ORIGINAL RESEARCH PAPER

OPHTHALMOLOGY

COMPARISON OF VISUAL RESULTS BETWEEN ULTRATHIN AND CONVENTIONAL HYDROPHILIC FOLDABLE LENSES

KEY WORDS: Intraocular Lens, Accommodation, Phacoemulsification

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ABSTRACT

Purpose: To evaluate the near visual performance of Ultrathin and standard monofocal Foldable intraocular lenses after phacoemulsification.

Setting: St.Stephen's hospital, Department of Ophthalmology, Tis Hazari, Delhi, India

Methods: Forty (40) patients were enrolled and randomized into two groups of 20 eyes in each group to the type of intraocular lens – Ultrathin or foldable. All patients underwent routine phacoemulsification surgery. Both the groups were evaluated for visual acuity including distance and near vision, amplitude of accommodation and contrast sensitvity upto 3 months after surgery

Results: Postoperative distance corrected near vision was better in Ultrathin intraocular lens group than in Foldable Intraocular lens group. Postoperative average distance corrected near correction required was less in Ultrathin intraocular lens compared to Foldable intraocular lens but was not of statistical significance. The amplitude of accommodation as measured by the two subjective methods was not significantly different between the two groups. In our study, contrast sensitivity increased during the follow up period of 3 months in Ultrathin lens.

Conclusion: This study shows that thinner intraocular lenses can provide better restoration of near vision post cataract surgery although amplitude of accommodation was not significantly different between the two intraocular lenses.

INTRODUCTION

Cataract is an important cause of visual impairment worldwide. The techniques and results of cataract surgery have changed dramatically during the past three decades. Smaller incisions have become the standard with phacoemulsification now being the method of choice for most surgeons[1]. Along with these advances have come improved intraocular lens materials and designs. As patient's demands and expectations are increasing emphasis has shifted from providing mere good visual acuity as measured by snellen's chart to functional vision. With recent advances intraocular lenses have been introduced that are supposed to provide aberration free, good contrast sensitivity and spectacle free vision for both near and distance. Various studies with thin intraocular lenses have shown that they provide good distance and near visual acuity[2,3]. It has been hypothesized that by making the lens thinner, aberrations[6] are reduced. The current study was conceived to study the visual and surgical results of ultrathin intraocular lenses and compare the same to conventional foldable intraocular lenses. Foldable lenses have the advantage of implantation through a smaller incision than conventional intraocular lenses made of polymethylmethacrylate.[4,5]

Ultrathin IOLs were developed that can be inserted through such small incisions. It was proposed that by making the lens thinner other aberrations such as coma, distortion and glare are reduced[6]. In a study by Dogru M, Honda R[3], after phacoemulsification 8 patients were implanted with thin optic design intraocular lens and 10 patients were implanted acrylic IOL. The corneal incision size was 2.2 mm in the former case while 3.5 mm with acrylic IOL. The final BCVA was better than 20/25 in all eyes in the thin optic group and in 90% in the acrylic foldable IOL group. All eyes in both IOL groups attained an uncorrected near acuity of better than 20/100. The thin optic design IOL had a significantly better contrast sensitivity Most of the conventional IOLs provided only distance visual correction while problems of near vision and accommodation persisted. Multifocal IOLs have been developed to improve the near visual acuity by the optical properties of the intraocular lens . Improvement in near vision as studied by Sen H.N, Sarikkola AU et al[8] was seen. Visual results including uncorrected and distance corrected near visual acuity were better with bilateral multifocal implantation than patients with bilateral monofocal implantation as studied by Javitt J, Brauweiler HP et al[9].

Various factors are known to influence good uncorrected visual acuity for distance and near vision post cataract surgery such as astigmatism[16-20] and axial IOL movement (pseudophakic accommodation)[14,15].

Accommodating IOLs are designed to restore accommodation based on several different mechanisms. Various studies by Harman FE, Maling S et al[10]; Mastropasqua L, Toto L et al[11] and Kuchle M, Seitz B et al[12] found good visual results.

Accommodation is an increase in the dioptric power of the eye that enables the image of near objects to be focused on the retina. An increase in the optical power of the eye occurs because of an increase in the anterior and posterior surface curvatures of the crystalline lens resulting from contraction of the ciliary muscles.As patients develop presbyopia, they present with difficulty in near vision tasks. These problems manifest earlier in hyperopes and in emmetropes at about 40 years of age[13].

