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ORIGINAL RESEARCH

Visual and Refractive Outcomes and Patient Satisfaction Following Implantation of Monofocal IOL in One Eye and ERV IOL in the Contralateral Eye with Mini-Monovision

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Title: Visual and refractive outcomes and patient satisfaction following implantation of monofocal intraocular lens in one eye and ERV intraocular lens in the contralateral eye with mini-monovision.

Purpose: To evaluate the outcomes following implantation of monofocal intraocular lens in one eye and ERV intraocular lens in the contralateral eye with mini-monovision.

Methods: Twenty-five subjects underwent bilateral cataract surgery, wherein the dominant eye received monofocal Tecnis-1 IOL, while in the contralateral eye received the Tecnis Symphony ERV IOL. The dominant eye was targeted for emmetropia and the non-dominant eye for myopia of −0.50 to −0.75D. Binocular uncorrected and corrected distance (UDVA, CDVA), intermediate (UIVA, CIVA), and near (UNVA, DCNVA) visual acuity; reading speeds, defocus curve and contrast sensitivity were studied at 6 months post-operatively.

Results: At 6 months post-operatively the mean binocular UDVA, CDVA, UNVA and DCNVA were 0.007±0.07, −0.13±0.06, 0.26±0.09 and 0.44±0.10 LogMAR, respectively. Binocular UIVA and DCIVA at 60 cm were 0.22±0.10 and 0.18±0.08 LogMAR and at 80 cm was 0.16±0.11 and 0.15±0.10 LogMAR, respectively. Mean uncorrected reading speeds evaluated with SRD at 40, 60 and 80 cm were 114.4±6.9, 126.4±7.9 and 123.16±5.8 words per minute. Contrast sensitivity values did not show significant difference for any spatial frequency tested. At 6 months, only 12% (3 patients) reported mild halos. Spectacle independence satisfaction scores were 96%, 100% and 88% for distance, intermediate and near.

Conclusion: Implantation of monofocal intraocular lens in one eye and ERV intraocular lens in the contralateral with mini-monovision resulted in good outcomes for far and intermediate, and satisfactory outcomes for near vision, with good tolerance to mini-monovision at the end of 6 months.

Keywords: hybrid monovision, extended range of vision IOL, monofocal IOL

Introduction

Multifocal IOLs are known to provide better outcomes for near and intermediate vision, and a greater depth of focus; due to which they appear to deliver higher spectacle independence and patient satisfaction compared to monofocal IOLs.[1,2] Due to these advantages, various varieties of MFIOLs have been paired with monofocal intraocular lenses to restore the loss of accommodation following cataract surgery, especially in patients who already have a monofocal implant in

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one eye. The concept of "Hybrid monovision" wherein a monofocal IOL was implanted in the dominant eye and a diffractive multifocal IOL in the non-dominant eye was shown to provide superior outcomes in terms of post-operative near vision and patient satisfaction following cataract surgery.[3,4]

The recently introduced Tecnis Symfony IOL (Johnson & Johnson, New Jersey, USA) is based on the concept of chromatic aberration correction through a proprietary achromatic technology. In addition, the IOL is claimed to extend the range of vision by virtue of its novel, diffractive step-like optical profile.[5,6]

The current study was conducted to evaluate the visual and refractive outcomes and patient satisfaction following planned "Hybrid monovision" with extended range of vision (ERV) IOLs, wherein a monofocal IOL was implanted in one eye and an ERV IOL in the contralateral eye, in a 6-month prospective clinical trial.

Methodology

This prospective, single-centre study was approved by the institutional review board of Nethradhama Super speciality Eye Hospital, Bangalore, and was conducted in accordance with the principles of the Declaration of Helsinki. Only those patients who provided written informed consent and whose follow-ups were assured were included.

Inclusion criteria were eyes with senile cataract without any ocular co-morbidity; corneal astigmatism within 0.5 dioptres (D); IOL powers within the range of +10.00 D and +32.00 D, uneventful surgery, and assured follow-ups.

Exclusion criteria were age outside the range of 40–80 years, eyes with irregular astigmatism due to keratoconus or corneal scars, previous history of refractive surgery, severe dry eye, corneal dystrophies, active conjunctivitis, glaucoma, uveitis, pupillary abnormalities, retinopathy or macular dystrophy, neuro-ophthalmic diseases, and inability to read English language fluently.

Pre-Operative Assessment and IOL Power Calculation

All patients underwent complete ophthalmic examination including subjective refraction, non-contact tonometry, and slit-lamp biomicroscopy and dilated fundus examination. Biometry was performed with the IOL Master 700 (Carl Zeiss Meditec, Jena, Germany) using the Barrett-II Universal formula. The dominance of the eyes was tested using the camera, shooting or hole in the card test. In all subjects, the dominant eye was targeted for emmetropia, whereas the non-dominant eye was targeted at myopia of −0.75 D. The dominant and the non-dominant eyes were planned for implantation of Tecnis-1 monofocal IOL and Tecnis Symfony IOL, respectively. In subjects, where clear dominance could not be identified, the eye with advanced cataract received Tecnis-1 monofocal IOL. For all cases, the Tecnis-1 monofocal eyes were planned first. Second eye surgery with Symfony ERV IOL was scheduled within 2 weeks from the first eye surgery. Patients were appropriately counselled about neuroadaptation due to dissimilar optical systems in both eyes.

