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# The Changes in Intraocular Pressure After Phacoemulsification among Patients with Cataract

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## ABSTRACT

Phacoemulsification is currently one conventional surgical treatments for cataract. It can significantly deepen the central and peripheral anterior chamber depth (PACD), relieve pupillary block state, not only effectively reducing intraocular pressure, but also significantly lowering the incidence of complications. **Objectives:** To evaluate the changes in intraocular pressure in patients with cataract following phacoemulsification surgery. **Methods:** A Prospective observational study was conducted at the "Department of Ophthalmology, Jinnah Postgraduate Medical Centre, Karachi" in a time frame of six months. Pre-operative intraocular pressure was measured using a Goldman applanation tonometer, and Phacoemulsification and IOL implantation were performed. Postoperatively, IOP was measured at the 7th day, 30th and 60th post-operative day. To assess the change in intraocular pressure, repeated-measure ANOVA was used. Stratification was done. Post-stratification independent sample T-test/One-way ANOVA were applied as appropriate. The p-value ≤0.05 was considered statistically significant. **Results:** There were 58.2% male and 41.8% female patients. Mean age was 62.59 ± 9.66 years. Mean cataract duration was 15.34 ± 5.42 months. In our study, mean pre-operative intraocular pressure, post-operative intraocular pressure at 7th POD, 30th POD and 60th POD were 17.71 ± 2.12 mmHg, 14.70 ± 2.14 mmHg, 13.22 ± 2.17 mmHg, and 11.72 ± 2.22 mmHg, respectively. A significant mean difference for intraocular pressure (P=0.001) was observed. **Conclusions:** The intraocular pressure was significantly decreased as the time increased from preoperative status to postoperative status at 60th POD.

## INTRODUCTION

Cataracts have been established as the world's leading cause of blindness; Pakistan takes the largest share, 51%, per the statistics obtained from the National Blindness and Visual Impairment Survey conducted in 2002-03. Cataracts require surgery, normally, where the lens is usually replaced with an intraocular lens [1]. Even today, ECCE is done more frequently than phacoemulsification and is more common in developing countries like Pakistan [2, 3]. Phacoemulsification is currently one conventional surgical treatments for cataract, which has such advantages as involving a small self-sealing incision without sutures, less postoperative astigmatism and rapid visual recovery [3, 4]. It can significantly deepen the central and peripheral anterior chamber depth (PACD) relieve pupillary block state, not only effectively reducing intraocular pressure, but also significantly lowering the incidence of complications [5, 6]. Raised IOP is a reversible risk factor for glaucoma [7]. Reducing IOP is currently the

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only way to arrest or prevent glaucomatous optic neuropathy [8]. Cataract surgery has been documented to have an IOP-lowering effect, regardless of the presence or absence of glaucoma. In angle-closure glaucoma, phacoemulsification has been reported as a method that can help to reduce IOP [9, 10]. Phacoemulsification has been stated to have a comparable IOP-lowering effect to LASIK for OAG eyes; nevertheless, this is less compared to ACG-affected eyes [11]. Risk factors for achieving a greater IOP reduction after cataract surgery involve having a higher IOP preoperatively, less anterior chamber depth, and a higher ratio of IOP to ACD [10]. Other authors also noted further biometric variables, including AL, LT, lens-capsule anterior-posterior (LP) position, and lens-capsule back arch, which have also been found to affect IOP shifts following cataract surgery. The pathways through which phacoemulsification leads to a decrease in IOP have not been determined to date. Nevertheless, it is rather evident that the outflow facility increases in the postoperative period after the cataract surgery. In an OAG or normal eye, there is no change in the width of the angle. Thus, the reduction of IOP cannot be explained with the help of the increase in the flow rate in the TM through the aqueous humor. One of them is that the improvement comes from enhancing the trabecular meshwork's functioning. Several hypotheses explain the decrease in intraocular pressure after the surgery. For instance, as the lens is enlarged, the anterior capsule pushes on the ciliary body and uveal tract, pushing Schlemm's canal and trabecular meshwork to realize low IOP [12]. Since glaucoma surgeries are often not followed up with the necessary aftercare in developing countries, phacoemulsification may be a safer method of lowering intraocular pressure (IOP) in patients with mild to moderate glaucoma. It also assists in reducing the risk factors that are usually found with other forms of glaucoma surgery [13]. Whereas raised IOP is a cause of irreversible optic nerve damage.

