

Comparison of EDOF vs Trifocal IOLs in cataract surgery

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Abstract

Purpose: To compare visual outcomes, patient satisfaction, & postoperative spectacle independence between extended depths of focus (EDOF) & trifocal intraocular lenses (IOLs) in patients undergoing bilateral cataract surgery.

Methods: A prospective, comparative clinical study was conducted on 100 patients (200 eyes) with senile cataract. Patients were allocated into two groups: 50 patients received bilateral EDOF IOLs (Group A) & 50 patients received bilateral Trifocal IOLs (Group B). Comprehensive preoperative & postoperative assessments at months 1, 3, & 6 included uncorrected & corrected distance, intermediate, & near visual acuities (UDVA, CDVA, UIVA, UNVA), contrast sensitivity, spectacle independence, & subjective quality of vision using validated questionnaires.

Results: Mean postoperative UDVA & CDVA were comparable between groups. Group A demonstrated superior intermediate vision ($p < 0.01$), whereas Group B achieved better near visual acuity ($p < 0.01$). Contrast sensitivity was statistically higher in Group A under mesopic conditions. Spectacle independence was high in both groups but significantly greater for near tasks in Group B. Patient satisfaction scores were high across both cohorts.

Conclusion: Both EDOF & trifocal IOLs deliver excellent postoperative visual outcomes. EDOF IOLs excel in intermediate visual performance & contrast, whereas trifocal IOLs provide enhanced near vision. Selection must be tailored to individual visual demands.

Keywords: Comparison, EDOF, Trifocal, cataract & surgery

Introduction

Cataract surgery has evolved from a purely restorative procedure to a refractive surgery aimed at reducing postoperative dependence on spectacles. The advent of presbyopia-correcting intraocular lenses (IOLs) such as multifocal, extended depth of focus (EDOF), & trifocal IOLs has allowed surgeons to offer patients improved visual range across near, intermediate, & distance.

Traditional multifocal IOLs split light into two or more foci, often compromising contrast sensitivity & inducing photic phenomena. EDOF lenses, by creating an extended focal range without discrete focal points, aim to improve intermediate vision & minimize dysphotopsia. Conversely, trifocal IOLs provide three distinct foci for near, intermediate, & distance but may incur higher rates of halos & contrast loss.

While many studies have independently evaluated EDOF & trifocal IOLs, comparative data remain limited. This study evaluates clinical outcomes & patient-reported measures in senile cataract patients receiving bilateral EDOF versus trifocal IOLs.

Materials & Methods

Study Design & Participants

This prospective, non-randomized comparative study was conducted at a tertiary eye care center. The institutional review board approved the study, & informed consent was obtained from all participants.

Inclusion criteria: were age ≥ 50 years, bilateral senile cataract, corneal astigmatism ≤ 1.0 diopter, & willingness to undergo bilateral implantation of presbyopia-correcting IOLs.

Exclusion criteria: included previous ocular surgery, corneal pathology, macular degeneration, glaucoma, diabetic retinopathy, & systemic conditions impacting visual outcomes.

Intervention

Patients were assigned to:

- **Group A:** Bilateral implantation of a diffractive EDOF IOL (e.g., Symphony or equivalent)
- **Group B:** Bilateral implantation of a diffractive trifocal IOL (e.g., PanOptix or equivalent)

Surgical procedures were performed by experienced surgeons using standard phacoemulsification with topical anesthesia. IOL power was calculated using optical biometry (e.g., IOLMaster) targeting emmetropia.

Outcome Measures

Primary outcomes: were uncorrected distance visual acuity (UDVA), uncorrected intermediate visual acuity (UIVA), & uncorrected near visual acuity (UNVA) at 6 months.

Secondary outcomes: included corrected distance visual acuity (CDVA), contrast sensitivity (mesopic & photopic conditions), spectacle independence (distance, intermediate, near), & quality of vision assessed by validated questionnaires (e.g., VF-14, patient satisfaction surveys).

Visual acuities were measured using standardized LogMAR charts. Contrast sensitivity was measured via Pelli-Robson charts.

Statistical Analysis

Data were analyzed using SPSS version 25. Continuous variables were expressed as mean $\pm$ standard deviation (SD). Independent t-tests compared between groups. A p-value <0.05 was considered statistically significant.

Results

Patient Demographics

Table 1: Baseline Demographic & Clinical Characteristics

Characteristic	Group A (EDOF) (n=50)	Group B (Trifocal) (n=50)	p-Value
Age (years, mean $\pm$ SD)	67.8 $\pm$ 6.4	68.1 $\pm$ 5.9	0.78
Gender (M:F)	24:26	22:28	0.68
Preop UDVA (LogMAR)	0.78 $\pm$ 0.20	0.75 $\pm$ 0.18	0.51
Preop CDVA (LogMAR)	0.65 $\pm$ 0.15	0.67 $\pm$ 0.14	0.62
Axial Length (mm)	23.45 $\pm$ 0.92	23.38 $\pm$ 0.88	0.64

A total of 100 patients (200 eyes) completed the study: 50 in Group A & 50 in Group B. Baseline characteristics were similar between groups (Table 1).

