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Original Research Article

Intraocular Pressure Changes in Narrow Iridocorneal Angles after Phacoemulsification

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Abstract

Introduction: The prevalence of glaucoma and cataracts has been rising. The crowded anterior segment architecture that results in appositional contact between the trabecular meshwork and the peripheral iris is the cause of primary angle closure. A technique to control intraocular pressure and deepen the anterior chamber is lens extraction. ***Objectives:*** To evaluate intraocular pressure changes in narrow angle eyes following phacoemulsification with intraocular lens implantation. ***Methodology:*** The study was carried out between March 2015 and August 2017 at Department of Ophthalmology of Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh on patients diagnosed with narrow-angle who also developed cataract. A narrow angle was defined as an anterior chamber angle grading of 2 or less on Shaffer grading in three or more quadrants. In accordance with the inclusion and exclusion criteria, a sample from the study population was drawn using the purposive type sampling technique. Participants in this prospective trial had foldable lens implantation after phacoemulsification surgery. Goldman applanation tonometry was done prior to surgery as well as on the tenth and thirtieth postoperative day. ***Results:*** The study included thirty eyes from 29 individuals, with a male to female ratio of 1:1 and an overall mean age of 62.03±8.95 years. Preoperative IOP was 13.66±1.69 mm Hg on average. The mean IOP at the 10th and 30th POD was 11.83±2.21 mm Hg and 11.00±2.07 mm Hg, respectively. At the final follow-up, the mean IOP drop was 2.66 mm Hg ($p<0.05$). ***Conclusion:*** In individuals with narrow angles, phacoemulsification combined with posterior chamber intraocular lens implantation can lower intraocular pressure. These results support the notion that phacoemulsification combined with foldable IOL implantation is a useful technique for reducing intraocular pressure.

Keywords: Intraocular pressure (IOP), Anterior chamber (A/C), Open angle (OA), Narrow angle (NA), Post-operative day (POD).

INTRODUCTION

Globally, glaucoma and cataracts are the two most common causes of blindness (51 and 8 percent, respectively). After diabetic retinopathy, glaucoma is the second most common cause of irreversible blindness in developed nations, and its burden tends to rise with aging populations [1, 2].

In the aged population, both diseases often coexist in a percentage that is projected to rise. In light of these findings, cataract surgery ranks among the most popular surgical procedures carried out globally, and it has been proposed that it may have a positive clinical outcome for both conditions [3].

The crystalline lens, especially a cataractous lens, plays a significant role in the narrowing of the angle by pushing the peripheral iris anteriorly, as evidenced by advanced imaging techniques. The volume of the crystalline lens greatly rises as the eye ages. The zonules exert anteriorly directed pressure on the ciliary body and uveal tract as the lens matures, displacing the anterior lens capsule forward and compressing the trabecular meshwork and canal of Schlemm [4]. Intraocular pressure rises as a result of an increase in the pressure inside the Schlemm tube and trabecular meshwork, which causes the aqueous drainage pump to fail [5].

The thickness and volume of the lens grow as cataracts progress. Additionally, the lens shifts forward, which is recognized as a major risk factor for pupillary

block and makes the aforementioned issue more noticeable [6].

Due to their long-term risk of visual morbidity, eyes with narrow-entry iridocorneal angles have recently been classified as primary angle-closure suspects and occludable by the International Society of Geographical and Epidemiological Ophthalmology. Occludable angle eyes are thought to be in the pre-glaucomatous stage and are expected to develop into primary angle closure glaucoma (PACG) in the course of the disease.[6] The initial surgical choice for treating glaucoma in patients with concomitant chronic angle-closure glaucoma and cataract has been proposed to be phacoemulsification surgery alone [7, 8].

The opacified or hazy human lens is removed during cataract surgery, cleaned thoroughly. An improved method of extracapsular cataract surgery is phacoemulsification. Nowadays, phacoemulsification is used to remove most cataracts. Following the removal of the cataract, the surgeon typically replaces it with an intraocular lens (IOL), which is a brand-new artificial lens. We refer to this process as "intraocular lens implantation [4]."

