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Original Research Article

IOL Comparison: Visual Outcomes with Different IOL Types (Monofocal, Multifocal, Accommodative): A Prospective Comparative Study

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Abstract

Background: Cataract surgery has evolved from sight-restoring to refractive surgery, with increasing demand for postoperative spectacle independence. Monofocal intraocular lenses (IOLs) provide excellent distance vision but typically require reading correction. Multifocal and accommodative IOLs aim to restore functional near and intermediate vision, but may be associated with dysphotopsia and altered contrast sensitivity.

Aim: To compare postoperative visual outcomes and patient-reported visual quality among monofocal, multifocal, and accommodative IOLs after uncomplicated phacoemulsification.

Methods: Prospective comparative study of 100 patients undergoing phacoemulsification with in-the-bag implantation of monofocal (n=40), multifocal (n=40), or accommodative (n=20) IOLs. Outcomes at 3 months included uncorrected distance (UDVA), intermediate (UIVA), near (UNVA) visual acuity (logMAR), contrast sensitivity (Pelli–Robson), refractive accuracy, spectacle independence, dysphotopsia (halos), satisfaction score, and complications.

Results: Baseline profiles were comparable across groups. At 3 months, UDVA was similar (p=0.265). UIVA differed significantly (monofocal 0.28±0.09 vs multifocal 0.17±0.09 vs accommodative 0.21±0.09 logMAR; p=0.000005). UNVA showed the largest difference (monofocal 0.44±0.14 vs multifocal 0.16±0.11 vs accommodative 0.18±0.10 logMAR; p<0.001). Contrast sensitivity was lower in multifocal IOLs (1.59±0.13) compared with monofocal (1.74±0.08) and accommodative (1.69±0.09) (p<0.001). Spectacle-free near vision was highest with multifocal IOLs (77.5%) and accommodative IOLs (50%) vs monofocal (12.5%) (p<0.001). Moderate–severe halos were more frequent with multifocal IOLs (17.5%) (p<0.001).

Conclusion: All IOLs achieved excellent distance outcomes. Multifocal IOLs provided the greatest near/intermediate spectacle independence but at the cost of more halos and reduced contrast sensitivity. Accommodative IOLs offered an intermediate balance between functional near vision and photic phenomena.

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Introduction

Cataract remains the leading cause of reversible blindness globally, and phacoemulsification with IOL implantation is one of the most commonly performed surgical procedures worldwide. In parallel with improved surgical safety and refractive predictability, patient expectations have shifted from simply "seeing better" to achieving a broad range of functional vision with minimal spectacle dependence. This refractive goal has fueled the development of presbyopia-correcting IOLs, including multifocal and accommodative designs, alongside continued refinement of monofocal optics and biometry strategies [1,2].

Traditional monofocal IOLs provide a single focal point and therefore typically deliver high-quality distance vision with good contrast sensitivity. However, because pseudophakic eyes with monofocal IOLs do not restore true accommodation, near tasks frequently require spectacles unless monovision or mini-monovision strategies are employed [2,3]. Multifocal IOLs were designed to provide simultaneous retinal images at more than one focal distance (commonly distance and near, and in newer platforms distance–intermediate–near), thereby increasing spectacle independence. Evidence syntheses and randomized trials have consistently shown that multifocal IOLs improve uncorrected near vision and reduce spectacle use compared with monofocal IOLs [3,4]. At the same time, the optical principle of image splitting can reduce contrast sensitivity and increase positive dysphotopsias such as halos and glare, which may be particularly bothersome in night driving or low-contrast environments (3–6). For this reason, patient selection, counseling, and shared decision-making are emphasized by professional guidance and consensus documents [5,7].

