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Monocular and Binocular Visual outcomes of an Enhanced Monofocal (Mono-EDOF) Intraocular Lens and the Impact of Pre-Operative Parameters

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ABSTRACT

Background: Enhanced monofocal Intraocular Lenses (IOLs) offer improved intermediate vision while maintaining high contrast sensitivity. The RayOne EMV and EMV Toric IOLs leverage controlled positive spherical aberration to enhance depth of focus, making them suitable for monovision strategies. This study evaluates the impact of preoperative parameters — corneal Spherical Aberration (SA), Higher-Order Aberrations (HOAs), and Chang Waring chord (CW-chord)-on monocular and binocular vision outcomes following implantation with primarily mini-monovision refractive targeting.

Methods: This retrospective, single-center study analyzed 147 eyes of 74 patients implanted with RayOne EMV or EMV Toric IOLs. Patients were categorized into four refractive target groups (bilateral emmetropia, mini-monovision, modest monovision and full monovision). Preoperative SA, HOAs, and CW-chord were measured and classified as high or low. Uncorrected Distance (UDVA), Corrected Distance (CDVA), and Uncorrected Near Visual Acuity (UNVA) were assessed at one-month follow-up.

Results: Mini-monovision patients achieved high levels of UDVA (80.4% at 6/6 or better) and UNVA (84% at N8 or better). Preoperative SA and CW-chord showed no significant correlation with postoperative UDVA, UNVA, or CDVA ($p>0.05$). However, higher preoperative HOAs were associated with reduced CDVA (correlation coefficient = +0.26, $p<0.05$), suggesting a mild impact on best-corrected visual acuity.

Conclusion: SA and CW-chord had minimal influence on postoperative vision, while higher HOAs were linked to reduced CDVA. These findings support the effectiveness of enhanced monofocal IOLs and highlight the need for further research on preoperative predictors to refine patient selection and optimize outcomes.

Clinical Relevance: Assessing certain preoperative parameters may enhance surgical planning and visual outcome predictability in patients receiving this enhanced monofocal IOL.

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Background

The evolution of Intraocular Lens (IOL) technology has significantly advanced visual rehabilitation for cataract patients, with a diverse array of lenses tailored to optimize specific visual outcomes [1]. Traditional monofocal IOLs, known for their high contrast sensitivity and minimal visual disturbances, correct distance vision effectively but necessitate postoperative glasses for near and intermediate vision [2,3]. Enhanced monofocal IOLs address this gap by extending the depth of focus and improving intermediate visual acuity without introducing significant photic phenomena often associated with multifocal lenses with growing evidence supporting their adoption as the new standard of care in cataract surgery [3-6].

To further leverage the optical characteristics of enhanced monofocal IOLs and increase both binocular performance and spectacle independence, refractive targeting is employed to customize visual outcomes, ranging from bilateral emmetropia to monovision. In monovision, the dominant eye is typically targeted for emmetropia, while the non-dominant eye is targeted for myopia, ranging between -0.25 D and -0.75 D for mini-monovision and up to -2.00 D for full-monovision, depending on the patient's specific needs and the surgeon's discretion [7].

The Ray One EMV (RAO200E, or toric version RAO210T) IOL is a non-diffractive, enhanced monofocal lens that induces a controlled amount of positive spherical aberration in the central region, which gradually decreases towards the periphery to maintain good contrast in low light with larger pupils, in contrast to a standard spherical IOL. By increasing the total spherical aberration, this IOL aims to provide good vision from distance to intermediate range, with a depth of focus of approximately 1.5 D and even EDOF-like performance in mini-monovision setting [8-10].

In the present study, 4 categories of monocular refractive targets were established: emmetropic, slight myopic, moderate myopic, and high myopic targets, corresponding to 4 binocular vision categories: bilateral emmetropia, mini-monovision, modest monovision, and full monovision. These categories enable a more nuanced analysis of how targeted refraction influences visual outcomes across a spectrum of visual tasks.

