# Original Article

# A comparison of the contrast sensitivity function between age-matched phakic emmetropes and pseudophakic individuals with aspheric intraocular lenses

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**Abstract:**

**PURPOSE:** The purpose of this study is to compare the contrast sensitivity function (CSF) between eyes of age-matched individuals with aspheric intraocular lens (IOL) and emmetropia.

**METHODS:** A prospective hospital-based case–control study in South India was conducted to study the CSF in the eyes of patients between the ages of 50–60 years. The CSF was compared between those with emmetropia and those implanted with an indigenous aspheric IOL. Twenty-five consecutive patients were recruited in both groups. The independent sample $t$-test was used for analysis.

**RESULTS:** The mean age was 53.08 ± 1.96 years and 57.68 ± 2.85 years in normal emmetropes and emmetropic pseudophakic with aspheric IOL, respectively. The mean CSF showed a statistically significant difference ($P < 0.000$) between the normal emmetropic eyes and pseudophakic eyes with the values being 1.91 and 1.572, respectively.

**CONCLUSION:** The CSF was significantly better in the eyes of age-matched normal emmetropes when compared to those with an aspheric IOL implanted.

**Keywords:**

Contrast sensitivity, emmetropia, India, intraocular, lenses

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## Introduction

Cataracts account for nearly 50%–80% of the blindness in India.[1] In an effort to tackle this burden of cataract blindness, the National Program For Control of Blindness has laid emphasis in improving the facilities for cataract surgery. In the year 2016–2017, nearly 98% of the target of 6.6 million surgeries were achieved across the country.[2] The impetus toward achieving such targets is mainly based on visual acuity as the benchmark of visual function. In addition, an improved accessibility to advanced surgical facilities is leading to an increased demand for early cataract surgery for refractive purposes. An increasing number of patients presenting for cataract surgery are opting for the implantation of an aspheric intraocular lens (IOL) especially the indigenously manufactured affordable ones.[3] However, the role of other factors such as glare and contrast sensitivity (CS) in the eventual overall visual outcome cannot be undermined. The purpose of this study is to compare one such factor, i.e., CS function (CSF) in an Indian cohort. The difference in CSF between eyes implanted with aspheric and spherical IOLs, as well as between unifocal and multifocal IOLs has been studied well. We attempt to study this difference between age-matched

patients with emmetropic eyes and patients whose eyes are implanted with an aspheric IOL.

## Methods

This was a prospective case–control study performed at a Teaching hospital in South India. Twenty-five consecutive patients, who underwent aspheric IOL implantation after uncomplicated phacoemulsification were chosen as cases. Their CSF at the end of 6 weeks of surgery was compared with 25 age-matched patients (controls) with emmetropia for distance. The study was reviewed by the Institution Research Ethics Committee (Approval No. IEC/ASR/011/2017), and informed consent was obtained from all participants before data collection. The tenets of the Declaration of Helsinki were followed during the conduct of this study. All the patients were chosen in the age group of 50–60 years. They were operated by a single surgeon (U. V), by a temporal clear corneal phacoemulsification with an aspheric IOL ("SupraPhob"-Appasamy associates, India) implantation. The patients with postoperative complications among the cases, and those with other ocular comorbidities, in both groups, were excluded from the study. The measurement of visual acuity was performed as Snellen fraction values which were later converted to modified LogMAR units. The visual acuity as per Snellen chart was scored as the smallest letter size on which the patient identifies at least three letters correctly. The CS was assessed using the Aurolab CSF test. All the patients were tested monocularly using optimum refractive correction with appropriate addition for the screen distance (+0.75 Diopter Sphere for the test chart). The test was conducted for all the participants in a quiet room, illuminated with overhead fluorescent tubes. Scoring of CSF was performed by noting the values on the screen on progressively decreasing CS. A change of screen progressively decreased CS by 0.05 log units. Testing ended when the patient was unable to identify any letter on the screen.

An independent sample $t$-test was applied to compare both the groups. Statistical data analysis was performed using Windows Microsoft excel software.

## Results

The mean CSF in normal emmetropes and emmetropic pseudophakic with aspheric IOL was 1.91 log units and 1.575 log units, respectively. The mean age was 53.08 ± 1.96 years and 57.68 ± 2.85 years in normal emmetropes and emmetropic pseudophakic with aspheric IOL, respectively. The male to female ratio was 15:10 and 12:13 in both the groups, respectively. A statistically significant difference was found in CSF between both the groups ($P$ = 0.000) with age-matched normal individuals having better CSF as compared to

emmetropic pseudophakic individuals. The results are summarized in Table 1.

## Discussion

The present study analyzed whether any difference existed between the CS of pseudophakic eyes with an aspheric IOL and age-matched normal eyes. It found a significantly lowered CSF in patients eyes implanted with aspheric IOLs when compared to age-matched emmetropic eyes.

