

# Evaluation of Effects of Uncomplicated Cataract Surgery on Intraocular Pressure

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## Abstract

**Background:** Cataract surgery is one of the most commonly performed elective surgeries in the world. Besides, the phacoemulsification technique adopted as standard procedure for cataract extraction has a potential of intraocular pressure (IOP)-modification. The time effect and the magnitude of affection of IOP post phacoemulsification are still debatable.

**Aim of Study:** The purpose of this study was to evaluate the magnitude of effect of the phacoemulsification cataract extraction procedure and foldable posterior chamber intraocular lens (PC IOL) implantation on intraocular pressure (IOP) and the average change in that effect 6 months postoperatively in normal (non-glaucomatous) subjects.

**Materials and Methods:** 49 patients (eyes) were included in our study all were undergoing phacoemulsification and foldable PC IOL implantation. IOP was recorded preoperatively, three months, and 6 months postoperatively.

**Results:** The range of intraocular pressure was 10-22 mmHg preoperatively and 10-20 mmHg postoperatively. There was a highly significant reduction in mean IOP from  $16.41 \pm 2.75$  mmHg to  $13.82 \pm 2.14$  mmHg ( $P < 0.001$ ).

**Conclusion:** Cataract surgery with phacoemulsification was associated with a statistically significant reduction in IOP in non-glaucomatous eyes with an open angle, the effect lasts throughout the time of follow up of 6 months.

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## Introduction

Cataract surgery is the most commonly performed ophthalmic surgical procedure of any kind, and the use of phacoemulsification to remove the cataract is increasingly becoming the standard of care worldwide [1].

In patients without glaucoma, glaucoma suspects and glaucoma patients, cataract surgery by phacoemulsification has been found to lead to a small decrease in intraocular pressure (IOP) [1-8]. Shingleton BJ, et al. (2006) showed that this modest decrease in IOP is sustained until 5 years after cataract surgery [9]. Several mechanisms seem to be involved in this postoperative IOP decrease: biochemical changes with the trabecular meshwork cellular response to ultrasound [8], mechanical changes with the washout of the trabecular meshwork during phacoemulsification [9], anatomical changes with a widening of the iridocorneal angle improving trabecular meshwork access [10-12] or changes in the Uveal tract increasing aqueous humor outflow [13-15].

Lens extraction produced a significant IOP reduction in patients with primary angle-closure glaucoma (PACG) [10-14]. Similarly, in

pseudo exfoliation glaucoma (PXG), the washout of the trabecular meshwork during phacoemulsification seems to be responsible for the postoperative IOP decrease [9,10,16-18]. Nevertheless, for POAG patients, the effect of cataract surgery on IOP and the number of medications remains unclear. In a meta-analysis for the American Academy of Ophthalmology, Chen et al. showed a modest 13% average decrease in IOP in patients with POAG after phacoemulsification alone [3]. However, studies evaluating IOP after phacoemulsification in POAG eyes showed substantial variability of results with IOP reduction ranging from -7% [19] to -22% [20]. Similarly, the number of glaucoma medications varied from -7% [21] to -59% [22] after cataract surgery. This may in part be explained by the variability of inclusion and exclusion criteria in these studies with some patients presenting with normal-tension glaucoma (NTG), uncontrolled glaucoma, or even patients with prior laser iridotomy, suggesting participation of angle closure mechanisms, and by the different study design.

## Aim of Study

The purpose of this study was to study effect of cataract surgery with phacoemulsification and posterior chamber intraocular lens (PCIOL)



implantation on intraocular pressure (IOP) in non-glaucomatous eyes with open angle.

### Patients and Methods

This was a pilot study conducted in Al\_Ebsar private hospital/ Kufa-Najaf during the period from October 2016 to September 2017.

#### Inclusion criteria

- Patient with no history of chronic medical diseases.
- No history of previous ocular surgery, ocular diseases and/or chronic use of topical ocular medication.
- IOP less than 24 mmHg.
- Anterior chamber angle more than 25 degree.
- Phakic other eye.

The number of eyes used for this database was 49, 25 right eyes and 24 left eyes underwent full ophthalmological assessment including tonometry using Goldman applanation Tonometer (Haag-Streit AG, Köniz, Switzerland.), funduscopy and Pentacam corneal tomography (Oculus Optikgeräte GmbH, Wetzlar, Germany) to assess the anterior chamber angle.