Langenbucher, Huber S et al[14] defined the ability to see improved near vision in pseudophakic eyes as pseudophakic accommodation or pseudophakic pseudoaccomodation. Pseudophakic accommodation is a dynamic change in the refractive state of the eye caused by interaction between the contracting ciliary muscle and the zonular capsular bag IOL resulting in a change in refraction at near fixation while pseudophakic pseudoaccomodation is due to the static optical properties of the pseudophakic eye independent of the ciliary muscle resulting in improved uncorrected near vision.

Different methods to measure amplitude of accommodation in the pseudophakic eye have been proposed by Langenbucher, Huber S et al[14] as given in the following table.

Measurement of amplitude of accommodation in pseudophakic eye

Dynamic		Static	
Objective	*Subjective*	*Objective*	*Subjective*
• Dynamic streak • Retinoscopy • Photorefractometery	• Subjective • Near point • Defocussing • Refractometer With near/far • Target	• Direct : Autorefractometry • Indirect : Change in anterior Chamber depth(A scan)	• Refractometry

Methods

Type of study

A prospective randomized study to compare the visual results between Ultrathin and Hydrophilic Foldable intraocular lenses after phacoemulsification was done. Informed consent was obtained from all patients.

Patient selection

Target population visiting the Ophthalmology department, St. Stephen's Hospital, Delhi with operable senile cataract for phacoemulsification surgery.

Sample size

40 patients were enrolled and randomized into two groups of 20 eyes in each group to the type of intraocular lens. All patients underwent routine phacoemulsification surgery.

Group	Incision size	Site of incision	Type of intraocular lens	No. of eyes
I	3.2 mm	Temporal	FOLDABLE	20
II	2.8 mm	Temporal	ULTRATHIN	20

Inclusion criteria

i) Patients of either sex, age above 45 yrs.
ii) Visually significant senile cataract with nuclei of grade I to III (LOCS classification) was taken up for study.

Exclusion criteria

(A) Preoperative:
i) Patients with irregular and oblique astigmatism.
ii) Patients who had undergone any previous surgery on the eye to be operated.
iii) Patients with the following ocular abnormalities were excluded from the study such as Glaucoma, Iridocyclitis, Corneal disorders, Pseudoexfoliation, Tear film abnormality, Retinal detachment, Vitreous haemorrhage, Age related macular degeneration , Posterior uveitis

Ophthalmologic evaluation:

A detailed history and clinical examination was done. Visual acuity, uncorrected (UCVA) and best corrected (BCVA) was measured by Snellen's chart at a distance of 6 m. Refraction was done wherever possible. Near vision and contrast sensitivity was determined. Slit lamp bio-microscopy was performed to see any abnormality in tear film and cornea, to look for anterior chamber depth and to find out the type of cataractous lens and grade the nuclear hardness. Cataract grading was done at the slit lamp using LOCS III classification[21]. Intra ocular pressure (IOP) was measured by Goldmann applanation tonometer. Detailed fundus examination was performed with direct and indirect ophthalmoscope. Keratometry was done using Bausch and Lomb type of manual keratometer to determine the corneal component of astigmatism. IOL power calculation by SRK II formula Implantation of Ultrathin IOL (*Ultrasmart* by Ellis Ophthalmic technology) or hydrophilic acrylic foldable IOL (*Acryfold* by Al Optics) in the bag was done with the help of disposable injector through the same incision . Acryfold IOL is an acrylic hydrophilic biconvex foldable lens with a square edge all over. Ultrasmart IOL is an acrylic hydrophilic, thin, aspheric, biconvex intraocular lens with a square edge all over.

The incision was slightly enlarged for insertion of foldable IOL.

Measurement of Amplitude of accommodation using two subjective tests:

(1) Push up test

Patient was asked to wear distance correction and a spherical reading glass of 2 D dioptres was added. A small reading chart was moved towards the eye from a distance of 50 cm till the patient noticed blurring of optotypes. Reading distance was converted to dioptres and corrected for the 2 D near addition to get the subjective accomodation.

(2) Minus lens procedure

Patient was asked to wear distance correction. Patient is asked to focus one line above his best corrected visual acuity line on the distance chart placed at 6 m. Defocussing was done in steps of -0.25 D and patient is asked to notice blurring. The minus lens at which blurring is noted is defined as the accomodation amplitude.

4. Contrast sensitivity

Measurement of contrast sensitivity was done using Pelli – Robson chart placed at a distance of 3 m. It was recorded with distance correction.