Post-operative follow-ups were performed at 1 day, 1 week, 1 month, and 6 months post-surgery. The following tests were performed from the first week onwards: assessment of binocular uncorrected (UDVA) and corrected distance visual acuity (CDVA), binocular uncorrected (UNVA) and distance-corrected near visual acuity (DCNVA) at 40 cm, and binocular uncorrected (UIVA) and distance-corrected intermediate visual acuity (DCIVA) at 60 cm using ETDRS charts (Precision Vision, La Sella, IL, USA); binocular mesopic contrast sensitivity testing (F.A.C.T. Stereo Optical Co. Inc., Chicago) with distance correction; and defocus curve testing from +2.50 to −4.00 D.

Reading performance was evaluated using the Salzburg reading desk (SRD) (University Eye Clinic, Paracelsus Medical University of Salzburg, Austria) which provides for controlled reading distance and automated calculation of logarithmic reading acuity and the reading speeds. From one week onwards, and uncorrected (UCRS) and distance corrected reading speeds(DCRS) with a minimum reading speed of 80 words per minute (wpm), representing the lower limit for recreational sense-capturing reading, were evaluated.[7] Also, a quality of vision (QOV) questionnaire was obtained at one and six months follow-ups regarding dysphotopsia symptoms and spectacle independence for various activities.[8]

Surgical Technique

All operations were performed by a single experienced cataract surgeon (S.G.), using a standard phacoemulsification technique (Phaco-chop) under topical anaesthesia. The UNFOLDER Platinum 1 Series Screw-Style Inserter (Johnson & Johnson, New Jersey, USA) was used to inject the IOL through a 2.8 mm temporal clear corneal incision for both the eyes. Post-operative medications included topical prednisolone (1%, Pred Forte, Allergan), moxifloxacin (0.5%, Vigamox, Alcon), and nepafenac (0.1%,

Nevanac, Alcon) in tapering dosage for 6 weeks; along with lubricant eye drops on an SOS basis.

Statistical Analysis

Statistical analysis was performed using the SPSS software for Windows version 17.0.0 (IBM Corp., Armonk, NY). The normality of data samples was checked. Student's *t*-test for paired data was used when parametric analysis was possible, whereas the Mann–Whitney test was applied to assess the significance of differences when parametric analysis was not possible. A *p* value of 0.05 or less was considered statistically significant. All values were expressed as mean ± standard deviation (SD).

Results

A total of 25 patients with a mean age of 64.76 ± 9.2 years, undergoing bilateral cataract surgery with Tecnis −1 monofocal IOL in one eye and Tecnis Symfony ERV IOL in the contralateral eye were recruited in the study. Table 1 provides the demographic and pre-operative data of all the study subjects. Since mini-monovision was performed, the post-operative visual outcomes and reading speeds were evaluated binocularly.

Visual Outcomes

Table 2 shows the binocular visual outcomes for distance, near and intermediate visual acuity and reading speeds at 6 months post-operatively.

At 6 months, 88% patients had binocular UDVA of 20/20 or better, whereas, all (100%) patients had a binocular UDVA of at least 20/32, (Figure 1). The binocular cumulative CDVA graph showed 92% of patients having 20/20 or better and 100% patients have CDVA of 20/32 or better (Figure 1). The mean UDVA in eyes with Tecnis-1 IOL was 0.04 ± 0.08 Log MAR, which was significantly better than eyes implanted with Symfony IOL (0.20 ±0.07 Log MAR), p= 0.00.

All patients had an uncorrected binocular near vision of 20/50; however, 8% of patients had a cumulative UNVA of 20/20 or better and 84% patients 20/32 or better (Figure 2). The UNVA in the ERV IOL eyes was significantly better compared to the monofocal eyes (LogMAR 0.21 ± 0.09 versus 0.47± 0.18), p=0.00.

The cumulative binocular UIVA of 20/40 or better was achieved in 100% and 96% patients at 60 and 80 cm, respectively. However, 43% of patients achieved UIVA of 20/25 or better at 60 cm, whereas this percentage was 65% at 80 cm (Figure 3). There was no statistically significant difference between the mean UIVA values at 60 and 80 cm (p =0.10) (Table 2).

Refractive Outcome

The mean SE in the Tecnis −1 monofocal IOL group was −0.10 ±0.25 D, whereas in the Symfony ERV IOL group it was −0.79 ±0.31 D at six months post-operatively, the difference between the two being statistically significant (p= 0.00) (Table 3).

Ninety-six percent of eyes in the monofocal group had post-op SE within ±0.50 D, and all eyes were within ± 1.00 D of SE predictability. On the other hand, in the ERV group, 16% eyes achieved post-op SE refraction within ±0.50 D, and all eyes were within ± 2.00 D of SE predictability (Figure 4).

Table 1 Demographic and Pre-Operative Data of Patients Included in the Study

Parameter	Monofocal IOL (Tecnis-1) (n=25 Eyes) Mean ± SD	ERV IOL (Symfony) (n=25 Eyes) Mean ± SD	p-value
Sphere (D)	−0.46±2.17	−0.33±2.07	0.82
Cylinder (D)	−0.22±0.73	−0.06±0.76	0.45
SE (D)	−0.57±2.40	−0.36±2.35	0.75
UDVA(LogMAR)	0.46 ± 0.28	0.44 ± 0.27	0.8
CDVA (LogMAR)	0.29 ± 0.16	0.32 ± 0.22	0.52
K1(D)	43.35 ± 1.23	43.19 ± 1.41	0.78
K2 (D)	44.20 ± 1.26	43.73 ± 1.42	0.9
Corneal astigmatism(D)	0.39 ± 0.39	0.31 ± 0.31	0.72
Axial length(mm)	23.56 ± 1.17	23. 6 ± 1.14	0.93
IOL power (D)	20.93 ± 3.26	21.86 ± 2.79	0.56

Abbreviations: D, dioptre; SE, spherical equivalent; UDVA, uncorrected distance visual acuity; CDVA, corrected distance visual acuity; K, keratometry.

