

Original Article **Cataract**

Clinical study on visual outcomes with four different intraocular lens following cataract surgery

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ABSTRACT

Objectives: The aim of this study was to evaluate and compare the visual acuity and refractive outcomes of four commonly used posterior chamber intraocular lens (IOL) brands implanted during routine cataract surgery. All the lenses were monofocal, hydrophobic acrylic but belonged to a variable price range.

Material and Methods: This was a retrospective study of cataract surgery patients who underwent phacoemulsification with four different types of IOL. The IOLs studied were Tecnis Eyhance ICB00 (Group A), AcrySof IQ SN60WF (Group B), Hoya iSert 150 (Group C), and S lens (Group D); 35 eyes in each group. The parameters studied were uncorrected distance visual acuity (UCVA), best-corrected visual acuity (BCVA), and manifest refraction on post-operative days (POD) 1, 7, and 30.

Results: On average, 97.14% of patients attained BCVA of 6/12 or better at the final follow-up; 83.57% of patients attained UCVA of 6/6–6/12 at the final follow-up. The highest percentage of patients achieving good UCVA (6/6–6/12) was seen with AcrySof IQ (94.28%), followed by S-Lens (88.57%), Hoya iSert 150 (82.85%), and Eyhance (68.57%). In POD 1, log MAR UCVA in the four groups did not show any difference ($P = 0.42$). In POD 7, Group B (AcrySof IQ) had statistically significantly better UCVA as compared to the other three groups ($P = 0.04$). In POD 30, the UCVA in Groups B, C, and D were comparable, which was better than Group A (Eyhance) ($P = 0.01$). The spherical equivalent required to achieve BCVA was lowest in Group B (0.15 ± 0.24) and highest in Group A (0.30 ± 0.28) ($P = 0.13$).

Conclusion: All four IOLs produced comparable post-operative visual acuity and refractive outcomes. Surgeons can confidently select more affordable monofocal IOLs without compromising the quality of care, considering both the percentage of patients achieving the optimal vision and the consistency of the outcomes across different lens types.

Keywords: Cataract surgery, Monofocal lens, Visual outcome

INTRODUCTION

Cataract surgery with intraocular lens (IOL) implantation is one of the most commonly performed surgical procedures worldwide.^[1] As the global population continues to age, the demand for cataract surgery has steadily increased. The selection of the appropriate IOL is a critical component of achieving optimal visual outcomes for patients. IOLs come in a variety of materials, designs, and optical properties to address different patient needs and preferences.^[2]

Accurate biometric measurements are essential for selecting the ideal IOL power and minimizing refractive errors after cataract surgery. The IOL Master 700, a swept-source optical coherence

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tomography-based biometry device, has become widely accepted for its precision and reliability in measuring key parameters such as axial length, keratometry, and anterior chamber depth. The integration of this advanced biometry technology has helped surgeons achieve even more predictable refractive results.^[3]

While many IOL brands have demonstrated excellent clinical results, it is valuable to directly compare the visual and refractive outcomes of different IOL options to help guide surgeon selection. There have been comparative evaluations between different types of monofocal lenses,^[4] monofocal versus multifocal,^[5] and lenses of different prices.^[2] This retrospective study aimed to evaluate and compare the visual acuity and refractive outcomes of four commonly used posterior chamber IOL brands implanted during routine cataract surgery, with consideration of the high-quality biometric data obtained using the IOL Master 700. All the lenses were monofocal, hydrophobic acrylic but belonged to a variable price range.

MATERIAL AND METHODS

Study design

This retrospective study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Informed consent was obtained from all participants before their inclusion in the study. The study protocol was reviewed and approved by the Institutional Review Board.