6. Recording of complications if any

The data was compiled and statistical analysis was done by two sample unequal variance t test. A p value < 0.05 was considered significant.

Chi- square test was used to assess whether corneal astigmatism affects postoperative visual acuity in patients.

RESULTS

The mean age of patients in group 1 (17 men, 3 women) was 56 ± 8.7 years .The mean age of patients in group 2 (15 men, 5 women) was 54.4 ± 7.1 years (range 46 to 75 years). There was no statistically significant difference in age between the two groups.

There was no significant difference between the two groups regarding best corrected distance visual acuity.

Distance corrected near visual acuity: There was a statistically significant difference between the two groups ($p < 0.05$) with group 2 being better on all postoperative days (Table 1 and 2).

Post operative average near correction required at 3 months over distance correction was 1.775 ± 0.707 D in group 1 and 1.425 ± 0.730 D in group 2. No significant difference was seen between the two groups ($p = 0.1$).

When measured by subjective test minus lens method (Table 3), the amplitude of accommodation averaged 0.96 ± 0.1D for group 1 and 0.85 ± 0.1D for group 2 on first postoperative day. When measured by subjective test minus lens method, the amplitude of accommodation averaged 0.96 ± 0.1D for group 1 and 0.85 ± 0.1D for group 2 on first postoperative day. On postoperative first week, it was 0.96 ± 0.44 D for group 1 and 0.91 ± 0.63D for group 2. On postoperative second week, it was 0.96 ± 0.45D for group 1 and 0.91 ± 0.45 D for group 2. On postoperative fourth week, it was 0.96 ± 0.45D for group 1 and 0.86 ± 0.44 D for group 2.

On postoperative sixth week, it was 0.97 ± 0.41D for group 1 and 1.05 ± 0.56 D for group 2 . On postoperative third month, it was 1.07 ± 0.4D for group 1 and 0.93 ± 0.44 D for group 2.

There was no significant difference between the two groups on any postoperative day.

Significant correlation was found between amplitude of accommodation measured by minus lens method and distance corrected near acuity in group 1 on postoperative days first postoperative day (r : 0.48 , p > 0.05), 2nd week (r : 0.48 , p > 0.05) and 4th week (r: 0.48, p > 0.05) . No significant correlation was found between amplitude of accommodation measured by minus lens method and distance corrected near vision in group 2 .

When measured by subjective test push up method (Table 4), the amplitude of accommodation averaged 1.67 ± 0.29 D for group 1 and 1.65 ± 0.28 D for group 2 on first postoperative day. On postoperative first week, it was 1.53 ± 0.28 D for group 1 and 1.65 ± 0.26D for group 2. On postoperative second week, it was 1.56 ± 0.29 D for group 1 and 1.6 ± 0.31D for group 2.

On postoperative fourth week, it was 1.53 ± 0.29 D for group 1 and 1.62 ± 0.3D for group 2. On postoperative sixth week, it was 1.41 ± 0.24 D for group 1 and 1.61 ± 0.31D for group 2. On postoperative 3rd month, it was 1.51 ± 0.31 D for group 1 and 1.62 ± 0.31D for group 2.

Significant difference between the two intraocular groups was seen only on sixth postoperative week visit.

In group 1, significant correlation was found between near vision and amplitude of accommodation as measured by push up method only on sixth postoperative week (r : 0.52 , p > 0.05) . In group 2 , significant correlation was found between distance corrected near vision and amplitude of accommodation as measured by push up method on postoperative day 1 (r : 0.51 , p > 0.05) and postoperative first week only (r : 0.51 , p > 0.05) .

Contrast sensitivity measured in normal room illumination was 1.65 log units or better in 80 % in group 1 and 75 % in group 2 in first postoperative day. It was 65% in group 1 and 75 % in group 2 on third postoperative month. Contrast sensitivity was more in group 2 after first postoperative day till 3 months. At 3 months, contrast sensitivity had markedly decreased in group 1.

DISCUSSION

In a randomized prospective controlled clinical study, after defining proper exclusion and inclusion criteria, visual results between Ultrathin and hydrophilic foldable intraocular lenses were compared. The intraocular lenses used in this study were Acryfold (group 1 - foldable) and *Ultrasmart* (group 2 - Ultrathin) intraocular lenses. This study was taken to determine any significant difference between the two intraocular lenses implantation in providing better visual function and surgical outcome. Follow up was done on day 1, week 1, week 2, week 4, week 6 and 3rd month postoperatively.

