ORIGINAL RESEARCH

Comparison of visual results of implantation of silicone, acrylic, and hydrogel intraocular lenses

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Abstract

Aim: To compare visual function after cataract surgery and implantation of three types of foldable lenses (silicone, acrylic, or hydrogel lenses).

Materials and Methods: Sixty one eyes undergoing small incision phacoemulsification surgery were randomly allocated to one of three types of intraocular lens. At 1 month postoperatively, visual function was measured and compared.

Results: At 1 month postoperatively, the mean best corrected visual acuity of eyes with silicone, acrylic, and hydrogel intraocular lenses (logarithmic Minimum Angle of Resolution scale) were 0.11, 0.12, and 0.14, respectively. The percentage of eyes with silicone, acrylic, and hydrogel intraocular lenses with a best corrected visual acuity of 20/25 or better were 72.22%, 66.67%, and 56.25%, respectively. The percentage of these eyes with contrast sensitivity ≥ 1.50 was 72.22%, 71.43%, and 75.00% for silicone, acrylic, and hydrogel, respectively. There were no statistically significant differences in the mean best corrected visual acuity and contrast sensitivity between the three groups.

Conclusion: There were no significant differences in visual function in terms of best corrected visual acuity and contrast sensitivity between the three different types of intraocular lens.

Key words: *Best corrected visual acuity, Contrast sensitivity, Intraocular lens*

Introduction

Phacoemulsification with insertion of a foldable intraocular lens (IOL) through a small incision into the capsular bag has recently become the preferred method of treatment for cataracts. The numerous advantages of small incision cataract surgery — less corneal distortion with lower induced astigmatism, fewer intra-operative and postoperative complications, less inflammation and faster rehabilitation — have encouraged surgeons to use foldable IOLs.[1] Some studies have shown that the IOL's biomaterial and design can affect the cellular reaction on the IOL surface[2,3] or the rate of posterior capsule opacification.[4] For the patients, however, the major concern is recovery of visual function following surgery. This study aims to compare the visual function after small incision surgery and implantation of three types of foldable IOLs, namely silicone, acrylic, or hydrogel lenses.

Materials and methods

Between April 1998 and July 1998, small incision phacoemulsification was performed for 61 eyes. The demographic data of these patients are listed in **Tables 1 and 2**. This was a prospective study where the operated eyes were randomly allocated to one of the three IOL types.

Table 1. Distribution by age

	Mean age (years)	Standard deviation
Silicone	67.7	6.3
Acrylic	68.6	8.8
Hydrogel	69.0	7.1
Overall	68.4	7.6

Table 2. Distribution by gender			
	Male	Female	Total
Silicone	9	9	18
Acrylic	11	16	27
Hydrogel	3	13	16
Overall	23	38	61

Table 3. Range of power of implanted lenses	
	Power (diopters)
Silicone	12.5 - 26.0
Acrylic	16.0 - 25.0
Hydrogel	19.5 - 25.0

The IOLs compared were:
- silicone IOL — two types of lenses were used — Allergan (Irvine, USA) SI30NB and Staar (California, USA) AA4203
- acrylic IOL — Alcon (Fort Worth, USA) MA30BA (Acrysof)
- hydrogel IOL — Storz (Florida, USA) H60M (Hydroview).

The range of power of these IOLs is shown in **Table 3**.

Patients with ocular pathologies in addition to cataract were excluded. One patient with intraoperative posterior capsule (PC) rupture was also excluded from the study. All the cataracts were removed using phacoemulsification with the Alcon Legacy machine. A superior 3.2 mm incision was made with a diamond 3.2 mm keratone making a short (2 mm) scleral tunnel. Continuous curvilinear capsulorrhexis was performed using a bent 25 gauge needle. Phacoemulsification was performed using the 'stop-and-chop' technique. Folding forceps were used to fold the IOLs, except in the case of the Staar AA4203 plate IOLs, which were folded in a cartridge. The IOLs were inserted by Kelman-Mcpherson Forceps, except for the Staar AA4203 IOLs, which were inserted by the Staar injector. The visco-elastic material used was Ocucoat (Storz, Florida, USA).

At 1 month postoperatively, best corrected visual acuity (BCVA), manifest refraction, contrast sensitivity, lens position and anterior chamber cellular reaction by slit lamp examination were recorded. Contrast sensitivity was measured using the Pelli Robson Chart (Metropia Ltd, Cambridge, England). Visual acuity and contrast sensitivity among the three groups were compared using the analysis of variance (ANOVA), the two-tailed t-test and the chi-squared test.

Results

At 1 month postoperatively, the mean BCVA of eyes with silicone, acrylic, and hydrogel IOL implants (in logarithmic Minimum Angle of Resolution scale) were 0.11, 0.12, and 0.14, respectively. There was no statistically significant difference in the mean BCVA among these three groups. No lens decentration or excessive cellular reaction in the anterior chamber was noted.