The study included 140 eyes from patients who underwent phacoemulsification and IOL implantation between June 2023 and December 2023. Participants with uncomplicated age-related cataracts were included in the study. The selection of lenses was done by the patients depending on the package that they opted for. The lenses evaluated were Tecnis Eyhance ICB00 (Johnson and Johnson Vision), Alcon AcrySof IQ SN60WF (Alcon Laboratories Inc.), Hoya iSert 150 (Hoya Surgical Optics), and S lens (Sidapharm). Tecnis Eyhance is a monofocal lens with a slightly enhanced depth of focus, which is attained by the modification of the anterior lens surface.^[6] AcrySof IQ is monofocal, composed of hydrophobic acrylic material which has a blue light and ultraviolet (UV) light filter.^[4] Hoya iSert 150 is a monofocal, spherical lens, having a UV filter, made of hydrophobic acrylic with polymethyl methacrylate haptic tips. It is available as a preloaded injector delivery. S lens is monofocal, aspheric, and made of hydrophobic acrylic material. The study included participants who had paid for the procedure themselves. The package of cataract surgery in our setup ranged from Indian Rupee (INR) 25000 (S lens and Hoya iSert 150), INR 30000 (AcrySof IQ) to INR 35000 (Tecnis Eyhance).

Exclusion criteria

Patients were excluded from the study if they had any history of ocular inflammation, trauma, diabetic retinopathy, uveitis, glaucoma, retinal pathology, or previous ocular surgeries. This exclusion ensured the study focused on a homogeneous group of patients with primary age-related cataracts.

Pre-operative assessment

Before surgery, all the participants underwent a thorough ophthalmic evaluation, which included visual acuity (unaided and best corrected), auto refractometry, slit-lamp examination, rebound tonometry, and dilated fundus evaluation. Optical biometry was done using IOL Master 700, which provided precise measurements. Emmetropic or the nearest myopic refraction was targeted in the selection of IOL power from the biometry calculation.

- Axial length
- Keratometry readings (K1, K2, and ΔK)
- IOL power.

Surgical procedure

All surgeries were performed by a single-experienced surgeon using standard phacoemulsification techniques with the Centurion vision system (Alcon). Either topical or peribulbar anesthesia was used. A 2.2 mm clear corneal incision was used; Tecnis Eyhance and AcrySof IQ were inserted through a 2.2 mm incision, whereas Hoya iSert 150 and S lens were inserted through a 2.8 mm incision. The selected IOL was implanted into the posterior chamber following lens removal. Operative details such as IOL power implanted and A-constant were recorded.

Post-operative assessment

Post-operative evaluations were conducted on day 1, day 7, and day 30. The following parameters were measured and recorded:

- Uncorrected distance visual acuity (UCVA)
- Best-corrected visual acuity (BCVA)
- Manifest refraction.

Visual acuity at a distance was checked with Appasamy visual terminal at 6 meters. All patients received standard post-operative steroid eye drops (Prednisolone acetate 1%) tapered over 30 days, in addition to cycloplegic (Homatropine 2%) eye drops and antibiotic (Moxifloxacin 0.5%) eye drops for one week.

Data analysis

Data were analyzed using appropriate statistical methods to compare the performance of the four IOLs in terms of

visual and refractive outcomes. Summary statistics, including means and standard deviations (SDs), were calculated for each IOL group in MS Excel (Office 2019). Comparisons between groups were made using analysis of variance and *post hoc* tests where applicable. $P < 0.05$ was considered to be significant statistically.

RESULTS

We studied a total of 140 eyes of 125 patients. The eyes were divided into four groups, each having 35 eyes. Group A was implanted with Tecnis Eyhance, Group B with AcrySof IQ, Group C with Hoya iSert 150, and Group D with S lens. The mean age of patients in each group, sex distribution, mean axial length, and keratometry readings are given in Table 1. When we analyzed the pre-operative data, there was no statistically significant difference between the four IOL groups with respect to axial length, Keratometry values (K1, K2), and astigmatism (ΔK). Hence, the visual outcome following surgery is unlikely to be affected by these parameters. Surgically induced astigmatism for a 2.2 mm incision is 0.2, and for a 2.8 mm incision is 0.3.

Pre-operative vision in Group A ranged from perception of light (PL)+ to 6/12, in Group B from hand motion (HM)+ to 6/9, in Group C from HM+ to 6/9, and in Group D from PL+ to 6/9. The mean and SD of post-operative vision on days 1, 7, and 30 in logMAR are given in Table 2. A comparison of pre-operative and post-operative visual acuity (UCVA) in all the groups on days 1, 7, and day 30 is illustrated in Figure 1.

