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-glauciomatous 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 IOP, 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 of 103 patients without ocular co-morbidity, all of whom underwent phacoemulsification between October 2002 and December 2003. All subjects were assessed by the same clinician (SI), who was masked to patients’ identity; however, it was not possible to mask pseudophakia. This study was approved by the ethics committee of Waterford Regional Hospital and eyes with a history of trauma or surgery were excluded.

The following were recorded in the preoperative assessment, which is typically 1–2 weeks before surgery: best corrected visual acuity (BCVA); ACD; lens thickness; axial length (AXL); IOP; and severity of lens opacity. The same details, except lens thickness and grade of lens opacity, were recorded 8–9 weeks after surgery, and 4 weeks after discontinuation of topical steroids.

The BCVA was measured using a Snellen chart at 6 metres, and was converted into logMAR equivalent (counting fingers, hand movements, and perception of light were given arbitrary values of 1.7, 1.8, and 1.9, respectively). The ACD, lens thickness, and AXL were measured using an ultrasound A-scanner (Sonomed Model 100A) by the contact technique. This method of has been validated by previous investigators and three readings were taken and averaged. Three readings of IOP were measured using a Goldmann applanation tonometer attached to a slit lamp, and the mean was recorded. All IOP measurements were taken between 11 am and 4 pm. The cataract was classified according to the Lens Opacities Classification System (LOCS-III).

Surgical procedures were performed under retrobulbar anaesthesia: Xylocaine-MPF 4%, Hyalase, and Chirocaine. All operations were performed through a 2.85 mm clear corneal incision. A continuous curvilinear capsulorrhexis was completed following viscoelastic injection and hydrodissection was performed using BSS. After removal of the nucleus and cortex, a foldable, posterior chamber intraocular lens (PCIOL) was implanted in the capsular bag following enlargement of the incision to 3.2–3.5 mm. PCIOLs included Acrysof MA30BA or an Akreos Adapt lens. A 10/0 Nylon thread was used to seal the corneal incision if corneal stromal hydration was insufficient. Subconjunctival injection of 0.25 ml of DBL (dexamethasone) and 0.7 ml of Zinacef was given.

Data were analysed by SPSS software package (version 11) and differences between preoperative and postoperative values were assessed by the paired Student tailed t test. Categorical data were analysed using the $\chi^2$ test, and correlations between continuous data were assessed using the Pearson correlation coefficient. Multiple linear regression was performed in order to investigate the relation between IOP drop and several variables. A p value of less than 0.05 was considered statistically significant.

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 or ACD (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 represents a mean drop of 2.55 (1.78) mm Hg (p<0.00001). The extent of IOP reduction postoperatively was directly related to preoperative IOP (r = 0.745; r² = 56%; p<0.001) (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 preaxial AXL were not significantly related to IOP reduction (multivariate analysis) (range of p values: 0.174–0.869).

We investigated the predictive value of a novel ratio (preoperative IOP/preoperative ACD), and named this the pressure to depth ratio, or PD ratio. The PD ratio was positively related to the extent of IOP reduction (r = 0.852; r² = 73%; p<0.01) (fig 4). Twenty nine eyes (28%) had a PD ratio >6.0, and they exhibited a mean reduction in IOP of 4.90 (1.34) mm Hg, and this reduction was significantly greater than for eyes with a PD ratio <6.0 who had a mean IOP reduction of 1.64 (0.84) mm Hg (p<0.001). Furthermore, 96% of eyes with a PD ratio >6.0 exhibited an IOP drop of ≥2 mm Hg, compared with only 38% of those with a PD ratio <6.0 who had a mean IOP reduction of 1.45 (0.84) mm Hg (p<0.001).

Table 1 Main data outcomes from the study

<table>
<thead>
<tr>
<th></th>
<th>Before surgery</th>
<th>After surgery</th>
<th>Paired t test (p value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>76.07 (9.33)</td>
<td>76.00 (9.12)</td>
<td>&lt;0.00001</td>
</tr>
<tr>
<td>range</td>
<td>43–94</td>
<td>43–94</td>
<td></td>
</tr>
<tr>
<td>BCVA (logMAR)</td>
<td>0.6 (0.53)</td>
<td>0.2 (0.2)</td>
<td>&lt;0.00001</td>
</tr>
<tr>
<td>range</td>
<td>0.1–1.9</td>
<td>0.0–1.0</td>
<td></td>
</tr>
<tr>
<td>ACD (mm)</td>
<td>2.97 (0.44)</td>
<td>4.07 (0.34)</td>
<td>&lt;0.00001</td>
</tr>
<tr>
<td>range</td>
<td>1.88–4.82</td>
<td>3.11–5.14</td>
<td></td>
</tr>
<tr>
<td>IOP (mm Hg)</td>
<td>15.23 (2.47)</td>
<td>12.68 (1.65)</td>
<td>&lt;0.000001</td>
</tr>
<tr>
<td>range</td>
<td>6–23</td>
<td>6–15</td>
<td></td>
</tr>
<tr>
<td>Lens thickness (mm)</td>
<td>4.30 (0.59)</td>
<td>4.07 (0.34)</td>
<td>&lt;0.00001</td>
</tr>
<tr>
<td>range</td>
<td>2.2–5.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AXL (mm)</td>
<td>23.10 (0.97)</td>
<td>23.14 (0.98)</td>
<td>0.1444</td>
</tr>
<tr>
<td>range</td>
<td>20.57–25.72</td>
<td>20.44–25.78</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. 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.
A novel ratio, incorporating preoperative ACD and IOP, was found to be more strongly predictive for IOP reduction following cataract surgery ($r^2 = 73\%$) than either of these parameters in isolation ($r^2 = 21\%$ for ACD and $36\%$ for IOP). Thus, the PD ratio may be a useful tool in the management of non-glaucomatous eyes where a high IOP reduction is desirable and where cataract exists.

Tong et al. have shown that IOP reduction was statistically similar for non-glaucomatous and glaucomatous eyes 6 months after phacoemulsification and PCIOI implantation. Other have found that the reduction in IOP after cataract extraction can allow for reduced use of postoperative antiglaucoma medication in POAG patients. Should the predictive value of the PD ratio be confirmed in further study on eyes with POAG, it may be reasonable to incorporate its use into the surgical decision making process in an attempt to avoid the greater risk of complications inherent in glaucoma filtration surgery when compared with cataract surgery. 

Mechanisms that have been hypothesised to explain the reduction in IOP following cataract surgery include: improvement of aqueous outflow facility by widening the drainage angle; and/or an effect on the ciliary body (capsular bag contraction) which results in reduced aqueous production. 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. 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.

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.

**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; sharifissa@yahoo.co.uk

Accepted for publication 1 October 2004

**REFERENCES**

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)

Notes

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/