Despite the growing popularity of the enhanced monofocal lenses, their outcomes can vary depending on individual patient characteristics, preoperative assessments, and targeted refractive outcomes. Preoperative factors such as corneal Spherical Aberrations (SA), Higher-Order Aberrations (HOAs), and the Chang Waring chord (CW-chord) may influence postoperative outcomes though their significance following non-diffractive enhanced IOL implantation remains unclear [11-13]. Enhanced monofocal IOLs often correct SA and minimize HOAs, to improve clarity and reduce optical side effects [14-16]. The CW-chord's role in refractive outcomes further underscores the importance of precise preoperative assessment [17]. As IOL designs become more sophisticated, understanding these preoperative parameters becomes increasingly important in predicting postoperative vision quality and minimizing optical side effects. A better understanding of these factors is essential for further optimizing postoperative results. The present study explores the influence that preoperative factors have on clinical outcomes of enhanced monofocal IOLs, offering a personalized approach to visual rehabilitation.

Methods

Study Design

The present study was a retrospective, single-centre clinical audit conducted at South Bank Day Hospital, Australia. Anonymized data from 149 consecutive eyes were reviewed, with each patient followed up at one-month post-implantation. Patients included in the study had received their implantations between November 2022 and November 2023, covering a 12-month period.

Study Participants

Included patients were 40 years or older of both sexes who presented with senile bilateral cataracts and were suitable for cataract surgery with bilateral implantation of the RayOne EMV or EMV Toric IOL (Rayner, Worthing, UK). Patients aiming to enhance their vision without seeking complete spectacle independence were included in the study. Other inclusion criteria were potential for Corrected Distance Visual Acuity (CDVA) of 0.1 logMAR or better postoperatively, and calculated IOL power in the range of +10.0 to +30.0 D. Preoperative SA, HOA and CW-Chord levels were not used to include or exclude patients from implantation of the EMV IOL.

No eyes were excluded from the study due to corneal pathology such as pterygium or corneal scar. Patients likely to require further retinal surgery, had a history of laser vision correction, or those who had other coexisting ocular pathologies that contributed to vision loss, such as glaucoma (only stable treated mild glaucoma with no significant vision loss on 24-2 were included), diabetic retinopathy, and age-related macular degeneration, were not included in this analysis. Patients who had keratoconus, those with corneal irregularities of >1.0 D, those who did not have bilateral implantation of RayOne EMV IOL, and patients who did not complete the one-month follow-up were also excluded from the study. Finally, 147 eyes of 74 patients were analysed in the study (See Figure 1).

Surgical Intervention and IOL Technology

A single experienced surgeon (DJG) performed all surgeries. All surgeries were performed under topical anaesthesia with clear corneal temporal phacoemulsification using the Centurion phacoemulsification machine (Alcon, Geneva, Switzerland) and in-the-bag implantation of IOL. IOL Master 700 (Carl Zeiss Meditec AG, Germany) was employed to measure biometric parameters.

Mini-monovision with a target of -0.25D to -0.75D in the 'near' eye was planned for most patients undergoing bilateral RAO200E EMV and RAO210T EMVT IOL implantation, however some patients were targeted for higher degrees of monovision or for bilateral emmetropia. This was based on the surgeon's discretion and patient preference.

The Barrett Universal II formula (lens factor 1.67; design factor 3.5) was used to calculate the IOL power with no A-constant adjustment. The target refraction for emmetropic target eyes favoured slight hyperopia (mean target 0.10D ± 0.20D, range -0.25D to 0.49D), as a slightly myopic Mean Prediction Error (MPE) had been reported with a 1.67 Lens Factor (LF). Our results confirmed a myopic tendency in the refractive outcomes (-0.32 MPE for emmetropic target eyes). This MPE has subsequently been addressed with an optimised lens factor of 1.51, along with optimised constants for other formulae available online at iolcon.org. For astigmatism, the non toric or toric IOL power that would give the lowest predicted postoperative astigmatism value was selected. Eyes were categorized into four groups based on the target refraction. These groups were emmetropic target eyes (+0.49 D to -0.25 D), slight myopic target eyes (-0.26 D to -0.75 D), moderate myopic target eyes (-0.76 D to -1.25 D), and high myopic target eyes (<-1.25 D). Similarly, patients were categorised into four groups based on the target refraction in near eye which were: bilateral emmetropia (+0.49 D to -0.25 D), mini-monovision (-0.26 D to -0.75 D in 'near' eye), modest monovision (-0.76 D to -1.25 D in 'near' eye), and full monovision (>1.25 D in 'near' eye).

All patients received post operative Dexamethasone 0.1% eye drops four times per day and Ilevro eye drops once per day to the operative eye for 28 days.

