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Indian Journal of Clinical and Experimental Ophthalmology

Journal homepage: www.ijceo.org

Original Research Article

A study of contrast sensitivity in eyes with hydrophobic and hydrophilic acrylic foldable posterior chamber intraocular lens

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ARTICLE INFO

Article history:
Received 19-01-2024
Accepted 05-03-2024
Available online 04-07-2024

Keywords:
Hydrophobic
Hydrophilic
Contrast sensitivity
Phacoemulsification

ABSTRACT

Aim: The aim of this study was to evaluate the effect of PCIOL on contrast sensitivity function in patients following Phacoemulsification surgery.

Materials and Methods: This was an analytical observational study done on patients who underwent uneventful phacoemulsification with either hydrophobic or hydrophilic posterior chamber IOL's. Contrast sensitivity function (CSF) was measured preoperatively and postoperatively after 3 months with Pelli-Robson chart and compared. Normally distributed data was analysed using the independent sample t-test for intergroup comparison and for intragroup comparison before and after cataract surgery, paired t-test was used.

Results: Out of 50 patients underwent phacoemulsification surgery, 52% were females and 56% were belonged to age group of 51 to 60 years. 25 patients received hydrophobic intraocular lens and other 25 patients received hydrophilic intraocular lens. Postoperative mean contrast sensitivity (1.997 ± 0.01) was found statistically significant ($p < 0.01$) as compared to the preoperative contrast sensitivity (1.556 ± 0.16). Significant improvement in contrast sensitivity was observed after cataract surgery in both the groups ($p<0.05$).

Conclusion: The reduced contrast sensitivity function due to cataract, improved after surgery. On the other hand, optical properties and the material of IOL has no impact on contrast sensitivity postoperatively.

1. Introduction

Methods of cataract surgery have progressed from intracapsular cataract extraction (ICCE) to phacoemulsification, enabling intraocular lens implantation through small, suture less incisions. The use of foldable optic structures allow larger optical zones, reducing glare and improving overall outcomes. Even after a successful cataract surgery with intraocular Lens (IOL) implantation and satisfactory refractive results, patients frequently express concerns about the quality of their vision.

Contrast sensitivity (CS) plays a crucial role in visual quality, and it can decline after cataract surgery and intraocular lens (IOL) implantation. The optical design, dimensions, and spectral transmission characteristics of the IOL are factors that can affect contrast sensitivity.[1]

Contrast refers to the extent of black-to-white variation in an object or target. The contrast threshold represents the minimum contrast needed for clear object perception, while contrast sensitivity (CS) is the capacity to discern crisp and distinct outlines of minute objects.[2,3]

While a patient may have 6/6 visual acuity, there can be a reduction in contrast sensitivity. Interestingly, the

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https://doi.org/10.18231/j.ijceo.2024.049

psychological impact of this loss in contrast sensitivity can sometimes be more distressing than the decline in visual acuity alone.[4]

Moreover, contrast sensitivity tends to decline earlier in the progression of ocular pathologies, even when visual acuity remains unimpaired. Visual acuity, in such cases, often underestimates the initiation and/or extent of visual impairment.[5]

The reduction in contrast sensitivity can impact everyday tasks like driving, reading, walking, using computers, and recognizing faces, thereby diminishing the overall quality of life.[6,7]

While Snellen's chart measures visual acuity with high contrast, real-world scenarios may lead to visual impairment caused by decreased contrast sensitivity. In low-contrast conditions, both visual acuity and overall vision quality may decline. Contrast sensitivity is acknowledged as a superior predictor of visual acuity, offering insights beyond what visual acuity alone can provide.[8]

Evaluating contrast sensitivity serves as a valuable addition to standard visual acuity tests and should be incorporated into the regular optometric examination, even for patients with normal vision.[9–11]

The Pelli Robson chart, a widely adopted contrast sensitivity test, is known for its speed, repeatability, and reliability. This test is straightforward to administer, and in employing the psychophysics of letter recognition with printed letters of consistent size but varying contrast levels. Its proven reliability, effectiveness, and seamless integration into routine optometric assessments have been validated.[12,13]

This is an analytical observational study to compare the effect of Hydrophilic and Hydrophobic Posterior Chamber Intraocular lens (IOL) on contrast sensitivity function in patients following an uneventful phacoemulsification surgery.