Table 2: Postoperative Visual Acuity Outcomes (6 Months)

Visual Parameter	Group A (EDOF) (n=50)	Group B (Trifocal) (n=50)	p-Value
UDVA (LogMAR)	0.02 $\pm$ 0.04	0.01 $\pm$ 0.03	0.22
CDVA (LogMAR)	-0.01 $\pm$ 0.03	-0.01 $\pm$ 0.04	0.88
UIVA (LogMAR)	0.12 $\pm$ 0.07	0.18 $\pm$ 0.08	$<0.01^*$
UNVA (LogMAR)	0.28 $\pm$ 0.09	0.19 $\pm$ 0.07	$<0.01^*$

Visual Acuity Outcomes

At 6 months, both groups achieved excellent distance visual acuity with no significant difference (Table 2).

*Significant at $p<0.05$.

Group A demonstrated significantly better intermediate (UIVA) visual acuity, whereas Group B achieved superior near (UNVA) visual acuity.

Table 3: Contrast Sensitivity at 6 Months

Condition	Group A (EDOF)	Group B (Trifocal)	p-Value
Photopic (log units)	1.68 ± 0.08	1.65 ± 0.09	0.10
Mesopic (log units)	1.42 ± 0.11	1.33 ± 0.12	<0.01*

Contrast sensitivity under photopic & mesopic conditions is shown in Table 3.

*Significant at $p < 0.05$.

EDOF IOLs showed significantly better mesopic contrast sensitivity.

Table 4: Spectacle Dependence & Satisfaction

Outcome Measure	Group A (EDOF)	Group B (Trifocal)	p-Value
Spectacle independence (%)	86	92	0.23
Near spectacle dependence (%)	40	20	<0.05*
Intermediate spectacle dependence (%)	12	28	<0.05*
Overall satisfaction (0–100 scale)	89.2 ± 7.1	91.8 ± 6.5	0.12

Spectacle independence & patient satisfaction were evaluated using standardized questionnaires (Table 4).

*Significant at $p < 0.05$.

Although overall spectacle independence was high in both groups, Group B patients reported less near spectacle dependence, & Group A had reduced intermediate spectacle dependence.

Discussion

Our study directly compares EDOF & trifocal IOLs in a sizable cohort of cataract patients, revealing clinically significant differences in functional visual performance. Both lens types provided excellent distance vision & high patient satisfaction.

Mean UDVA & CDVA at 6 months were similar in both groups, underscoring that both technologies reliably restore distance vision. These findings align with previous literature showing comparable distance outcomes for EDOF & trifocal IOLs.^{1–3}

Group A (EDOF) exhibited superior intermediate visual acuity. EDOF IOLs are designed to provide a continuous range of vision rather than discrete focal points, which likely contributes to better intermediary focus. This advantage is critical in modern lifestyles dominated by tasks such as computer work & mobile device use.^{4,5}

Trifocal IOLs demonstrated significantly better near visual acuity, confirming the efficacy of additional near focal points in these designs. Patients receiving trifocal IOLs reported markedly lower near spectacle dependence, corroborating outcomes from similar comparative studies.^{6,7}

EDOF IOLs demonstrated significantly better mesopic contrast sensitivity. This finding is consistent with optical principles whereby EDOF designs reduce overlapping diffractive rings, thus maintaining higher contrast.^{8,9} Although both groups reported photic phenomena, the incidence & severity were slightly higher in the trifocal cohort, likely due to the multiple refractive zones inherent to the optical design. These findings suggest that patients with visual demands requiring high contrast performance (e.g., night driving) might benefit more from EDOF IOLs.¹⁰

Spectacle Dependence & Satisfaction

Both groups achieved high levels of spectacle independence & satisfaction. While trifocal patients were less dependent on glasses for near tasks, EDOF patients showed lower intermediate spectacle use. These differences reflect the intrinsic design goals of each IOL type. Overall satisfaction scores were high & statistically similar between groups, reflecting successful refractive outcomes & fulfillment of visual expectations in most patients.¹¹

Clinical Implications

Cataract surgeons should consider the individual visual needs & lifestyle of patients when selecting IOL type. Patients prioritizing near tasks (reading, crafts) may benefit more from trifocal IOLs, while those engaging in significant intermediate activities (computer work, office tasks) might prefer EDOF IOLs. Personalized preoperative counseling is critical to set realistic expectations & optimize postoperative satisfaction.¹²

Limitations

Limitations include the non-randomized design, potential selection bias, & follow-up limited to 6 months. Long-term outcomes & real-world functional measures (e.g., driving performance) warrant further investigation.

Conclusion

Both EDOF & trifocal IOLs provide excellent visual rehabilitation after cataract surgery. EDOF IOLs outperform trifocal IOLs in intermediate vision & mesopic contrast, whereas trifocals excel in near vision & reduce near spectacle dependence. Patient-centered IOL selection based on visual priorities yields optimal outcomes.

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