Comparison of the functional visual outcomes in pseudophakic patients implanted with different intraocular lenses

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Abstract

A good functional visual outcome after meticulous cataract surgery and intraocular lens implantation is the ultimate aim of every eye care practitioner. Combining the measurement of functional acuity contrast sensitivity testing along with visual acuity testing adds to our knowledge of visual performance. This study aims at assessing the functional visual outcome before and after cataract surgery with different IOL materials.

Aims: To evaluate ,compare and analyse the visual outcome and contrast sensitivity functions in pseudophakic patients with hydrophobic acrylic, hydrophilic acrylic, spherical silicone and aspheric silicone intraocular lenses using the high contrast sensitivity Snellen's chart as well as low contrast sensitivity Sloan letter chart before and after cataract surgery

Material and Methods: Retrospective, Randomised study, conducted over a period of 2 years from January 2004 to December 2005 at a tertiary eye care institute in Chennai.

Results: The aspheric silicone IOL may provide an improvement in the quality of vision as measured by our clinical results of contrast sensitivity testing followed by the hydrophobic acrylic IOL and the hydrophilic Acrylic and the spherical silicone IOL.

Keywords: Contrast Sensitivity, Functional Visual Acuity, Aspheric IOL, Pseudophakia.

Introduction

A good functional visual outcome after meticulous cataract surgery and intraocular lens implantation is the ultimate aim of every eye care practitioner. Gaining an acceptable "real world" vision , enabling routine tasks like night driving ,walking in the dusk, identifying familiar objects in the dim light is the dream of every aged person who is undergoing cataract surgery.

So the importance of extending the measurement of visual performance beyond the Snellen's acuity chart and the impetus of Contrast Sensitivity is now felt strongly .Keeping this fact in mind, this study has been done to evaluate the variations in functional visual outcome following uneventful phacoemulsification procedure with different types of foldable intraocular lens implantation.

This study concentrates mainly on the assessment of the functional components of vision using the high contrast sensitivity Snellen's chart as well as the low contrast sensitivity Sloan letter chart.

Aims of the study

To evaluate ,compare and analyse the visual outcome and contrast sensitivity functions in pseudophakic patients with hydrophobic acrylic, hydrophilic acrylic ,spherical silicone and aspheric silicone intraocular lenses using the high contrast sensitivity Snellen's chart as well as low contrast sensitivity Sloan letter chart before and after cataract surgery .

Material and Methods

Retrospective, randomised study, conducted over a period of 2 years from January 2004 to December 2005 at a tertiary eye care institute in Chennai.

Inclusion criteria:

1. Senile cataracts in the age group of 50 to 75 years
2. Uneventful intraoperative and postoperative period
3. No ocular comorbidity
4. Good patient compliance

Exclusion criteria:

1. Combination surgeries
2. Preexisting ocular co-morbidity such as Glaucoma ,Diabetic Retinopathy , or Uveitis
3. Systemic illness (Diabetes >10 years duration, Neurologic disorders)
4. Diseases which are known to affect Contrast Sensitivity (eg .High hyperopia > +6.0D and High myopia > -6.0 D & Keratometric cylinder (> 1.5D)
5. Intraoperative and postoperative complications
6. Posterior capsule opacification
7. Noncompliant patient

Protocols followed:

1. Approval for research from institution
2. Informed consent from patient.
3. Preliminary assessment:
   a. Patient demographics
      Name, Age, Sex, MRD No.
   b. Vision assessment using Snellen's high contrast visual acuity chart and pinhole
   c. Retinoscopic refraction
   d. Contrast sensitivity measurements with best spectacle correction under photopic (85 candelas /m2) luminance levels and mesopic

(6 cd/m2) luminance levels using low contrast sensitivity Sloan letter chart (a subset of Snellen's letters with similar recognition threshold) -a non patterned contrast sensitivity function chart based on the Pelli Robson chart of decreasing contrast threshold from 25% to 0.6 %. All measurements were done under standard illumination conditions in similar surroundings by a single person familiar in the usage of the chart and measurement technique with emphasis on giving adequate time and encouragement to the patient to obtain the maximum reading of contrast threshold.

e. Slit lamp examination.
f. Intraocular pressure measurement using Goldmann's applanation tonometer.
g. Dilated fundus examination by Indirect Ophthalmoscopy using 20D and Slitlamp biomicroscopy using 90 D/ 78D.
h. Cycloplegic refraction

4. Preoperative assessment
   a. Keratometry reading by Bausch & Lomb keratometer
   b. Axial length measured using A mode ultrasonography
   c. Effective power of the intraocular lens was calculated using Sanders Retzlaff Kraff II formula
   d. Lacrimal passage patency
   e. Baseline investigations Hb%, TC, DC, ESR, B. Urea, S.Creatinine, Random B. sugar, and ECG recording
5. Surgical technique

   All surgeries done by a single surgeon.

