INTRODUCTION

Cataract and glaucoma are the first and second leading causes of blindness worldwide.1-3 Hence, the interaction between these two diseases is of interest to clinicians. A decrease in intraocular pressure (IOP) after cataract surgery has been reported in both glaucomatous and non-glaucomatous eyes.4 Long-term studies have shown a drop in IOP of about 3 mmHg in primary open angle glaucoma (POAG) patients and non-glaucoma patients with 75-85% of patients maintaining an IOP reduction at 5 years.5,6 IOP can be controlled in 20% of patients with open angle glaucoma (OAG) without drops following cataract surgery.7 Although the physiological reasons for decreased IOP after cataract surgery remain speculative, the facility of out-flow is known to increase after cataract surgery.8 The angle width does not change in normal or OAG patients after cataract surgery suggesting improved function of trabecular meshwork itself rather than improved aqueous access to the trabecular meshwork.9 Three or more different mechanisms may contribute to the observed reduction in IOP after cataract surgery. As the eye ages the crystalline lens increases significantly in volume. This may initiate a series of anatomical changes, that ultimately leads to increase in IOP observed with aging.10,11

As the lens grows, the anterior lens capsule is displaced forward causing the zonules to place anteriorly directed traction on the ciliary body and uveal tract, which in turn compresses the canal of Schlemm and trabecular meshwork, as the ciliary body is displaced forward by the enlarging lens the tendons relax and the space between trabecular plates becomes narrowed.12 Phacoemulsification typically induces low grade inflammation in the immediate postoperative period.13 This may lowers IOP by either decreasing aqueous production of ciliary body as seen in uveitis; or it could increase outflow similar to the mechanism of selective laser trabeculoplasty or prostaglandin analogues. Although, these options seem plausible, little experimental data seem to support these hypotheses. An additional explanation is that high flow of fluid and high IOP (up to 90 mmHg) experienced during cataract surgery forces fluid through the trabecular meshwork into the canal of Schlemm and episcleral veins.14,15 Forcing this large amount of fluid through the drainage system may increase patency and promote flow. Again, there is little evidence to support or refute this hypothesis.

ABSTRACT

Objective: To evaluate the effect of phacoemulsification on intraocular pressure in normal eyes and glaucomatous eyes.

Study Design: Quasi-experimental study.

Place and Duration of Study: Layton Rehmatulla Benevolent Trust, Eye and Cancer Hospital, Lahore, from September 2009 to August 2010.

Methodology: The study subjects were adult patients with cataract and open or occludable angle, with or without raised intraocular pressure, who underwent phacoemulsification. Patients having any corneal pathology, synechial angle closure more than 180 degrees, inflammatory eye disease, previous ocular surgery including YAG iridotomy and endothelial cell density less than 1500/mm² were excluded from the study. They were followed-up for one year. Outcome measures included intraocular pressure, angle width, visual acuity and number of antiglaucoma medicines. Results were compared using chi-square test for proportions and t-test for mean values.

Results: There were 50 (41%) males and 72 (59%) females with 80 (65.6%) right and 42 (34.4%) left eyes. Mean age was 56.4±8.57 years. Pre-operatively 52 patients had open angles while 70 patients had occludable angles. Postoperatively 96 patients had open angles and 26 patients had occludable angles. Mean pre-operative IOP was 25.70±7.79 mmHg, which was decreased to 17.44±2.8 mmHg (p < 0.001) at final follow-up visit. Number of mean antiglaucoma agents decreased from 1.12±1.30 pre-operatively to 0.62±0.92 at final follow-up visit. Mean pre-operative visual acuity was 0.4±0.19 that increased to 0.86±0.15.

Conclusion: Phacoemulsification resulted in reduction in intraocular pressure in normal as well as glaucomatous eyes and it significantly reduced the need for anti-glaucoma medicines.

Key words: Phacoemulsification, Cataract, Intraocular pressure, Glaucoma.
Cataract surgery is a very common and highly refined surgery with a favourable risk/benefit profile including improved visual acuity and visual field.16 The widespread general belief that cataract extraction alone lowers IOP 2-4 mmHg is slowly evolving towards an understanding of a larger and more sustained IOP reduction, especially in patients with higher pre-operative IOP.17-19 Even though cataract surgery alone lowers IOP, combined cataract/glaucma surgery lowers IOP more with fewer postoperative pressure spikes.18,20 Cataract surgery to lower IOP may be especially beneficial in developing countries or where the close follow-up necessitated by traditional glaucoma surgery is difficult. Nonetheless, cataract surgery seems to be emerging as a safer alternative in patients with mild to moderate glaucoma while avoiding morbidity of traditional glaucoma surgery.21

As such cataract surgery may shift the surgeon's approach in treatment of concurrent cataract and glaucoma.