Pre-Operative and Post-Operative Assessments

All eyes had comprehensive eye examination pre-operatively, at baseline, and one month after surgery. Visual Acuity (VA) was measured using Early Treatment Diabetic Retinopathy Study (ETDRS) charts, with 100% contrast, under photopic conditions and reported in logMAR. Uncorrected Distance Visual Acuity (UDVA) and Corrected Distance Visual Acuity (CDVA) were assessed monocularly and binocularly at 4 meters. Uncorrected Near Visual Acuity (UNVA) was measured at 40 cm. The visual acuities were measured at a one-month follow-up visit.

Pre-operatively, corneal spherical aberrations (SA, Z4,0), Higher Order Aberrations (HOA RMS) and Chang Waring Chord (CW-chord) were measured for all eyes using Pentacam HR (Oculus, United States) at the 6 mm optical zone. However, no patients were excluded based on the results of these measurements. Spherical aberration, HOA, and CW-Chord were divided into high and low categories respectively, to examine the impact of pre-operative factors on VA outcomes. The corneal SA (Z4,0) was computed as high ≥ 0.4 and low < 0.4, HOAs as high ≥ 0.3 and low < 0.3, and the CW-chord as high ≥ 0.5 mm and low <0.5 mm [18].

Statistical analysis data was tabulated and analyzed using R software (Version 4.3.3). The primary outcome measures of this audit were monocular UDVA, UNVA, and CDVA and binocular UDVA, and UNVA, at one month postoperatively. Secondary outcome measures of the audit were the impact of pre-operative investigations such as SA, HOA, and CW-chord on monocular VAs.

Statistical Analysis

All statistical analyses were conducted using (R software version 4.3.3). The demographic data of the participants were summarized using descriptive statistics, including mean and Standard Deviation (SD) for continuous variables and frequencies with percentages for categorical variables.

To assess the relationship between continuous variables, Pearson's correlation coefficient was computed. For comparing differences between two independent groups, an independent samples t-test was performed. A p-value of < 0.05 was considered statistically significant for all analyses.

Results

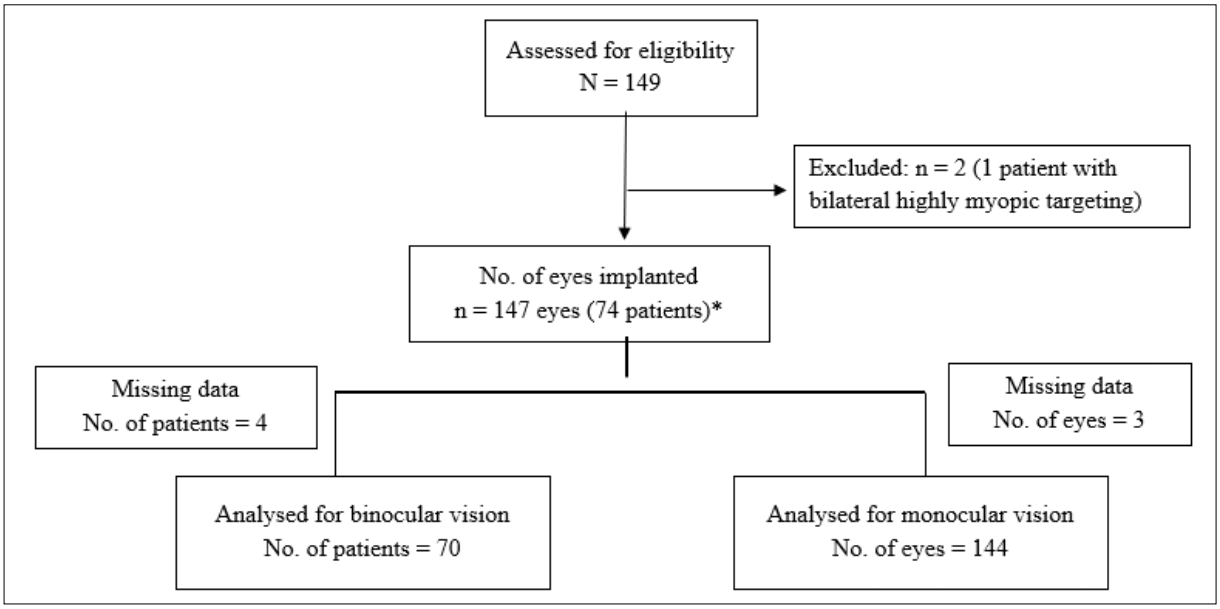
Study Participants

A total of 147 eyes (74 patients, 32 males and 42 females) were implanted with EMV (n=30) and EMVT (n=117) for improvement in VA (Figure 1). The basic demographic, pre-operative ocular parameters and the target refraction for binocular and monocular vision are given in Table 1.