2. Materials and Methods

The initiation of the study was preceded by obtaining permission from higher authorities and clearance from the Institutional Ethics Committee. Conducted over a period of six months, from June 2023 to November 2023, this observational study prospectively observed patients who underwent uncomplicated phacoemulsification with posterior chamber intraocular lens implantation at the Department of Ophthalmology, Alluri Sitaramaraju Academy of Medical Sciences, Eluru, Andhra Pradesh.

A total of 50 patients meeting the inclusion and exclusion criteria underwent uneventful Phacoemulsification surgery were divided into two groups of 25 patients each.

Group A underwent Phacoemulsification with Foldable Hydrophilic Aspheric PCIOL implantation (Acryfold, Appasamy Associates).

Group B underwent Phacoemulsification with Foldable Hydrophobic Aspheric PCIOL implantation (SupraPhob, Appasamy Associates).

Patients having visually significant nuclear cataract up to NO3 NC3 according to LOCS III (Lens opacities classification classification system III) who underwent uneventful phacoemulsification surgery with foldable posterior chamber Intraocular lens in the bag and had postoperative vision better than or equal to 6/9 were included in the study.

Following were excluded from the study

1. Patients with nuclear cataract greater than NO3 NC3, cortical and Posterior sub-capsular cataract.
2. Patients with uncontrolled diabetes mellitus.
3. Patients having degenerative conditions of Macula e g ARMD.
4. Patients having any other ocular pathologies which will affect the contrast sensitivity function.
5. Patients with history of previous ocular surgery other than cataract.
6. Complicated cataract surgeries like associated vitreous loss, Posterior capsular rent, other than in the bag intraocular lens implantation.

Patients meeting the inclusion and exclusion criteria were examined preoperatively. The assessments included visual acuity was measured in LogMAR values using Snellen's test types and the evaluation of contrast sensitivity function was measured with Pelli-Robson's contrast sensitivity chart, Corneal curvature (K1, K2) readings were measured with Autorefractor/keratometer, Intraocular Pressure measurement was measured with Goldmann Applanation Tonometer, Anterior segment evaluation was done with slit lamp biomicroscope, Dilated Fundus examination was done with Slit-lamp lenses, Axial length calculation and Intraocular power calculation was done by A scan. Postoperatively patients were evaluated for their Uncorrected visual acuity (UCVA), Best-corrected visual acuity (BCVA) and Contrast sensitivity function test using Pelli-Robson contrast sensitivity chart under Photopic luminance conditions with best spectacle correction at 12^{th} week and assigned a score, with the scoring ranges from 0 to 2, where a score of 2.0 indicates normal contrast sensitivity at 100%. Scores below 1.5 (75%) are indicative of visual impairment, and a score below 1.0 (50%) signifies visual disability.

2.1. Statistical analysis

Microsoft Excel and IBM Statistical Package for the Social Sciences (SPSS) version 20 were employed for data analysis. Numerical data was presented as Mean and Standard Deviation. Intergroup comparisons for normally distributed data were conducted using the independent sample t-test, while intragroup comparisons before and after

cataract surgery utilised the paired t-test. A P-value less than 0.05 was deemed statistically significant.

3. Results

A total of 50 patients who underwent uneventful phacoemulsification surgery with foldable IOL in the bag had a postoperative vision better than or equal to 6/9 were enrolled in our study, of whom 25 patients received hydrophobic intraocular lens and other 25 patients received hydrophilic intraocular lens. The majority of individuals undergoing phacoemulsification surgery were in the age group of 51 to 60 years (56%), with 26% of patients aged 50 or below. Females accounted for 52% of the cases, and 62% of the surgeries were performed on the right eye. (Table 1).

The Mean Preoperative Best corrected visual acuity (BCVA) in the Hydrophobic group was 0.656 ± 0.208 and in Hydrophilic group it was 0.696 ± 0.203 measured in LogMAR, whereas Postoperative BCVA it was 0.184 ± 0.114 for Hydrophobic group and 0.196 ± 0.130 for the Hydrophilic group (Table 2).

Table 3 depicted; Mean Contrast sensitivity function postoperatively (1.997± 0.01) to be statistically significant (P value <0.01) to the preoperative contrast sensitivity (1.556 ± 0.16), signifying there was significant improvement in the Contrast sensitivity function post cataract surgery with Intraocular lens implantation (Figure 1). Paired t-test was done to analyse the data before and after cataract surgery.