Phacoemulsification surgery has been proposed as a means of lowering intraocular pressure (IOP) in eyes with or without glaucoma, in addition to removing the opacified lens. The anterior chamber anatomy and angle arrangement are among the elements that may impact its varying magnitude [9].

Intraocular pressure (IOP) is considered a significant modifiable risk factor for the advancement of glaucoma. According to reports, the narrow angle group experienced a mean (SD) intraocular pressure drop of 2.75 (0.60) mm Hg six months following phacoemulsification surgery [10, 11].

This prolonged decrease in intraocular pressure emphasizes the value of phacoemulsification surgery as an addition to the current toolkit that includes trabeculectomy and tube shunt surgery. Preoperative anterior chamber depth and the amount of intraocular pressure reduction appear to be inversely correlated (ACD). Because of its improved safety profile over conventional glaucoma procedures, it is a desirable option for certain individuals, especially those who do not have severe glaucoma [12, 13].

MATERIALS AND METHODS

This prospective controlled trial was carried out at Department of Ophthalmology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka from February 2018 to January 2020. Purposive sampling technique was applied.

After receiving permission and ethical approval from Institutional review board (IRB) of BSMMU, a total of 30 patients aged 45 or more having visually significant cataract having narrow angles (Shaffer grades of 2 or less in three or all four quadrants) with or without the history of peripheral iridotomy were included in the study who underwent phacoemulsification cataract surgery with intra ocular lens (IOL) implantation in the Department of Ophthalmology, BSMMU, were included in the study.

Patients with history of previous penetrating ocular surgery, complications during cataract surgery (such as posterior capsular rupture and vitreous loss, secondary glaucoma, peripheral anterior synechiae, topical glaucoma therapy, optic nerves graded as having a cup-disc ratio greater than 0.6 (vertical meridian), subluxated cataract and previous ocular trauma were excluded from the study.

Complete clinical evaluation including history, physical examination, relevant ocular examinations, some special ocular examinations like – intraocular pressure, fundus examination, and gonioscopy was done before and after surgery.

Angle assessment was done by Sussman Four Mirror Diagnostic Gonioscope under low ambient illumination.

The Shaffer system: Describes the angle between the trabecular meshwork and the iris as follows:

- Grade 4: The angle between the iris and the surface of the trabecular meshwork is 45°
- Grade 3: The angle between the iris and the surface of the trabecular meshwork is greater than 20° but less than 45°.
- Grade 2: The angle between the iris and the surface of the trabecular meshwork is 20°. Angle closure is possible.
- Grade 1: The angle between the iris and the surface of the trabecular meshwork is 10°. Angle closure is probable in time.

Surgical Technique

All patients were given short-acting mydriatic drugs (tropicamide 0.8 percent and phenylephrine 5.0 percent) to dilate their pupils on the day of operation. Three times, five minutes apart, a single drop of 0.5 percent proparacaine was used as topical anesthesia before surgery. Following the use of topical anesthetic, a temporal clean corneal incision of 2.8 mm was made. After injecting 0.1 ml of 0.1 percent trypan blue to stain the capsule, 2.0 percent hydroxypropyl methyl cellulose was used to reconstitute the anterior chamber. Using 27-gauge bend needle cystotome, a continuous curvilinear capsulorhexis with a diameter of roughly 5.0 mm was made; a 27-gauge cannula attached to a 3cc syringe of balanced salt solution was used for cortical-cleaving hydro-dissection and delamination. For phacoemulsification, a divide and conquer technique was employed. An automated irrigation and aspiration

handpiece was used to remove the cortical remains, and the posterior capsule was polished. The capsular bag was subsequently implanted with a foldable hydrophobic acrylic intraocular lens (AcrySoft Single Piece, Alcon, Inc.) with a 6.00 mm optic and 13.00 mm haptic diameter. The ocular viscoelastic device was cleaned appropriately. The surgeon consistently verified that the IOL was precisely inserted into the capsular bag at the conclusion of the procedure. Corneal stromal hydration was done to seal the corneal incisions.

One day after surgery, the patients were released from the hospital with a prescription for a conventional course of treatment that included Moxifloxacin 0.5% eye drop and dexamethasone 0.1% eye drops every 4 hours for 4 weeks, with tapering doses over the subsequent 4 weeks. On the first, tenth, and thirtyth post-operative days (POD), postoperative follow-up appointments were arranged.