Under Topical anaesthesia uneventful Phacoemulsification (Phacochop technique) was done using the Bausch and Lomb Millenium unit. Foldable intraocular lens was implanted in the bag, good centration was critically ensured.

Postoperatively all the patients were treated with Prednisolone Acetate 1% eye drops and Oflacin 0.3% eye drops on a tapering schedule .Patients were randomized to receive one of the 4 IOL types.

Intraocular lenses implanted in this study were

1. Hydrophobic Acrylic - ACRYSOF SA60 AT - Group A
2. Hydrophilic Acrylic -AKREOS ADAPT - Group B
3. Spherical Silicone - CLARIFLEX - Group C
4. Aspheric Silicone -TECNIS Z9000 - Group D

If any patient required surgery for the other eye the same intraocular lens was implanted in the fellow eye. All patients were examined at 2nd day, 1st week, 1 month, 3 months, 6 months and 1 year postoperatively.

After 1 month at every visit the following examination were done

1. Vision
   a. High contrast using Snellen's chart
   b. Low contrast using Sloan letter chart under photopic and mesopic conditions as mentioned previously.

   The preoperative and the postoperative best corrected visual acuity were measured by the same certified ophthalmic technician in a controlled testing environment using a projected Snellen chart ,calibrated illumination and room lighting. One certified ophthalmic technician did the preoperative and postoperative functional contrast sensitivity testing with best spectacle correction for target distance (1m) under standard luminance levels as mentioned earlier.
2. Retinoscopic refraction
3. Slit lamp examination
4. Tonometry
5. Dilated fundus examination

The visual outcomes of the 4 groups of intraocular lenses were compared interindividually.

Results

This Retrospective Randomised study was conducted over a period of 2 years and evaluated commonly used IOL's of different materials.

A total of 117 eyes of 84 patients were enrolled in the study over a period of 1 year and followed for 1 year. There was no loss of patient data due to attrition during the study period.

Age Distribution: The mean age of the patients was 64.3. The range was from 52 to 76 years.

Sex distribution: Of the total 84 patients, 46 were males and 38 were females.

Laterality: Unilateral implantation was done in 51 patients and bilateral implantation in 33 patients.

Patient Distribution: Hydrophobic Acrylic IOL (Group A) was implanted in 32 eyes of 22 patients.
Hydrophilic Acrylic IOL (Group B) was implanted in 30 eyes of 21 patients.
Spherical Silicone (Group C) was implanted in 27 eyes of 20 patients.
Aspheric Silicone IOL (Group D) was implanted in 28 eyes of 21 patients.

All the patients were followed up for a period of 1 year. The BCVA was noted using the Snellen's chart and there was uniform improvement in all the groups after surgery.

For ease of plotting results, the Snellen's visual acuity is taken as 6/60 (1), 6/36 (2), 6/24 (3), 6/18 (4), 6/12 (5), 6/9 (6) & 6/6 (7).

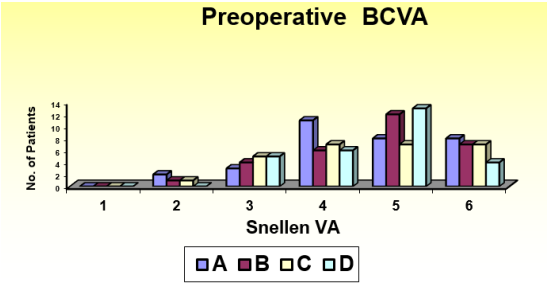

Fig. 1: Preop BCVA in groups A, B, C, D

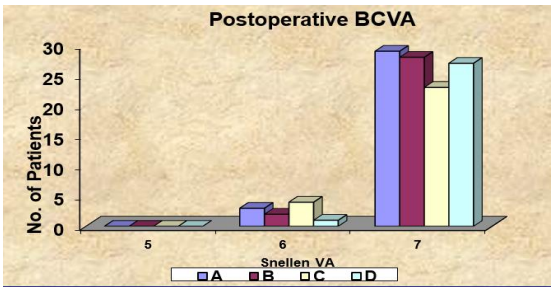

Fig. 2: Postop BCVA in groups A, B, C, D

Table 1: Pre Op. BCVA

Pre Op. BCVA	Group A	Group B	Group C	Group D
6/60	0	0	0	0
6/36	2	1	1	0
6/24	3	4	5	5
6/18	11	6	7	6
6/12	8	12	7	13
6/9	8	7	7	4
6/6	-	-	-	-

Table 2: Post Op. BCVA

Post Op. BCVA	Group A	Group B	Group C	Group D
6/12	-	-	-	-
6/9	3	2	4	1
6/6	29	28	23	27

The BCVA was noted down at each visit for all the four groups.