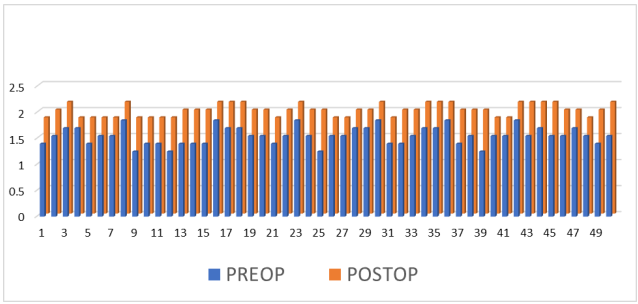

Figure 1: Contrast sensitivity function before and after cataract surgery

Postoperative contrast sensitivity function in patients who received Hydrophobic (2.018 ± 0.12) or Hydrophilic (1.976 ± 0.12) intraocular lens was statistically significant (P value <0.01) to their preoperative contrast sensitivity values, which were 1.586 ± 0.15 and 1.526 ± 0.18 respectively (Table 4), (Figures 2 and 3). Paired t-test was done to analyse the data before and after cataract surgery.

At 12 weeks postoperative period, 25 patients who received hydrophobic intraocular lens and the other 25 patients who received hydrophilic intraocular lens had a mean contrast sensitivity of 2.018 ± 0.12 and 1.976 ± 0.12 respectively. An independent sample t-test was performed

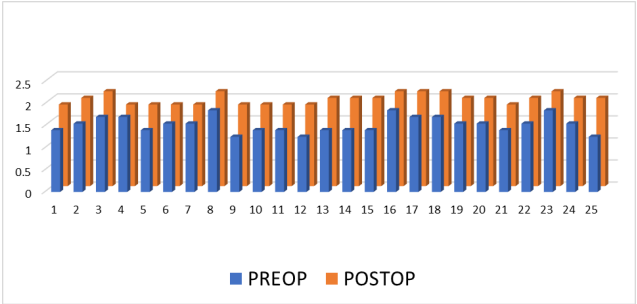

Figure 2: Contrast sensitivity function after phacoemulsification and Hydrophilic Intraocular lens implantation

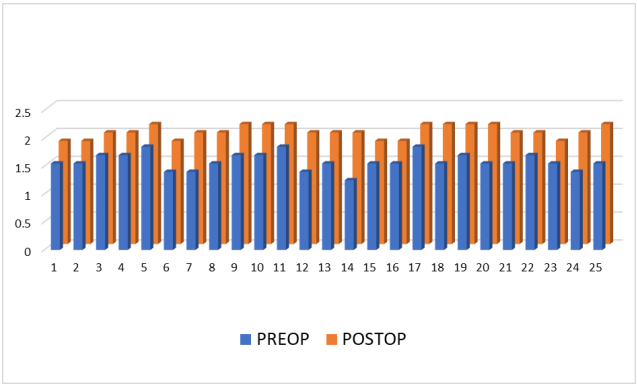

Figure 3: Contrast sensitivity function after phacoemulsification and Hydrophobic Intraocular lens implantation

to assess the data between groups, indicating no statistically significant difference. (P value = 0.21) between the two groups (Table 5) (Figure 4).

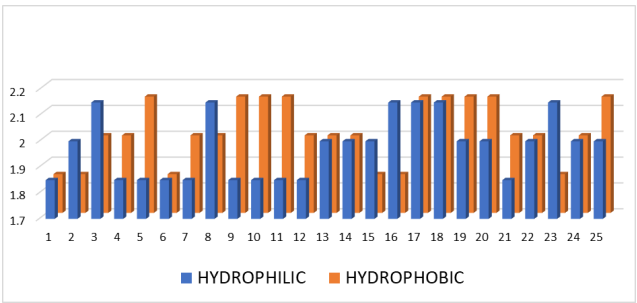

Figure 4: Postoperative comparison of contrast sensitivity function between hydrophilic and hydrophobic Intraocular lens

4. Discussion

The current study sought to compare the enhancement of contrast sensitivity function following phacoemulsification, utilising either hydrophobic or hydrophilic posterior chamber intraocular lenses (PCIOLs).