Table 2 Binocular Visual Acuity Outcomes at 6 Months Post-Operatively

Parameter	Uncorrected	Distance Corrected	p-value
	(Mean± SD) [Range]	(Mean± SD) [Range]	
Visual acuity (LogMAR)			
Distance	0.007±0.07(UDVA) [−0.1 to 0.2]	−0.13±0.06(CDVA) [−0.2 to −0.18]	0.00
Near	0.26±0.09(UNVA) [0.1 to 0.4]	0.44±0.10(DCNVA) [0.2 to 0.6]	0.00
Intermediate (60 cm)	0.22±0.10(UIVA) [−0.1to 0.3]	0.18±0.08(DCIVA) [−0.1to 0.3]	0.18
Intermediate (80 cm)	0.16±0.11(UIVA) [−0.1to 0.4]	0.15±0.10(DCIVA) [−0.1to 0.3]	0.79
Reading speeds (wpm)			
Reading speed (40 cm)	114.48 ± 6.98 [100to 127]	108.52 ± 7.63 [93 to 121]	0.006
Reading speed (60 cm)	126.44 ± 7.93 [115 to 143]	125.88 ± 7.46 [112 to 142]	0.84
Reading speed (80 cm)	123.16 ± 5.89 [111to 132]	127.28 ± 5.67 [113 to 136]	0.07
Uncorrected reading speeds40 cm v/s 60 cm			0.00
Uncorrected reading speeds40 cm v/s 80 cm			0.00
Uncorrected reading speeds60 cm v/s 80 cm			0.10

Abbreviations: UDVA, uncorrected distance visual acuity; CDVA, corrected distance visual acuity; UNVA, uncorrected near vision acuity; DCNVA, distance-corrected near visual acuity; UIVA, uncorrected intermediate visual acuity; DCIVA, distance-corrected intermediate visual acuity.

In the monofocal group, 88% percent eyes and in the ERV group 96% of eyes had post-operative refractive astigmatism within ±0.50 D. All eyes in both groups were within ± 1.00 D of cylindrical correction (Figure 5).

Reading Speeds

Figure 6 shows the mean uncorrected and corrected reading speeds at 40, 60 and 80 cm, evaluated with the SRD. At 40 cm, the uncorrected reading speed was

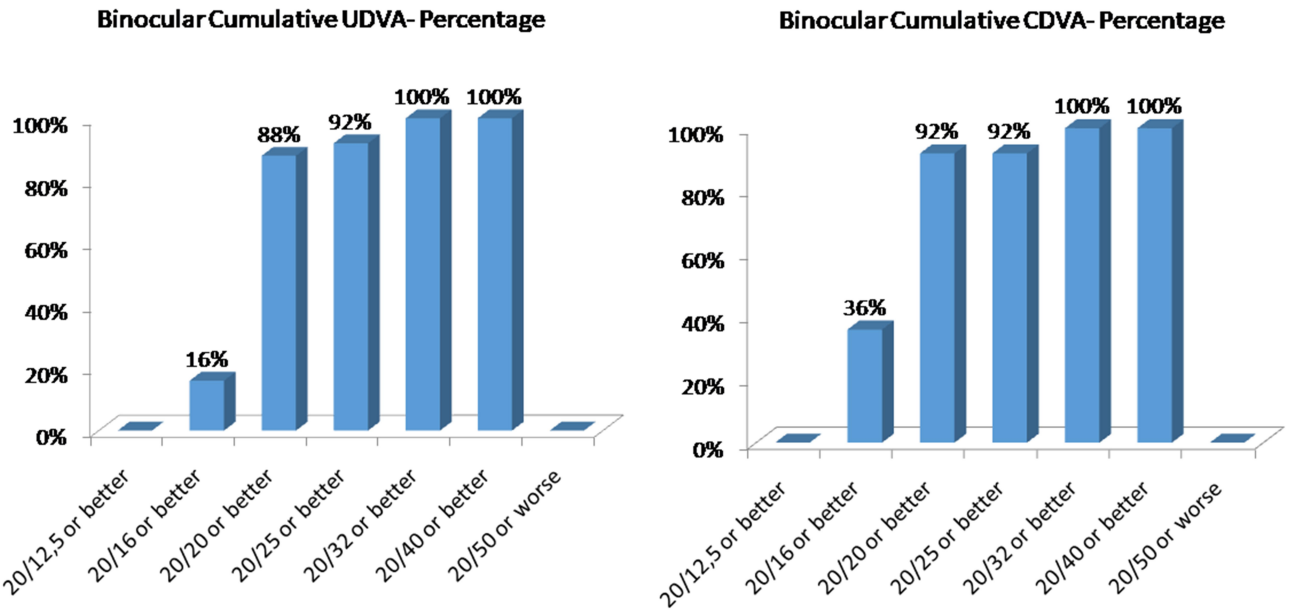


Figure 1 Percentage binocular cumulative UDVA and CDVA for the monofocal and ERV groups, 6 months post-operatively.