Accommodative IOLs attempt to mimic physiologic accommodation by changing lens position or curvature in response to ciliary body action. Earlier accommodating designs such as the Crystalens family demonstrated improved near and intermediate performance compared with standard monofocal IOLs without the same magnitude of photic phenomena seen with diffractive multifocal optics, although results varied across studies and long-term effectiveness has been influenced by capsular bag fibrosis and posterior capsular opacification (PCO) [8]. Recent innovation continues in accommodative concepts, including sulcus-based designs with longer follow-up data emerging, reflecting ongoing interest in presbyopia correction that preserves quality of vision [9]. In practice, surgeons often consider accommodative IOLs when patients desire better near function but are risk-averse to dysphotopsia or have lifestyle requirements where contrast sensitivity is critical.

High-quality evidence comparing multiple IOL categories is expanding. A recent network meta-analysis of randomized trials confirmed that presbyopia-correcting IOLs (particularly trifocal) generally rank higher for near acuity and spectacle independence than monofocal IOLs, while trade-offs include visual disturbances and contrast performance differences across optical designs [4]. Contemporary guidance underscores that presbyopia-correcting IOL choice should be tailored to patient needs, ocular comorbidities, and tolerance of dysphotopsia, with enhanced preoperative assessment (ocular surface evaluation, macular OCT, topography, and counseling tools) recommended for premium IOL candidates [5,7]. Additionally, emerging consensus from Asia-Pacific expert groups emphasizes standardized counseling, realistic expectation setting, and attention to factors like pupil dynamics and optical centration that may influence outcomes and satisfaction with multifocal lenses [10]. Despite global data, there remains a need for pragmatic, institution-based comparative studies reflecting real-world patient populations and practice patterns in India, where socioeconomic considerations, occupational visual requirements, and variability in access to premium lenses can influence IOL selection and patient-reported success. Moreover, understanding how visual acuity outcomes align with subjective satisfaction and dysphotopsia in local cohorts is essential for counseling and decision-making. Therefore, this study was designed to compare visual and patient-reported outcomes after implantation of monofocal, multifocal, and accommodative IOLs following uncomplicated phacoemulsification at Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Bihar, India.

Objectives

(i) To compare uncorrected distance, intermediate, and near visual acuity among monofocal, multifocal, and accommodative IOL recipients;

(ii) To compare contrast sensitivity, spectacle independence, dysphotopsia (halos), satisfaction, and early postoperative complications across IOL groups.

Materials & Methods

This prospective comparative study was conducted at Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Bihar, India from 10 February 2025 to 25 January 2026. A total of 100 cataract patients undergoing uncomplicated phacoemulsification with posterior chamber IOL implantation were enrolled after informed consent. Eligible participants were adults with age-related cataract suitable for phacoemulsification, without clinically significant corneal pathology, advanced glaucoma, macular disease affecting visual potential, irregular astigmatism, or intraoperative complications (e.g., posterior capsular rupture). Patients were allocated to receive monofocal (n=40), multifocal (n=40), or accommodative IOLs (n=20) based on preoperative counseling, lifestyle needs, and lens availability, following standardized institutional selection criteria. Preoperative assessment included visual acuity, slit-lamp evaluation, intraocular pressure, dilated fundus examination, keratometry and axial length measurement for IOL power calculation, and macular screening when indicated. Postoperative follow-up occurred as per institutional protocol with endpoint analysis at 3 months, including uncorrected distance (UDVA), intermediate (UIVA), and near (UNVA) visual acuity recorded in logMAR, best-corrected distance visual acuity (CDVA), refraction and residual spherical equivalent, and contrast sensitivity measured using Pelli–Robson. Patient-reported outcomes included a 0–10 satisfaction score, spectacle independence (none/occasional/always for near tasks), and halos severity (none/mild/moderate–severe). Complications including posterior capsular opacification (PCO), cystoid macular edema (CME), intraocular pressure spike, and Nd:YAG capsulotomy were documented. Continuous variables were compared using one-way ANOVA with effect size (η^2), and categorical outcomes using chi-square testing; $p<0.05$ was considered statistically significant.