A good CSF is the key improve our visual performance in our day-to-day activities. Various published studies have used different methods to assess CSF. These include small letter contrast test,[4] CSV-1000,[5] vision contrast test system (VCTS) 6500,[6] functional acuity contrast test ( replacement for the popular Vistech VCTS chart),[7] the Pelli–Robson letter chart,[8] the Melbourne Edge Test[9] and the Mars Letter Contrast Sensitivity Test.[10] CS test reports show a contrast threshold (i.e., lightest shade of gray just perceived) for each of several letters. Although the test is similar to a visual acuity test using a Snellen's chart, in that it has several different sized letters or grid patterns, these letters or patterns are displayed in six or more shades of gray instead of standard black letters as in Snellen's chart.

Clinical evidence from various studies interprets a measurable loss in CS with functional disability in various ocular conditions such as glaucoma, macular diseases, diabetic retinopathy, and cataracts.[11-14] Trueb *et al*. compared visual acuity and CSF in eyes implanted with unifocal aspheric (AcrySof IQ IOL, Alcon Laboratories, Fort Worth, TX, USA) and spherical IOLs (AcrySof SN60AT IOL, Alcon Laboratories, Fort Worth, TX, USA) in 262 eyes with an average age (75.49 + 8.65) after cataract surgery, concluded that aspheric IOLs showed better photopic and mesopic CSF at medium and high spatial frequencies than eyes implanted with the spherical IOLs.[15] Kasper *et al*. compared intraindividually visual performance

### Table 1: Summary of results

|  | Pseudophakic emmetropes | Normal emmetropes |
|---|---|---|
| Number of patients in each group | 25 | 25 |
| Mean age±SD (years) | 57.68±2.85 | 53.08±1.96 |
| Male:female ratio | 12:13 | 15:10 |
| Mean lot contrast sensitivity | 1.572 | 1.91 |
| Statistical inference |  |  |
| df | 33.00 | |
| $t$ statistics | 14.19 | |
| $P$ | 0.000 | |

SD = Standard deviation

patients regarding photopic high-contrast visual acuity (HCVA), mesopic HCVA, mesopic low-contrast visual acuity , and CS in patients after implantation of aspherical IOL (Tecnis Z9000, AMO) in one eye and a spherical IOL (Sensar AR40e, AMO) in the other eye in an age range of 59–82 years found no statistically significant differences in visual acuity or CS measurements.[16] In a systematic review with meta-analysis by Schuster *et al*. concluded that patients with aspheric IOLs achieve better CSF as compared to spherical IOLs especially under dim light.[17]

Different studies have a heterogeneous opinion regarding outcome over CS. Under photopic conditions, no statistically significant difference in CS was found on comparing between trifocal IOL (Fine Vision Micro F) and bifocal IOL (Tecnis ZMB00) groups by Cochener.[18] Similarly, no statistically significant difference in CS was found between trifocal (Fine Vision Micro F) versus bifocal ReSTOR SN6AD1 by Jonker *et al*.[19] However, Mojzis *et al*. found a significantly higher level of CS in the trifocal group (AT Lisa tri 839MP) than in the bifocal group (AT Lisa 801).[20]

Bhattacharjee *et al*. studied the CSF of eyes implanted with IOLs having blue light absorbing chromophore versus those without and compared them with normal emmetropes.[21] They found the CSF in the eyes implanted with chromophore containing IOLs to be nearest to the normal eyes. Unlike their study, the IOLs used in our cases lacked the blue light absorbing chromophore.

Our study showed a significant level of better CS in the eyes of age-matched normal patients as compared to those implanted with aspheric IOLs. This strengthens the need for consideration of all aspects of visual function, rather than depending on acuity assessment alone. These, including CS, should be considered while weighing the benefits and risks of cataract or clear lens extraction for purely refractive purposes.

Despite all participants being between 50 and 60 years of age, the difference in the mean age between cases and controls being around 4 years might be considered a limitation. The CS using other charts have found variations in photopic and mesopic environments, which was lacking in our study.[16,17] The pupil diameter also plays a role in determining CSF in pseudophakia,[22] which if recorded may have further strengthened our results. Although all the pseudophakic patients in this study had aspherical IOL implantation in the bag, some unexpected visual performance could be expected due to tilting or displacement of the IOL, higher order aberrations, and changes in corneal optical aberrations postsurgery. Inability to measure these could be one of the major limitations of the study. The use of a

single brand of aspheric IOL may also be considered a limitation and further comparisons with other brands in a larger cohort of patients would help in validating the conclusion of this study.

## Conclusion

The contrast sensitivity function was significantly better in the eyes of age matched emmetropes when compared to those implanted with an aspheric IOL.

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### Conflicts of interest
The authors declare that there are no conflicts of interests of this paper.