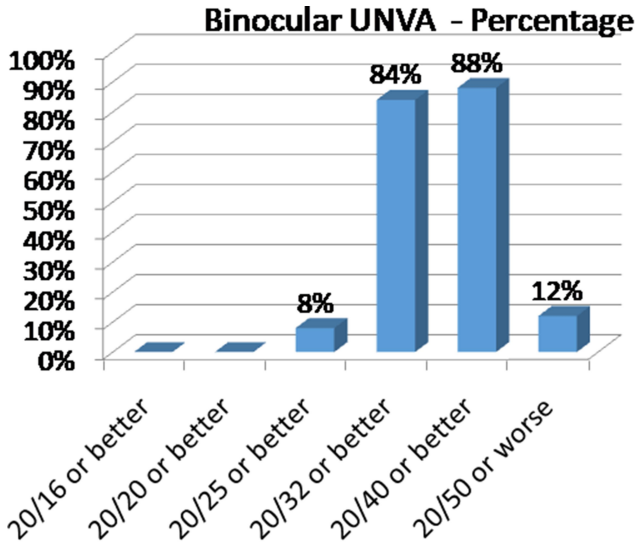


Figure 2 Percentage binocular uncorrected near visual acuity (UNVA), for the monofocal and ERV groups, 6 months post-operatively.

significantly better compared to corrected values (p-value=0.006), however, at 60 and 80 cm, no significant difference was observed between the uncorrected and corrected reading speeds (p-value =0.84 for 60 cm, 0.07 for 80 cm) (Table 2). The uncorrected reading speeds at 60cm and 80 cm were significantly better than at 40cm (p-value=0.00 for both comparisons), however, no significant difference was observed between the uncorrected reading speeds at 60 and 80cm (p-value=0.10) (Table 2)

Contrast Sensitivity

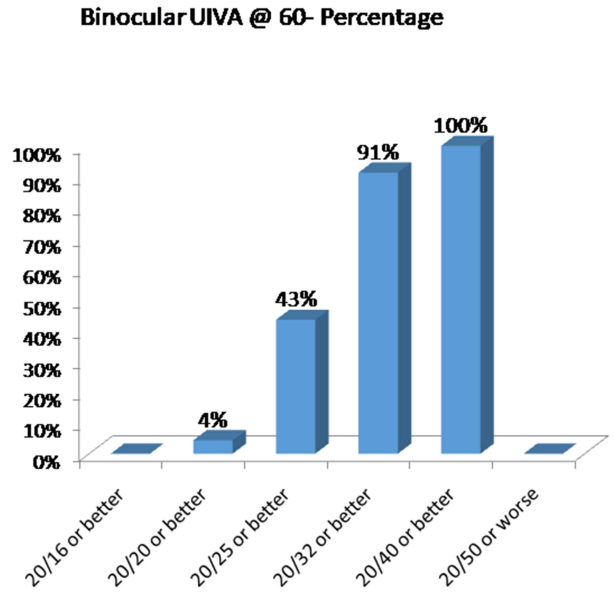
Table 3 shows the mean contrast sensitivity values for Tecnis-1 monofocal and Symfony ERV IOL groups, measured after correction, using the F.A.C.T. chart in photopic conditions at 6 months post-operatively. The results did not show significant difference for any of the spatial frequencies evaluated (Table 3, Figure 7).

Defocus Curve

Binocular distance corrected defocus curves were charted from +1 to −4 D defocusing lenses, for all patients at 6 months. The curve showed a peak corresponding to best visual acuity at 0 D, followed by a gradual decline in best-corrected vision towards the myopic range. The curve was relatively smoother without any distinct multiple peaks thereafter (Figure 8). The range of functional vision, ie a visual acuity of 0.2 LogMAR (20/32) or better was seen to be spread over a defocus range of approximately 3.0 D.

Patient Satisfaction Questionnaire

A QOV questionnaire which graded glare, haloes and starbursts on a score of 1–4 for each symptom (overall score 12, 1 being the highest and 4 being the lowest in severity) obtained at 1 and 6 months, showed 50% (12/25) patients complaining of mild to moderate haloes at 1 month, which reduced to 12% (3/25) of patients, reporting only mild haloes by the end of 6 months. No patient reported severe haloes post-operatively at any time point.



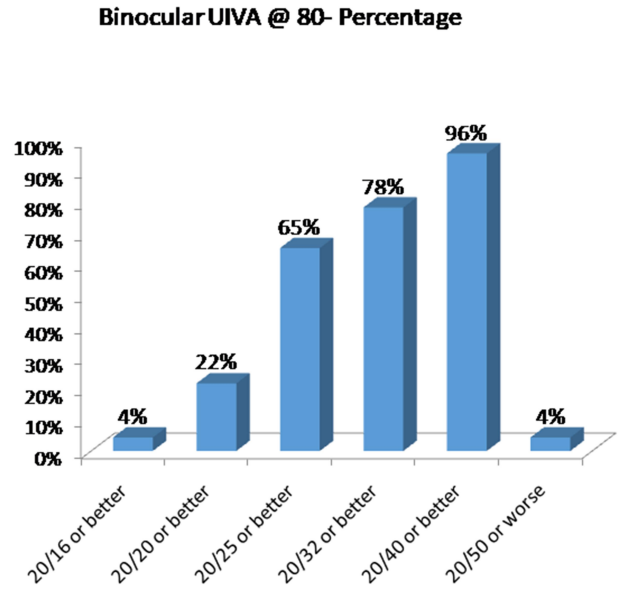


Figure 3 Percentage binocular uncorrected intermediate visual acuity (UIVA) @ 60 and 80 cm 6 months post-operatively.

