Ohtsuki K. Apparent accommodation in pseudophakic eyes after implantation of posterior chamber intraocular lenses. *Am J Ophthalmol* 1983;96(4):435-438.

23 Bala C, Poyales F, Guarro M, *et al*. Multicountry clinical outcomes of a new nondiffractive presbyopia-correcting IOL. *J Cataract Refract Surg* 2022;48(2):136-143.

24 Bova A, Vita S. Clinical and aberrometric evaluation of a new monofocal IOL with intermediate vision improvement. *J Ophthalmol* 2022;2022:4119698.

25 Alvarado-Villacorta R, Yim TW, Hernandez-Quintela E, *et al*. Surgical interventions for presbyopia. *Cochrane Database Syst Rev* 2025;4(4):CD015711.

26 Stodulka P, Slovak M. Visual performance of a polynomial extended depth of focus intraocular lens. *Open J Oph* 2021;11(3):214-228.

27 Guo D, Meng J, Zhang K, *et al*. Tolerance to lens tilt and decentration of two multifocal intraocular lenses: using the quick contrast sensitivity function method. *Eye Vis (Lond)* 2022;9(1):45.