Statistical analysis was carried out by using Statistical Package for Social Sciences (SPSS) version 26. The mean values were calculated for continuous variables. The quantitative observations were indicated by frequencies and percentages. P value < 0.05 was considered as statistically significant.

RESULTS

Table 1: Age and sex distribution of the study participants (N=30)

Variables	Frequency	Percentage (%)
Sex		
Male	15	50.0
Female	15	50.0
Age (Years)		
Mean±SD	62.03±8.95	

Table I is the age and sex distribution of the study participants. It shows that out of 30 patients 36.7% belonged to age group 51-60 years followed by ,36.7% in 61-70 years age group. The median age of the respondents were 60.50 years. Minimum age were 45 years and maximum age were 76 years. Among the respondents 50% were male and 50% were female.

Our observation was 50% of patient have age more than 60.50 years, 50% of patient have age less than 60.50 years, 25% of patient have age below 55years, 25% of patient have age above 69.50 years.

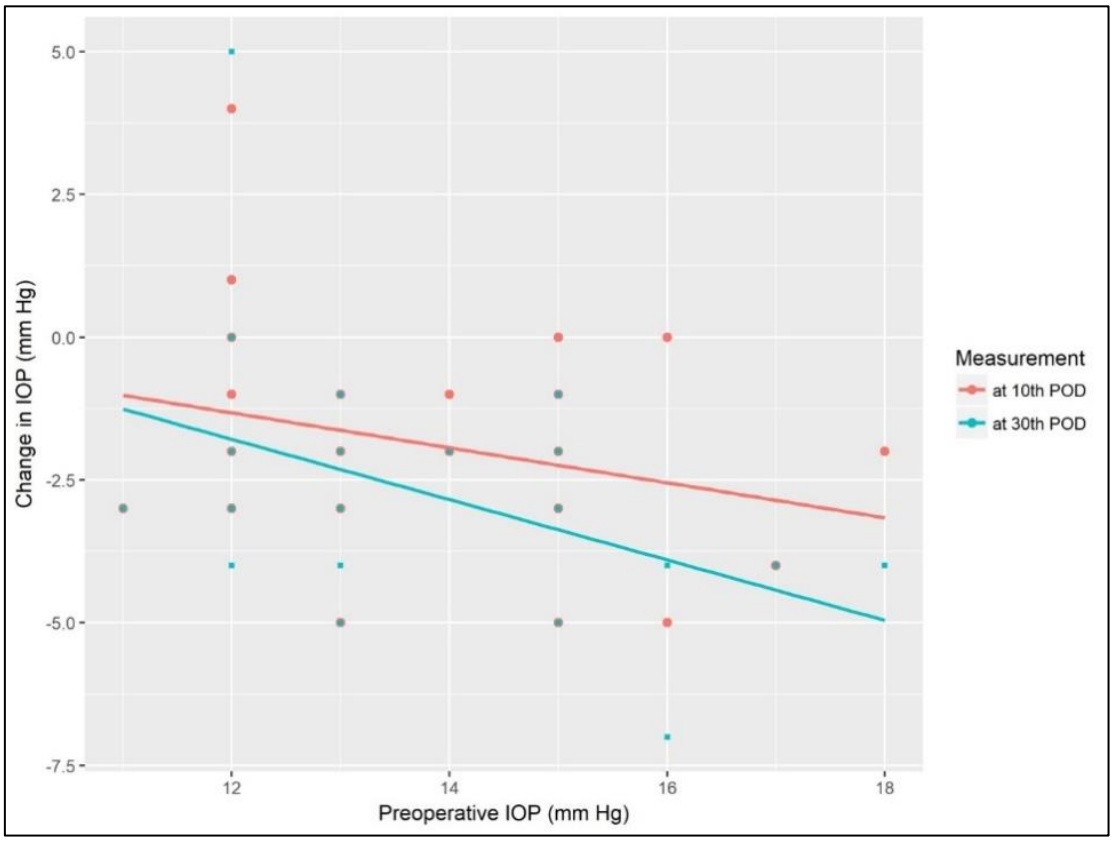

Figure 1: Correlation between preoperative intraocular pressure (IOP) and change in intraocular pressure over postoperative period