The post-operative status of the cornea was noted in all cases. Any eye having corneal stria was treated with 5% hypertonic saline. As this may serve as a confounding factor in early post-operative UCVA, so for the purpose of analysis the final (4th week) UCVA and BCVA were considered. On average, 97.14% of patients in the study attained a BCVA of 6/12 or better at the final follow-up; 83.57% of patients attained UCVA of 6/6–6/12 at the final follow-up. On analyzing the different lenses, varied outcomes were observed after 4–6 weeks. The highest percentage of patients achieving good UCVA (6/6–6/12) was seen with AcrySof IQ (94.28%), followed by S-Lens (88.57%), Hoya iSert 150 (82.85%), and Eyhance (68.57%). This was not the same when BCVA was compared between the groups. Hoya iSert fared best in this parameter, where 100% of patients attained BCVA of 6/6–6/12, followed by AcrySof IQ (97.14%), S-Lens (97.14%), and Eyhance (94.28%).

Table 2 shows that log MAR UCVA in post-operative day (POD) 1 in the four groups did not show any difference statistically ($P = 0.42$). In POD 7, however, Group B (AcrySof IQ) had statistically significantly better UCVA as compared

to the other three groups ($P = 0.04$). In POD 30, the UCVA in Groups B, C, and D were comparable, which was better than Group A (Eyhance), the difference being significant statistically ($P = 0.01$). The post-operative spherical equivalent in the four groups was comparable. The spherical equivalent required to achieve BCVA was lowest in Group B (0.15 ± 0.24) and highest in Group A (0.30 ± 0.28), though not a significant difference. This explains why 31.43% of patients in Group A did not have good UCVA (6/6–6/12). There were no intraoperative or post-operative complications in any of the study groups.

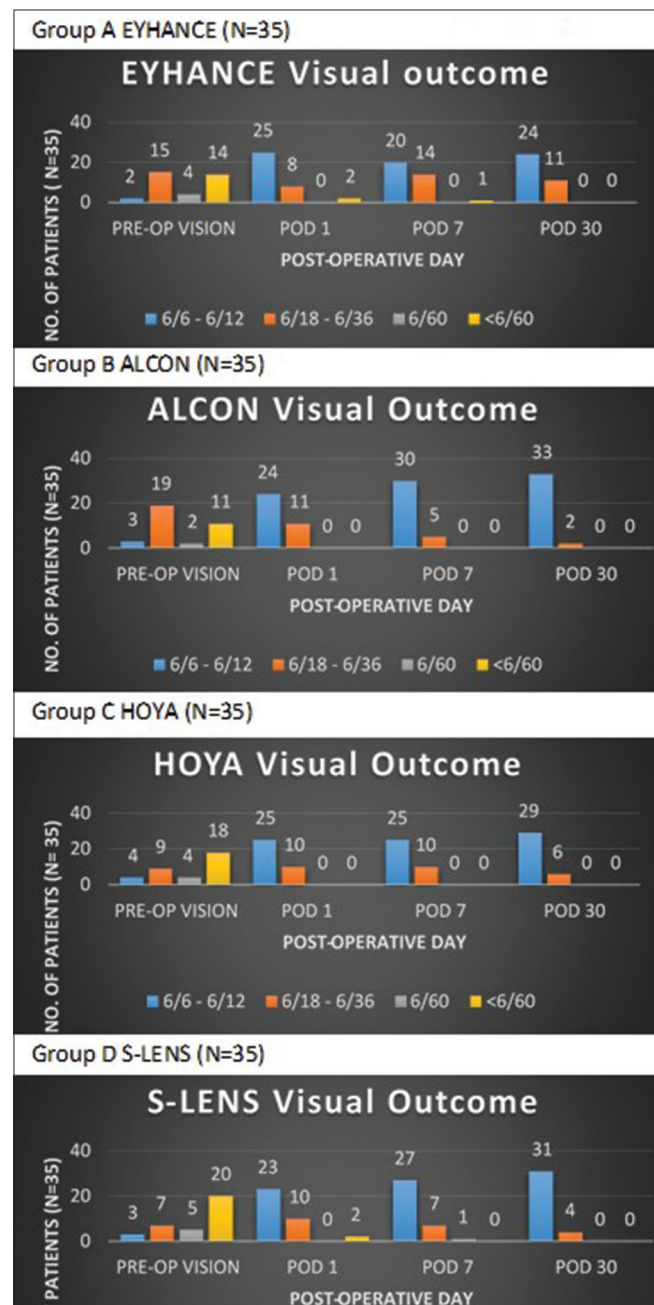


Figure 1: Pre- and post-operative visual outcomes among four groups.