Table 1: Demographic and Biometric Characteristics of the Study Participants

Parameters	Value Mean ± SD (min, max)
Age (years),	68.61 ± 9.09 (42.21, 87.51)
IOL power (D)	20.66 ± 2.64 (13.5, 27.0)
Corneal astigmatism (D)	-0.80 ± 0.51 (-2.56, 0.0)
Axial length (AL) (mm)	23.63 ± 0.99 (21.58, 26.32)
Anterior chamber depth ACD (mm)	3.16 ± 0.36 (2.41, 4.32)
Pre-op spherical equivalent (SE)	0.54 ± 1.82 (-4.5, 4.0)
Mean refractive target	
Overall group (n=147)	-0.22 ± 0.45 (-2.46, 0.49)
Emmetropic target eyes (n=82)	0.10 ± 0.20
Slight myopic target eyes (n=54)	-0.48 ± 0.12
Moderate myopic target eyes (n=9)	-0.96 ± 0.14
High myopic target eyes (n=2)	-1.46 ± 0.08
Corneal spherical aberration (Z4,0) (μm)	0.31 ± 0.12 (-0.43, 0.70)
Higher order aberrations (HOAs) (μm)	0.18 ± 0.12 (0.05, 0.92)
CW-Chord (mm)	0.35 ± 0.16 (Q1,Q3: 0.25, 0.4)

Figure 1: Flowchart of Participants



* - Only single eye was assessed for one patient. Thus, total number of patients for binocular vision was 74.

Refractive Outcomes

The mean subjective refractive outcome at 1-month follow-up was -0.22 ± 0.44 D in the emmetropic group (n=79), -0.48 ± 0.65 D in the slight myopic group (n=53), -1.14 ± 0.92 D in moderate myopic group (n=9) and -1.87 ± 0.18 D in high myopic group (n=2). Additionally, the post-operative refractive cylinder was -0.40 ± 0.32 D in the emmetropic target eyes (n=82), -0.38 ± 0.37 D in the slight myopic target eyes (n=54), -0.48 ± 0.57 D in the moderate target eyes (n=9), and 0.13 ± 0.18 D in the high myopic target eyes (n=2).

Monocular Visual Acuity Results

Table 2 presents the monocular UDVA, CDVA and UNVA at one-month follow-up for the four target groups (mean ± SD), and Figure 2 and Figure 3 the percentage of eyes achieving specific UDVA and UNVA levels in each group, respectively.

In the emmetropic target group (n=80), 97.5% of eyes reached a VA level of 6/12 (0.30 logMAR) for UDVA at one-month follow-up. Additionally, 83% of eyes reported 6/12 (0.30 logMAR) or better in the slight myopic target group (n=53). On the other hand, only 35.5% of eyes, cumulatively, reached a VA level of N8 (0.30 logMAR) for UNVA in the emmetropic group, while 78.84% of eyes, cumulatively, reached the VA level of N8 (0.30 logMAR) in the slight myopic group (Figure 3).

Table 2: Mean logMAR Monocular UDVA, CDVA, and UNVA at 1 Month Postoperatively

VA	Target group	N (No of eyes)	Mean ± SD
UDVA	Emmetropic target eyes	80	0.01 ± 0.15
	Slight myopic target eyes	53	0.17 ± 0.17
	Moderate myopic target eyes	9	0.33 ± 0.25
	High myopic target eyes	2	0.35 ± 0.07
CDVA#	Emmetropic target eyes	68	-0.07 ± 0.08
	Slight myopic target eyes	49	-0.04 ± 0.08
	Moderate myopic target eyes	9	-0.03 ± 0.09
	High myopic target eyes	1	-0.12
UNVA^	Emmetropic target eyes	76	0.49 ± 0.25
	Slight myopic target eyes	52	0.27 ± 0.17
	Moderate myopic target eyes	9	0.14 ± 0.07
	High myopic target eyes	2	0.07 ± 0.00

Legend: # CDVA data of 17 Eyes was Missing; ^ UNVA data of 5 Eyes was Missing.