Figure 1 is the scatter plot of change in intraocular pressure measured at 10th and 30th postoperative day measured from preoperative values against preoperative intraocular pressure. Here red color indicates average change in intraocular pressure measured at 10th postoperative day and blue color

indicates average change in intraocular pressure measured at 30th postoperative day. It shows the correlation between preoperative intraocular pressure and change in average intraocular pressure measured at 10th and 30th postoperative day. At 10th postoperative day r=-0.265(p-value 0.156) which indicates that higher preoperative intraocular pressure associated with more decrease in intraocular pressure postoperatively, but not statistically significant. At 30th postoperative day r=-0.423 (p-value 0.019) which indicates an enough evidence that higher preoperative intraocular pressure has a significant negative association with the change in postoperative intraocular pressure that is expected to decrease.

Our observation was intraocular pressure decreased at 30th postoperatively more significantly after phacoemulsification surgery.

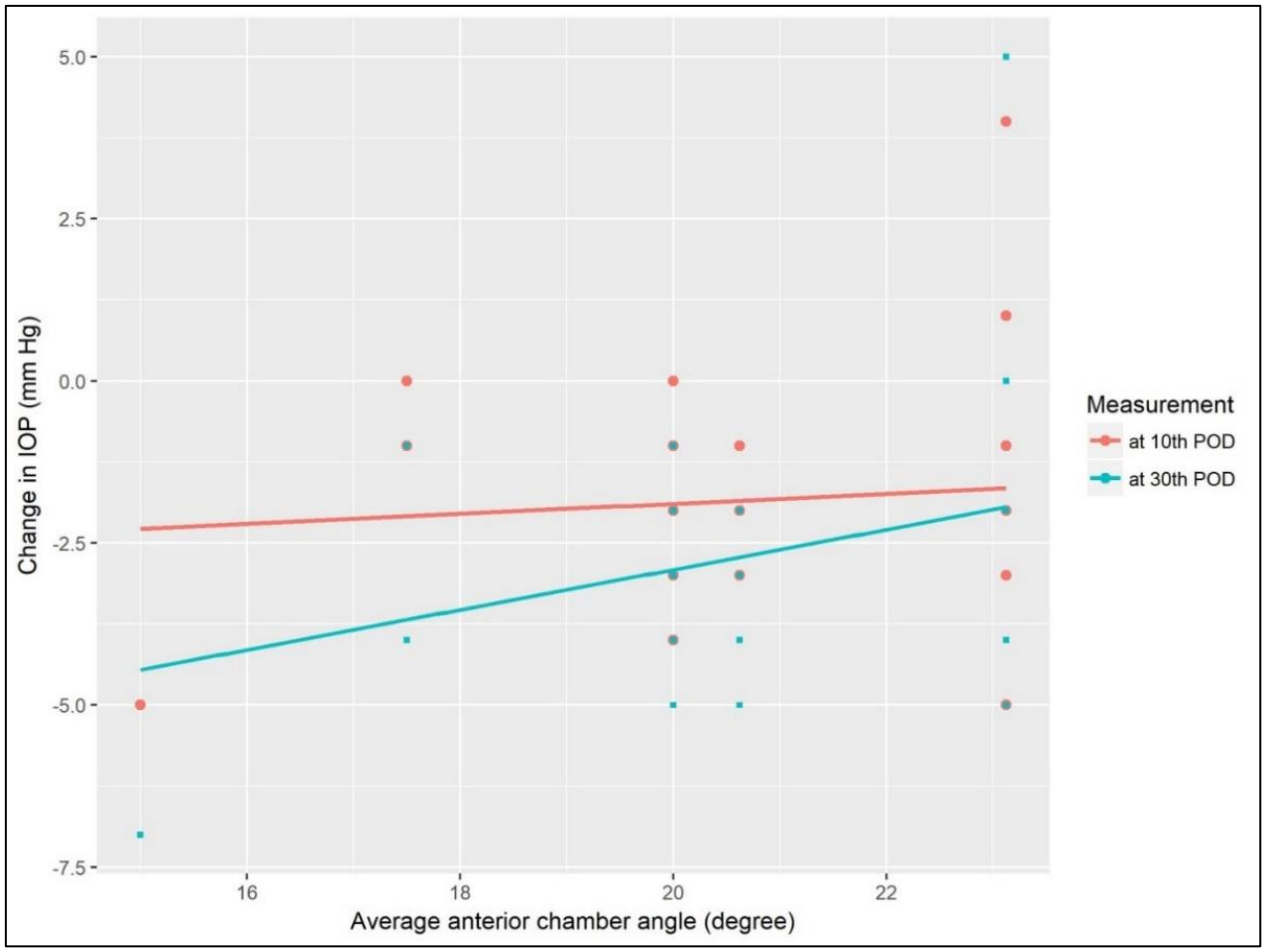

Figure 2: Change in intraocular pressure (IOP) in relation to average anterior chamber angle

Figure 2 is the scatter plot of change in intraocular pressure versus preoperative average anterior chamber angle, measured at 10th and 30th postoperative day. Here red color indicates change in intraocular pressure measured at 10th postoperative day and blue color indicates change in intraocular pressure measured at 30th postoperative day. Figure VI shows that at 10th postoperative day decrease in intraocular pressure was more in case of preoperative narrow average anterior chamber angle. But at 30th postoperative day decrease in intraocular pressure was more than 10th postoperative day in case of preoperative narrow average anterior chamber angle respondents.

So, our observation was intraocular pressure tends to decrease more at 30th postoperative day in preoperative narrow average anterior chamber angle respondents.

Table 2: Change in intraocular pressure (IOP, mm of Hg) after phacoemulsification with posterior chamber intraocular lens implantation

Variable	Mean±SD,mm of Hg	Mean of changes in IOP from preoperative (postop -preop)	P value
