Anterior capsule contraction and intraocular lens decentration and tilt after hydrogel lens implantation

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Abstract

Aim—To prospectively investigate changes in the area of the anterior capsule opening, and intraocular lens (IOL) decentration and tilt after implantation of a hydrogel IOL.

Methods—100 patients underwent implantation of a hydrogel IOL in one eye and an acrylic IOL implantation in the opposite eye. The area of the anterior capsule opening, and the degree of IOL decentration and tilt were measured using the Scheimpflug videophotography system at 3 days, and at 1, 3, and 6 months postoperatively.

Results—The mean anterior capsule opening area decreased significantly in both groups. At 6 months postoperatively, the area in the hydrogel group was significantly smaller than that in the acrylic group. The mean percentage of the area reduction in the hydrogel group was also significantly greater than that in the acrylic group, being 16.9% in the hydrogel group and 8.8% in the acrylic group. In contrast, IOL decentration and tilt did not progress in either group. No significant differences were found in the degree of IOL decentration and tilt throughout the follow up period.

Conclusions—Contraction of the anterior capsule opening was more extensive with the hydrogel IOL than with the acrylic IOL, but the degree of IOL decentration and tilt were similar for the two types of lenses studied.

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All surgeries were performed by the same surgeon (KH) using standardised surgical procedures and medications. An approximately 3.5 mm scleral pocket incision was made for implantation of either IOL. After the incision, a 5.5 mm continuous capsulorhexis was created using a 25 gauge bent needle with 1% sodium hyaluronate. Following a thorough hydrodissection, the nucleus was emulsified and the cortical material aspirated completely. The lens capsule was reformed with sodium hyaluronate and the IOL placed into the capsular bag. In no case were any sutures placed. Eyes with surgical complications, including anterior capsule tears, posterior capsule rupture, and zonular dialysis, were excluded from the analysis.

Patients underwent examinations to measure the anterior capsule opening, and the degree of IOL decentration and tilt at 3 days, and at 1, 3, and 6 months after surgery using the Scheimpflug videophotography system (EAS-1000; Nidek Inc, Gamagori, Japan). The methods to measure the anterior capsule opening area, as well as the decentration length and tilt angle using the EAS-1000 system have all been described in previous studies. All measurements with the EAS-1000 system were carried out by five experienced ophthalmic technicians who were unaware of the purpose of this study.

Statistical analyses were performed to compare differences in the measurement data between the hydrogel and acrylic IOL groups using the Mann-Whitney U test. The repeated measures analysis of variance (ANOVA) was also used to compare differences between the various time points. Discrete parameters were compared using the χ² test. Any differences showing a p value of less than 0.05 were considered to be statistically significant.

Results

Of the 100 enrolled patients, 93 completed the 6 month follow up; seven patients did not undergo examination at 6 months after surgery. The average patient age was 71.4 (SD 6.5) years old, with a range of 52–85 years. There were 34 men and 66 women. No statistically significant difference was found regarding age between the hydrogel and acrylic IOL groups. At the first postoperative examination, after full mydriasis at 3 days after surgery, all IOLs were confirmed to be implanted in the capsular bag.

Table 1 summarises the mean area of the anterior capsule opening in the hydrogel and acrylic groups. The mean opening area decreased significantly after implant surgery in both groups (p <0.0001). The Mann-Whitney U test showed no significant difference between groups in the mean area at 3 days, or at 1 and 3 months after surgery. However, at 6 months the opening area in the hydrogel group was significantly smaller than that in the acrylic group (p = 0.0444). Furthermore, the mean percentage of area reduction in the hydrogel group at both 3 and 6 months after surgery was significantly greater than that in the acrylic group (Fig 1).

Table 1  Mean (SD) area of the anterior capsule opening (mm²) in the hydrogel and acrylic IOL groups

<table>
<thead>
<tr>
<th>Postoperative interval</th>
<th>Hydrogel group</th>
<th>Acrylic group</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 week</td>
<td>26.9 (3.7)</td>
<td>26.3 (3.5)</td>
<td>0.2533*</td>
</tr>
<tr>
<td>1 month</td>
<td>24.5 (5.0)</td>
<td>24.3 (5.0)</td>
<td>0.7067*</td>
</tr>
<tr>
<td>3 months</td>
<td>22.4 (5.3)</td>
<td>23.4 (4.9)</td>
<td>0.1979*</td>
</tr>
<tr>
<td>6 months</td>
<td>22.6 (5.3)</td>
<td>24.1 (4.7)</td>
<td>0.0444†</td>
</tr>
<tr>
<td>p Value</td>
<td>&lt;0.0001‡</td>
<td>&lt;0.0001‡</td>
<td></td>
</tr>
</tbody>
</table>

*No statistical significance.
†Statistically significant difference between the groups.
‡Statistically significant difference between the postoperative points.

patient. All patients were allocated the day before surgery, by random number tables, to one of two groups: (A) those who received a hydrogel IOL (Hydroview, H60M) in the left eye and a hydrophobic acrylic IOL (AcrySof, MA60BM, Alcon Surgical Inc, Fort Worth, TX, USA) in the right eye, and (B) those who were implanted with a hydrogel IOL in the right eye and with an acrylic IOL in the left eye. Patients, examiners, and the surgeon were masked to randomisation. The H60M has a round 6.0 mm hydrogel optic and poly(methylmethacrylate) haptics; the MA60BM has a round 6.0 mm hydrophobic acrylic optic and poly(methylmethacrylate) haptics.

