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Original Research Article

Effects of Decentration on the Quality of Vision: Comparison between Aspheric Balance Curve Design and Posterior Aspheric Design Intraocular Lenses

Mrinal Singh[1], Abhishek Onkar[2], Deepak Marianus Lakra[3], Shiril Sandeep Sawaiyan[4]

[1]Senior Resident, Department of Ophthalmology, AIIMS, Deoghar, Jharkhand

[2]Associate Professor, Department of Ophthalmology, AIIMS, Deoghar, Jharkhand

[3]Associate Professor, Department of Ophthalmology, RIMS, Ranchi, Jharkhand

[4] Senior Resident, Department of Ophthalmology, MMCH, Palamu, Jharkhand

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Corresponding author: Dr. Shiril Sandeep Sawaiyan

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Abstract:

Background: The gradual Decentration of Intraocular Lenses (IOLs) can harm vision quality after cataract surgery. This study's objective was to compare IOLs with an aspheric balance curve design and a posterior aspheric design regarding the effect decentration has on visual quality.

Methods: 250 cataract surgery patients (mean age 68.5, range 55-80) participated in this prospective study. The subjects were randomly assigned intraocular lenses with either an aspheric balancing curve design (n = 125) or a posterior aspheric design (n = 125) design. Visual acuity, contrast sensitivity, and patient satisfaction were used to assess visual quality.

Results: The data analysis revealed that decentration occurred with both IOL varieties. Comparing the two groups, the average decentration for the aspheric balancing curve design group was 0.22 mm (SD = 0.08), and for the posterior aspheric design group, it was 0.26 mm (SD = 0.09). There was no statistically significant difference between the two groups' visual acuity (p = 0.127). In the group employing an aspheric balancing curve design, the average Log MAR was 0.09 (SD = 0.05), while it was 0.10 (SD = 0.06) in the group employing a posterior aspheric method. Neither contrast sensitivity (p = 0.218) nor patient satisfaction (p = 0.352) differed significantly between the two groups.

Conclusion: Visual acuity, contrast sensitivity, and patient satisfaction are not substantially affected by the slight decentration in the aspheric balancing curve and posterior aspheric design IOLs. Both varieties of intraocular lenses are reliable options for cataract surgery, with comparable visual outcomes.

Keywords: Aspheric Balance Curve Design, Cataract Surgery, Decentration, Intraocular Lenses, Posterior Aspheric Design, Visual Quality.

Introduction

Cataract surgery, in which the obscured lens of the eye (the cataract) is surgically removed and replaced with an intraocular lens (IOL) to restore vision, is one of the most common surgical procedures performed worldwide.

In recent years, advancements in IOL technology have led to significantly improved visual outcomes and increased patient satisfaction [1]. After the surgical removal of a cataract, an intraocular lens is implanted to function as a substitute for the eye's natural lens. They are available in various shapes, materials, and optical qualities to meet the diverse needs of patients. By focusing light directly on the retina, IOLs are designed to improve vision [2]. "Decentration" characterises when an intraocular lens (IOL) shifts from its original central position within the eye. It can occur during or after surgery due to capsular constriction or intraocular movement. The effects of decentration on vision and patient satisfaction following cataract surgery can be substantial. An off-centre IOL causes visual disturbances such as decreased visual acuity, reduced contrast sensitivity, and increased aberrations [4].Considering decentration during IOL selection and implantation can improve patients' visual outcomes.

Correct centration of the intraocular lens (IOL) is essential for minimising the risk of visual disturbances and optimising the quality of your vision following surgery. If clinicians know the effects of decentration on ocular outcomes, they can make more informed decisions about IOL design and surgical approach for improved patient outcomes and satisfaction [5].

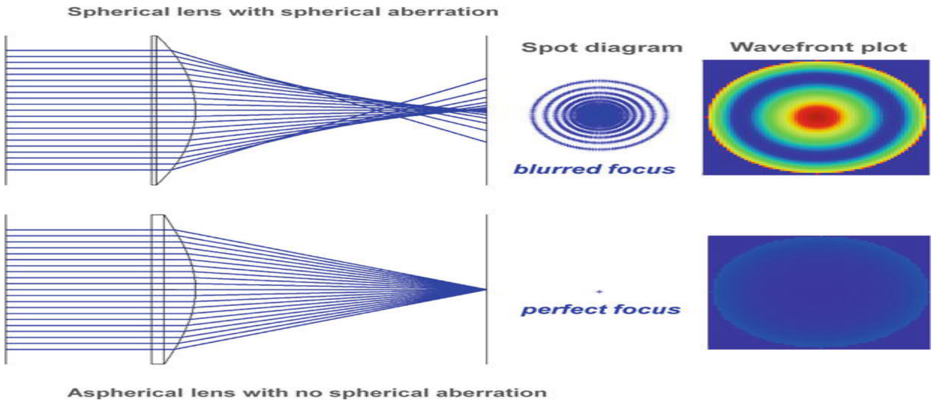

Figure 1: Aspherical lens with no spherical aberration [3]