Contrast sensitivity was tested in photopic conditions (85 cd/m^2) and mesopic conditions (6 cd/m^2) using the SLOAN letter chart of decreasing contrast threshold (25%, 10%, 5%, 2.5%, 1.25%) the results were noted down as the number of letters read and in photopic conditions, the 25%, 10%, 5%, 2.5%, and 1.25% cheets were used and under mesopic illumination 25%, 10%, 5%, and 2.5% charts were used. The results have been tabulated below.

Table 3: Preoperative CS (Photopic)

	A	B	C	D
25%	48	46	49	44
10%	32	31	30	32
5%	15	12	11	14
2.5%	6	8	4	7
1.25%	4	3	2	2

Table 4: Preoperative CS (Mesopic)

	A	B	C	D
25%	21	16	19	18
10%	5	6	4	7
5%	2	3	1	2
2.5%	-	-	-	-

Postoperatively CS was tested from the 1st month after surgery with best spectacle correction. There was a significant difference in the contrast sensitivity functions among the 4 groups with the aspheric silicone IOL (Group D) showing the best contrast sensitivity in both photopic and mesopic conditions followed by the hydrophobic acrylic IOL (Group A) and the hydrophilic acrylic IOL (Group B) and finally the spherical silicone IOL (Group C). The results are shown below.

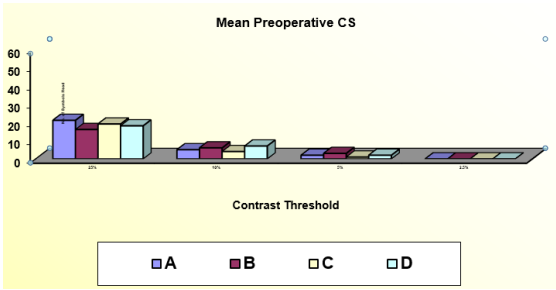

Fig. 3: Mean Preop Contrast Sensitivity in Groups A, B, C, D

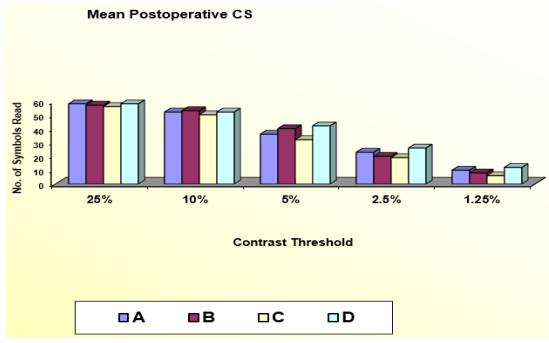

Fig. 4: Mean Postop Contrast Sensitivity in Groups A, B, C, D

Table 5: Mean Post-Operative CS (Photopic)

	A	B	C	D
25%	58	57	56	58
10%	52	53	50	52
5%	36	40	32	42
2.5%	23	20	19	26
1.25%	10	8	6	12

Table 6: Mean Post- Operative CS (Mesopic)

	A	B	C	D
25%	48	46	42	51
10%	42	44	39	48
5%	32	29	27	38
2.5%	21	18	16	26

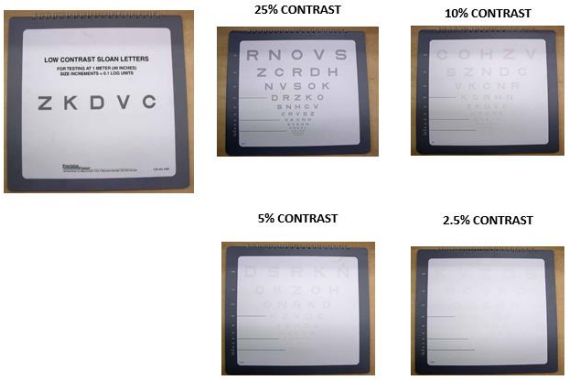

Fig. 5: Pelli Robson Low Contrast Sloan Letter Chart at 25%, 10%, 5% & 2.5%

Discussion

Even in healthy subjects, there is a decrease in retinal image quality and contrast sensitivity with age starting around the age of 50 years.[11,19,17] Guirao et al.[12] found a slightly larger spherical aberration in middle aged and older corneas, while Oshika et al.[20] found an increase in total corneal aberrations with age, but no correlation between corneal spherical aberrations and age. The results of both studies indicated that the increase in corneal aberrations was too small to account for the measured reduction of retinal image quality with age.