Preoperative IOP	13.66±1.69	-	-
IOP on10th POD	11.83±2.21	-1.83	**0.0007**
IOP on 30th POD	11.00±2.07	-2.66	**0.0001**

Table 2 shows that mean preoperative intraocular pressure were 13.66 mm of Hg, on an average they are dispersed as ±1.69 mm of Hg. At 10th postoperative day mean intraocular pressure were 11.83 mm of Hg, on an average they are dispersed as ±2.21 mm of Hg. At 30th postoperative day mean intraocular pressure were 11.00 mm of Hg, on an average they are dispersed as ±2.07 mm of Hg. Mean of decrease in intraocular pressure at 10th postoperative day were 1.83 mm of Hg and at 30th postoperative day were 2.66 mm of Hg. As the p-value of the test of hypothesis is less than 0.05. That means that the postoperative change in intraocular pressure at 10th and 30th day are statistically significant in negative or lower direction which is expected.

Our observation was after surgery mean IOP decreased significantly over 10th and 30th postoperative days and more decreased at 30th postoperative day in comparison to 10th postoperative day.

Table 3: Mean of changes in intraocular pressure (IOP) in between 10th postoperative day and 30th postoperative day (Paired-Sample t-test)

Variable	Mean±SD, mmHg	Mean of Changes in IOP, mm Hg from 30th postoperative	**P value**
10thPostoperative IOP	**11.83±2.21**	**-0.83**	**0.001**
30thPostoperative IOP	**11.00±2.07**		

Table 3 is the mean of changes in intraocular pressure in between 10th postoperative and 30th postoperative day. It shows that mean intraocular pressure at 10th postoperative day were 11.83 mm of Hg, on an average they are dispersed as ±2.21 mm of Hg. At 30th postoperative day mean intraocular pressure were 11.00 mm of Hg, on an average they are dispersed as ±2.07 mm of Hg. Mean of changes in intraocular pressure (decrease) from 10th postoperative day was 0.83 mm of Hg. As the p-value of the test of hypothesis that there is no change against the change will be negative is 0.001and which is less than 0.05. That means that the postoperative change in intraocular pressure (decrease) at 30th day are statistically significant in negative or lower direction which is expected.

So our observation was mean change in intraocular pressure decreased at 30th postoperative day from 10th postoperative day.