The patient's age, gender, laterality of the eye, preoperative IOP and postoperative IOP were noted. The number of male included was 23 and the number of females was 26. The mean age of the subjects was  $61.67 \pm 16.44$  years.

All the subjects had undergone cataract surgery with phacoemulsification and posterior chamber IOL implantation. The surgeries were performed by the same machine and by the same surgeon.

The IOP was measured with a Goldmann applanation tonometer and recorded preoperatively, and 6 months postoperatively.

Data were collected by using a data collection sheet (computerized excel Microsoft 2010) including age, sex, laterality of the eye, preoperative IOP and postoperative IOP

#### Ethical Issue

The study protocol was approved by council of the Kufa Medical College department of surgery.

Agreement of Al\_Ebsar private hospital /Najaf.

#### Statistical Analysis

Data of the 49 patients with cataract were entered, managed and analyzed by using the statistical package for social sciences (SPSS) software for windows, version 22.

The results and findings were presented in tables and figures with an explanatory paragraphs. Level of significance (P value) of  $<0.001$  indicated a significant difference.

#### Results

A total of 49 cataract cases were reported to evaluate change in IOP after phacoemulsification, Mean age was  $61.67 \pm 16.44$  years and the range of age was from 8 up to 86 years. The distribution of patients according to 10 years intervals is shown in figure 1 and it is obvious that the age interval of 60-69 years witnessed the highest proportion of cases accounting for 18 patients (36.7%). The study included 23 male patients (46.94%) and 26 female patients (53.06%) and male to female ratio

was 1:1.13 with no significant difference ( $P>0.05$ ), as shown in figure 2. According to laterality of the eye there were 25 patients with right eye and 24 patients with left eye, 51.02 % versus 48.98% ( $P>0.05$ ), as shown in figure 3. The range of intraocular pressure was 10-23 mmHg preoperatively and 10-20 mmHg post-operatively. There was highly significant reduction in mean intraocular pressure from  $16.41 \pm 2.75$  mmHg to  $13.82 \pm 2.14$  mmHg ( $P<0.001$ ), as shown in figure 4. Maximum reduction in IOP observed in patients with higher preoperative IOP values. No significant correlation between age, gender and laterality of eye with preoperative IOP as shown in figure 5 and table 1.

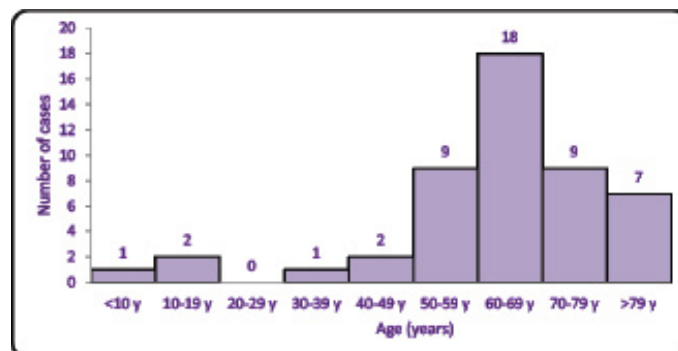


Figure 1: Histogram showing the distribution of cases according to 10 years age intervals.

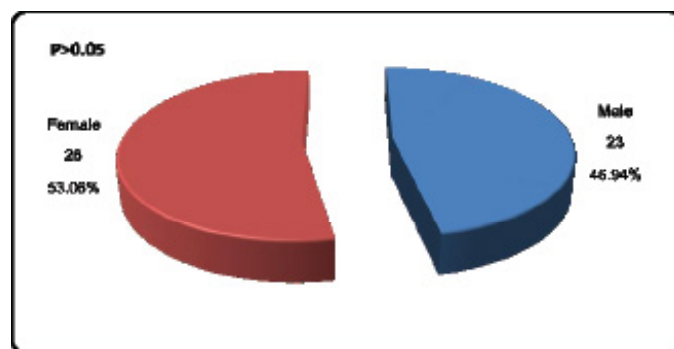


Figure 2: Pie chart showing distribution of cases according to gender.