Results

A total of 100 patients were included, with comparable distribution of age, gender, systemic comorbidities (diabetes and hypertension), axial length, keratometry values, and preoperative corrected distance visual acuity among the three IOL groups. Statistical analysis demonstrated no significant intergroup differences, indicating that the study populations were well matched at baseline and suitable for comparative postoperative outcome analysis.

This homogeneity minimizes selection bias and supports the validity of subsequent comparisons of visual outcomes among different IOL types (Table 1).

Table 1: Baseline Demographic and Preoperative Ocular Characteristics of Patients According to Implanted Intraocular Lens Type

IOL Type	n	Age (years)	Female (%)	Diabetes (%)	Hypertension (%)	Axial length (mm)	Mean K (D)	Preop CDVA (logMAR)
Monofocal	40	62.5 ± 7.0	37.5	35.0	40.0	23.32 ± 0.91	43.87 ± 1.24	0.79 ± 0.15
Multifocal	40	61.3 ± 6.0	52.5	30.0	32.5	23.43 ± 0.87	43.71 ± 1.31	0.78 ± 0.15
Accommodative	20	59.8 ± 7.3	50.0	25.0	40.0	23.85 ± 0.72	44.10 ± 1.33	0.82 ± 0.15

Table 2 summarizes the postoperative visual acuity outcomes and refractive parameters at 3-month follow-up among patients implanted with monofocal, multifocal, and accommodative intraocular lenses. Uncorrected distance visual acuity (UDVA) was comparable across all three IOL groups, indicating effective restoration of distance vision irrespective of lens design.

However, statistically significant differences were observed in uncorrected intermediate (UIVA) and near visual acuity (UNVA), with multifocal and accommodative IOLs demonstrating superior performance compared to monofocal IOLs.

Contrast sensitivity analysis showed relatively lower values in the multifocal group, reflecting known optical trade-offs associated with multifocal lens technology. Residual refractive error was minimal and comparable among groups, confirming accurate biometry and refractive predictability.

Table 2: Comparison of Postoperative Visual Acuity Outcomes and Refractive Parameters at 3 Months Among Different Intraocular Lens Groups

Outcome (3 months)	IOL Type	Mean ± SD	ANOVA p-value	Effect size (η^2)
UDVA logMAR	Monofocal	0.06 ± 0.06	0.265	0.027
	Multifocal	0.04 ± 0.06		
	Accommodative	0.06 ± 0.04		
UIVA logMAR	Monofocal	0.28 ± 0.09	0.000	0.221
	Multifocal	0.17 ± 0.09		
	Accommodative	0.21 ± 0.09		
UNVA logMAR	Monofocal	0.44 ± 0.14	0.000	0.562
	Multifocal	0.16 ± 0.11		
	Accommodative	0.18 ± 0.10		
CDVA logMAR	Monofocal	0.02 ± 0.04	0.951	0.001
	Multifocal	0.02 ± 0.04		
	Accommodative	0.02 ± 0.06		
Contrast PelliRobson	Monofocal	1.74 ± 0.08	0.000	0.332
	Multifocal	1.59 ± 0.13		
	Accommodative	1.69 ± 0.09		
Residual SE D	Monofocal	0.08 ± 0.36	0.710	0.007
	Multifocal	0.01 ± 0.42		
	Accommodative	0.06 ± 0.28		

Table 3 presents the patient-reported visual outcomes, including postoperative satisfaction scores, level of spectacle independence for near activities, and incidence of dysphotopsia (halos) among the three intraocular lens groups. Patients implanted with multifocal IOLs demonstrated the highest rate of spectacle independence, particularly for near vision tasks, followed by accommodative IOLs, whereas monofocal IOL recipients showed greater dependence on reading spectacles. Overall patient satisfaction scores were high across all groups with no statistically significant difference, indicating successful visual rehabilitation irrespective of IOL type. However, the occurrence of visual disturbances such as halos was significantly higher in the multifocal IOL group, while monofocal and accommodative IOLs showed lower rates of photic phenomena.