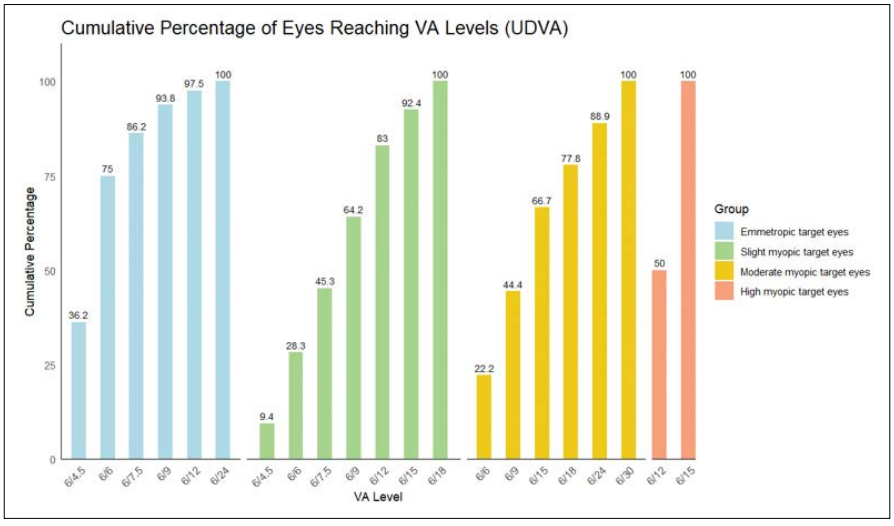


Figure 2: Percentage of Eyes to Reach Monocular UDVA Levels in Each Group

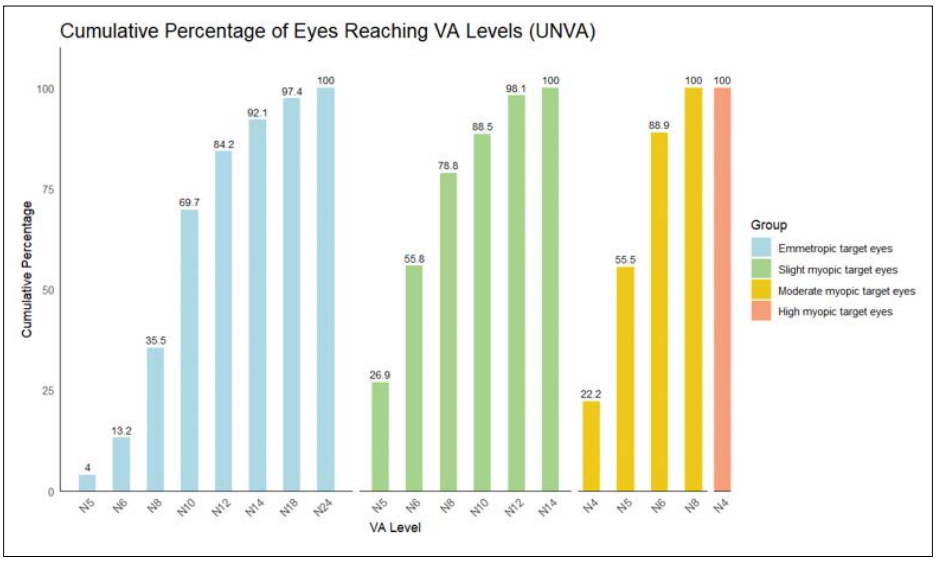


Figure 3: Percentage of Eyes to Reach Monocular UNVA Levels in Each Group

Binocular Visual Acuity Results

Table 3 presents the binocular UDVA and UNVA at one-month follow-up for the four target groups (mean ± SD), and Figure 4 and Figure 5 the percentage of patients achieving specific UDVA and UNVA levels in each group, respectively.

The major target group, i.e. mini-monovision, achieved 6/6 (0.00 logMAR) UDVA or better in 80.4% of the operated patients at the one-month follow-up. All patients (n=11) in the modest monovision and full monovision groups achieved 6/6 (0.00 logMAR) UDVA (Figure 4). Moreover, 84% of the patients in the mini-monovision group achieved UNVA of N8 (0.30 logMAR) or better in the mini-monovision group (n=51). In comparison, 100% of the patients in the modest monovision achieved N6 (0.18 logMAR) or better UNVA (Figure 5).