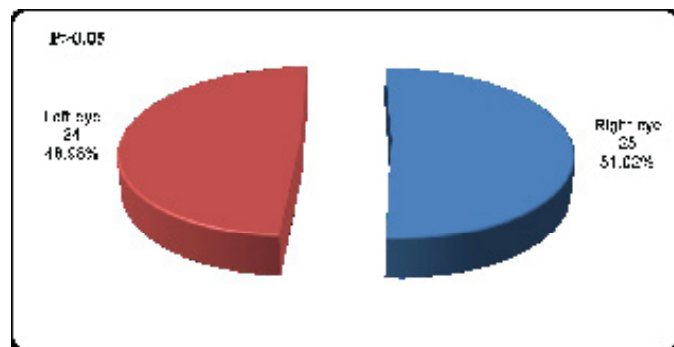


Figure 3: Pie chart showing distribution of cases according to laterality of eye involved.

Table 1: Correlation between preoperative IOP and gender of patients and side of eye.

| Characteristic | Value     | N  | Mean IOP (mmHg) | SD   | P     |
|----------------|-----------|----|-----------------|------|-------|
| Gender         | Male      | 23 | 16.48           | 2.23 | 0.869 |
|                | Female    | 26 | 16.35           | 3.17 |       |
| Laterality     | Right eye | 25 | 16.32           | 3.09 | 0.821 |
|                | Left eye  | 24 | 16.50           | 2.40 |       |

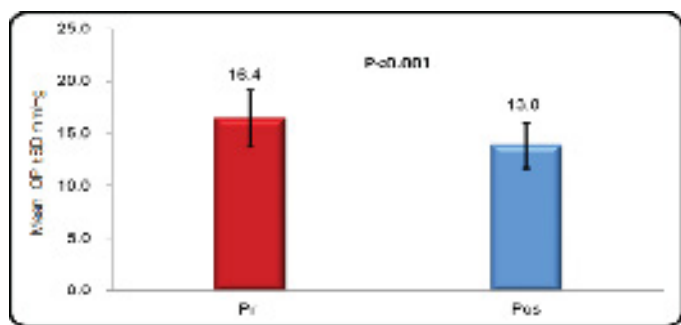


Figure 4: Bar chart showing comparison of mean IOP before and after operation.

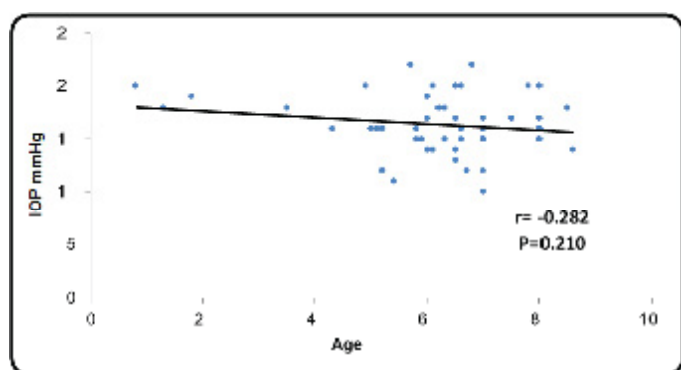


Figure 5: Pearson correlation between age of the patients and pre-operative IOP.

## Discussion

Many studies demonstrated the effect of cataract extraction on IOP in patient with closed or narrow angle glaucomatous eyes and we try to study the effect of phacoemulsification on IOP in patients with normal open angle of anterior chamber. This study found statistically significant difference between mean IOP measurements before, and 6 months after cataract surgery and we choose the 6 months interval to avoid any effect on IOP resulted from any topical medication used postoperatively and to give the corneas enough time to clear any effect of surgery on the functionality of endothelium and hence the corneal thickness.

There was highly significant reduction in mean IOP from  $16.41 \pm 2.75$  mmHg to  $13.82 \pm 2.14$  mmHg ( $P < 0.001$ ). The earliest studies of IOP after cataract surgery showed little if any reduction of intraocular pressure. In contrast, many recent studies including current study showed a significant reduction in IOP after cataract surgery. However, the results of earliest studies probably don't apply today because of advances in surgical technique and intraocular lens technology.

### The proposed Pathophysiology of Reduced IOP after Cataract Surgery

Although the physiological reasons for decreased IOP after cataract surgery remain speculative, the facility of outflow is known to increase after cataract surgery. The angle width does not change after cataract surgery suggesting improved function of the trabecular meshwork itself rather than improved aqueous access to the trabecular meshwork. Three different mechanisms may contribute to the observed reduction in IOP after cataract surgery:

#### Lens-induced Changes to Outflow Pathway

As the eye ages, the crystalline lens increases significantly in

volume. This may initiate a series of anatomical changes that ultimately leads to the increase in IOP observed with aging. 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 the trabecular meshwork. Since the anterior tendons of the ciliary muscles contribute to the architecture of the trabecular meshwork, as the ciliary body is displaced forward by the enlarging lens the tendons relax and the space between trabecular plates becomes narrowed. Phacoemulsification and IOL implantation reconfigures the anterior segment to its position earlier in life. By returning the anterior lens capsule to a more posterior location, the zonules exert posterior traction on the ciliary body and scleral spur. This results in expansion of the trabecular meshwork and Schlemm's canal.