In the young human eye, the positive spherical aberration induced by the cornea is partially compensated by the negative spherical aberration of the lens.[2,4,5,7,8] As the eye gets older, the aberrations of these ocular components decouple, since the positive spherical aberration of the cornea changes little with age,[12,20] while alterations in the lens cause an increase in spherical aberration, becoming also positive with age.[10] This loss of balance leads to an increase in total ocular aberrations and explains the degradation of the ocular optics in older persons.[2,4] Also it helps to understand why the contrast sensitivity after implantation with a spherical IOL is similar or lower than in normal phakic eyes of the same age, even though these IOLs are optically superior to the natural crystalline lens[1,3] since a spherical IOL has an inherent positive spherical aberration, again there is no correction of the positive spherical aberration of the cornea. These findings have lead to the development of an aspheric IOL,[15] to compensate for the corneal spherical aberration. Corneal topography measurements and determination of the wave front aberration in patients presenting for cataract surgery resulted inthe design of an IOL with a modified prolate anterior surface (flatter curve in the periphery), producing an amount of negative spherical aberration similar to that of the young crystalline lens. This approximates the optical system of the youthful eye.[14]

Contrast sensitivity testing[9] is a more comprehensive measure of visual function than visual acuity, which determines perception of high-contrast letters and numbers. In the patient who complains of visual loss and has lens changes contrast sensitivity testing may demonstrate a significant loss of visual function not appreciated in testing of visual acuity.

In this study, modern clear corneal cataract surgical techniques with the implantation of a flexible, foldable IOL resulted in a low incidence of complications and excellent visual outcomes. This study did not control for IOL type or style as the 4 lenses tested were intentionally different. Either factor may have contributed to the optical performance of the IOLs.[6] It is difficult to postulate that haptic design or lens style[13] contributes to a difference in contrast sensitivity delivered through the optic therefore, no attempt was made to control for these factors.

It is also postulated that the larger the pupil, the greater the contribution from the degrading effects of optical aberrations.[14] Therefore, one would expect the optical performance of the aspheric IOL used in the present study to perform better under conditions in which the pupil would be larger (ie, mesopic conditions). The data confirmed this hypothesis. It has also been shown with optimal bench testing that lens centration less than 0.4mm and lens tilt than 7 degrees maximize the effects of the aspheric IOL[14]. In the present study, no effort was made to determine the tilt or centration of any IOL. With today's advanced microincision cataract surgery techniques, these parameters were likely well within the tolerance for IOL implantation.[2]

Using the Modulation Transfer Function, Guiaro et al.[11] found that the decline in visual performance in older individuals is caused by changes in the crystalline lens that interfers with optical performance. Unlike wave front analysis, which depends on these refractive changes, contrast image analysis is little affected by the focus of the image. In the present study, the optical aberration contributed by the lens was the only variable changed.

In a prospective randomized trial of the aspheric lens, Packer and coauthors[18] found that the aspheric IOL provided significantly better contrast sensitivity at 1.5 and 3.0 cpd under mesopic conditions and at 6.0, 12.0 and 18.0 cpd under photopic conditions. They also compared the aspheric IOL with the conventional spherical acrylic IOL. They found that at peak contrast sensitivity, the aspheric IOL group had 38.5% greater contrast under

photopic conditions and 77.9% greater under mesopic conditions.

In a comparison of the aspheric silicone IOL and the spherical silicone IOL, Mester[16] and Coauthors found that clinically, spherical aberration can be eliminated and the positive spherical aberration of the aging eye can be compensated for by modifying the IOLs anterior surface. The improvement with the aspheric IOL was most notable at mesopic testing levels.

Patients benefit from the success of modern cataract surgery. Along with improved outcomes, however, comes the responsibility of surgeons to continue to strive for better functional visual performance while incurring the least disability from the procedure. High-technology IOLs[15] and microminiaturized surgical techniques can leave patients spectacle free after cataract surgery. In future lenses may restore accommodation, and reading glasses may become obsolete. However, surgeons must continue to seek to provide better quality vision. Improved contrast sensitivity may be what the cataract patient needs. This is no longer an optical theory but is now a scientifically demonstrable reality.

Conclusion

1. The comparison of the functional visual outcome of different intraocular lenses in this study showed that there was an uniform improvement in the best corrected visual acuity among the 4 groups after cataract surgery.
2. The aspheric silicone IOL may provide an improvement in the quality of vision as measured by our clinical results of contrast sensitivity testing which showed a better performance of this group under both photopic and mesopic conditions followed by the hydrophobic acrylic IOL and the hydrophilic Acrylic and the spherical silicone IOL.

The results support the hypothesis that implantation of an anterior, modified, prolate, aspheric IOL improves functional visual performance.

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