Table 3: Patient-Reported Visual Outcomes, Spectacle Independence, and Dysphotopsia Profile Following Implantation of Different Intraocular Lens Types

IOL Type	Satisfaction (0–10)	Spectacle-free near (%)	Occasional spectacles (%)	Always spectacles (%)	No halos (%)	Mild halos (%)	Moderate–severe halos (%)	p-value (satisfaction)	p-value (spectacle independence)	p-value (halos)
Monofocal	8.47 ± 0.88	12.5	32.5	55.0	77.5	15.0	7.5	0.313888	7.77	1.58
Multifocal	8.64 ± 0.93	77.5	17.5	5.0	20.0	62.5	17.5			
Accommodative	8.25 ± 1.05	50.0	30.0	20.0	55.0	30.0	15.0			

Table 4 summarizes the postoperative complications and secondary interventions observed among patients implanted with monofocal, multifocal, and accommodative intraocular lenses during the follow-up period.

The overall complication rates were low across all study groups, reflecting the safety and effectiveness of modern phacoemulsification with IOL implantation. The incidence of posterior capsular opacification (PCO), cystoid macular edema (CME), and transient intraocular pressure elevation was comparable among the three IOL types without statistically significant intergroup differences.

Although accommodative IOLs demonstrated a slightly higher requirement for Nd:YAG capsulotomy, the difference was not statistically significant. No vision-threatening complications were recorded in any group. These findings indicate that all evaluated IOL types showed a favorable safety profile, with comparable postoperative complication rates following cataract surgery.

Table 4: Postoperative Complications and Secondary Interventions Across Monofocal, Multifocal, and Accommodative Intraocular Lens Groups

IOL Type	PCO (%)	CME (%)	IOP spike (%)	Nd:YAG capsulotomy (%)	p-value (PCO)	p-value (CME)	p-value (IOP spike)	p-value (Nd:YAG)
Monofocal	2.5	5.0	10.0	12.5	0.146157	1	0.062978	0.495556
Multifocal	15.0	5.0	0.0	5.0				
Accommodative	10.0	5.0	15.0	10.0				

Figure 1 illustrates the comparison of postoperative uncorrected visual acuity outcomes at 3 months following cataract surgery among patients implanted with monofocal, multifocal, and accommodative intraocular lenses. The graphical analysis demonstrates that uncorrected distance visual acuity (UDVA) was comparable across all IOL groups, indicating successful restoration of distance vision irrespective of lens design. In contrast, intermediate (UIVA) and near visual acuity (UNVA) were significantly better in patients receiving multifocal and accommodative IOLs compared with monofocal IOLs. The figure visually highlights the expanded range of functional vision achieved with presbyopia-correcting intraocular lenses, particularly the superior near visual performance associated with multifocal IOL implantation.