Table 3 Uniocular Post-Operative Data

Parameter	Monofocal IOL(Tecnis)	ERV IOL(Symfony)	p-value
	n = 25 Eyes	n = 25 Eyes	
	Mean± SD [Range]	Mean± SD [Range]	
UDVA (LogMAR)	0.04±0.08 [−0.08to 0.22]	0.20±0.07 [0.02to 0.32]	0.00
CDVA (LogMAR)	−0.02±0.04 [−0.1to 0.08]	−0.01±0.03 [−0.1to 0]	0.35
Sph (D)	−0.07±0.17 [−0.5to 0.25]	−0.71±0.29 [−1.25to 0]	0.00
Cyl (D)	−0.16±0.42 [−1to 0. 5]	−0.16±0.17 [−0.5to 0]	0.69
SE (D)	−0.10±0.25 [−0.5to 0]	−0.79±0.31 [−1.5to 0]	0.00
UNVA	0.47±0.18 [0.1to 0.7]	0.21±0.09 [0to 0.5]	0.00
DC NVA	0.78±0.07 [0.7to 0.9]	0.39±0.06 [0.3to 0.5]	0.00
FACT			
A (1.5 cpd)	1.2 ± 0.09 [1.11to 1.4]	1.16 ± 0.09 [0.95to 1.25]	0.19
B (3 cpd)	1.55 ± 0.1 [1.3to 1.76]	1.52 ± 0.08 [1.3to 1.6]	0.18
C (6 cpd)	1.43 ± 0.08 [1.36to 1.52]	1.40 ± 0.12 [1.08to 1.52]	0.45
D (12 cpd)	1.09 ± 0.08 [0.9to 1.18]	1.05 ± 0.10 [0.9to 1.18]	0.24
E (18 cpd)	0.65 ± 0.08 [0.6to 0.78]	0.64 ± 0.07 [0.6to 0.78]	0.53

Abbreviations: UDVA, uncorrected distance visual acuity; UDVA, uncorrected distance visual acuity; D, dioptre; UNVA, uncorrected near visual acuity; DCNVA, distance corrected near visual acuity; cpd, cycles per degree.

Regarding spectacle independence; satisfaction scores were 96% (24/25), 100%, 80% (20/25) for distance, intermediate and near vision, respectively. Twelve percent (3/25) of patients reported the need for reading glasses for fine print at 6 months (Table 4).

Adverse Effects and Complications

No intra-operative or post-operative complications such as cystoid macular oedema, post-op uveitis, secondary glaucoma or posterior capsule opacification requiring YAG-Capsulotomy were noted in any of the eyes of either group.

Discussion

The extended range of vision IOL evaluated in the current study has been shown to provide visual restoration which is better or comparable to that achievable with a multifocal IOL, but without the known level of visual degradation associated with this type of IOL. This can be possibly explained by the fact that the extended range of vision IOL does not induce aberrations or multiple foci to achieve depth of focus. Also, the correction of chromatic corneal aberration together with the specific diffractive pattern generates an extended range of clear vision.[9,10] The objective of this study was to assess clinical

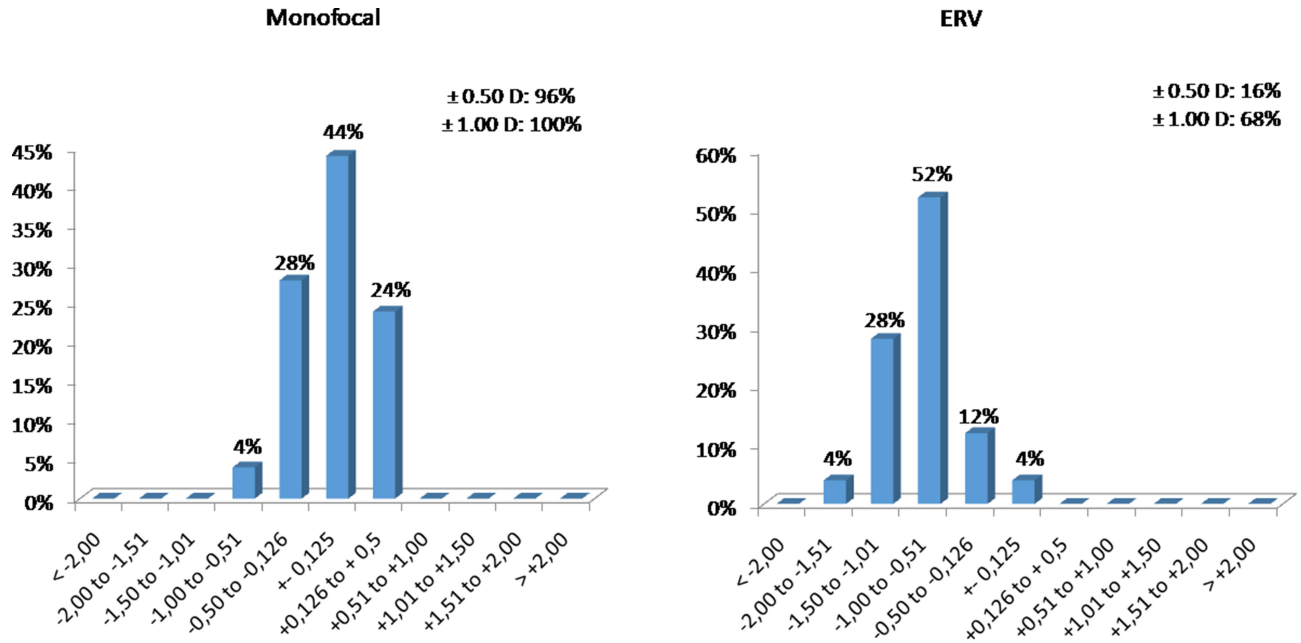


Figure 4 Post-operative spherical equivalent (SE) predictability for the Tecnis-1 monofocal and Symfony ERV groups, 6 months post-operatively.

