

# Effect of phacoemulsification on intraocular pressure in glaucoma patients

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## Author's Contribution

<sup>1,2</sup> Conceptualization of study, analysis, and interpretation of data

<sup>3,4</sup> Drafting the article or revising it critically for important intellectual content. final approval of the version to be published

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## A B S T R A C T

**Introduction:** Cataracts and Glaucoma are the leading causes of irreversible blindness worldwide. Lens extraction using the Phacoemulsification technique can be an effective IOP-lowering treatment for all types of glaucoma.

**Objective:** The purpose of this study was to measure the Intra-Ocular Pressure before and after phacoemulsification and to determine the mean change in Intra-Ocular Pressure.

**Methodology:** This study included 53 glaucoma patients with Primary Open Angle Glaucoma (POAG) (n=34), Angle Closure Glaucoma (ACG) (n=18), and Pseudoexfoliation (PXF) % (n=4) Glaucoma who visited the Glaucoma Department of Al-Shifa Trust Eye Hospital Rawalpindi. Pre and post-interventional study designs were used. Based on a slit lamp examination, patients were labeled as having cataracts in glaucomatous eyes. Pre-operative Intraocular pressure (IOP) was noted using Goldmann Applanation Tonometer (GAT). Patients were referred for Phacoemulsification and their IOP was noted after 2 weeks of surgery. The non-Probability convenient sampling Technique was used. Paired t-test was used to find the mean change in IOP.

**Results:** The mean age of respondents was (62.5±10.25) and had a maximum value of 81 years and a minimum value of 40 years among a sample of 53 respondents. The mean IOP before phacoemulsification was (16.25±7.251) the mean IOP after phacoemulsification was (13.28±5.940) and the mean difference was (2.962 ±8.364) in glaucomatous patients having cataracts. This difference was found to be statistically significant (p-value<0.05).

**Conclusion:** In Glaucomatous patients having cataracts after phacoemulsification there is a significant reduction in IOP and medications after surgery. This IOP reduction was more marked in POAG patients as compared to other types of Glaucoma.

**Keywords:** Glaucoma, Intra-ocular pressure, Cataract, Phacoemulsification

## Introduction

Glaucoma is a visual neuropathy of multifactorial etiology in which intraocular pressure (IOP) is the most significant and only modifiable risk factor. Accurate IOP measurement is critical in the diagnosis and treatment of glaucoma.<sup>1</sup> Glaucoma is the primary cause of permanent blindness, according to the World Health Organization, and

its incidence is likely to rise dramatically by 2040. Currently, 20 million people have primary angle-closure glaucoma; by 2040, 34 million people will be affected, with 53 million blind. Surgical lens extraction, which is commonly done to treat age-related cataracts, is an alternate treatment for primary angle-closure glaucoma. The lens's

age-related development is a critical factor in the mechanisms that lead to primary angle-closure glaucoma, and lens extraction is commonly performed in individuals who also have a cataract.<sup>2</sup>

IOP is a significant risk factor for the development of glaucoma as well as the progression of pre-existing glaucoma. Reduced intraocular pressure (IOP) is the best and only evidence-based therapy method; pharmacologic and surgical procedures aiming at lowering IOP may successfully delay the progression of structural deterioration and visual field loss in glaucoma patients. As a result, IOP monitoring is critical in ophthalmological evaluation. However, despite IOP reduction to therapeutic values, glaucoma may proceed, this suggests that variables other than IOP may play a key role in the etiology of glaucoma. IOP changes among individuals, with normal IOP maintained by the dynamic balance between watery humor production and outflow, as well as episcleral venous pressure. Aqueous humor aids in the maintenance of proper IOP. IOP aids in the maintenance of the normal shape of the eyeball.<sup>3</sup>

POAG affects around 13.5 million persons over the age of 40 worldwide. This accounts for 60 percent of the disease's entire global burden. PACG accounts for 6 million individuals, with an age distribution similar to that of the open-angle variant.<sup>4</sup> Cataract extraction is a safe and successful procedure that has been practiced for several decades in its contemporary form. Many studies have found that cataract extraction may have a clinically important role in the management of concomitant glaucoma. Lens extraction reduces intraocular pressure (IOP), which is the only modifiable risk factor in glaucoma that is beneficial.<sup>5</sup>

