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Comparison Between Visual Outcome And Patient Satisfaction With Extended Depth Of Focus Lens Implanted In Monofocal Pseudophakic Patients

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Abstract
Background*: Monofocal intraocular lenses (IOLs) provide excellent distance vision following cataract surgery but offer limited intermediate and near vision, often necessitating spectacle use. Extended Depth-of-Focus (EDOF) IOLs have been developed to provide a continuous range of vision with improved spectacle independence and patient satisfaction.*
Aim: *To compare visual outcomes and patient satisfaction following implantation of an EDOF intraocular lens in the second eye of monofocal pseudophakic patients.*
Materials and Methods: *This follow-up study was conducted in the Department of Ophthalmology at a tertiary care hospital. Ninety-four monofocal pseudophakic patients with senile cataract in the fellow eye were enrolled. All patients underwent phacoemulsification with EDOF IOL implantation in the cataractous eye. Distance, intermediate, and near visual acuity were assessed preoperatively and postoperatively on day 1, day 7, and day 30. Binocular visual performance and patient satisfaction were evaluated using a validated questionnaire. Data were analyzed using SPSS version 22, and a p-value <0.05 was considered statistically significant.*
Results*: The majority of patients were aged 60–80 years (60.6%), and 59.6% were females. Distance visual acuity improved significantly following EDOF implantation, with the mean LogMAR improving from 0.40 ± 0.24 in monofocal eyes to 0.19 ± 0.05 at postoperative day 30 (p<0.001). By day 30, 78.7% of patients achieved N6 intermediate vision, while 74.4% attained N8–N10 near vision. Mean binocular distance visual acuity improved from 0.45 ± 0.30 preoperatively to 0.26 ± 0.23 postoperatively (p<0.001). Patient satisfaction increased significantly from 1.54 ± 0.54 preoperatively to 4.54 ± 0.58 postoperatively (p<0.001).*
Conclusion: *Implantation of an EDOF intraocular lens in the fellow eye of monofocal pseudophakic patients significantly improved distance, intermediate, and near visual acuity, enhanced binocular visual performance, and increased patient satisfaction. EDOF IOLs provide greater spectacle independence while maintaining excellent distance vision, making them an effective option for visual rehabilitation in these patients.*
Keywords: *Cataract surgery, Extended depth-of-focus intraocular lens, EDOF, Monofocal intraocular lens, Pseudophakia, Visual acuity, Patient satisfaction, Spectacle independence.*

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I. Introduction

Cataract is defined as any opacity or clouding of the crystalline lens of the eye that interferes with the passage of light, ultimately impairing vision. It is the leading cause of visual impairment and avoidable blindness worldwide, especially in developing countries. Human crystalline lens accounts for 15 to 20 dioptres of the refractive power of the eye. The cornea contributes another 43 dioptres. Cataract surgery involves the removal of the opacified crystalline lens, making the eye aphakic. Before the invention of intraocular lenses (IOLs) by Sir Harold Ridley to correct aphakia, spectacle correction was the norm. Cataract surgery with monofocal intraocular lens (IOL) implantation achieves excellent visual results for distant vision.1 The patient needs glasses for intermediate and near distances. Multifocal IOLs have been developed to improve postoperative uncorrected near and intermediate visual acuity (VA).2 They do not completely solve the problem as photic phenomena such as glare, haloes, and starbursts have been reported post-surgery in up to78% of patients.3-5 EDOF IOL, or extended depth of focus IOL, is a new technology in the treatment of presbyopia-correcting lenses. The basic optical principle is to create a single-elongated focal point to enhance the depth-of-focus, on the contrary to mono-focal IOLs in which light is focused on one single point or Multi-focal or MF IOLs having 2 or 3 discrete points. MF IOLs which show at each of their foci secondary out-of-focus images corresponding to the rest of the foci, this causes halos. The characteristics of halos depends on the lens design (especially the magnitude of the addiction)

and pupil size.6 The elongated focus of EDOF IOLs provide a continuous range of focus without a clearly asymmetric IOL power distribution. This avoids the presence of secondary out-of-focus images.7,8 It eliminates the overlapping of near and far images (as seen in MF IOLs) thus eliminating the halos. Several optical bench reports have shown that the EDOF lenses provide better optical quality than MF and monofocal lenses.9-11 Nevertheless, in practice, EDOF lenses provide excellent intermediate vision, but inadequate quality for near vision.7,8 Although it is usually recommended to have both eyes implanted with the same multifocal or EDOF IOLs.12,13 some patients with a monofocal IOL implant in one eye are disappointed with their intermediate and near uncorrected vision and ask to reduce spectacle dependence for these 8 ranges. One option is to implant a monofocal IOL targeted for intermediate or near vision (monovision) in the second eye, but this is not a satisfactory solution in all cases. Hence, this study was conducted to evaluate the visual performance and patient's satisfaction with the implantation of the EDOF IOL in the second eye of a patient previously implanted with a monofocal IOL in the first eye.