Table 3: Mean logMAR Binocular UDVA and UNVA at 1 Month Postoperatively

VA	Target group	N (No of patients)	Mean ± SD
UDVA	Bilateral emmetropia	8	-0.07 ± 0.09
	Mini-monovision	51	-0.03 ± 0.10
	Modest monovision	9	-0.08 ± 0.06
	Full monovision	2	-0.06 ± 0.09
UNVA	Bilateral emmetropia	8	0.18 ± 0.09
	Mini-monovision	51	0.23 ± 0.16
	Modest monovision	9	0.13 ± 0.05
	Full monovision	2	0.07 ± 0.00

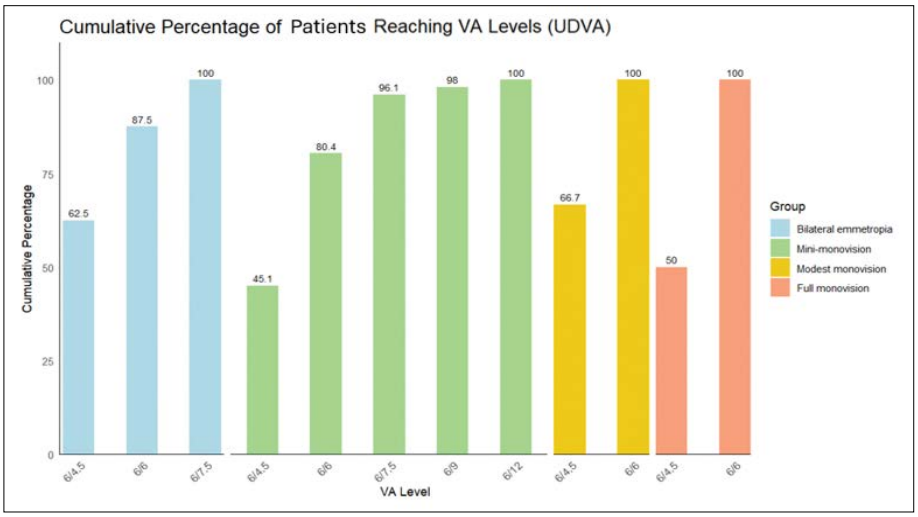


Figure 4: Percentage of Patients Reaching Binocular UDVA Levels in Each Group

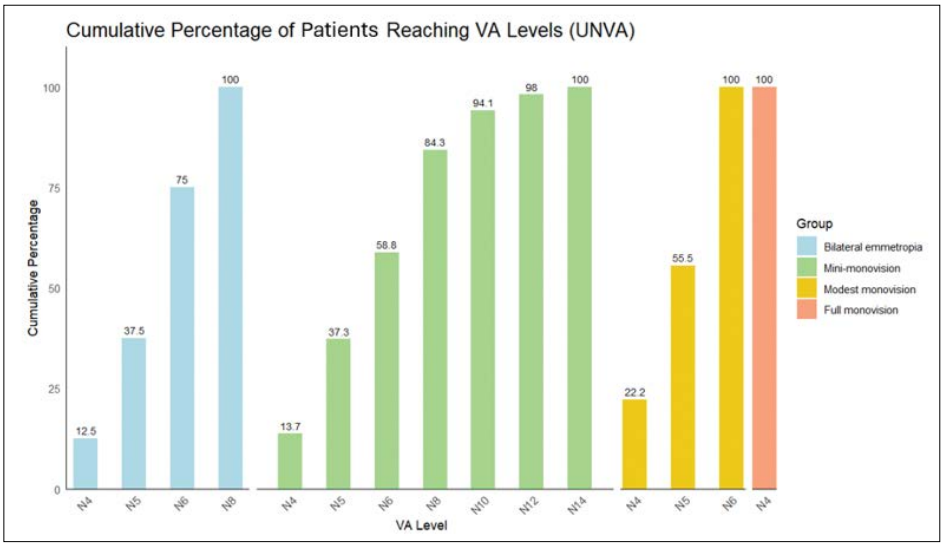


Figure 5: Percentage of Patients Reaching Binocular UNVA Levels in Each Group

Impact of Pre-Operative Parameters on the Visual Acuity Outcomes

There was no significant effect ($p>0.05$) of the pre-operative SA (Z4,0) and CW-chord length on the visual acuity outcomes of UDVA, UNVA and CDVA. Moreover, the SA or CW-Chord levels were not statistically correlated with the VA outcomes (Table 4). Similarly, the pre-operative HOAs had a negligible effect on UDVA and UNVA. However, CDVA was found to be statistically reduced with higher pre-operative HOAs, despite CDVA in the high HOA group still being better than 0 logMAR. Also, CDVA was found to be moderately positively correlated with pre-operative HOAs (correlation coefficient = +0.26) (Table 4).