Table 1: Preoperative data.

	Types of intraocular lenses				P-value
	Eyhance	AcrySof IQ	Hoya iSert 150	S lens	
Age (Mean±SD)	67.54±8.71	63.22±6.27	65.07±7.44	67.38±6.36	0.21
Sex					
Male	14	16	15	18	
Female	21	19	20	17	1
Axial Length (Mean±SD)	22.88±0.71	23.28±0.94	22.87±0.83	22.09±0.87	0.27
K1 (Mean±SD)	44.53±1.43	44.4±1.84	44.75±1.76	44.2±1.7	0.62
K2 (Mean±SD)	45.05±1.38	45.47±2.14	45.45±1.72	47.07±1.79	0.85
ΔK (Mean±SD)	-0.70±0.58	0.90±0.77	-0.71±0.50	-0.87±0.47	0.6

SD: Standard deviation, K1: Flat K, K2: Steep K, ΔK: Difference between K2 and K1, or corneal astigmatism

Table 2: Mean of logMAR values for postoperative vision on day 1, 7 and 30.

	Types of intraocular lenses				P-value
	Eyhance	AcrySof IQ	Hoya iSert 150	S lens	
logMAR POD 1 (Mean±SD)	0.35±0.55	0.24±0.19	0.25±0.18	0.25±0.18	0.42
logMAR POD 7 (Mean±SD)	0.37±0.44	0.18±0.16	0.25±0.19	0.30±0.30	0.04
logMAR POD 30 (Mean±SD)	0.26±0.19	0.13±0.14	0.20±0.17	0.19±0.14	0.01
Spherical eq. (Mean±SD)	0.30±0.28	0.15±0.24	0.22±0.28	0.20±0.18	0.13

SD: Standard deviation, POD: Postoperative day, LogMAR: Logarithm of minimum angle of resolution, eq.: Equivalent

DISCUSSION

The WHO advises that at least 90% of patients undergoing cataract surgery should achieve satisfactory visual outcomes (6/6–6/18), with no more than 5% experiencing poor vision (<6/60) after the procedure in any service setting.^[7] This study compared the visual outcomes of four lenses with similar qualities but varying prices.

Since the development of the ancient “couching” technique in the 5th century BC, cataract surgery has continuously evolved.^[8] One key consumable in phacoemulsification cataract surgery is IOLs. Unfortunately, due to the increased branding of IOLs, current economic instability, and rising inflation, the cost of surgery continues to escalate. The issue of IOL cost has been addressed by producing low-cost lenses, making the technology more accessible to those who cannot afford expensive options. However, an ethical question arises: are these low-cost IOLs as effective and safe as their branded, more expensive counterparts? This study aimed to address that concern, and it demonstrates that branding is not a significant factor in terms of visual acuity when surgical variables are controlled. Such studies comparing multiple lens options have been conducted in the past. However, there are yet no reports on the comparison of post-operative visual acuity of patients implanted with Hoya iSert 150 and S Lens, which, though belong to the imported segment, are economically viable. Moreover, these two lenses have additionally been compared with two immensely popular and well-accepted branded lenses. This is the strength of our study.

Goslings *et al.*^[9] studied outcomes of aspheric monofocal (Vivonex iSert) with Tecnis Eyhance, a modified monofocal IOL designed to slightly extend the depth of focus. He concluded that Eyhance offers improved intermediate vision compared to standard aspheric monofocal IOLs. The benefit of this improvement on patients’ self-perceived vision after surgery appears to be limited. In terms of distance vision rehabilitation, no significant differences were found between the modified and standard monofocal IOLs.

