Intraocular pressure rise after small incision cataract surgery: a randomised intraindividual comparison of two dispersive viscoelastic agents

Georg Rainer, Rupert Menapace, Oliver Findl, Barbara Kiss, Vanessa Petternel, Michael Georgopoulos, Barbara Schneider

Abstract

Aim—To evaluate the effects of the dispersive viscoelastic agents Ocucoat (hydroxypropyl methylcellulose 2%) and Viscoat (sodium chondroitin sulphate 4%-sodium hyaluronate 3%) on postoperative intraocular pressure (IOP) after bilateral small incision cataract surgery.

Methods—This prospective, randomised study comprised 80 eyes of 40 consecutive patients with age related cataract in both eyes scheduled for bilateral small incision cataract surgery. The patients were randomly assigned to receive Ocucoat or Viscoat during cataract surgery of the first eye. The second eye was operated later and received the other viscoelastic agent. Cataract surgery was performed with a temporal 3.2 mm sutureless posterior limbal incision, phacoemulsification, and implantation of a foldable silicone intraocular lens. The IOP was measured preoperatively as well as 6 hours, 20–24 hours, and 1 week postoperatively.

Results—At 6 hours after surgery the mean IOP increased by 4.6 (SD 5.1) mm Hg in the Ocucoat group (p<0.001) and by 8.6 (8.1) mm Hg in the Viscoat group (p<0.001). The increase was significantly higher in the Viscoat group than in the Ocucoat group (p=0.004). Intraocular pressure spikes of 30 mm Hg or more occurred in two eyes in the Ocucoat and in nine eyes in the Viscoat group (p=0.023); 20–24 hours and 1 week postoperatively the mean IOP was not statistically different.

Conclusion—These findings indicate that Viscoat causes a significantly higher IOP increase and significantly more IOP spikes than Ocucoat in the early period after small incision cataract surgery.

An increase in postoperative intraocular pressure (IOP) is a major postoperative complication within 24 hours after cataract surgery.1–3 Intraocular pressure spikes of 30 mm Hg or higher in the early period after cataract surgery may be associated with pain, corneal epithelial oedema, and damage of the optic disc, particularly in patients with glaucoma. This has become a concern, since an increasing number of cataract patients are operated in an outpatient setting and discharged shortly after cataract surgery. A main cause for the postoperative IOP increase is that the viscoelastic agent remains in the eye, which causes a mechanical obstruction of the trabecular meshwork.4

Ocucoat (hydroxypropyl methylcellulose) and Viscoat (sodium chondroitin sulphate–sodium hyaluronate) are dispersive viscoelastic agents with low viscosity at zero shear rate (Table 1). The dispersive nature causes better adherence of the viscoelastic agent to the corneal endothelium, possibly resulting in better protection of the corneal endothelium against fluid turbulence and lens fragments during phacoemulsification. This has led to frequent use of such dispersive viscoelastic agents in routine small incision cataract surgery. In the USA, among ASCRS members, Viscoat is used as viscoelastic agent in about 30%,6 and in Europe, among German language surgeons, Ocucoat or other hydroxypropyl methylcellulose preparations are used in about 45% of cataract surgeries.7

A potential drawback, however, is the difficulty of completely removing the dispersive viscoelastic agents at the end of surgery, possibly resulting in an increased postoperative IOP. For small incision phacoemulsification cataract surgery that currently is the most frequently performed technique, only one study reports on the effect of Viscoat,8 and there has been no study reporting the effect of Ocucoat on postoperative IOP.

We therefore conducted a prospective, randomised, patient and observer masked study to evaluate the effect of Ocucoat and Viscoat on postoperative IOP after bilateral small incision cataract surgery.