This expansion improves function of the trabecular meshwork and valves in Schlemm's canal. Ultimately outflow facility increases and IOP decreases. The implanted artificial lens does not enlarge with time, hence IOP does not change postoperatively.

It is plausible that structural changes following cataract surgery relieve compressive forces on the trabecular meshwork and Schlemm's canal. Therefore, regardless of anterior chamber depth (ACD) and anterior chamber angle width, outflow facility improves and IOP decreases with lens extraction.

### Inflammation Induced by Cataract Surgery

Phacoemulsification typically induces a low grade inflammation in the immediate postoperative period. It is plausible that the induced inflammation lowers IOP by either decreasing aqueous production of the ciliary body as seen in uveitis; or it could increase outflow similar to the mechanism of selective laser trabeculoplasty or prostaglandin analogues.

### Fluidics of Phaco Emulsification:

An additional explanation is that high flow of fluid and high IOP (up to 90mmHg) experienced during cataract surgery forces fluid through the trabecular meshwork into the canal of Schlemm and the episcleral veins. Forcing this large amount of fluid through the drainage system may increase patency and promote flow [12].

An example of recent studies is a study done in Morocco by Bhallil S, et al. on 2009, evaluated IOP changes after phacoemulsification with PCIOL implantation in normal patients, and this study showed a mean decrease in IOP of 2.25 mmHg postoperatively [16].

Poley BJ, et al. (2008) conducted a retrospective study on 2008, to evaluate the long-term effect of phacoemulsification with intraocular lens (IOL) implantation in normotensive and ocular hypertensive eyes [17]. Eyes were divided into 5 groups based on IOP, The final mean IOP reduction was 6.5 mm Hg in the 31 to 23 mm Hg presurgical IOP group, 4.8 mmHg in the 22 to 20 mmHg group, 2.5 mmHg in the 19 to 18 mmHg group, and 1.6 mmHg in the 17 to 15 mmHg group. In the 14 to 9 mmHg group, the mean IOP at the final examination was 0.2 mmHg higher. The IOP reductions at 1 year were sustained over 10 years and were similar in patients of all ages.

A retrospective study done by Shingleton BJ, et al. (1999) to compare the effects of clear corneal phacoemulsification on IOP in patients without glaucoma, glaucoma suspects, and patients with glaucoma [18]. The mean preoperative IOP was  $16.42 \text{ mmHg} \pm 2.77$  (SD),  $17.59 \pm 4.15$  mmHg, and  $16.97 \pm 4.86$  mmHg in the 3 groups, respectively. At 1 year, the mean IOP was lower in all groups:  $14.37 \pm$



2.97 mmHg,  $15.68 \pm 3.38$  mmHg, and  $15.86 \pm 4.00$  mmHg, respectively.

Other study done by Kung JS, et al. (2015) showed that cataract extraction produce a significant and sustained IOP reduction in individuals with open-angle glaucoma, ocular hypertension, and angle-closure glaucoma [19].

A study done by Pal VK, et al. (2013) to evaluate the long-term changes in IOP after extra capsular cataract extraction (ECCE) versus phacoemulsification in otherwise normal cataract patients [20]. There was a mean fall in IOP of 2.70 mmHg in the ECCE group and 2.74 mmHg in the phaco group, i.e. Significant IOP reduction may be expected after cataract surgery with either ECCE or phacoemulsification with IOL implantation.

## Conclusion and Recommendation

Uncomplicated phacoemulsification has significant effect on IOP and should be kept in mind in cases of combined cataract and glaucoma cases planned for surgery.

Average reduction of 3-7 mmHg is anticipated following phacoemulsification in eyes with open angle of anterior chamber and this reduction can aid in the control of IOP in patient with mild to moderate or borderline glaucoma

The time last for this reduction in IOP was shortly proved for the time interval of 6 months according to this study and further studies with prolonged time of follow up is needed to ascertain the continuity of this effect on IOP.

## Disclosure

Authors has no any financial interest or correlation with any generic name for any company mentioned.

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