Table 1: Distribution of patients

Parameters	Hydrophobic IOL G roup	Percentage (%)	Hydrophilic IOL Group	Percentage (%)
Age group				
</= 50 years	6	24%	7	28%
51 - 60 years	15	60%	13	52%
61 - 70 years	4	16%	5	20%
> 70 years	0		0	
Gender				
Male	15	60%	9	36%
Female	10	40%	16	64%
Eye				
Right	12	48%	19	76%
Left	13	52%	6	24%

Table 2: Mean visual acuity in patients before and after cataract surgery with the intraocular lenses

Best Corrected Visual Acuity (BCVA) in LogMAR (Logarithm of the Minimum Angle of Resolution)		Mean ± Standard Deviation	P Value
Hydrophobic IOL Group	Preoperative	0.656 ± 0.208	< 0.01
	Postoperative	0.184 ± 0.114	
Hydrophilic IOL group	Preoperative	0.696 ± 0.203	< 0.01
	Postoperative	0.196 ± 0.130	

Table 3: Contrast sensitivity function in both the groups before and after Phacoemulsification surgery with intraocular lens implantation

Contrast sensitivity function	Mean ± Standard Deviation (95% Confidence interval)	P Value
Preoperative	1.556 ± 0.16 (1.516 – 1.596)	<0.01
Postoperative	1.997 ± 0.01 (1.967 – 2.027)	

Table 4: Contrast sensitivity function before and after cataract surgery with intraocular lens implantation

Contrast Sensitivity Function		Mean ± Standard Deviation (95% Confidence Interval)	P Value
Hydrophobic IOL Group	Preoperative	1.586 ± 0.15 (1.526 – 1.646)	< 0.01
	Postoperative	2.018 ± 0.12 (1.978 – 2.058)	
Hydrophilic IOL Group	Preoperative	1.526 ± 0.18 (1.456 – 1.596)	< 0.01
	Postoperative	1.976 ± 0.12 (1.936 – 2.016)	

Table 5: Comparison ofcontrast sensitivity function between hydrophilic and hydrophobic posterior chamber intraocular lens

Contrast Sensitivity function in postoperative group	Mean± Standard deviation (95% confidence interval)	P Value
Hydrophilic IOL group	1.976 ± 0.12 (1.936-2.016)	0.21
Hydrophobic IOL group	2.018 ± 0.11 (1.978 – 2.058)	

Cataract surgery with PCIOL Implantation generally results in improved contrast sensitivity in patients with significant cataract. The Abbe number assesses the chromatic dispersion of optical materials, where higher values indicate lower chromatic dispersion and superior optical quality.[14] Hydrophobic intraocular lenses (IOLs) exhibit lower Abbe numbers compared to hydrophilic IOLs, leading to greater chromatic dispersion and increased chromatic aberration in hydrophobic IOL materials.

Hygroscopy refers to a material's capacity to absorb and retain water. An elevation in hygroscopy diminishes the typical postoperative occurrence of glistenings – tiny fluid-filled micro vacuoles that emerge following intraocular lens (IOL) implantation. This is likely due to water entering the material, interacting with hydrophilic groups and preventing the accumulation in micro vacuoles.[15]

IOLs with high water content, characteristic of hydrophilic lenses, offer enhanced biocompatibility and reduced incidence of glare.

Unfortunately, glistening's commonly affect hydrophobic IOLs. This study shows that the chromatic dispersion, glare disability and glistening's due to lens material have no effect on the contrast sensitivity function.

The result of the study revealed that the contrast sensitivity improvement in patients is observed following cataract surgery, regardless of the intraocular lens material used.

Anthony Chang et al.'s[16] study concluded that over a span of 9 years, the hydrophobic intraocular lens (IOL) exhibited a higher occurrence of glistenings compared to the hydrophilic IOL. However, these glistenings did not impact Corrected Distance Visual Acuity (CDVA) or contrast sensitivity.

According to a study conducted by Akman A et al[17] on glare disability in patients with hydrophilic and hydrophobic acrylic intraocular lens implants, it was concluded that eyes with hydrophilic acrylic IOL demonstrated superior results in glare disability compared to those with hydrophobic acrylic IOL. However, there was no significant difference between the two groups in terms of log contrast sensitivity values.

Aging has been shown to affect the contrast sensitivity[18] but most of the subjects in this study were in the age group of 51 – 60 years (56%) and this might have not affected the results of this study. Only normal healthy subjects were enrolled in this study and patient with any ocular pathology or surgical complications which would have probably altered the contrast sensitivity function were not considered in this study.

5. Limitations

A primary limitation of our study was the relatively short three-month postoperative follow-up period. Extending the duration of follow-up would have provided additional valuable insights. More sophisticated methods are available to test contrast sensitivity function than Pelli Robson chart and contrast sensitivity under mesopic conditions was not measured in this study. Assessing the contrast sensitivity function under varied lighting conditions and utilizing advanced equipment could lead to a more comprehensive functional evaluation.