This study aimed to find changes in the population with raised IOP and people using medication to lower their mean IOP just by performing cataract surgery, which ultimately will improve their visual acuity and reduce intraocular pressure to avoid morbidity and the need for frequent follow-ups.

## METHODS

A six-month prospective observational study was carried out at the Department of Ophthalmology, Jinnah Postgraduate Medical Centre, Karachi (18-06-2021 to 17-12-2021) by using a non-probability convenience sampling technique. Data were collected after approval of the study from the College of Physicians and Surgeons Pakistan (CPSP) under letter no (CPSP/REU/OPL-2018-186-1972). Sample size calculation was done using the WHO criteria. Sample size calculated after keeping the mean change of IOP after 3 months of Phacoemulsification was 8.37 ± 6.16, Margin of error 10% and confidence interval 95%. The required sample size for this study is 146 [14]. The assessment criteria for the study included patients who were aged between 18 to 80 years, of either sex, who had phacoemulsification surgery. Cataracts affected the patients' vision for 1 to 2 years and interfered with their sight to a great extent, including glare, blurriness, and spotty vision. Patients with some complaints of these symptoms and others whose cataracts affected their activities greatly formed the study population. Patients who developed intraoperative complications or required other procedures that could have influenced the IOP level (Those, with such conditions as capsular rupture, the use of a pupil dilator, or secondary open-angle glaucoma, pigment dispersion or pseudo exfoliation syndrome, were excluded) or who had prior use of intraocular surgery or trauma or other ocular diseases that may affect visual acuity or influence IOP measurements such as a corneal scar, age-related macular degeneration or congenital abnormality. The participants were selected consecutively, regardless of whether they had early diabetic retinopathy (DR) or any other eye complication, from the outpatient department and operation theatre of the eye unit at JPMC, where they provided written informed consent to participate in the study. Pre-operative intraocular pressure was measured using a Goldman applanation tonometer and documented and Phacoemulsification and IOL implantation were performed by a Consultant Ophthalmologist with more than 10 years of experience, and postoperatively, IOP was measured at the $7^{th}$ day, $30^{th}$ and $60^{th}$ post-operative day. Moreover, data on age, gender, ethnicity, socioeconomic status, occupation, place of residence, laterality of eye, duration of cataract and comorbid conditions like DM, HTN, etc were recorded on a pre-structured proforma. Data analysis was done using the specialized statistical software SPSS version 24.0. The descriptive statistic values of the mean ± standard deviation of the quantitative variables, such as ages and intraocular pressure before the operation, at the 7th, 30th, and 60th days after the surgery, were applied. Frequency and percentages were computed for all the qualitative variables like gender, comorbid conditions and Laterality of eye. To assess the change in intraocular pressure, repeated-measure ANOVA was used. Effect modifiers were controlled through stratification of age and gender. The p-value<0.05 was considered statistically significant.

## RESULTS

Results show demographic information and the history of patients. Most of the patients belonged to the age group

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>60 years (80; 54.8%), followed by ≤ 60 years (66; 45.2%), and the mean age was 62.59 ± 9.66 years, while gender distribution shows male were in the majority, 58.2% and 41.8% were female. Patients having cataract were divided into two groups: ≤12 months and >12 months, whereas the majority of subjects having cataract were observed in duration of >12 months (93; 63.7%) and ≤12 months (53; 36.3%), mean cataract duration was observed as 15.34 ± 5.42 months. Status of co-morbids indicates that among study patients, 34.9% of patients were having hypertensive, 35.6% patients had diabetes mellitus, 6.2% patients had tuberculosis, 2.1% patients had hepatitis B and 2.1% patients had hepatitis C. Results showed that 63% patients had cataract at right side and 37% at left side, while cortical (47.9%) was the most common position of cataract followed by nuclear cataract position (26.7%), Table 1.