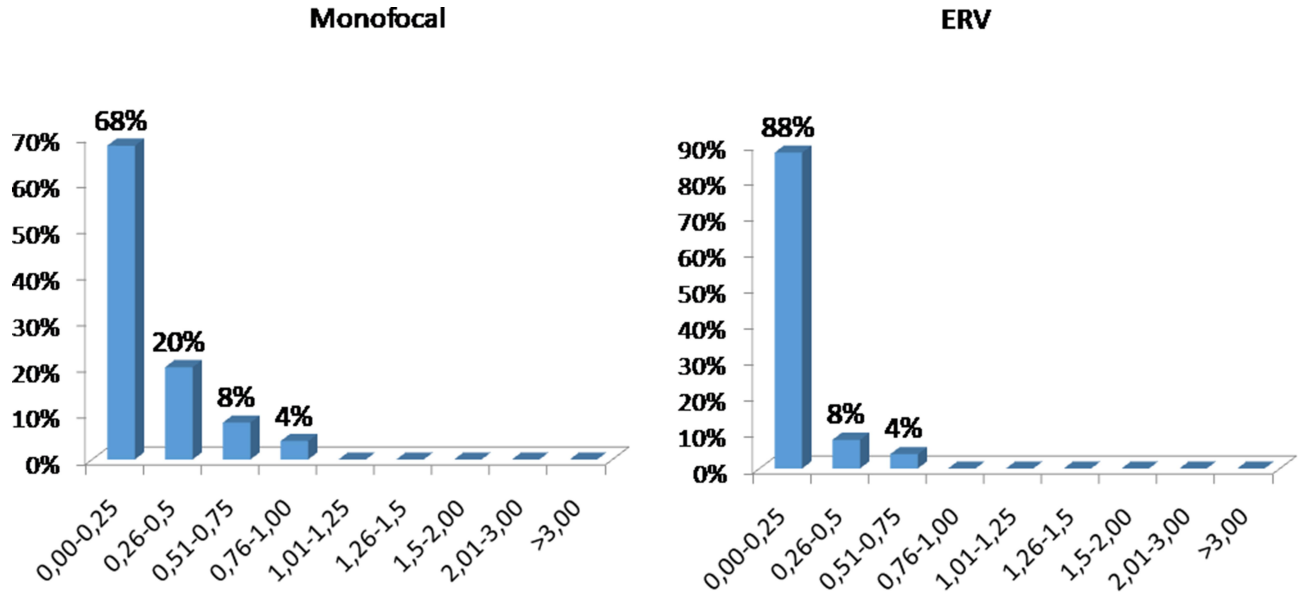


Figure 5 Post-operative refractive astigmatism (dioptres) for the Tecnis-1 monofocal and Symfony ERV groups, 6 months post-operatively.

outcomes, quality of vision and patient satisfaction with an intentional planning of a monofocal IOL in one eye and an ERV IOL in the contralateral eye. As a significant number of patients presenting for cataract surgery opinion already have one eye operated elsewhere with a monofocal implant, the acceptability of this combination was an interesting area to explore.

Studies comparing trifocal IOLs such as the Acrysof IQ PanOptix and Finevision trifocal IOLs, with the Symfony ERV IOL, clearly demonstrated significantly better near vision with trifocal IOLs.[11,12] Hence, while planning hybrid monovision with ERV IOL, it becomes mandatory to target the non-dominant eye for slight myopia of −0.5 to −0.75 D, provided the monofocal eye is emmetropic; thus creating a mini-monovision. In a recent study by Cochener et al, where a sub-analysis of 411 patients from the multicenter CONCERTO study was performed aiming at evaluating the outcomes after bilateral

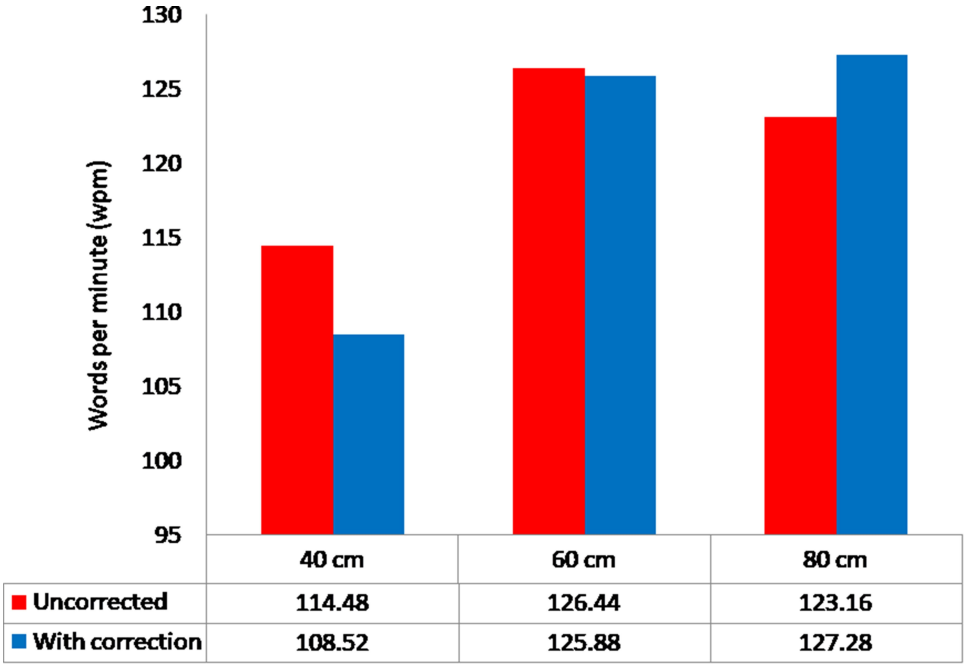


Figure 6 Reading speeds with Salzburg Reading Desk, for the Tecnis-1 monofocal and Symfony ERV groups, 6 months post-operatively.