As patient's expectations for visual rehabilitation are increasing, there is a demand for intraocular lenses that can be safely inserted through small incisions, provide aberration free, better contrast sensitivity and excellent uncorrected distance and near visual acuity. Intraocular lenses that could be inserted through small incision size such as foldable and rollable IOL's have become popular.

Postoperative uncorrected distance visual acuity was better in group 2 implanted with Ultrathin IOLs compared to foldable IOLs on all postoperative visits and was significantly better on postoperative day 1, 2nd week, 4th week and 3rd month (p < 0.05).

Postoperative best corrected visual acuity was similar in both the groups till 6 weeks and at 3rd month it was significantly better in group 2 compared to group 1 (p < 0.05)

All patients had BCVA in range of 6/6-6/9 in both the groups except one patient in group 1 there was a drop of one line at 3 months postoperative time. This was attributed to the development of posterior capsular opacity.

The distance corrected near acuity was significantly better in group 2 compared to group 1 on all postoperative visits (p < 0.05).

Postoperative average near correction required was less in group 2 compared to group 1 but was not significantly different (p = 0.1).

In our study, postoperative best corrected distance visual acuity was comparable in both the groups while distance corrected near visual acuity was significantly better with Ultrathin IOLs compared to foldable IOLs.

Studies with thin intraocular lenses have shown to provide good distance and near visual acuity but were not found to be significantly different from foldable IOLs.[2,3] It has been hypothesized that by making the lens thinner , aberrations are reduced .

In our study, amplitude of accommodation was measured using two different subjective tests, minus lens method and push up method. Amplitude of accommodation as measured by minus lens method was more with foldable intraocular lens compared to Ultrathin intraocular lens in most of the postoperative visits but the difference was not statistically significant.

The amplitude of accommodation as measured by push up method was better with Ultrathin intraocular lens on most of the postoperative days but there was significant difference between the two groups only on one of the postoperative visits. Correlation between distance corrected near visual acuity and amplitude of accommodation was found only at some of the postoperative visits in both the groups.

Although Ultrathin IOL was found to give better near visual results than foldable IOL, it could not be demonstrated by the subjective tests used to measure pseudophakic accommodation.

In our study, contrast sensitivity increased during the follow up period of 3 months with Ultrathin lens. Best corrected visual acuity also became better during the follow up period and was significantly better at 3 months with Ultrathin intraocular lens.

No significant postoperative inflammation was seen in any eye in both the groups.

CONCLUSION:

This study shows that thinner intraocular lenses can provide better restoration of near vision post cataract surgery although amplitude of accommodation as measured by both objective and subjective methods was not significantly different.

Table 1: Distribution of postoperative distance corrected near vision in group1

Postop NVC GP 1	PO 1 day	PO 1 week	PO 2 week	PO 4 week	PO 6 week	PO 3 mth
Worse than N12	15	14	13	13	13	14
N12 or better	5	6	7	7	7	6
N6	0	1	1	1	1	1

Table 2 : Distribution of postoperative distance corrected near vision in group2

Postop NVC GP 2	PO 1 day	PO 1 week	PO 2 week	PO 4 week	PO 6 week	PO 3 mth
Worse than N12	5	7	8	7	7	9
N12 or better	15	13	12	13	13	11
N6	6	6	2	2	2	2

Table 3: Amplitude of accommodation by minus lens method in patients

Postop AOA (D) Minus Lens Method (mean)	PO 1 day	PO 1 week	PO 2 week	PO 4 week	PO 6 week	PO 3 mth
Group 1	0.96± 0.1	0.96 ± 0.44	0.96 ± 0.45	0.96 ± 0.45	0.97 ± 0.41	1.07 ± 0.4
Group 2	0.85 ± 0.1	0.91 ± 0.63	0.91 ± 0.45	0.86 ± 0.44	1 .05 ± 0.56	0.93 ± 0.4

Table 4: Amplitude of accommodation by push up method in patients

Postop AOA (D) Push Up Method (mean)	PO 1 day	PO 1 week	PO 2 week	PO 4 week	PO 6 week	PO 3 mth
Group 1	1.67 ± 0.29	1.53 ± 0.28	1.56 ± 0.29	1.53 ± 0.29	1.41 ± 0.24	1.51 ± 0.31
Group 2	1.65 ± 0.28	1.65 ± 0.26	1.6 ± 0.3	1.62 ± 0.3	1.61 ± 0.31	1.62 ± 0.31

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