**Table 1:** Demographic Information and History of Patients

| Variables | Frequency (%) | Mean ± SD |
|---|---|---|
| **Age Groups** | | |
| < 60 Years | 66 (45.2%) | 62.59 ± 9.66 |
| >60 Years | 80 (54.8%) | |
| **Gender** | | |
| Male | 85 (58.2%) | – |
| Female | 61 (41.8%) | |
| **Cataract Duration** | | |
| <12 Months | 53 (36.3%) | 15.34 ± 5.42 |
| >12 Months | 93 (63.7%) | |
| **Status of Co-Morbids** | | |
| Hypertension | 51 (34.9%) | – |
| Diabetes Mellitus | 52 (35.6%) | |
| Hepatitis B | 3 (2.1%) | |
| Hepatitis C | 3 (2.1%) | |
| Tuberculosis | 9 (6.2%) | |
| Others | 10 (6.8%) | |
| None | 18 (12.3%) | |
| **Side of the Eye** | | |
| Right Eye | 92 (63%) | – |
| Left Eye | 54 (37%) | |
| **Type of Cataract** | | |
| Nuclear | 39 (26.7%) | - |
| Cortical | 70 (47.9%) | |
| Post subscapular | 37 (25.3%) | |

Findings demonstrate descriptive statistics of intraocular pressure; mean pre-operative intraocular pressure, post-operative intraocular pressure at 7th POD, 30th POD, and 60th POD were 17.71 ± 2.12 mmHg, 14.70 ± 2.14 mmHg, 13.22 ± 2.17 mmHg, and 11.72 ± 2.22 mmHg, respectively, Table 2.

**Table 2:** Descriptive Statistics of Intraocular Pressure (mmHg)

| Pre-Operative (Mean ± SD) | Range | Minimum | Maximum |
|---|---|---|---|
| 17.71 ± 2.12 | 7.30 | 15.20 | 22.50 |
| **Post-Operative IOP on 7th Post-Operative Day** | | | |
| 14.70 ± 2.14 | 8 | 11.60 | 19.60 |
| **Post-Operative IOP on 30th Post-Operative Day** | | | |
| 13.22 ± 2.17 | 8.70 | 9.70 | 18.40 |
| **Post-Operative IOP on 60th Post-Operative Day** | | | |
| 11.72 ± 2.22 | 9.20 | 8.00 | 17.20 |

Findings indicate a significant mean difference association was observed for intraocular pressure (p=0.000), and mean compassion was also computed for stratified categories of age groups, Table 3.

**Table 3:** Mean Comparison of Intraocular Pressure (mmHg)

| Intraocular Pressure | Mean ± SD | p-value |
|---|---|---|
| Pre-Operative | 17.71 ± 2.12 | <0.001 |
| Post-Operative on the 7th Day | 14.70 ± 2.14 | |
| Post-Operative on the 30th Day | 13.22 ± 2.17 | |
| Post-Operative on the 60th Day | 11.72 ± 2.22 | |

Significant association was also documented (p-value 0.000*) after using ANOVA tests, Table 4.