Patients and methods

This prospective randomised study comprised 80 eyes of 40 consecutive patients with bilateral age related cataract scheduled for small incision cataract surgery and implantation of an intraocular lens (IOL). The study protocol was approved by the ethics committee of the Vienna University School of Medicine. Written informed consent was obtained from all patients in the study. Exclusion criteria were previous ocular surgery, ocular hypertension (IOP higher than 22 mm Hg), and primary or

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**Table 1** Biophysical properties of the viscoelastic agents

<table>
<thead>
<tr>
<th>Content</th>
<th>Ocucoat</th>
<th>Viscoat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroxypropyl methylcellulose 2%</td>
<td>Sodium chondroitin sulphate 4%–sodium hyaluronate 3%</td>
<td></td>
</tr>
<tr>
<td>90 000</td>
<td>600 000</td>
<td></td>
</tr>
<tr>
<td>Molecular weight (daltons)</td>
<td>4000</td>
<td>40 000</td>
</tr>
<tr>
<td>Viscosity at zero shear rate (cps)</td>
<td>4000</td>
<td>40 000</td>
</tr>
</tbody>
</table>
Table 2 Preoperative and postoperative mean IOP (mm Hg), SD, and range

<table>
<thead>
<tr>
<th>Time</th>
<th>Ocucoat</th>
<th>Viscoat</th>
<th>p Value**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative</td>
<td>14.0 (2.8) (8–20)</td>
<td>14.1 (2.9) (8–19)</td>
<td>0.602</td>
</tr>
<tr>
<td>6 hours postop</td>
<td>18.5 (6.0) (9–39)</td>
<td>22.7 (8.7) (12–48)</td>
<td>0.004</td>
</tr>
<tr>
<td>20–24 hours postop*</td>
<td>14.0 (3.5) (8–24)</td>
<td>14.7 (4.0) (9–24)</td>
<td>0.551</td>
</tr>
<tr>
<td>1 week postop</td>
<td>13.9 (2.7) (9–20)</td>
<td>13.8 (2.9) (7–20)</td>
<td>0.313</td>
</tr>
</tbody>
</table>

*Eyes that had an IOP of 30 mm Hg or more at 6 hours postoperatively have been excluded.

Table 3 Mean IOP change (mm Hg), SD, and range from preoperatively to 6 hours, 20–24 hours and 1 week postoperatively

<table>
<thead>
<tr>
<th>Time</th>
<th>Ocucoat</th>
<th>Viscoat</th>
<th>p Value**</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 hours postop</td>
<td>4.6 (5.1) (−3–21)</td>
<td>8.6 (8.1) (−2–32)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>20–24 hours postop*</td>
<td>0.3 (3.3) (−6–7)</td>
<td>0.9 (3.0) (−4–8)</td>
<td>0.130</td>
</tr>
<tr>
<td>1 week postop</td>
<td>−0.4 (2.0) (−5–4)</td>
<td>−0.2 (2.3) (−4–4)</td>
<td>0.584</td>
</tr>
</tbody>
</table>

*Eyes that had an IOP of 30 mm Hg or more at 6 hours postoperatively have been excluded.

**Difference from preoperatively.

Results

Table 2 shows the mean preoperative and postoperative IOP. There was no significant “between group” difference in preoperative IOP. At 6 hours postoperatively, the mean IOP was significantly lower in the Viscoat group than in the Ocucoat group. At 20–24 hours and at 1 week postoperatively, there was no significant difference in the Viscoat group.

Mean IOP changes from preoperatively to 6 hours, 20–24 hours, and 1 week postoperatively are listed in Table 3. At 6 hours, the mean IOP increased significantly in both groups. At 20–24 hours and at 1 week there was no significant change in either group.

Figure 1 compares the mean IOP changes in the two groups. At 6 hours, the mean IOP increase was significantly higher in the Viscoat group than in the Ocucoat group (p=0.004). At 20–24 hours and at 1 week, there were no significant differences (p=0.662 and p=0.650, respectively).

Table 4 shows the number, percentage, and IOP in eyes with an IOP increase of 30 mm Hg or higher at 6 hours after surgery. There were significantly more eyes with an IOP increase of 30 mm Hg or higher in the Viscoat group than in the Ocucoat group. The highest IOP values were 48 mm Hg in the Viscoat group and 39 mm Hg in the Ocucoat group.
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Discussion

Viscoelastic agents are widely used in small incision cataract surgery. Their use has several advantages, and especially dispersive viscoelastic agents are thought to protect the corneal endothelium from extensive damage during the phacoemulsification procedure. However, viscoelastic agents have the disadvantage of causing an increase in IOP. This has become a major concern, since an increasing number of cataract surgeries is performed on an outpatient basis and patients are often discharged shortly after surgery. In this study, we evaluated the effect of two commonly used dispersive viscoelastic agents on the IOP after small incision cataract surgery.