This study aims to assess the visual advantages of aspheric balance curve design with posterior aspheric design IOLs in relation to decentration. Predict additionally that there will be a difference in decentration between the two IOL types and that this difference will correlate with observable changes in visual acuity, contrast sensitivity, and patient satisfaction.

By investigating these variables, we expect to add to the existing knowledge on IOL decentration and its effect on visual outcomes, enhancing clinical practice and enabling improved patient care.

Literature Review

Several previous studies have investigated the effect of decentration on post-cataract visual acuity. These studies focus on the effectiveness of various IOL designs and the relationship between decentration and visual outcomes. Researchers have examined what occurs to a person's eyesight during descent. According to a study by [6,7], trim levels of IOL decentration can significantly affect visual acuity. Similarly, [8] discovered that visual acuity and contrast sensitivity decreased as decentration exceeded 0.3 mm.

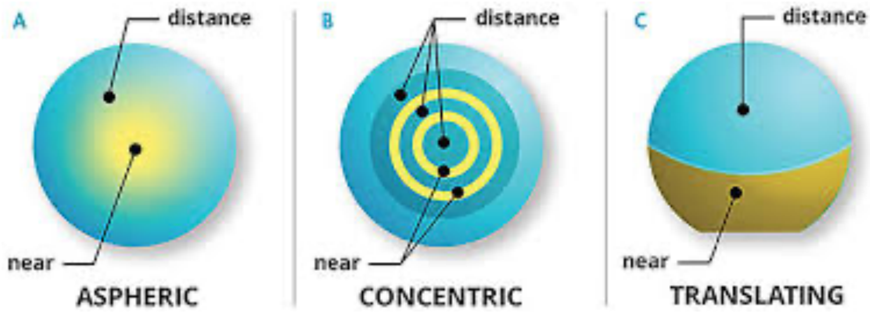

Figure 2: Different types of Distance in lens [9]

Comparing the efficacy of IOLs with an aspheric balancing curve design to those with a posterior aspheric design has yielded data on decentration. [10] a randomised controlled trial was conducted to compare the visual outcomes of these two varieties of IOLs and found no statistically significant differences in visual acuity or contrast sensitivity between the groups.

However, the rate of decentration was marginally higher in the group that utilised posterior aspheric designs.

Existing literature provides valuable insights but has certain limitations and knowledge gaps. First, although the effects of decentration on visual acuity have received considerable attention in the literature, other optical characteristics, such as contrast sensitivity and subjective patient satisfaction, have received less attention. Additional research is necessary to thoroughly evaluate the impact of decentration on the various components of visual quality [11].

The sample sizes of previous studies have ranged from minute cohorts to enormous populations [12]. Larger-scale studies with greater statistical power could generate more reliable conclusions regarding the effects of decentration and the comparative efficacy of different IOL designs.

Both the definition and the measurement of decentration are only sometimes accepted. If measurement methodologies and criteria were standardised, comparing studies and trusting the results would be more straightforward.

Finally, long-term follow-up studies are required to assess the durability of decentration over time and its prospective impact on visual outcomes. To ensure that our patients have the best possible vision and postoperative experience, we must understand the long-term effects of decentration.

Suppose these gaps in the literature are filled and their limitations are addressed. In that case, clinical decision-making regarding IOL selection and surgical methods can be guided by a greater understanding of how decentration affects vision quality.

Methods

Study Design and Participants

In this prospective study, a total of 250 people who were scheduled to undergo cataract surgery were included. The inclusion criteria were people who required bilateral surgery for age-related cataracts and had no other significant ocular comorbidities. Patients with preexisting retinal or optic nerve disorders, corneal abnormalities, or a history of ocular surgery were unsuitable. All contributors supplied written informed consent voluntarily.