II. Materials And Methodology

This follow-up study was conducted in the Department of Ophthalmology at a tertiary care hospital. The study included monofocal pseudophakic patients with senile cataract in the fellow eye who fulfilled the predefined inclusion and exclusion criteria. Based on previous studies, considering the mean and standard deviation of the EDOF group (0.15 ± 0.14) and the monofocal group (0.23 ± 0.17), with a 90% confidence interval, the calculated sample size was 47 patients in each group, giving a total sample size of 94 participants. Convenience sampling was used for patient recruitment.

Patients with a monofocal intraocular lens implanted in one eye and senile cataract in the fellow eye were included in the study. Patients with corneal astigmatism greater than 1.0 D, corneal dystrophies, corneal opacities, ocular surface disease, ocular infections, amblyopia, pre-existing ocular pathology, glaucoma, intraocular inflammation, previous ocular surgery other than phacoemulsification, intraoperative complications, or those unwilling to provide informed consent were excluded.

After obtaining approval from the Institutional Ethics Committee, eligible patients were enrolled following written informed consent. A detailed history including demographic characteristics, systemic comorbidities, and previous ocular medical and surgical history was recorded. Baseline investigations included complete blood count, random blood sugar, and viral markers (HIV and HBsAg). General physical examination and comprehensive ophthalmic evaluation were performed for all participants.

The ophthalmic examination included assessment of uncorrected and best-corrected distance visual acuity using the Snellen chart, near visual acuity, contrast sensitivity, slit-lamp examination of the anterior segment, cataract grading using the Lens Opacities Classification System III (LOCS III), and fundus examination.

All enrolled patients underwent uneventful phacoemulsification with implantation of an extended depth of focus (EDOF) intraocular lens in the fellow eye. Postoperative evaluations were performed on postoperative day 1, day 7, and day 30. At each visit, manifest refraction, uncorrected distance visual acuity (UCDVA), uncorrected intermediate visual acuity (UCIVA), and uncorrected near visual acuity (UCNVA) were recorded.

Patient satisfaction and visual quality were assessed preoperatively and three weeks after surgery using a validated Johnson & Johnson questionnaire. The questionnaire evaluated binocular visual performance, spectacle independence, glare and halo symptoms, and overall satisfaction. Responses were graded on a five-point scale and categorized into positive or negative outcomes for statistical analysis. Visual outcomes and patient-reported satisfaction were compared between the study groups.

III. Results

A total of 94 patients were enrolled in the study. The majority of patients belonged to the 60–80 years age group (57, 60.6%), followed by 40–60 years (34, 36.2%). Females constituted a higher proportion of the study population than males (59.6% vs. 40.4%). The left eye was operated on in 54 (57.4%) patients, while the right eye was operated on in 40 (42.6%) patients. These findings indicate that cataract was more common among elderly individuals, with a predominance of female patients.(Table 1)

Distance visual acuity showed progressive improvement following EDOF intraocular lens implantation. The mean LogMAR visual acuity improved from 0.40 ± 0.24 in the monofocal pseudophakic eye to 0.31 ± 0.17 on postoperative day 1, 0.23 ± 0.10 on day 7, and 0.19 ± 0.05 on day 30. The improvement across the follow-up period was highly statistically significant ($p < 0.001$), indicating excellent distance visual outcomes with the EDOF lens.(Table 2)

Patients demonstrated substantial improvement in both intermediate and near vision following EDOF lens implantation. By postoperative day 30, 74 (78.7%) patients achieved N6 intermediate vision, compared with only 3 (3.2%) patients in the monofocal group. Similarly, 70 (74.4%) patients attained N8–N10 near vision after EDOF implantation, reflecting a marked enhancement in functional near vision. These findings highlight the superior intermediate and near visual performance achieved with the EDOF lens.(Table 3)

A significant improvement was observed in binocular visual performance following EDOF implantation. The mean distance visual acuity improved from 0.45 ± 0.30 LogMAR preoperatively to 0.26 ± 0.23 LogMAR at postoperative day 30 ($p < 0.001$). Intermediate vision also improved markedly, with the proportion of patients achieving N6 vision increasing from 2.1% preoperatively to 42.6% postoperatively. Likewise, near vision improved significantly, with more patients achieving better near visual acuity (N6–N10) after surgery. Overall, binocular distance, intermediate, and near vision showed statistically significant improvement following EDOF implantation.(Table 4)

