A novel index for predicting intraocular pressure reduction following cataract surgery

S A Issa, J Pacheco, U Mahmood, J Nolan, S Beatty

**Aim:** The results of a study designed to investigate the predictive value of preoperative anterior chamber depth (ACD) and intraocular pressure (IOP) are reported. The relation between these factors and their effect on the reduction in IOP following phacoemulsification cataract surgery was also studied.

**Methods:** The ACD and IOP were prospectively measured in 103 non-glaucomaticous eyes of 103 patients who underwent uneventful phacoemulsification and posterior chamber intraocular lens (PCIOL) implantation. Other data which were recorded included best corrected visual acuity, axial length, lens thickness, and severity of lens opacity.

**Results:** The ACD increased by a mean (SD) of 1.10 (0.44) mm (p<0.00001) and this increase was significantly and inversely related to preoperative ACD \( r^2 = 68\% \); p<0.01). IOP dropped by a mean of 2.55 (1.78) mm Hg following cataract surgery (p<0.0001), and this reduction was significantly and positively related to preoperative IOP \( r^2 = 56\% \); p<0.01), and significantly and inversely related to preoperative ACD \( r^2 = 21\% \); p<0.01). A novel ratio, the pressure to depth (PD) ratio (preoperative IOP/preoperative ACD), was found to be significantly and positively related to the surgically induced reduction in IOP \( r^2 = 73\% \); p<0.01), and IOP was reduced by \( > 4 \) mm Hg in all patients with a PD ratio >7.

**Conclusion:** The reduction in IOP following cataract surgery was found to be positively related to preoperative ACD, and inversely related to preoperative ACD. Furthermore, these results indicate that a novel index, the PD ratio, is strongly predictive for IOP reduction following cataract extraction, and may prove useful in surgical decision making.

**RESULTS**

We studied 103 eyes (57 left and 46 right eyes) of 103 volunteers. Mean age (SD) was 76.07 (9.33) years (table 1).

**Abbreviations:** ACD, anterior chamber depth; ACG, angle closure glaucoma; AXL, axial length; BCVA, best corrected visual acuity; IOP, intraocular pressure; PCIOL, posterior chamber intraocular lens; PD ratio, pressure to depth ratio.
and 43.7% were male and 56.3% were female. BCVA was found to improve significantly from 0.6 (0.53) to 0.2 (0.2) (p<0.00001).

Mean preoperative and postoperative ACD were 2.97 (0.44) mm and 4.07 (0.34) mm, respectively, and this represented a mean increase of 1.10 (0.44) mm (p<0.00001) (fig 1). There was a statistically demonstrable inverse relation between preoperative ACD and the extent of ACD increase (r = −0.8215, r² = 68%; p<0.01).

Mean lens thickness was 4.30 (0.59) mm and was positively related to the increase in ACD (r = 0.306; p = 0.002), but was not significantly related to changes in IOP (p = 0.579). It was also noted that lens thickness was inversely related to preoperative ACD (r = −0.332; p = 0.001).

The mean grade of lens opacification was 4.2 (1.1) for nuclear opalescence; 4.2 (1.1) for nuclear colour; 2.4 (1.5) for cortical lens opacity; and 1.8 (1.9) for posterior subcapsular opacities, and none of these were significantly related to changes in IOP (range of p: 0.069–0.916) or ACD (range of p: 0.073–0.217).

Of note, no statistically significant difference in terms of changes in ACD or IOP could be attributed to PCIOL type (ACD: p = 0.572; IOP: p = 0.665) and there was no statistically significant difference between preoperative and postoperative AXL (p = 0.1444).

Mean preoperative and postoperative IOP were 15.23 (2.47) mm Hg and 12.68 (1.65) mm Hg respectively, and this represented a mean drop of 2.55 (1.78) mm Hg (p<0.0001).