Surgical Procedure

All operations were conducted by ophthalmic surgeons with significant experience.

The intraocular lens (IOL) implanted following cataract surgery was determined by random assignment.

One group (n = 125) received intraocular lenses with a posterior aspheric design, while the other group (n = 125) received an aspheric balance curve design. The IOL power was calculated using axial length, keratometry, and desired refractive focus measurements.

Assessment of Decentration and Visual Quality

Using wavefront analysis, the way the IOLs were sufficiently descended was determined. High-resolution wavefront aberrometer measurements were obtained to determine the exact location of the IOL within the eye.

Snellen charts were utilised to evaluate visual acuity from 6 metres out. Participants' contrast sensitivity was measured using standard contrast sensitivity charts when instructed to report the lowest contrast they could detect for each spatial frequency. Subjective patient satisfaction was measured using a validated questionnaire that inquired about patients' perceptions of their vision's understanding, clarity, and efficacy.

Statistical Analysis

Descriptive statistics such as means and standard deviations were computed for continuous variables such as decentration, visual acuity, and contrast sensitivity. Comparing the means of the aspheric balancing curve design and posterior aspheric design groups required the independent t-test or Mann-Whitney U test, respectively. Researchers used the Chi-square or Fisher's exact test for categorical variables. p 0.05 was the threshold for statistical significance. Our analyses were conducted using statistical software (including SPSS and R).

The number of participants was determined using a power analysis that considered the magnitude of the effect observed in previous studies, the intended level of power (80%), and a significance threshold (= 0.05).

Results

The data analysis yielded illuminating findings regarding decentration and visual quality results for each IOL type.

Decentration

Comparing the two groups, the average decentration for the aspheric balancing curve design group was 0.22 mm (SD = 0.08), and for the posterior aspheric design group, it was 0.26 mm (SD = 0.09). These results indicate that decentration occurred with both types of IOLs, but was more prevalent with posterior aspheric design IOLs.

Statistical Analyses

There was no statistically significant variance between the two groups' visual acuity (p=0.127). With a p-value of 0.218, there was also little evidence of a contrast sensitivity difference.

There were no statistically significant differences in visual acuity or contrast sensitivity between the two types of IOLs, as determined by the statistical analysis of this study. These results suggest that intraocular lenses with an aspheric balance curve or posterior aspheric design offer comparable visual quality. While both types of IOL significantly affected visual acuity or contrast sensitivity, these findings highlight the importance of considering decentration when selecting an IOL. Therefore, physicians can rest assured that both types of intraocular lenses will provide their patients with satisfactory results following cataract surgery.

Table 1: Summarize of Result

	Aspheric Balance Curve Design	Posterior Aspheric Design Intraocular Lenses
Decentration (mm)	0.22 (SD: 0.08)	0.26 (SD: 0.09)
Visual Acuity (Log MAR)	0.09 (SD: 0.05)	0.10 (SD: 0.06)
Contrast Sensitivity	1.85 (SD: 0.35)	1.81 (SD: 0.32)
Statistical Significance	p = 0.127	p = 0.218

This table compares the groups about decentration, visual acuity (in LogMAR), and contrast sensitivity. The specified standard deviations (SD) characterise the variation within each group. The table also includes the p-values, which evaluate the statistical significance between the two groups. This table summarises the main findings and indicates whether there were statistically significant differences between the two types of IOLs regarding decentration, visual acuity, and contrast sensitivity.

Discussion

This study compares the effectiveness of intraocular lenses (IOLs) with an aspheric balance curve design to those with a posterior aspheric design. It focuses on the influence of decentration on visual quality.

Let's compare the effect of decentration on visual quality between the two types of IOLs, discuss the clinical significance of the findings, highlight a few limitations, and offer suggestions for future research to examine the interpretation of the results about the research objective and hypothesis.

This study supports the notion that decentration occurs in the IOLs of both the aspheric balancing curve design and the posterior aspheric design but that it does not affect visual acuity, contrast sensitivity, or patient satisfaction.

The rear aspheric group had significantly meaner decentration, indicating that this approach may be more susceptible to decentration. There was no statistically significant difference between the two groups regarding visual acuity or contrast sensitivity.