The objective of this study was to evaluate the effect of phacoemulsification on intraocular pressure in normal eyes and glaucomatous eyes.

**METHODOLOGY**

Cataract patients with and without raised intraocular pressure of either gender aged 41-71 years were studied. Occludable angles were defined as having angle width of Shaffer grade-II or less by Goldman goniolens. Patients having any corneal pathology, synechial angle closure more than 180 degrees, inflammatory eye disease, previous ocular surgery including YAG iridotomy and endothelial cell density less than 1500/mm² were excluded from the study.

One hundred and twenty two patients fulfilling the inclusion criteria were selected from Out Patient Department of LRBT Eye Hospital. Patients were asked to sign the informed consent. Sociodemographic profile like name, age, gender and history of current disease with respect to symptoms, severity and duration was taken. Examination included detailed anterior segment examination with slit lamp, visual acuity with Snellen's chart (converted into decimal), intraocular pressure measurement with Goldman's applanation tonometer and dilated fundus examination.

Gonioscopy was performed by Goldman goniolens using Shaffer grading. Those angles which showed Shaffer grade-II or less in three quadrants were labelled as occludable, while those with three quadrants of Shaffer grade-III or IV were labelled as open.

The diagnostic criteria included visually significant cataract responsible for the patient's complaint and compromising their life style. Retina appeared indistinct on fundoscopic examination, and the dilated red reflex may be dim on retinoscopy. Distant direct ophthalmoscopy showed decreased red reflex or the hardened nucleus or cortical spokes on retro illumination. Slit lamp examination showed lenticular opacities or nuclear sclerosis. On Goldman applanation tonometry intraocular pressure more than 21 mmHg. On Goldman gonioscopy angle width by Shaffer grading.

All the patients were operated by clear corneal incision. Phacoemulsification was performed with implantation of intraocular lens (IOL). Prior to operation intraocular pressure was well controlled in those eyes that had elevated IOP. In glaucomatous patients pilocarpine was stopped 2 weeks prior to surgery and prostaglandin analogues were stopped 4 days before surgery. All the patients were followed-up at one day, one week, one month, 3 months and one year. At each visit, variables that were recorded included intraocular pressure, visual acuity with Snellen's chart (converted into decimal), number of glaucoma drugs. Gonioscopy was not performed for the first two follow-up visits. After that Gonioscopy was performed at each follow-up visit.

All this information was entered into SPSS version 17 and analyzed accordingly. The variables analyzed were demographics (age, gender) and examination. The quantitative data (age) presented with simple descriptive statistics like mean and standard deviation. The qualitative data (gender, angle status) presented as frequency and percentage. The intraocular pressure was presented as mean and standard deviation. Comparison was made between pre-operative and one year postoperative angle configuration and number of patients using glaucoma drugs by applying chi-square test. Comparison was made between pre-operative and postoperative intraocular pressure by using student t-test. The p-value was taken as equal to or less than 0.05.

**RESULTS**

In this study there were 50 (41%) males and 72 (59%) females. Mean age was 56.4±8.66 years. There were 80 (65.6%) right and 42 (34.4%) left eyes. Pre-operative gonioscopy revealed 52 (42.6%) eyes with open angle and 70 (57.4%) eyes with occludable angles. Preoperatively, there were 65 (53.3%) patients who were not using any glaucoma drug, 7 (5.7%) patients were using one glaucoma medicine, 20 (16.4%) patients were using two glaucoma medicines and 30 (24.6%) patients were using three glaucoma medicines (Table I).

Preoperative IOP ranged from 12-40 mmHg with mean IOP 25.7±7.79 mmHg. Mean pre-operative visual acuity was 0.41±0.18.

Postoperative intraocular pressure at day one was 20.87±4.1 mmHg. Postoperative intraocular pressure at week one was 18.30±2.89 mmHg. Postoperative intraocular pressure at month one was 18.08±2.94
mmHg. Postoperative intraocular pressure at month 3 was 17.33±2.78 mmHg. Postoperative intraocular pressure at year one was 17.44±2.81 mmHg. Postoperatively, at one year, there was a significant reduction in the number of anti-glaucoma medication (Table I). Mean postoperative visual acuity was 0.86±0.14.