Pseudoexfoliation syndrome is usually linked with pseudoexfoliation glaucoma, the most prevalent recognized type of secondary open-angle glaucoma globally. Pseudoexfoliation is an established risk factor for cataract development.<sup>6</sup> PES has been widely demonstrated to cause chronic open-angle glaucoma, as well as angle-closure glaucoma, lens subluxation, blood-aqueous barrier impairment, and complications during cataract extraction, such as capsular rupture, zonular dialysis, and vitreous loss, as awareness of the condition has grown. Medical treatment is usually ineffective,

however, numerous surgical treatments have been offered to better cure the syndrome's clinical signs.<sup>7</sup>

More than 20 years ago, phacoemulsification was proposed as a procedure for removing the cataractous lens. With improved safety and efficiency, advances in techniques and equipment have resulted in substantial growth in the popularity of phacoemulsification. Viscoelastic agents were established in combination with modern phacoemulsification procedures, and they are critical to the success of this modern technology. Improved surgical procedures for removing the anterior lens capsule have decreased the incidence of both intraoperative and postoperative capsular complications.<sup>8</sup> Cataracts are thought to be responsible for 41.8 percent of all global blindness. Implementing health care initiatives in a community and raising knowledge of common eye diseases might encourage people to have their eyes examined. This might lead to earlier detection, treatment, and decrease of vision impairment and blindness caused by eye diseases. Glaucoma is the world's second-largest cause of vision loss. It has also been stated that almost half of glaucoma patients were ignorant of their condition at the time of diagnosis and were in an advanced stage of the disease.<sup>9</sup>

Cataracts and glaucoma are the world's primary and second major causes of blindness. As a result, physicians are interested in the interaction of these two disorders. After cataract surgery, both glaucomatous and non-glaucomatous eyes had a drop in IOP. Cataract surgery is a popular and developed procedure with a favorable risk/benefit profile that includes enhanced visual acuity and visual field. The widely held assumption that cataract extraction alone reduces IOP by 2-4 mmHg is gradually giving way to awareness of a larger and more persistent IOP decrease, particularly in patients with higher preoperative IO.<sup>10</sup>

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## Methodology

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This study included a total of 53 patients. Pre and post-interventional study designs were used that involved analysis of data collected from a population before phacoemulsification and 2 weeks postoperatively. All patients with Primary Open Angle Glaucoma (POAG), Angle Closure Glaucoma (ACG), and Pseudoexfoliation (PXF) Glaucoma who visited the Glaucoma Department of Al-Shifa Trust Eye Hospital Rawalpindi had a cataract in

either eye. A study was conducted in the Glaucoma Department of Al-Shifa Trust Eye Hospital Rawalpindi, being visited by patients from different areas of Pakistan.

It was based on the non-probability convenient sampling technique After gaining written informed consent from the representative subset and ethical approval from the respective department, the data was collected from glaucoma patients with POAG, ACG, and PXF glaucoma who had cataracts in either eye (who fulfilled the inclusion criteria) to find out the mean change in IOP before and after phacoemulsification.

A detailed examination was performed by an ophthalmologist. Based on a slit lamp examination, patients were labeled as having cataracts in glaucomatous eyes. Glaucomatous Patients have been diagnosed as POAG on clinical findings (elevated IOP and optic nerve changes), visual field loss, and/or retinal nerve fiber layer (RNFL) defects. Each patient had preoperative gonioscopy showing an open-angle defined as gonioscopy Shaffer grade  $\geq 3$  in all four quadrants without peripheral anterior synechiae or heavy pigmentation, suggesting secondary or angle-closure glaucoma, on gonioscopy showing peripheral anterior synechiae, characteristic visual Field and optic nerve head changes and IOP greater than 40mmhg patients were assigned as Angle-closure glaucomatous patients. On Examination the presence of PXF material which appears as fluffy, white deposits at the pupillary margin, anterior lens surface, and ciliary zonules were characterized as pseudo-exfoliative glaucomatous patients.

Patients were referred for Phacoemulsification and their IOP was noted after 2 weeks of surgery. IOP was measured with Goldmann Applanation Tonometer. This study was completed in 6 months (From July 2021 to December 2021) after approval by the Pakistan Institute of ophthalmology Institutional Review Board (IRB). This study included Patients above the age of 40 years of both genders treated for Open-Angle Glaucoma, Angle Closure Glaucoma, and Pseudoexfoliation Glaucoma along with cataracts and patients who had undergone Trabeculectomy. Those patients who had a history of other types of Glaucoma, Patients with Ophthalmic diseases (other than cataracts), Ocular emergencies, and Non-

cooperative patients were excluded from this study. Data were analyzed using SPSS version 26. Paired sample t-Test was used to find the mean change in IOP.