**Table 4:** Mean Comparison of Intraocular Pressure (mmHg) According to Age Group

| Variables | | Intraocular Pressure Mean ± SD | p-value |
|---|---|---|---|
| ≤60 Years | Pre op IOP | 17.71 ± 2.14 | 0.001* |
| | Post op IOP at 7th POD | 14.99 ± 2.18 | |
| | Post op IOP at 30th POD | 13.54 ± 2.21 | |
| | Post op IOP at 60th POD | 12.02 ± 2.29 | |
| >60 Years | Pre op IOP | 17.71 ± 2.12 | 0.001* |
| | Post op IOP at 7th POD | 14.46 ± 2.09 | |
| | Post op IOP at 30th POD | 12.96 ± 2.11 | |
| | Post op IOP at 60th POD | 11.47 ± 2.15 | |

Repeated Measures of ANOVA was applied. p≤0.05 is considered significant. *Significant at the 0.05 level.

## DISCUSSION

The sample for this study comprised 146 cataract patients; the data were collected to reflect changes in intraocular pressure following the phacoemulsification procedure. The findings provided by the study suggested that the majority of the participants were male. The demographic characteristics of the patients showed that all patients belonged to the rural area, the mean age of the patients was 62 years, and the overall duration of the illness from symptom onset was 15 months in the present study. The mean of preoperative intraocular pressure was 17.71 ± 2.12 mmHg, and at POD 1 was 14.70 ± 2.14, POD 2 was 13.22 ± 2.17, and POD 3 was 11.72 ± 2.22 as depicted in Table 3. Therefore, the IOP was significantly reduced from the preoperative measurement to 60 days after the surgery. As noted by Poley et al. an IOP decrease is usually noted within 1 to 6 weeks after phacoemulsification [14]. This study also revealed that the reduction in IOP was generally proportional to the degree of IOP at the initial stage of the