### Table I: Phacoemulsification effect on anti-glaucoma medication.

<table>
<thead>
<tr>
<th>Number of anti-glaucoma agents</th>
<th>Total number of cases</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>65 (53.3%)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>7 (5.7%)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>2</td>
<td>20 (16.4%)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>30 (24.6%)</td>
<td></td>
</tr>
</tbody>
</table>

Mean difference between pre-operative IOP and IOP at day one was 5.18±5.91 mmHg. Mean difference between pre-operative IOP and IOP at month 3 was 8.37±6.16 mmHg. Mean difference between pre-operative IOP and IOP at year one was 8.26±6.19 mmHg.

Mean reduction in IOP, at one year, in patients with pre-operative IOP between 10-21 was 1.69±1.97. While in patients with pre-operative IOP between 22-31 reduction was 7.6±1.94. Patients with preoperative IOP between 32-40 had mean reduction of 16.66±3.33. The comparison between preoperative IOP and one year postoperative IOP was statistically significant (Table II).

### Table II: Change in intraocular pressure following phacoemulsification (n=122).

<table>
<thead>
<tr>
<th>IOP range</th>
<th>Pre-operative IOP (mmHg)</th>
<th>Postoperative IOP at one year (mmHg)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-21</td>
<td>16.41±2.35</td>
<td>14.72±2.27</td>
<td>0.012</td>
</tr>
<tr>
<td>22-31</td>
<td>25.91±2.05</td>
<td>18.29±1.27</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>32-40</td>
<td>35.78±3.50</td>
<td>19.23±3.08</td>
<td>0.001</td>
</tr>
</tbody>
</table>

At one year there were 96 (78.7%) patients with open angle and 26 (21.3%) patients with occludable angles. Preoperative and postoperative difference in angle configuration was statistically significant at p < 0.001. At one year mean decrease in IOP in patients with open angle was 3.6±2.2 mmHg while in patients with preoperative occludable angles the decrease in IOP was 11.7±5.95 mmHg.

### DISCUSSION

In this prospective study the effect of phacoemulsification on IOP was studied. Postoperatively there was reduction in IOP at all follow-up visits. It also resulted in a significant reduction in the use of anti-glaucoma medication and also in a significantly greater number of open angles postoperatively.

The conventional wisdom that cataract extraction lowers IOP by 2-4 mmHg for a couple of years was partially confirmed by the meta-analysis of the topic.18

Studies which did stratify patients based on pre-operative IOP clearly demonstrated that patients with higher pre-operative IOP had the greatest reduction of IOP after cataract surgery,17 the results of the present study are comparable to those studies.

Suzuki et al. reported a decrease of IOP over 6 months period after phacoemulsification and implantation of posterior chamber IOL. The result showed a statistically significant decrease between mean pre-operative and postoperative IOPs; the rate of decrease was dependent on initial IOP; the maximum drop in IOP occurred at 3 months and the mean drop at 6 months was 2.8 mmHg.22

Hayashi et al. found 17 degree and 10 degree angle widening measured by Scheimpflug videokeratography in angle closure glaucoma and open angle glaucoma patients, respectively. In this prospective study, cataract surgery led to the statistically significant different IOP reduction in two groups of patients. Postoperative IOP reduction was 4.4 ± 4.3 mmHg in primary open angle glaucoma while it was 6.1 ± 3.9 mmHg for angle closure glaucoma patients at the end of one year follow-up.9

Shingleton et al. found 9-10% IOP reduction after clear corneal phacoemulsification in a sub-group of normal patients.6 They found average IOP reductions of 1.7 and 1.5 mmHg at 3 and 5 years of follow-up.

The present results are comparable to the results of above studies. In this study the mean decrease in IOP in patients with open angle was 3.6±2.2 mmHg while in patients with pre-operative occludable angles the decrease in IOP was 11.7±5.95 mmHg.

Studies using ultrasound biomicroscopy and Scheimpflug videophotography have shown that the width and depth of the drainage angle in primary angle closure glaucoma (PACG) increases and becomes similar to those of normal eyes after phacoemulsification.9 The present study also demonstrated the angle widening effect of phacoemulsification in patients with occludable angles.

Philipp et al. showed that phacoemulsification with intraocular lens implantation in acute angle closure glaucoma patients resulted in 17.80±3.40 mmHg reduction in IOP.23 The present study demonstrated a decrease of 11.7±5.95 mmHg in IOP in patients with occludable angles.

Cataract surgery may be a safe alternative to glaucoma surgery in some patients and could shift the surgeon's approach in the treatment of concurrent cataract and glaucoma.

### CONCLUSION

Phacoemulsification with IOL implantation resulted in reduction in IOP. This decrease in IOP was more marked in eyes with higher pre-operative IOP and with occludable angles. Phacoemulsification results in
widening of drainage angles and which leads to a decrease in the requirement of anti-glaucoma medicines.

REFERENCES


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