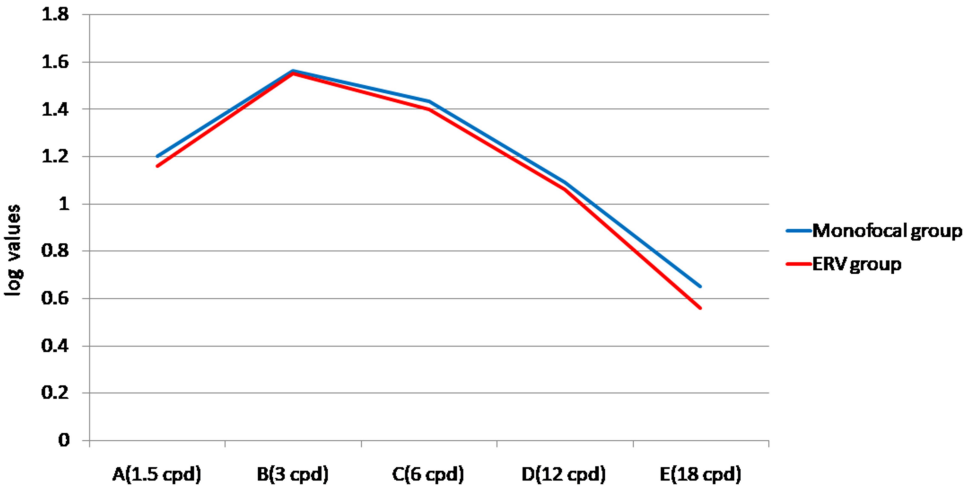


Figure 7 Binocular photopic contrast sensitivity for Tecnis-1 monofocal and Symfony ERV groups at 6 months post-operatively.

implantation of the Tecnis Symfony IOL. In the study, visual acuity, spectacle independence, photic phenomena incidence, and patient satisfaction outcomes were evaluated in six groups defined according to the level of monovision: ranging from 0 to >1.0 D. The authors concluded that mini-monovision of around 0.75 D provided a complete visual rehabilitation with minimal photic phenomena and high levels of patient satisfaction after implantation of the Tecnis Symfony IOL.[13] Besides good visual and spectacle independence outcomes, monovision levels of around 0.75 D were also found to provide low incidence of halos and glare, with 88.5% and 96.2%, respectively, not reporting them at all or reporting only occasionally. This incidence is minimal compared to the dissatisfaction rates and patient complaints due to these phenomena observed with multifocal IOLs.

It is a known fact that traditional MFIOL technologies can be associated with bothersome dysphotopsias, accounting up to 38.2% of the various causes of patient dissatisfaction following MFIOL implantation.[14] Mini-monovision has been shown to be an effective approach for both reducing spectacle independence as well as

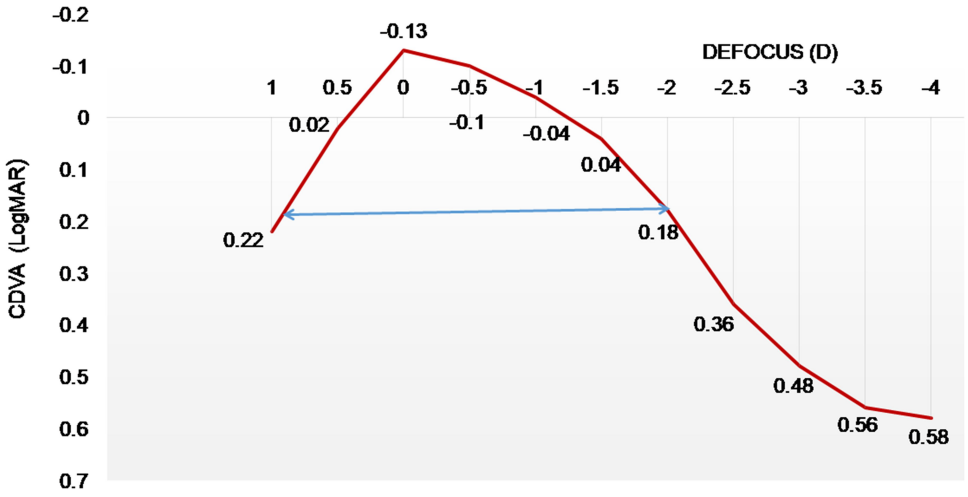


Figure 8 Defocus curves, y-axis= CDVA logMAR, x axes= level of defocus in dioptres for the Tecnis-1 monofocal and Symfony ERV groups.

dysphotopsia, which were found to be significantly less compared to multifocal intraocular lens implantation.[15,16] Since Tecnis Symfony ERV IOL has been shown to result in fewer dysphotopsia symptoms compared to traditional MFIOLs,[17] its combination with monofocal IOL in the contralateral eye, would theoretically result in further reducing the photic phenomena, potentially improving the tolerance and patient acceptability.

Table 4 QOV Questionnaire for Dysphotopsia Symptoms Grading and Spectacle Independence

Symptom Severity	Glare Grading
Nil	Grade 1
Mild	Grade 2
Moderate	Grade 3
Severe	Grade 4
Symptom Severity	**Haloes Grading**
Nil	Grade 1
Mild	Grade 2
Moderate	Grade 3
Severe	Grade 4
Symptom Severity	**Starbursts Grading**
Nil	Nil
Mild	Mild
Moderate	Moderate
Severe	Severe
Spectacle Independence	
Complete	80–100%
Partially dependent for certain activities	40–79%
Dependent on spectacles for all activities	<40%

Notes: Dysphotopsia symptoms (glare/haloes/starbursts) grading was done as per the following questionnaire: 1 = nil, no dysphotopsia symptoms experienced; 2 = mild/minimal dysphotopsia not affecting night vision and routine activities; 3 = moderate, dysphotopsia symptoms affecting night vision and routine activities, but manageable; 4 = severe, bothersome dysphotopsia, severe enough to interfere in routine activities. Spectacle independence was assessed on a scale of 0–100%.