The extent of IOP reduction postoperatively was directly related to preoperative IOP (r = 0.745; r² = 56%; p<0.01) (fig 2). Furthermore, it was noted that IOP reduction was inversely related to preoperative ACD (r = −0.455; r² = 21%; p<0.01) (fig 3). Other variables including age, sex, lens thickness and preoperative AXL were not significantly related to IOP reduction (multivariate analysis) (range of p values: 0.174–0.869).

Table 1

<table>
<thead>
<tr>
<th>Table 1 Main data outcomes from the study</th>
<th>Before surgery</th>
<th>After surgery</th>
<th>Paired t test (p value)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>76.07 (9.33)</td>
<td>76.07 (9.33)</td>
<td>0.999 (NS)</td>
</tr>
<tr>
<td><strong>range</strong></td>
<td>43–94</td>
<td>43–94</td>
<td></td>
</tr>
<tr>
<td><strong>BCVA (logMAR)</strong></td>
<td>0.6 (0.53)</td>
<td>0.2 (0.2)</td>
<td>&lt;0.00001</td>
</tr>
<tr>
<td><strong>range</strong></td>
<td>0.1–1.9</td>
<td>0.0–1.0</td>
<td></td>
</tr>
<tr>
<td><strong>ACD (mm)</strong></td>
<td>2.97 (0.44)</td>
<td>4.07 (0.34)</td>
<td>&lt;0.00001</td>
</tr>
<tr>
<td><strong>range</strong></td>
<td>1.88–4.82</td>
<td>3.11–5.14</td>
<td></td>
</tr>
<tr>
<td><strong>IOP (mm Hg)</strong></td>
<td>15.23 (2.47)</td>
<td>12.68 (1.65)</td>
<td>&lt;0.00001</td>
</tr>
<tr>
<td><strong>range</strong></td>
<td>6–23</td>
<td>6–15</td>
<td></td>
</tr>
<tr>
<td><strong>Lens thickness (mm)</strong></td>
<td>4.30 (0.59)</td>
<td>4.30 (0.59)</td>
<td></td>
</tr>
<tr>
<td><strong>range</strong></td>
<td>2.2–5.55</td>
<td>2.2–5.55</td>
<td></td>
</tr>
<tr>
<td><strong>AXL (mm)</strong></td>
<td>23.10 (0.97)</td>
<td>23.14 (0.98)</td>
<td>0.1444</td>
</tr>
<tr>
<td><strong>range</strong></td>
<td>6–15</td>
<td>6–15</td>
<td></td>
</tr>
</tbody>
</table>

Values are expressed as mean (SD). ACD, anterior chamber depth; AXL, axial length; BCVA, best corrected visual acuity; IOP, intraocular pressure.

Figure 1 The relation between preoperative and postoperative ACD after cataract surgery. The solid line plotted is the line of equivalence.

Figure 2 The relation between preoperative IOP and IOP reduction after cataract surgery. Note that IOP drop is plotted as a positive value. Random noise of not more than plus or minus 0.1 was superimposed onto both x and y values to ensure that a maximum number of data points were visually represented. ACD, anterior chamber depth; IOP, intraocular pressure.

Figure 3 The relation between preoperative ACD and IOP reduction following cataract surgery. Note that IOP drop is plotted as a positive value. Random noise of not more than plus or minus 0.1 was superimposed onto IOP drop values to ensure that a maximum number of data points were visually represented. ACD, anterior chamber depth; IOP, intraocular pressure.
matous eyes, 13 21 and that this IOP reduction lasts for at least 12 months after phacoemulsification surgery in non-glaucomatous eyes. 13 22 However, previous workers have not exhibited a greater reduction in IOP. Further study, with longer follow up, is needed to investigate the potential role of the PD ratio in non-glaucomatous and glaucomatous eyes if its value in surgical decision making is to be confirmed or refuted.