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surgery. As for their study, they divided the patients into different categories according to IOP at the preoperative stage, with both 124 eyes undergoing cataract surgery. In the study, observations were made after one-year follow-up of IOP operation, and the decrease was recorded to be as follows: eyes with pre-operative IOP of 29-23mmHg reduced to 8.5 mmHg, thus, having a reduction of 34%; eyes with pre-operative IOP of 22-20mmHg operated to 4.6 mmHg with a reduction of 22%; eyes with preoperative IOP of 19-18mmHg reduced to 3.4 mmHg with the reduction of 18%; while eyes with preoperative IOP of Remarkably, eyes with the preoperative IOP in a range of 14 mmHg to 5 mmHg rose by 1.7 mmHg or to 15%. The authors also mentioned that the reduction in IOP was, irrespective of the patient's age, up to ten years after the treatment. In a related study, Poley *et al.* observed 588 eyes which underwent phacoemulsification to have an IOL placed in the posterior chamber [14]. In five groups, the recruited patients were sub-grouped according to their preoperative intraocular pressure (IOP) values. In the 1-year surgical outcomes, the changes in IOP were evaluated as 27 % (6.5 mm Hg) in patients who had preoperative IOP levels between 31-23, 22 % (4.8 mm Hg) in patients with IOP between 22-15 and 14 % (2.5 mm Hg) in patients with IOP between 14-9. This IOP reduction was sustained throughout the 1-year follow-up and was identified for up to 10 years for pediatric and adult groups. Surgical intervention improved IOP control in this study, especially in the group with an IOP greater than 20 mmHg preoperatively. Several other studies have postoperatively revealed that IOP is significantly lower in PAC, PACG, narrow angles, and shallow ACD than in PAC [15]. Shingleton *et al.* studied ACD and IOP in 35 patients with occlusal angle and 35 normal open-angle patients after phacoemulsification [16]. This research evaluated the mean IOP and ACD levels at the initial examination, on the first day after the surgery and at the first, fourth, ninth, and twelfth months from the three groups of the ideal surgical procedure. Possible explanations for these findings were the differences in ACD, preoperative IOP and IOP reduction postoperatively between the occlusal and open angles groups. In the same study, Azam *et al.* measured the ACD in 28 eyes booked for phacoemulsification and IOL implantation without complications [17]. They observed that it augmented in all eyes post-surgery, especially in the shallow ACD pre-operative plus shorter axial length patients. However, the difference in IOP reduction was even greater in eyes with a shallower preoperative ACD. The IOP variations after phacoemulsification were observed in 71 eyes in the study by Jansen and Höllhumer, wherein IOP was measured 5 weeks after the implantation of the IOL [18]. Pre and postoperative measurement of IOP was done at 3 weeks of follow-up and at the 50th week of follow-up. The eyes under 25 years of age were categorized according to the AL, and the statistical evaluation demonstrated that the IOP was reduced in the groups with shorter AL (21 to <23 mm and 23 to <25 mm), and the IOP was increased in the eyes having AL ≥25 mm. Therefore, angle opening and alteration in the position of the ciliary body might be the possible reasons for the decrease in intraocular pressure (IOP) for eyes having PAC and narrow angles. In their study, Nonaka et al. conducted a study on 31 subjects, PAC or PACG patients lined up for cataract surgery [19]. In the study, the investigators enhanced ultrasound bio microscopy, which revealed higher ACD, AOD, and TPD in the study group after the procedure. The authors supposed that the positioning of the anterior ciliary process might be changed after cataract surgery, and the anterior chamber depth may increase, which could lead to a change in IOP in PACG eyes. The clearance of blind spots after cataract surgery is even more significant in eyes with PAC or narrow angles, as evident from various studies. For instance, Zhou *et al.* recruited 53 patients who presented with cataracts and recruited them for the study and investigated the changes in the anterior chamber width and IOP of the patients 6 months before the phacoemulsification procedure [12]. The authors identified reduced IOP for quite a long time, and the widths of the anterior chamber angles after the surgery. No significant attempt could be made to attribute the postoperative IOP reduction to the preoperative width of the anterior chamber angle measurement in these patients who underwent cataract surgery. Likewise, another study by Shams *et al.* included 55 eyes of PACG patients, in which a decrease in IOP after cataract surgery was also reported [20]. Looking at their paper, they analyzed the IOP difference between the time before surgery and almost 7.2 months after it in their sample of subjects. They noted that a larger preoperative IOP led to a greater decrease in the variable. Besides, the consumption of glaucoma medications was reduced during the postoperative period in the present study. Another possible clinical implication of this reduction in IOP is observed in primary open-angle glaucoma (POAG) patients and normal individuals after cataract extraction. Shingleton *et al.* also have 55 eyes of POAG, forty-four eyes of suspected glaucoma, and fifty-nine eyes without glaucoma for 5 years after phacoemulsification and IOL implantation [16]. On final follow-up, there was a 1.8 ± 3.5 mmHg IOP lowering in the glaucoma group, a 1.3 ± 3.7 mmHg in the suspected glaucoma group, and a 1.5 ± 2.5 mmHg IOP reduction in the non-glaucoma group. In magnetic resonance imaging, the lens also grows bigger with age. It thus has a comparatively bigger atmospheric thickness, and the uveal tract shifts, roaring and moving forward.

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These actions cause a reduction in the available circumference area around the lens-iris interface, which minimizes circumferential forces on the aqueous humor and improves outflow according to the geometry of the scleral spur.

## CONCLUSIONS

It was concluded that the intraocular pressure was significantly decreased as the time increased from preoperative status to postoperative status at the 60th Postoperative day. Phacoemulsification involving a small self-sealing incision without sutures, a widely adopted surgical technique for cataract extraction, has been shown to result in a significant reduction in intraocular pressure (IOP) among patients with cataracts, particularly in those with higher preoperative IOP levels. This pressure-lowering effect suggests that cataract surgery may play a dual role in both visual rehabilitation and glaucoma management.

## Authors Contribution

Conceptualization: PAGK
Methodology: PAGK, AAK, SA
Formal analysis: PAK
Writing review and editing: NAC, D, IAP, SA

All authors have read and agreed to the published version of the manuscript

## Conflicts of Interest

All the authors declare no conflict of interest.

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