Singh *et al.*^[10] compared Technis Eyhance ICB00 and one-piece ZCB00 monofocal IOL and concluded that the uncorrected distant visual acuity was comparable in both the ICB00 and ZCB00 groups at the 6-week and 3-month follow-up periods, with no significant differences observed. The uncorrected intermediate and near vision were significantly better in ICB00 versus ZCB00 at 6 weeks and 3 months postoperatively. This finding is mirrored in the study by Kang *et al.*,^[11] who concluded that there was no significant difference in uncorrected distant visual acuity (UDVA) values postoperatively between the ICB00 and ZCB00 in the Asian population. But when it comes to uncorrected intermediate ($P < 0.001$) and near vision ($P < 0.05$), ICB00 fared better than ZCB00 at 3 months postoperatively.

Memon *et al.*^[2] compared three monofocal IOLs of varying cost and reported that branding is not a significant factor regarding visual acuity when surgical variables are controlled. In their large study population ($n = 3237$), 88.2%

attained BCVA between 6/6 and 6/12. In the third follow-up, no significant difference was found in BCVA of the three IOL groups, which were operated by senior surgeons. But when the rest of the surgeons' results were compared, the difference was statistically significant at the third follow-up. The median BCVA for the economical lens was 0.3 log MAR, for the moderately priced lens was 0.2 log MAR, and for the expensive lens was 0.2 log MAR ($P = 0.036$).

Shetty *et al.*^[4] compared three different types of monofocal IOL (Matrix Aurium, AcrySof single piece, and AcrySof IQ lens) and found that 69% of the eyes implanted with Matrix Aurium group had good UDVA post-surgery; the proportion was 48% and 57% in the AcrySof single piece and AcrySof IQ group ($P = 0.09$), respectively. The mean age (SD) in these groups was 58.9 ± 10.4 , 60.4 ± 11.3 , and 57.4 ± 14.9 years for Group A, B, and C, respectively.

In the present study on POD 30, Group B (Acrysof Alcon IQ) gave the best results of good visual acuity (6/6–6/12) with a proportion of 94.28%, followed by Group D (S-Lens) (88.57%), Group C (Hoya iSert 150) (82.85%), and Group A (Eyhance) (68.57%), respectively, with clinically significant difference in P -value for POD 7 and POD 30.

Limitations

This study has some limitations which need to be acknowledged. Tecnis Eyhance IOL is not a pure monofocal IOL, as it is designed to enhance intermediate vision alongside providing distance vision correction. This unique characteristic may influence the overall outcomes of the study and complicate comparisons with standard monofocal IOLs, which are intended solely for distance vision. This study did not include a detailed assessment of intermediate and near visual acuity. While these aspects of vision were informally evaluated, and glasses were prescribed for near vision to all patients, a thorough analysis was not performed. This oversight limits the understanding of how the different IOLs perform across all ranges of vision, particularly in the critical intermediate and near visual domains, which are essential for daily activities such as reading and using digital devices. Consequently, this may affect the overall assessment of patient satisfaction and quality of vision post-surgery. The study's population size of 140 participants is relatively small compared to other studies conducted in this area. Smaller sample sizes can limit the generalization of the findings and may not adequately capture the variability in outcomes that larger studies typically provide. As a result, this could lead to potential biases and affect the robustness of the conclusions drawn from the data. Larger sample sizes are generally necessary to achieve statistical significance and to ensure that the results are representative of the broader population.

CONCLUSION

This study evaluated the visual outcomes of four different monofocal IOLs and found not much of significant differences in performance, regardless of price. All four IOLs produced comparable post-operative visual acuity and refractive outcomes. This suggests that the cost of the lens does not play a major role in surgical success. These findings are particularly relevant in settings where cost is a concern. Surgeons can confidently select more affordable monofocal IOLs without compromising the quality of care, considering both the percentage of patients achieving the optimal vision and the consistency of the outcomes across different lens types. Any of the four monofocal IOLs studied can be effectively used in cataract surgery, with the success of the procedure depending more on the surgeon's skill than the cost or brand of the IOL.

Ethical approval

The study was approved by the Institutional Ethics Committee at Choudhury Eye Hospital & Research Centre, 2024/IEC/03, dated 30/01/2024.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

Dr. Haimanti Choudhury is on the editorial board of the Journal.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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