In contrast to our results with binocular implantation of Symfony ERV IOL,[8] wherein 32% (8/25) of the patients had complaints of seeing moderate-to-severe halos at night; in the present study, only 12% (3/25) patients reported halos and glare of mild grade; while in the rest of the 22 patients, these symptoms had completely resolved by the end of six months. Surprisingly, the dysphotopsia symptoms were low despite the monovision, suggesting that patients may adapt to hybrid monovision better compared to traditional monovision practiced with bilateral ERV IOLs, since the dominant eye; which is aimed for distance, does not additionally contribute to dysphotopsia, resulting in better acceptability.

Pseudophakia monovision with monofocal IOLs is a tried and tested strategy to restore the loss of accommodation post-cataract surgery. However, to achieve satisfactory near vision, one needs to perform traditional monovision, ie anisometropia of −1.50 D or above, which may be associated with various side effects and reduced patient satisfaction.[18,19] The advantage of hybrid monovision with ERV IOLs is that good near vision outcomes may be achieved by performing mini-monovision, thus avoiding most of the bothersome disadvantages of the traditional monovision.

A study by Cochener et al compared defocus curves of trifocal IOLs versus EDOF IOL, wherein with trifocal lenses, slight humps at the principal foci could be identified, however, the curve achieved with the EDOF Tecnis

Symfony IOL was smoother in the shape of a dome.[20] In the present study also, we found the binocular distance corrected defocus curves showing a relatively smoother and dome shaped (Figure 8). The range of functional vision, ie visual acuity of 20/32 or better, was seen to be spread over a defocus range of approximately 3.5 D; which was similar to those seen in both the above studies.

Regarding contrast sensitivity, we found no significant differences for any spatial frequency between monofocal and ERV IOL at 6 months post-op. This is in agreement with previously conducted studies wherein the contrast for both monofocal and Symfony ERV IOL was comparable.[9] Especially in context to the present study, where the monofocal IOL implanted was the aspheric and chromatic aberration correcting Tecnis-1 IOL; which is already shown to deliver excellent contrast after cataract surgery.[21] Both the IOLs, being manufactured on the same platform, when implanted together in contralateral eyes result in excellent quality of vision post-op.

Various studies have evaluated reading performance after MFIOLs following cataract surgery using Salzburg Reading Desk (SRD), which is a tool for systematic evaluation of everyday reading ability simulating natural conditions.[22,23] Alio et al, in their study evaluating the reading performance following Acri.LISA 366D diffractive multifocal IOL,[24] found that the average uncorrected reading speed at near (32.51 cm) was 117.7 words per minute(wpm). In our study, the average reading speeds at 40 cm was 114.48 wpm, which is almost similar to their study. Furthermore, we tested the reading speeds at distances of 60 cm and 80 cm, to see the performance of hybrid monovision for the complete range of near and intermediate vision. Compared to our previous study evaluating reading performance following bilateral Tecnis Symfony with mini-monovision,[8] the reading speeds at 60 and 80 cm in the present study were found to be better, the mean reading speed at 60 cm being 126 versus 119 wpm and at 80 cm being 123 versus 115 wpm. A similar observation was noticed for reading speeds at 80 cm in a study by Attia et al.[25] This could be possibly explained by the fact that bilateral implantation of Tecnis Symfony IOL in both these studies could have resulted in higher amount of glare and dysphotopsia arising from the screen while performing the test, thus potentially affecting the reading speed.

In the present study, we did not strictly follow the criteria for hybrid monovision, with respect to the dominance of the eye. In some patients, where the dominance of the eye could not be confirmed due to poor vision in one of the eyes, we decided to implant Tecnis-1 monofocal IOL in the eye with an advanced grade of cataract and Symfony ERV IOL in the contralateral eye. This does not have seem to make any difference in the outcomes, as it was shown in the earlier published studies that patient satisfaction as well as the visual results of crossed monovision were no different from conventional monovision.[26–28]

Conclusion

To our knowledge, this is the first study reporting clinical outcomes following hybrid monovision using ERV IOLs along with monofocal IOL in the contralateral eyes of the same patient. Although our sample size is small and follow-up relatively shorter, our results showed satisfactory visual outcomes for far, intermediate and near distances, with good patient satisfaction for the quality of vision and spectacle independence. This combination may be offered to patients who already have a monofocal implant in one eye (with minimum residual refraction) or may also be planned intentionally; as done in the present study.

Although we did not perform a direct comparison with a group where hybrid monovision was performed using a diffractive MFIOL, however, understanding the advantages of ERV IOL technology (better contrast, less photic phenomena, tolerance to residual refractive error) it may be suggested that these IOLs may be preferred over traditional MFIOLs for mix and match with monofocal IOLs. Further studies evaluating the results of hybrid monovision using ERV IOLs and their comparison with MFIOLs in a similar scenario are suggested to verify the results and inferences drawn from our paper.

Disclosure

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This paper was presented at the ASCRS Conference at Washington DC, in 2018, as a free paper presentation with interim findings. The presentation link can be found here: https://ascrs.confex.com/ascrs/18am/meetingapp.cgi/Paper/41301.

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