Table 4: Effect of Pre-Operative Parameters (SA, HOAs, and CH-Chord) on the CDVA, UDVA and UNVA Outcomes on Monocular Vision After EMV Implantation

Variable	Pre-op Parameter	N	Mean ± SD (LogMAR)	VA Range	p-value	Correlation
CDVA	Low SA (Z4,0) < 0.4 µm	103	-0.06 ± 0.08	(-0.12, 0.1)	0.615	+0.04
	High SA (Z4,0) ≥ 0.4 µm	24	-0.04 ± 0.09	(-0.12, 0.1)		
	Low HOA < 0.3 µm	109	-0.06 ± 0.08	(-0.12, 0.1)	0.003*	+0.26
	High HOA ≥ 0.3 µm	18	-0.03 ± 0.09	(-0.12, 0.1)		
	Low CW-Chord < 0.5 mm	97	-0.06 ± 0.08	(-0.12, 0.1)	0.555	+0.05
	High CW Chord ≥ 0.5mm	30	-0.05 ± 0.08	(-0.12, 0.1)		
UDVA	Low SA (Z4,0) < 0.4 µm	116	0.08 ± 0.18	(-0.12, 0.60)	0.852	-0.01
	High SA (Z4,0) ≥ 0.4 µm	28	0.12 ± 0.23	(-0.12, 0.7)		
	Low HOA < 0.3 µm	125	0.09 ± 0.20	(-0.12, 0.7)	0.105	+0.13
	High HOA ≥ 0.3 µm	19	0.08 ± 0.17	(-0.12, 0.4)		
	Low CW-Chord < 0.5 mm	113	0.09 ± 019	(-0.12, 0.7)	0.674	+0.03
	High CW Chord ≥ 0.5 mm	31	0.08 ± 0.20	(-0.12, 0.6)		
UNVA	Low SA (Z4,0) < 0.4 µm	112	0.37 ± 0.24	(0.07, 1.3)	0.072	+0.15
	High SA (Z4,0) ≥ 0.4 µm	27	0.42 ± 0.28	(0.07, 1.3)		
	Low HOA <0.3 µm	121	0.38 ± 0.25	(0.1, 1.3)	0.216	-0.10
	High HOA ≥ 0.3 µm	18	0.37 ± 0.28	(0.07, 1.3)		
	Low CW-Chord < 0.5 mm	108	0.36 ± 0.23	(0.07, 1.3)	0.464	+0.06
	High CW Chord ≥ 0.5 mm	31	0.44 ± 0.29	(0.10, 1.3)		

*Statistically Significant at the 5% Level of Significance

Adverse Events

No serious adverse events were reported. One patient reported night starburst; however, all of the patients were able to drive at night. One out of 117 eyes implanted with RayOne EMV Toric required post-op IOL rotation.

Discussion

The findings from this retrospective clinical audit demonstrate the potential of enhanced monofocal IOLs, such as the RayOne EMV and EMV Toric, to optimize visual outcomes across different refractive targets. These lenses aim to balance the benefits of traditional

monofocal IOLs with improved intermediate vision, making them an attractive option for patients seeking enhanced functional vision with minimal visual disturbances.

Monocular and Binocular Visual Outcomes

Monocular VA outcomes showed that the emmetropic and slight myopic target groups achieved excellent UDVA, with 97.5% and 83% of eyes reaching a UDVA of 6/12 (0.30 logMAR) or better, respectively. These results align with existing literature, emphasizing the distance vision provided by enhanced monofocal IOLs similar to traditional monofocal lenses while maintaining low incidences of photic phenomena such as glare and halos [4-10]. Furthermore, compared to trifocal lenses, a recent study found that Rayone EMV lenses with mini-monovision targets offered superior visual acuity at all distances and reduced dysphotopsia [19]. For near vision, the slight myopic target group performed better, with 78.84% achieving UNVA of N8 (0.30 logMAR) or better, highlighting the advantage of slight myopia in enhancing intermediate and near vision without the need for glasses [20]. Both the moderate and high myopic target groups showed 100% of eyes achieving N8 UNVA. Further studies involving larger number of patients in each group can confirm these results.