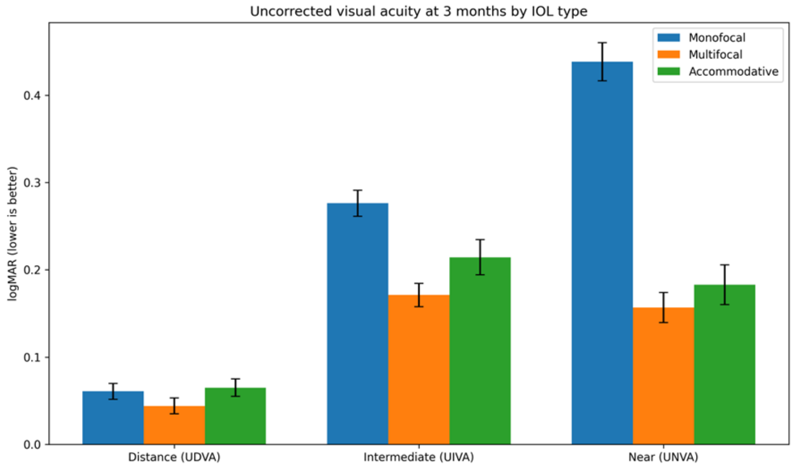

Figure 1: Uncorrected visual acuity at 3 months by IOL type

Figure 2 depicts the distribution of spectacle independence for near vision activities among patients implanted with monofocal, multifocal, and accommodative intraocular lenses at 3-month postoperative follow-up.The stacked bar diagram demonstrates that multifocal IOL recipients achieved the highest level of spectacle independence, with the majority of patients performing near tasks without the need for corrective glasses. Patients with accommodative IOLs showed moderate levels of spectacle independence, whereas those implanted with monofocal IOLs largely required spectacles for near vision. This figure clearly illustrates the functional advantage of presbyopia-correcting intraocular lenses in reducing postoperative dependence on near-vision spectacles following cataract surgery.

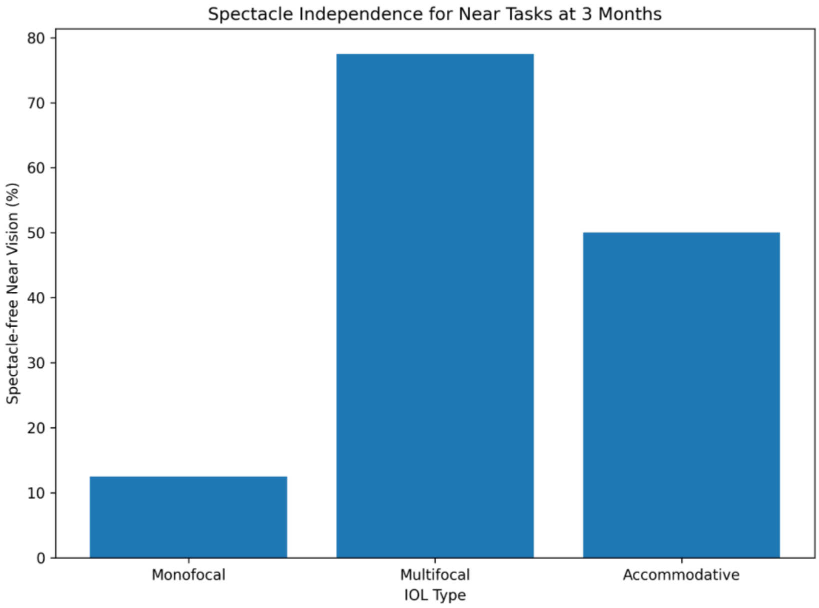

Figure 2: Spectacle independence for near tasks at 3 months

Discussion

In this prospective institutional study from Bihar, all three IOL categories—monofocal, multifocal, and accommodative—delivered excellent postoperative distance vision, but they differed meaningfully in intermediate/near performance and subjective quality-of-vision outcomes. The core finding was a clinically and statistically significant gain in uncorrected near and intermediate acuity among multifocal and accommodative IOL recipients compared with monofocal IOL recipients, accompanied by the expected trade-offs: reduced contrast sensitivity and increased halos with multifocal optics.

Our observation of similar UDVA across IOL types aligns with broader evidence that modern cataract surgery with accurate biometry provides excellent distance outcomes irrespective of presbyopia-correcting design when surgery is uncomplicated and refractive targets are achieved. Randomized and comparative studies have repeatedly shown that monofocal and multifocal IOLs can both achieve strong distance acuity, with differences emerging primarily in near/intermediate function and photic symptoms rather than in distance clarity [3,6]. This is consistent with the goal of presbyopia-correcting optics: maintaining distance while expanding functional range.