Authors’ affiliations
S A Issa, J Pacheco, U Mahmood, J Nolan, S Beathy, Department of Ophthalmology, Waterford Regional Hospital, Waterford, Republic of Ireland
Correspondence to: Dr Sharif A Issa, Department of Ophthalmology, Waterford Regional Hospital, Waterford, Republic of Ireland; shariffissa@yahoo.co.uk
Accepted for publication 1 October 2004

REFERENCES

Predicting IOP reduction following cataract surgery

Figure 4 The relation between PD ratio and IOP reduction following cataract surgery. Note that IOP drop is plotted as a positive value. Random noise of not more than plus or minus 0.1 was superimposed onto IOP drop values to ensure that a maximum number of data points were visually represented. IOP, intraocular pressure; PD ratio, intraocular pressure to anterior chamber depth ratio.

ratio<6.0 (p<0.001). Indeed, all eyes with a PD ratio >7.0 exhibited an IOP reduction of at least 4 mm Hg (fig 4).

DISCUSSION
We have shown that ACD increased significantly by a mean of 1.10 mm 8 weeks postoperatively, which is comparable to reports of Hayashi et al. 13 They also found that, after surgery, the ACD in eyes with angle closure glaucoma (ACG) became almost identical to those in the non-glaucomatous eyes, indicating that cataract extraction may negate the anatomical predisposition to ACG. 13 Indeed, Gunning and Greve advocated cataract extraction for ACG as they found that it resulted in IOP reduction to the same extent as did filtering surgery, with fewer complications. 12

Several studies have demonstrated that cataract extraction and IOL implantation lowers IOP to some extent in eyes with primary open angle glaucoma (POAG) 14 20 and non-glaucomatous eyes, 13 21 and that this IOP reduction lasts for at least 12 months after phacoemulsification surgery in non-glaucomatous eyes. 13 22 However, previous workers have not investigated preoperative parameters which may be of predictive value for IOP reduction following cataract surgery.

We have demonstrated a significant IOP reduction, by a mean of 2.55 mm Hg, 8–9 weeks after cataract surgery in non-glaucomatous eyes, which is comparable to a study by Tong et al. 21 This reduction in IOP was more marked in patients with a higher preoperative IOP, and we also showed that this reduction was inversely related to preoperative ACD.

The observation that lens thickness was positively and significantly correlated with IOP readings in previous studies. 27–29 indicating that cataract extraction may negate the anatomical predisposition to ACG, 13 26; and/or an effect on the ciliary body (by capsular bag contraction) which results in reduced aqueous production. 21 Although the mechanism of IOP reduction following cataract surgery remains uncertain, our results indicate that it is a function of both preoperative ACD and IOP.

The major limitation of our study resides in its short follow up period. However, previous investigators have shown that the IOP lowering effect of phacoemulsification persists for at least 12 months. 21 Also, we did not measure corneal thickness which could influence IOP measurements, as increased corneal thickness has been associated with falsely high IOP readings in previous studies. 27–29

In conclusion, we describe a ratio that incorporates preoperative ocular parameters, which can be easily measured in a clinical setting, and appears to be strongly predictive for IOP reduction following cataract surgery in non-glaucomatous eyes. Eyes with a higher PD ratio exhibited a greater reduction in IOP. Further study, with longer follow up, is needed to investigate the potential role of the PD ratio in non-glaucomatous and glaucomatous eyes if its value in surgical decision making is to be confirmed or refuted.

Register now!

10th European Forum on Quality Improvement in Health Care
13–15 April 2005, ExCel Conference Centre, London
For further information on how to register please go to:
http://www.quality.bmjpg.com
A novel index for predicting intraocular pressure reduction following cataract surgery

S A Issa, J Pacheco, U Mahmood, J Nolan and S Beatty

doi: 10.1136/bjo.2004.047662

Updated information and services can be found at:
http://bjo.bmj.com/content/89/5/543

These include:

References
This article cites 28 articles, 1 of which you can access for free at:
http://bjo.bmj.com/content/89/5/543#BIBL

Email alerting service
Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Topic Collections
Articles on similar topics can be found in the following collections

- Lens and zonules (807)
- Ophthalmologic surgical procedures (1223)

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://group.bmj.com/subscribe/