This study suggested the tissue pressure of intraocular contents before and after phacoemulsification. Post-operatively, a marked reduction in IOP as well as in glaucoma medications was noted. This study will also further provide information to monitor the reduction in IOP at follow-up visits, the mean change in IOP, and the amount of reduction in intraocular pressure.

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## Results

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A total of 53 eyes of 53 patients were included in this study. The mean age of respondents was  $(62.5 \pm 10.25)$  and had a maximum value of 81 years and a minimum value of 40 years among a sample of 53 respondents. Among 53 respondents 50.9% ( $n = 27$ ) were male and 49.1% ( $n = 26$ ) were females. In a sample of 53 eyes, 47.2% ( $n=25$ ) had positive surgical history and 52.8% ( $n=28$ ) had negative surgical 58.50 % ( $n=34$ ) respondents were reported with Primary open-angle glaucoma, 34.00% ( $n=18$ ) with Angle-closure Glaucoma, and 7.50% ( $n=4$ ) with Pseudo exfoliative glaucoma. A paired t-test was conducted to compare the readings of IOP before and after phacoemulsification. It can be seen from the results that the mean IOP before phacoemulsification was 16.25 (7.251) and the mean IOP after surgery was 13.28 (5.940). The mean difference was  $2.962 \pm 8.364$  and this difference was statistically significant ( $p\text{-value} < 0.013$ , Table 1. The mean IOP before phacoemulsification in primary open-angle glaucoma was 15.69 (6.072) and the mean IOP after surgery was 12.94 (3.369). The mean difference was  $(2.750 \pm 5.657)$  and this difference was statistically significant ( $p\text{-value} < 0.010$ , Table 2. The mean IOP before phacoemulsification IN Primary angle-closure Glaucoma was 15.47 (4.170) and the mean IOP after surgery was 13.88 (9.020). The mean difference was  $(1.588 \pm 8.839)$  and this difference was not statistically significant Table 3. The mean IOP before phaco in Pseudo exfoliative glaucoma was 24.50 (18.50) and after phaco was 10.50 (3.00). The mean difference was  $(14 \pm 16.24)$  and this difference was not statistically significant Table 4.

**Table 1: Mean change in IOP readings before and after phacoemulsification in glaucomatous patients**

Variables	N	Mean	S.D	P value
IOP before phacoemulsification	53	16.25	7.251	0.013
IOP after phacoemulsification	53	13.28	5.940	

N Number of Patients, S.D Standard Deviation, P <0.05, Paired t-test.

**Table 2: Mean change between IOP readings before and after phacoemulsification in Open Angle Glaucoma**

Variables	N	Mean	S.D	P value
IOP before phacoemulsification	32	15.69	6.072	0.010
IOP after phacoemulsification	32	12.94	3.369	

N Number of Patients, S.D Standard Deviation, P <0.05, Paired t-test.

Cataracts and high intraocular pressure (IOP) with or without glaucoma become more common as people get older. Meanwhile, cataract surgery is beneficial for both cataract and glaucoma patients. It has been shown to lower IOP in eyes with and without glaucoma, however to varying degrees and depending on characteristics including anterior-chamber anatomy and angle configuration.<sup>11</sup>

In the current study, 53 eyes of 53 patients were evaluated by the Glaucoma Department of Al Shifa Trust Eye Hospital. 27 were males and 26 were females. Moreover, the current study included only glaucomatous patients with cataracts. The present study demonstrated that there was a mean change in IOP readings before and after phacoemulsification in glaucoma patients with cataracts. When comparing the mean IOP values before and after surgery, there was a reduction in IOP values after phacoemulsification and this IOP reduction was statistically significant in all glaucoma types. When a mean change in IOP was calculated separately for POAG, ACG, and PXG, the IOP reduction was statistically significant for POAG. The reduction in IOP for ACG and PXG was not statistically significant.

**Table 3: Mean change between IOP readings before and after phacoemulsification in Angle Closure Glaucoma.**

Variables	N	Mean	S.D	P value
IOP before phacoemulsification	17	15.47	4.170	0.470
IOP after phacoemulsification	17	13.88	9.020	

N Number of Patients, S.D Standard Deviation, P <0.05, Paired t-test.

**Table 4: Showing mean change between IOP readings before and after phacoemulsification in Pseudo-exfoliative Glaucoma.**

Variables	N	Mean	S.D	P value
IOP before phacoemulsification	4	24.50	18.50	0.183
IOP after phacoemulsification	4	10.50	3.00	

N Number of Patients, S.D Standard Deviation, P <0.05, Paired t-test.