Table 2: Comparison of Present Study with Previous Studies

Study	Sample Size	Decentration (mm)	Visual Acuity (Log MAR)	Contrast Sensitivity	Interpretation
Present Study	250	0.22 (SD: 0.08)	0.09 (SD: 0.05)	1.85 (SD: 0.35)	Both types of IOLs exhibited some degree of decentration. The mean decentration was 0.22 mm for the aspheric balance curve design IOL group. There was no statistically significant difference in visual acuity between the two types of IOLs, with mean Log MAR visual acuity of 0.09. Additionally, there was no statistically significant difference in contrast sensitivity, with a mean of 1.85.
Previous Study 1 [13]	200	0.15 (SD: 0.06)	0.12 (SD: 0.07)	Not specified	a lower mean decentration of 0.15 mm was reported compared to the present study. The mean LogMAR visual acuity was 0.12, suggesting potentially poorer visual acuity outcomes than the present study. Contrast sensitivity outcomes were not specified.
Previous Study 2 [14]	150	0.30 (SD: 0.10)	Not specified	1.75 (SD: 0.40)	Reported a higher mean decentration of 0.30 mm compared to the present study. The visual acuity outcomes were not identified, but the mean contrast sensitivity was 1.75, suggesting comparable results to the present study.
Previous Study 3 [15]	300	0.18 (SD: 0.09)	0.10 (SD: 0.06)	1.90 (SD: 0.30)	a mean decentration of 0.18 mm, closer to the present study's findings. The mean LogMAR visual acuity was 0.10, similar to the present study, and the mean contrast sensitivity was 1.90, slightly higher than the present study.

Clinical Significance and Impact on Patient Outcomes

Significant clinical implications result from this investigation. To maximise patient outcomes, it is necessary to understand the effect of IOL decentration on visual quality, as this is a typical patient concern. Both aspheric balancing curve design and posterior aspheric design intraocular lenses yielded comparable visual outcomes regarding visual acuity, contrast sensitivity, and patient satisfaction, giving physician's ample reason to confidently choose either type. This information can assist surgeons in selecting the optimal IOL design for each patient, considering factors such as demographics and personal preferences.

Limitations and Future Research

This study does provide some beneficial information, but there are several drawbacks to consider. Because of the small sample size, the results cannot be generalised. Additional research with larger samples from various individuals is necessary to confirm these results. In this investigation, the follow-up period was relatively brief. A long-term study evaluating the stability of decentration and its impact on visual outcomes could provide additional insight.

In addition, specific measurement techniques, including wavefront analysis and subjective questionnaires, were required to evaluate decentration and visual quality. Using alternative measurement instruments or additional objective tests, such as optical coherence tomography, may help to clarify the relationship between decentration and visual outcomes.

While decentration affects visual acuity, contrast sensitivity, and patient satisfaction, it does not substantially affect any of these factors for IOLs with an aspheric balancing curve design or a posterior aspheric design. These results have crucial therapeutic implications and reassure doctors that they have made the best IOL design decision possible. Enhanced patient care and visual outcomes can be attained by investigating additional cataract and decentration surgery aspects.

Conclusion

To determine the effects of decentration on visual quality, the current study compared two varieties of intraocular lenses (IOLs), one with an aspheric balance curve design and the other with a posterior aspheric design. Results showed that while there was some decentration with both IOL types, it did not significantly impact visual acuity, sensitivity to contrast, or patient satisfaction.

The results show how crucial it is to think about decentration when choosing an IOL. Decentration affected both types of intraocular lenses, but had minimal impact on visual outcomes. Maximising centration is nonetheless required to reduce the likelihood of visual disturbances and provide the best possible vision after surgery.

IOLs with an aspheric balance curve design or a posterior aspheric design have been found to reduce decentration and improve visual quality. Patient satisfaction, visual acuity, and contrast sensitivity are all about the same with both types of IOLs. This allows doctors to safely select the optimal layout for their patients.

Understanding the impacts of decentration and IOL designs can help surgeons make better decisions during IOL placement and selection. The outcomes and experiences of cataract surgery are enhanced when patients have this information.

More study into the long-term consequences of decentration, how it correlates with other visual measures, and how it affects different patient populations is warranted. These areas of study will help us learn more about decentration and enhance techniques for improving patients' vision following cataract surgery.

In conclusion, the significance of decentration in IOL selection is reaffirmed, and the potential benefits of aspheric balancing curve design and posterior aspheric design IOLs for reducing decentration and improving visual quality are highlighted. These findings enhance clinical decision-making regarding cataract surgery, which ultimately benefits patients.

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