Our findings indicate that in the early postoperative period after small incision cataract surgery, Viscoat causes a significantly higher IOP increase and significantly more IOP spikes than Ocucoat. At 6 hours postoperatively, the mean IOP increased by about 9 mm Hg in the Viscoat group and by about 5 mm Hg in the Ocucoat group. IOP spikes of 30 mm Hg or higher occurred in nine eyes in the Viscoat group compared with two eyes in the Ocucoat group. At 20–24 hours the mean IOP decreased to preoperative values in both groups. However, in this study no IOP lowering medication was given at the end of surgery. The fact that both viscoelastic agents caused a significant IOP increase and IOP spikes of 30 mm Hg or more, argues for a prophylactic use of IOP lowering medication.

In a previous study we compared the effect of Healon5, a cohesive viscoelastic agent, and Viscoat on postoperative IOP after small incision cataract surgery which was performed by the same surgeon (RM). At 6 hours postoperatively, the IOP increase was about 10 mm Hg in the Viscoat group which is comparable with the result of the present study. There has been no other report on postoperative IOP after small incision cataract surgery with Viscoat.

Moreover, there has been no report on postoperative IOP after small incision cataract surgery with Ocucoat. The postoperative IOP increase of about 5 mm Hg at 6 hours postoperatively with Ocucoat seems to be similar to that of Healon (sodium hyaluronate 1%)\textsuperscript{9} and Healon5 (sodium hyaluronate 2.3%).\textsuperscript{8} Articles reporting the effect of Viscoat or Ocucoat on postoperative IOP used manual extracapsular cataract extraction (ECCE),\textsuperscript{10–16} or phacoemulsification cataract surgery with a 7 mm incision.\textsuperscript{17} In two further studies antiglaucomatous agents were used and the IOP was measured at 1 day postoperatively only.\textsuperscript{18} However, these reports are difficult to compare and often contradictory, since the postoperative IOP varies interindividually and with the surgical technique.

The mechanism of postoperative IOP increase is not yet fully understood. A major reason for the postoperative IOP increase seems to be the amount of the remaining viscoelastic agent at the end of surgery. It is assumed that the remaining viscoelastic agent mechanically obstructs the trabecular outflow pathway and hence decreases the outflow facility.\textsuperscript{1} In order to avoid a postoperative IOP increase, a thorough removal of viscoelastic agent is vital. Surgical techniques for the removal of viscoelastic substances, especially from behind the IOL, have been described,\textsuperscript{20–22} but a complete prevention of a postoperative IOP increase could not be achieved with any technique.

In our study, both Ocucoat and Viscoat were equally removed with great care from the anterior chamber as well as from behind the IOL at the end of the surgery. However, it was nearly impossible to completely remove both viscoelastic agents without injuring the endothelium and other vulnerable structures of the eye. Assuming that the amounts of the remaining viscoelastic substances were similar in our study, the difference in postoperative IOP increase between the two viscoelastic agents might be explained by differences in their biophysical properties. The clearance of the viscoelastic agent through the trabecular meshwork is believed to be dependent upon the viscosity and molecular weight of the used materials.\textsuperscript{11} Theoretically, the lower the viscosity and the molecular weight of the viscoelastic agent, the faster is the clearance through the trabecular meshwork. In accordance with this theory, in our study Ocucoat which is less viscous and has a lower molecular weight than Viscoat caused less IOP increase. The lower viscosity of Ocucoat compared with Viscoat, may, however, have the disadvantage of poorer endothelial cell protection.

In conclusion, our study shows that in the early postoperative period after small incision cataract surgery Viscoat caused a significantly
higher IOP increase and significantly more IOP spikes than Ocucoat. Although the viscoelastic agents were removed thoroughly, both Ocucoat and Viscoat caused a significant IOP increase compared with the preoperative IOP. Therefore IOP monitoring is necessary after small incision cataract surgery, and the use of IOP lowering medications is recommended, particularly in patients with compromised optic discs.

None of the authors has a proprietary interest in any product mentioned.

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