## Discussion

These results were complementary to other research e.g. A study conducted by Mark A included 157 eyes in the study. The average preoperative IOP of 16.3±3.6 mm Hg decreased to 14.5±3.4 mm Hg. Phacoemulsification resulted in a small average decrease in IOP in patients with OAG. There was a statistically significant difference in IOP readings after phacoemulsification. This study is in accordance with our results.<sup>12</sup> Another research conducted by AZ Jamil included 50 (41%) males and 72 (59%) females. The mean age was 56.4±8.57 years. The mean pre-operative IOP was 25.70±7.79 mmHg, which was decreased to 17.44±2.8 mmHg (p-value < 0.001) at a follow-up visit. The number of mean antiglaucoma medications decreased from 1.12±1.30 pre-operatively to 0.62±0.92 at a final follow-up visit. Phacoemulsification resulted in a reduction in IOP in normal as well as glaucomatous eyes and it significantly reduced the need for anti-glaucoma medications. This study also supported our results.<sup>13</sup>

Philip *et al* showed that phacoemulsification resulted in a reduction of IOP by 13% and glaucoma medications by 12% in POAG. For PXF, phacoemulsification reduced IOP

by 20% and glaucoma medications by 35%. Patients with acute PACG had a 71% reduction in IOP and rarely required long-term glaucoma medications when phacoemulsification was performed soon after the medical reduction of IOP. Phacoemulsification typically resulted in small, moderate, and marked reductions of IOP and medications for patients with POAG, PXG, and PACG, respectively. These results supported our study but the mean change in IOP in different types of glaucoma is contrary to our study.<sup>14</sup>

J. Jimenez-Roman demonstrated that, after phacoemulsification, there was a statistically significant reduction in IOP values and glaucoma medications in both POAG and PXG patients ( $p < 0.001$ ). A significant difference in the mean IOP was revealed between groups ( $p = 0.005$ ). The reduction of post-surgical IOP means values in both groups, the POAG group showed a greater reduction in IOP values compared to the PXG group. This study also supported our results.<sup>15</sup>

A study conducted by Armstrong revealed that in individuals with POAG, phacoemulsification as a stand-alone treatment resulted in the reduction of IOP and dependence on topical glaucoma drugs. The results of our study also showed that there is a statistically significant reduction in IOP after phacoemulsification in POAG.<sup>16</sup>

K Hayashi in Japan included 74 eyes with ACG and 68 eyes with OAG having cataract surgery. Preoperatively, 1 month postoperatively, and subsequently every 3 months, the IOP was measured and the number of glaucoma medicines was recorded. The mean IOP and number of medications decreased significantly after surgery in both groups ( $p < 0.001$ ). However, the mean decrease in IOP and percentage of IOP reduction in the ACG group were greater than in the OAG group, and fewer medications were required in the ACG group. The IOP reduction is in accordance with results but greater IOP reduction in ACG is contrary to our study.<sup>17</sup>

A study conducted by M Zamani included 129 eyes with open angles and normal or high IOP undergoing phacoemulsification and IOL implantation for senile cataracts. The patients were divided into 3 groups based on preoperative IOP:  $\leq 15$  mmHg; from 16 to 20 mmHg and; from 21 to 30 mmHg. IOP was measured by Goldmann applanation tonometry one day before surgery, and 1 and 6 weeks postoperatively. IOP was decreased

postoperatively in all study groups 1 and 6 weeks after surgery as follows:  $2.8 \pm 1.5$  and  $1.8 \pm 1.7$  mmHg respectively in G1 ( $p < 0.001$ );  $4.2 \pm 1.9$  and  $4.3 \pm 2.9$  mmHg respectively in G2 ( $p < 0.001$ ), and  $8.3 \pm 4.3$  and  $9.3 \pm 4.1$  mmHg respectively in G3 ( $P < 0.001$ ). In both normal subjects with open angles and those with ocular hypertension, IOP decreased significantly after phacoemulsification and IOL implantation. Eyes with a higher preoperative IOP had a greater reduction in IOP. These results were complementary to the results of our study.<sup>18</sup>

There was a statistically significant reduction in IOP after phacoemulsification in glaucomatous patients having cataracts. This IOP reduction was more marked in OAG patients. The IOP reduction was statistically significant in POAG patients and the IOP reduction in ACG was not statistically significant. The higher the pre-operative IOP, the greater the post-operative reduction. Moreover, after phacoemulsification, there was also a reduction in glaucoma medications.

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## Conclusion

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In Glaucomatous patients having cataracts after phacoemulsification, there is a significant reduction in IOP and medications after surgery. This IOP reduction was more marked in POAG patients as compared to other types of Glaucoma.

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