Patient satisfaction improved remarkably after implantation of the EDOF intraocular lens. The mean satisfaction score increased from 1.54 ± 0.54 before surgery to 4.54 ± 0.58 after surgery, with a mean improvement of 3.00 ± 0.76. This difference was highly statistically significant ($t = 38.17$, $p < 0.001$), indicating that EDOF implantation not only improved objective visual outcomes but also significantly enhanced patients' overall satisfaction, visual quality, and spectacle independence.(Table 5)

IV. Discussion

The present follow-up study compared visual outcomes and patient satisfaction following implantation of an Extended Depth-of-Focus (EDOF) intraocular lens in the second eye of monofocal pseudophakic patients. The findings demonstrated that EDOF implantation significantly improved distance, intermediate, and near visual acuity while providing greater patient satisfaction and functional vision.

The majority of patients were aged 60–80 years (60.6%), with females comprising 59.6% of the study population. Similar demographic characteristics have been reported by Cochener et al.[14], Pedrotti et al.[15], Tomagova et al.[16], and Shemesh et al.[7].

Monofocal pseudophakic eyes showed significantly better unaided distance vision than cataractous eyes, confirming the effectiveness of cataract surgery with monofocal IOL implantation. Similar findings have been reported by Uma Sridhar[18].

Following EDOF implantation, distance visual acuity improved progressively, with most patients achieving excellent vision by postoperative day 30. These findings are consistent with those of Cochener et al.[14], Pedrotti et al.[15], Solomon et al.[19], and Tomagova et al.[16].

A major finding of the study was the significant improvement in intermediate and near vision after EDOF implantation. By postoperative day 30, 78.7% of patients achieved N6 intermediate vision, while 74.4% attained functional near vision (N8–N10). Similar improvements have been reported by **Böhm et al.[2o,] Kanclerz et al.**[21], **Solomon et al.[9], and Shemesh et al.**[17].

Patient satisfaction improved markedly after surgery, reflecting enhanced visual quality and reduced spectacle dependence. Comparable results have been reported by Solomon et al.[19], Ang et al.[22] and Shemesh et al.[17].

Overall, the present study confirms that EDOF intraocular lenses provide excellent distance vision while significantly enhancing intermediate and near visual performance, resulting in greater spectacle independence and higher patient satisfaction compared with conventional monofocal intraocular lenses.

V. Conclusion

Implantation of an Extended Depth-of-Focus (EDOF) intraocular lens in the second eye of monofocal pseudophakic patients resulted in significant improvement in distance, intermediate, and near visual acuity, with marked enhancement in binocular visual performance and patient satisfaction. Compared with conventional monofocal intraocular lenses, EDOF lenses provided superior functional vision and greater spectacle independence while maintaining excellent distance vision. These findings support the use of EDOF intraocular lenses as an effective option for improving overall visual outcomes and quality of life in monofocal pseudophakic patients undergoing cataract surgery in the fellow eye.

Conflict Of Interest: None
Finding: Nil

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Table 1. Baseline Characteristics of the Study Population (n = 94)

Variable	Frequency (%)
Age (years)	
<40	2 (2.1)
40–60	34 (36.2)
60–80	57 (60.6)
>80	1 (1.1)
Gender	
Male	38 (40.4)
Female	56 (59.6)
Operated Eye	
Right	40 (42.6)
Left	54 (57.4)

Table 2. Comparison of Distance Visual Acuity (LogMAR) Between Monofocal and EDOF Eyes

Group	Mean LogMAR ± SD
Monofocal pseudophakic eye	0.40 ± 0.24
EDOF Day 1	0.31 ± 0.17
EDOF Day 7	0.23 ± 0.10
EDOF Day 30	0.19 ± 0.05

Chi-square = 106.8, p <0.001

Table 3. Comparison of Intermediate and Near Vision Outcomes

Vision	Monofocal	EDOF Day 30	p value
Intermediate vision (N6)	3 (3.2%)	74 (78.7%)	0.061
Near vision (N8/N10)	18 (19.2%)	70 (74.4%)	0.01*

Table 4. Comparison of Preoperative and Postoperative Binocular Vision

Parameter	Preoperative	Postoperative Day 30	p value
Mean Distance Vision (LogMAR)	0.45 ± 0.30	0.26 ± 0.23	<0.001
Intermediate Vision (N6)	2 (2.1%)	40 (42.6%)	<0.001
Near Vision (N6–N10)	26 (27.7%)	42 (44.7%)	<0.001

Table 5. Patient Satisfaction Before and After EDOF Implantation

Variable	Mean ± SD	Mean Difference	p value
Preoperative Score	1.54 ± 0.54		
Postoperative Score	4.54 ± 0.58	3.00 ± 0.76	<0.001