6. Conclusion

To conclude, contrast sensitivity is an indicator of the visual quality. In our study, in both hydrophilic and hydrophobic groups, contrast sensitivity function showed similar improvement and no statistically significant difference was observed between the groups. Our study shows that optical properties and the material of IOL has no impact on the contrast sensitivity. It is crucial to highlight that our follow-up period was limited to three months, emphasising the necessity for a long-term follow-up to thoroughly evaluate the impact of intraocular lens material on contrast sensitivity.

7. Source of Funding

Nil.

8. Conflicts of Interest

Nil.

References

1. Mela E, Gartaganis S, Koliopoulos J. Contrast sensitivity function after cataract extraction and intraocular lens implantation. *Doc Ophthalmol*. 1996;92:79–91.
2. Stalin A, Dalton K. Relationship of Contrast Sensitivity Measured Using Quick Contrast Sensitivity Function With Other Visual Functions in a Low Vision Population. *Invest Ophthalmol Vis Sci*. 2020;61(6):21.
3. O'Carroll DC, Wiederman SD. Contrast sensitivity and the detection of moving patterns and features. *Philos Trans R Soc Lond B Biol Sci*. 1636;369(1636):20130043.
4. Sabel BA, Wang J, Cárdenas-Morales L, Faiq M, Heim C. Mental stress as consequence and cause of vision loss: the dawn of psychosomatic ophthalmology for preventive and personalized medicine. *EPMA J*. 2018;9(2):133–60.
5. Murugappan M, Vayalil J, Bade A. Reliability of quick contrast sensitivity function testing in adults without ocular disease and patients with retinitis pigmentosa. *Invest Ophthalmol Vis Sci*. 2016;57(12):616.
6. Haymes SA, Johnston AW, Heyes AD. Relationship between vision impairment and ability to perform activities of daily living. *Ophthalmic Physiol Opt*. 2002;22(2):79–91.
7. Richman J, Lorenzana LL, Lankaranian D, Dugar J, Mayer JR, Wizov SS, et al. Relationships in glaucoma patients between standard vision tests, quality of life, and ability to perform daily activities. *Ophthalmic Epidemiol*. 2010;17(3):144–51.
8. Bennett CR, Bex PJ, Bauer CM, Merabet LB. The Assessment of Visual Function and Functional Vision. *Semin Pediatr Neurol*. 2019;31:30–40.
9. Arditi A. Improving the design of the letter contrast sensitivity test. *Invest Ophthalmol Vis Sci*. 2005;46(6):2225–9.
10. Kiser AK, Mladenovich D, Eshraghi F, Bourdeau D, Dagnelie G. Reliability and consistency of visual acuity and contrast sensitivity measures in advanced eye disease. *Optom Vis Sci*. 2005;82(11):946–54.
11. Mahjoob M, Anderson AJ. Contrast discrimination under task-induced mental load. *Vision Res*. 2019;165:84–9.
12. Elliott DB, Sanderson K, Conkey A. The reliability of the PelliRobson contrast sensitivity chart. *Ophthalmic Physiol Opt*. 1990;10(1):21–4.
13. Mäntyjärvi M, Laitinen T. Normal values for the PelliRobson contrast sensitivity test. *J Cataract Refract Surg*. 2001;27(2):261–6.
14. Zhao H, Mainster MA. The effect of chromatic dispersion on pseudophakic optical performance. *Br J Ophthalmol*. 2007;91(9):1225–9.
15. Yildirim TM, Fang H, Schickhardt SK, Wang Q, Merz PR, Auffarth GU. Glistening formation in a new hydrophobic acrylic intraocular lens. *BMC Ophthalmol*. 2020;20(1):186.
16. Chang A, Kugelberg M. Glistenings 9 years after phacoemulsification in hydrophobic and hydrophilic acrylic intraocular lenses. *J Cataract Refract Surg*. 2015;41(6):1199–204.
17. Akman A, Bozbeyoglu S, Akova YA. Glare disability in patients with hydrophilic and hydrophobic acrylic intraocular lens implants. *Eur J Ophthalmol*. 2004;14(1):14–8.
18. Hawkins A, Szlyk J, Ardickas Z, Alexander K, Wilensky J. Comparison of Contrast Sensitivity, Visual Acuity, and Humphrey Visual Field Testing in Patients with Glaucoma. *J Glaucoma*.

2003;12(2):134–8.

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Cite this article: Mukkamala NRVL, Mathukumalli SSK, Undrakonda V, Pakalapati P. A study of contrast sensitivity in eyes with hydrophobic and hydrophilic acrylic foldable posterior chamber intraocular lens. *Indian J Clin Exp Ophthalmol* 2024;10(2):275-280.