Figure 1  Comparison of the mean percentage of the area reduction between the hydrogel and acrylic IOL groups. The mean percentage of the area reduction in the hydrogel group was significantly greater than that in the acrylic group at 3 and 6 months after surgery.

*Not statistically significant, † statistically significant.

Figure 2  Comparison of the mean length of decentration (mm) between the hydrogel and acrylic groups. Mean decentration length did not progress either in the hydrogel group (p = 0.8076, repeated measures ANOVA) or in the acrylic group (p = 0.9475). No statistically significant difference was observed in decentration between the two groups. *Not statistically significant.
Figure 2 displays the mean length of IOL decentration in the two groups. The mean length of decentration did not progress in either group (p = 0.8076 in the hydrogel group and p = 0.9475 in the acrylic group, repeated measures ANOVA). Furthermore, no statistically significant difference was found in decentration between the hydrogel and acrylic groups throughout the 6 month follow up period.

Figure 3 shows the mean degree of IOL tilt. The mean angle of tilt did not progress in either group (p = 0.6754 in the hydrogel group and p = 0.2819 in the acrylic group), and there was no significant difference in tilt angle between the two groups.

Four eyes (4.0%) in the hydrogel group underwent neodymium (Nd):YAG laser anterior capsulotomy within the 6 month follow up, while only one eye (1.0%) required laser treatment in the acrylic group. The mean opening area of the eyes that underwent anterior capsulotomy was 11.3 (SD 5.9) mm², and the average interval between implant surgery and anterior capsulotomy was 4.4 (2.3) months. There was no significant difference in the survival curve of eyes not requiring anterior capsulotomy between the two groups (p = 0.1733, Mantel-Cox log rank test).

Figure 4 illustrates representative retroillumination photographs at 6 months of eyes in the hydrogel and acrylic groups, respectively. In the eye with a hydrogel IOL, fibrosis of the anterior capsule opening margin is marked (Fig 4A), whereas in the opposite eye, with the acrylic IOL, fibrosis of the anterior capsule is much less (Fig 4B).

**Discussion**

Hydrogel materials are reported to be highly biocompatible in terms of their hydrophilic properties. However, a former hydrogel IOL with one piece plate haptic design had a high incidence of marked decentration. Furthermore, the serious complication of posterior capsule fibrosis is less than that with the hydrogel IOL. and with an open loop design, is now commercially available. It has been reported that this IOL has a unique clinical feature that results in extensive proliferation of lens epithelial cells on the surface, suggesting that this IOL has distinct surface properties. In this prospective study, we examined the extent of anterior capsule contraction and of IOL decentration and tilt due to capsular shrinkage.

Our study demonstrated that reduction of the anterior capsule opening area with the hydrogel IOL was greater than that with the acrylic IOL. The percentage of the area reduction at 6 months after surgery in the hydrogel group was approximately 17%, which was almost double that of the acrylic group. With reference to our previous report, the percentage of eyes with Nd:YAG laser anterior capsulotomy, while only 1.0% of eyes with the acrylic IOL required this additional procedure. These results indicate that the hydrogel IOL has certain disadvantages in terms of anterior capsule contraction.

In contrast, neither the hydrogel nor acrylic IOLs showed progression of decentration and tilt. Furthermore, the degree of IOL decentration and tilt of the two lenses was almost the same. Menapace et al. reported that a certain model of the former hydrogel IOL was...
not so markedly decentred in the capsular bag. Our results confirm that the Hydroview IOL with open loop design showed excellent centration so long as the IOL was placed in the bag.

The biological characteristics of the hydrogel IOL include high biocompatibility but weak adhesion to the lens capsule. As to the biocompatibility, many studies reported an extensive and persistent outgrowth of lens epithelial cells onto the IOL surface. In this series, we found only a slight membranous growth of lens epithelial cells which was not clinically relevant, although we cannot explain this. As to weak adhesion with the capsule, this can allow the space for synthesis of extracellular matrix due to myofibroblasts and, therefore, may lead to dense fibrosis under the anterior capsule. In addition, migration of spindle-shaped lens epithelial (fibre) cells into the retrolental space was noted in the early postoperative period (data not shown), which is consistent with previous studies. It thus may be that the weak adhesion of the hydrogel material to the capsule leads to these disadvantages.

In conclusion, contraction of the anterior capsule opening was greater with the hydrogel IOL than with the acrylic IOL. The area of the peripheral retina and also the reduced opening certainly limits the examination of the peripheral retina and also increases the difficulty of laser photocoagulation. Therefore, one should be particularly careful not to make a small capsulorhexis with the hydrogel IOL in patients with retinal morbidity. Furthermore, the open loop design hydrogel IOL shows good centration as long as implanted in the capsule. Therefore, surgeons should carefully place this lens into the capsular bag.

The authors have no proprietary interest in any of the materials described in this article.