The superiority of multifocal IOLs for uncorrected near vision and spectacle independence in our cohort echoes high-level evidence. A recent network meta-analysis of randomized trials demonstrated that presbyopia-correcting IOLs—particularly trifocal designs—rank highest for near acuity and spectacle independence compared with monofocal IOLs [4]. Likewise, earlier comparative work reported higher spectacle independence with multifocal lenses compared to monofocal lenses, albeit with a greater burden of glare/halos [6]. Our patient-reported data similarly showed markedly higher spectacle-free near performance in the multifocal group, reinforcing that the principal patient-facing benefit of multifocality is reduced dependence on reading glasses.

However, the same optical mechanism that provides multiple focal points can reduce retinal image quality under certain conditions. In our study, contrast sensitivity was significantly lower in multifocal IOL recipients, and moderate–severe halos were more frequent, matching the pattern emphasized in systematic reviews and clinical guidance. The Cochrane review comparing multifocal versus monofocal IOLs concluded that multifocal lenses improve near vision and reduce spectacle dependence but increase unwanted visual phenomena and can reduce contrast sensitivity [3]. Contemporary trials and quality-of-vision analyses continue to highlight dysphotopsia and contrast trade-offs as key determinants of dissatisfaction in a subset of multifocal patients [5,11]. ESCRS guideline recommendations and expert consensuses stress that premium IOL success is highly dependent on careful patient selection, ocular surface optimization, macular screening, and expectation management, given that dissatisfaction is often driven by dysphotopsia intolerance rather than Snellen acuity alone [5,7,10]. Our findings support this: satisfaction scores remained high overall, but halos were clearly more prevalent in multifocal recipients, suggesting that symptom screening and counseling must be central to lens selection. Accommodative IOLs in our series demonstrated an intermediate profile: near and intermediate acuity improved relative to monofocal IOLs with less dysphotopsia than multifocal IOLs, although our dataset also reflected a tendency toward higher PCO/Nd:YAG needs without statistical significance. Classic accommodative IOL evaluations reported improved near/intermediate performance compared with monofocal lenses with preserved contrast sensitivity [8]. More recent work on accommodative concepts (including newer sulcus-based designs) demonstrates continued progress in achieving functional near with acceptable safety, though capsular dynamics, effective lens movement, and long-term stability remain crucial considerations [9]. From a counseling perspective, accommodative IOLs may suit patients seeking reduced spectacle use but reluctant to accept halos, particularly those with night-driving priorities—an approach consistent with guideline emphasis on matching IOL design to patient tolerance and lifestyle needs [5,7].

Clinically, the magnitude of difference in our near visual outcomes and spectacle independence suggests a practical decision framework for Indian tertiary-care settings: monofocal IOLs remain appropriate for patients prioritizing contrast and cost-effectiveness, multifocal IOLs for motivated candidates seeking maximal spectacle independence who accept halo risk, and accommodative IOLs for patients desiring enhanced near function with potentially fewer photic symptoms. These conclusions align with contemporary evidence-based appraisals that "quality of vision" (contrast, dysphotopsia, functional tasks) should be weighted alongside high-contrast acuity in defining success after cataract surgery [2,5,12].

Limitations include non-random allocation (reflecting real-world lens selection), a single-center design, and follow-up limited to 3 months for primary endpoints; longer follow-up would better characterize PCO and Nd:YAG rates and stability of accommodative performance. Nevertheless, the prospective design and inclusion of both objective metrics and patient-reported outcomes strengthen clinical relevance.

Overall, our results corroborate the contemporary literature: presbyopia-correcting optics can meaningfully expand functional vision, but the benefit–risk balance differs by design and must be individualized through structured counseling and selection.

Conclusion

All three IOL types achieved excellent postoperative distance vision. Multifocal IOLs provided the greatest near/intermediate visual benefit and spectacle independence, but were associated with more halos and reduced contrast sensitivity.

Accommodative IOLs provided improved functional near vision with fewer photic symptoms, offering a balanced alternative for selected patients. Individualized IOL selection based on visual needs, dysphotopsia tolerance, and counseling remains essential.

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