Binocular assessments reinforced the functional vision benefits of these lenses. In the mini-monovision group, 80.4% achieved a binocular UDVA of 6/6 (0.0 logMAR) or better, and 84% achieved a UNVA of N8 (0.30 logMAR) or better. These outcomes underscore the importance of binocular summation, which enhances depth perception and contrast sensitivity, particularly in tasks requiring intermediate vision [16-22]. Patients in the modest and full monovision groups achieved superior UNVA results, with 100% reaching N6 (0.18 logMAR) or better, suggesting that targeting greater degrees of monovision may further enhance near vision capabilities [23]. Our findings are consistent with a recent study that used RayOne EMV lenses and found that mini-monovision targets are a dependable way to achieve near and intermediate VA without compromising distance VA [24].

Refractive Targeting and Postoperative Vision

Refractive targeting plays a pivotal role in customizing visual outcomes for patients. In this study, mini-monovision (-0.25D to -0.75D in the near eye) emerged as the most common strategy, offering a balanced compromise between distance and near vision. Previous studies have similarly demonstrated the efficacy of mini-monovision in reducing dependence on glasses for intermediate tasks without significant compromises in binocular vision [10-25].

The modest and full monovision groups demonstrated superior near vision outcomes, with all patients achieving excellent binocular UNVA, corroborating with a previous study [26]. These results underscore the importance of patient-specific targeting to meet individual visual needs. For patients prioritizing near tasks, such as reading or using electronic devices, targeting greater degrees of monovision may offer enhanced functionality. Moreover, our findings also demonstrated that UDVA was comparable across all groups. This may suggest that the pursuit of monovision strategies does not negatively impact distance vision in patients undergoing bilateral IOL implantation.

Influence of Preoperative Parameters

This study highlights the limited impact of preoperative parameters such as corneal SA and CW-chord on UDVA, UNVA, and CDVA outcomes. This finding contrasts with prior studies that identified SA and CW-chord as significant predictors of postoperative visual performance [27-29]. However, the previous studies incorporate either conventional monofocal, multifocal or extended depth of focus IOLs. The negligible effect in this study may stem from the design of the RayOne EMV IOL, which incorporates controlled positive spherical aberration, compensating for variations in corneal SA [29,30].

Higher-Order Aberrations (HOAs) showed a mild positive correlation with CDVA, indicating that higher preoperative HOAs may adversely affect distance vision outcomes. This aligns with research suggesting that elevated HOAs can degrade image quality and contrast sensitivity, particularly in low-light conditions [13-32]. This finding should be qualified, bearing in mind that the monocular CDVA of the high HOA group was still better than 0 logMAR (-0.03) and that this group was small (n=18). This correlation was not seen for UDVA or UNVA, but may indicate the benefit of thorough preoperative assessments to identify patients more likely to have slightly reduced CDVA.

Safety and Adverse Events

The safety profile of the RayOne EMV IOLs was consistent with previous reports of enhanced monofocal lenses, with no serious adverse events and a very low incidence of photic phenomena [8-19]. The single case of night starburst reported underscores the need for ongoing patient counseling about potential side effects, even with lenses designed to minimize such disturbances. YAG laser capsulotomy was conducted with a very low threshold, in all eyes with minimal or suspected Posterior Capsular Opacification (PCO) (7.5% of eyes at up to 12 months post-op). Posterior Capsular Opacification (PCO) remains a common long-term concern following cataract surgery and highlights the importance of regular postoperative monitoring [33].

Conclusion and Clinical Implications

These findings underscore the utility of enhanced monofocal IOLs in delivering high-quality vision tailored to diverse refractive targets. The RayOne EMV or EMV Toric IOLs, with their innovative design incorporating positive spherical aberration, demonstrate promising outcomes, particularly for patients seeking a balance between distance and intermediate vision. A mini-monovision approach delivers a useful range of distance and intermediate vision in most patients even with variation of preoperative aberration profile. The negligible clinical impact of some preoperative parameters found in this study warrants further investigation, particularly in larger cohorts, to refine patient selection criteria for newer IOL designs.

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