## References

1. Murthy G, Gupta SK, John N, Vashist P. Current status of cataract blindness and vision 2020: The right to sight initiative in India. Indian J Ophthalmol 2008;56:489-94.
2. National Programme for Control of Blindness: State Wise Targets & Achievement for Various Eye Diseases during; 2016-17. Available from: http://www.npcb.nic.in/writereaddata/mainlinkfile/File324.pdf. [Last accessed on 2017 Dec 27].
3. Yadav S, Sahay P, Maharana PK, Titiyal JS, Vajpayee RB, Sharma N. Comparison of visual performance and after cataract formation between two monofocal aspheric intraocular lenses following phacoemulsification for senile cataract: A randomized controlled study. Indian J Ophthalmol 2017;65:1445-9.
4. Grimson JM, Schallhorn SC, Kaupp SE. Contrast sensitivity: Establishing normative data for use in screening prospective naval pilots. Aviat Space Environ Med 2002;73:28-35.
5. Kelly SA, Pang Y, Klemencic S. Reliability of the CSV-1000 in adults and children. Optom Vis Sci 2012;89:1172-81.
6. Franco S, Silva AC, Carvalho AS, Macedo AS, Lira M. Comparison of the VCTS-6500 and the CSV-1000 tests for visual contrast sensitivity testing. Neurotoxicology 2010;31:758-61.
7. Hohberger B, Laemmer R, Adler W, Juenemann AG, Horn FK. Measuring contrast sensitivity in normal subjects with OPTEC 6500: Influence of age and glare. Graefes Arch Clin Exp Ophthalmol 2007;245:1805-14.
8. Pelli DG, Robson JG, Wilkins AJ. The design of a new letter chart for measuring contrast sensitivity. Clin Vis Sci 1988;2:187-99.
9. Verbaken JH, Johnston AW. Population norms for edge contrast sensitivity. Am J Optom Physiol Opt 1986;63:724-32.
10. Dougherty BE, Flom RE, Bullimore MA. An evaluation of the mars letter contrast sensitivity test. Optom Vis Sci 2005;82:970-5.
11. Hot A, Dul MW, Swanson WH. Development and evaluation of a contrast sensitivity perimetry test for patients with glaucoma. Invest Ophthalmol Vis Sci 2008;49:3049-57.
12. Kleiner RC, Enger C, Alexander MF, Fine SL. Contrast sensitivity in age-related macular degeneration. Arch Ophthalmol 1988;106:55-7.
13. Della Sala S, Bertoni G, Somazzi L, Stubbe F, Wilkins AJ. Impaired contrast sensitivity in diabetic patients with and without retinopathy: A new technique for rapid assessment. Br J Ophthalmol 1985;69:136-42.
14. Chylack LT Jr., Jakubicz G, Rosner B, Khu P, Libman J, Wolfe JK, *et al.* Contrast sensitivity and visual acuity in patients with early

cataracts. J Cataract Refract Surg 1993;19:399-404.

15. Trueb PR, Albach C, Montés-Micó R, Ferrer-Blasco T. Visual acuity and contrast sensitivity in eyes implanted with aspheric and spherical intraocular lenses. Ophthalmology 2009;116:890-5.

16. Kasper T, Bühren J, Kohnen T. Visual performance of aspherical and spherical intraocular lenses: Intraindividual comparison of visual acuity, contrast sensitivity, and higher-order aberrations. J Cataract Refract Surg 2006;32:2022-9.

17. Schuster AK, Tesarz J, Vossmerbaeumer U. The impact on vision of aspheric to spherical monofocal intraocular lenses in cataract surgery: A systematic review with meta-analysis. Ophthalmology 2013;120:2166-75.

18. Cochener B. Prospective clinical comparison of patient outcomes following implantation of trifocal or bifocal intraocular lenses. J Refract Surg 2016;32:146-51.

19. Jonker SM, Bauer NJ, Makhotkina NY, Berendschot TT, van den Biggelaar FJ, Nuijts RM, et al. Comparison of a trifocal intraocular lens with a +3.0 D bifocal IOL: Results of a prospective randomized clinical trial. J Cataract Refract Surg 2015;41:1631-40.

20. Mojzis P, Kukuckova L, Majerova K, Liehneova K, Piñero DP. Comparative analysis of the visual performance after cataract surgery with implantation of a bifocal or trifocal diffractive IOL. J Refract Surg 2014;30:666-72.

21. Bhattacharjee H, Bhattacharjee K, Medhi J. Visual performance: Comparison of foldable intraocular lenses. J Cataract Refract Surg 2006;32:451-5.

22. Alfonso JF, Fernández-Vega L, Baamonde MB, Montés-Micó R. Correlation of pupil size with visual acuity and contrast sensitivity after implantation of an apodized diffractive intraocular lens. J Cataract Refract Surg 2007;33:430-8.