The percentage of eyes implanted with silicone, acrylic, and hydrogel IOLs with a BCVA of 20/40 or better were 100% for each group. The corresponding percentages of eyes with a BCVA of 20/25 or better were 72.22%, 66.67%, and 56.25% for silicone, acrylic, and hydrogel IOLs, respectively. The corresponding percentages of eyes with a BCVA of 20/20 or better were 16.67%, 25.93%, and 12.50% for silicone, acrylic, and hydrogel IOLs, respectively (**Table 4**). There was no statistically significant difference in the percentages among the three groups at all three levels of BCVA achieved ($p > 0.05$).

The percentage of eyes with silicone, acrylic, and hydrogel IOLs with a contrast sensitivity of 1.50 or better were 72.22%, 71.43%, and 75.00%, respectively (**Table 5**). Again, there was no statistically significant difference in these percentages ($p > 0.05$).

Discussion

Because of variations in chemical structures, different IOLs differ in refractive indices, water content, folding and unfolding behavior, surface properties, mechanical strength, and clarity. The foldable IOL materials in this study fall into two groups: acrylate/methacrylate polymers and silicone elastomers. The silicone materials in the Staar AA4203 and Allergan SI30NB IOLs are both dimethylsiloxane (DMS). The material in the Alcon MA30BA IOL is a combination of 2-phenylethyl acrylate (PEA) and 2-phenylethyl methacrylate (PEMA), while the material in the Storz H60M IOL is a combination of 6-hydroxyhexyl methacrylate (HOHEXMA) and 2-hydroxyethyl methacrylate (HEMA).

Silicone has been used as a foldable lens material for many years. The main complications that have been reported with silicone lenses are lens decentration or dislocation, pupillary capture, lens discoloration, increase in pigment dispersion, and recurrent pigmented cellular membrane on the anterior surface of the IOL.[5,6] Silicone may also be more prone to adhesion by bacteria leading to postoperative endophthalmitis. For patients with retinal diseases requiring

Table 4. Best corrected visual acuity			
	Silicone (n = 18; %)	Acrylic (n = 27; %)	Hydrogel (n = 16; %)
20/40 or better	18 (100)	27 (100)	16 (100)
20/25 or better	13 (72)	18 (67)	9 (56)
20/20 or better	3 (17)	7 (26)	2 (13)
20/50 – 20/100	0 (0)	0 (0)	0 (0)
Worse than 20/100	0 (0)	0 (0)	0 (0)

Table 5. Proportion of eyes with contrast sensitivity ≥ 1.5	
	No. of eyes (%)
Silicone	13 (72.22)
Acrylic	19 (71.43)
Hydrogel	12 (75.00)

vitrectomy, silicone lenses may be associated with condensation of the posterior lens surface during fluid-air exchange or irreversible silicone oil adhesion.[7] Hydrogel IOLs are soft, hydrophilic, autoclavable, and more biocompatible, but may show some instability in the capsular bag, and are better implanted through an intact capsulorrhexis of 4.5 to 5 mm diameter.[8] Precipitates and calcification within poly-HEMA lenses have also been reported.[9] Acrylic lenses have been shown to have a lower incidence of posterior capsular opacification.[4]

There have been many studies investigating the visual results for patients of various IOL implants. In this study, 100% of patients achieved a BCVA of 20/40 or better 1 month after surgery. These results are comparable to those reported for foldable lenses such as plate-haptic silicone,[6] three-piece open-loop silicone,[10-13] hydrogel,[14,15] and acrylic.[16] In a study by Kohnen *et al.* comparing visual function in 55 patients implanted randomly with polymethyl methacrylate (PMMA), silicone, or acrylic IOLs, there were no statistically significant differences in their best corrected postoperative visual acuity, although slightly better visual acuity was achieved in the PMMA and acrylic groups.[17] This, again, is in line with the findings of the present study, although the IOL materials compared are not exactly the same.

In this study, we found no statistically significant difference in the contrast sensitivity levels for the three IOL groups. In Kohnen's study, it was found that patients with silicone IOLs had significantly lower contrast sensitivity than patients with PMMA IOLs, and that there was no significant difference in contrast sensitivity levels attained by patients in the acrylic and PMMA groups.[17] However, in another study comparing the effect of PMMA, silicone, and polyacrylic IOLs, no significant differences in postoperative BCVA and contrast sensitivity were found among the three groups although the incidence of posterior capsular opacification was lower with acrylic IOLs.[18]

It appears from this study that with modern surgical techniques and lens materials, the postoperative visual function attained by uncomplicated cataract surgery are not affected by the choice of lens, at least in the short term for the lenses used in this study. One drawback to this study is the short duration of follow-up. Nowadays, posterior capsular opacification is the most common complication of cataract surgery, and may take 2 to 3 years to develop.[18] Also, glare sensitivity and mesopic acuities were not studied, which may be important for patients who wish to drive at night.[17] Further study is suggested to determine the long-term visual outcome following IOL implantation with different materials.

Conclusion

The visual functions in terms of BCVA and contrast sensitivity were not found to be significantly different with the three IOL materials compared.

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