DISCUSSIONS

We investigated changes in intraocular pressure after phacoemulsification with intraocular lens implantation in narrow angle eyes in this prospective study.

In our investigation, we discovered that the average preoperative IOP was 13.661.69 mm of Hg. In non-glaucomatous eyes, IOP was lowered by a mean of 1.83 mm Hg at the 10th POD and 2.66 mm Hg at the 30th POD of phacoemulsification surgery (p0.05), which is comparable to a study. Who stated that their IOP reduced by a mean of 2.55(1.78) mm Hg after cataract surgery (p0.0001) [13].

Another study found conflicting findings. They discovered that after phacoemulsification with posterior chamber intraocular lens implantation in glaucomatous eyes, IOP increased by 1.7 mm Hg (15%) in individuals with preoperative intraocular pressure in the 5 to 14 mm Hg range (p-value 0.001) [12].

Other studies [14-16] found that after phacoemulsification surgery, IOP decreased by 2.91 mm Hg (17%) in the angle closure glaucoma group, but increased by 1.67 mm Hg (13% in the open angle glaucoma group). In the angle closure glaucoma group, the final IOP measured at the final visit reduced by 4.64 mm Hg, but there were no changes in the open angle glaucoma group.

Gunning and Greve (1998) [17] advocated cataract extraction for angle-closer glaucoma because it reduced IOP to the same extent as filtering surgery but with less risks. Moghimi *et al*., (2015) [18] found that the average IOP in their research subjects was 17.122.47 mm Hg at baseline, then reduced to 12.202.69 mm Hg at 3 months, with an average change of -4.952.26 mm Hg (p-value0.001).

Huang *et al*., (2011) [11] reported wide variation in mean IOP reductions (1.1-13.5mmHg). Their study also found that the postoperative IOP was reduced significantly in both groups. Six months after surgery, the mean (SD) IOP reduction was 2.75 (0.60) mm Hg (17.82%) in the narrow angle group and 1.55 (0.47) mm Hg (9.60%) in the open angle group, which were significantly different between the 2 groups (*P*=.004).

Liu *et al*., (2006) [19] and Liu *et al*., (2013) [20] studied a total of 361 patients with senile cataract and 44 patients with cataract associated with primary angle closure. In the cataract group, the mean IOP was 15.24±7.05 mmHg 1 day after surgery; 12.61±4.09 mmHg 1 week after surgery; 12.17±4.22 mmHg 1 month after surgery; 11.83±3.75 mmHg 3 months after surgery and 12.56±3.43 mmHg >3 months after surgery. The IOP pre-surgery was not statistically different from that 1 day after surgery (t=−3.82, P>0.05). The difference between the IOP pre-surgery and 1 week after surgery was statistically significant (F=6.259, P<0.01). The IOP in the cataract with PAC group on post-operative day 1 was 20.61±9.05 mmHg. After 1 week, it was 17.50±5.68 mmHg; after 1 month, 16.80±4.23 mmHg; after 3

months, 17.66±3.56 mmHg and after >3 months, 16.52±3.15 mmHg.

Shingleton *et al*., (1999) [21] and Shingleton *et al*., (2008) [22] reported a significant decrease in IOP after phacoemulsification through a clear corneal incision during a 12-month follow-up in eyes without glaucoma. They found average IOP reductions of 1.7 and 1.5 mm Hg postoperatively at two time point.

The following factors have been proposed as potential reasons of IOP reduction after phacoemulsification with posterior chamber intraocular lens implantation:

On the one hand, a decrease in aqueous humour secretion is almost always caused by increased traction on the ciliary body via the ciliary zonular fibres as a result of postoperative capsule shrinkage or IOL pressure on the ciliary body [23].

On the other hand, a decreased resistance to aqueous outflow is to be expected from the postoperative release of endogenous prostaglandin (F2), which is thought to improve uveoscleral outflow, as well as traction on the trabecular meshwork caused by shrinking of the artificial iris lens diaphragm. This mechanism implies that the intra trabecular space (space of frontana) may be opened via elastic connections between the anterior uvea and the cribriform layer of the trabecular meshwork [23].

According to our findings, higher preoperative intraocular pressure is associated with a greater decrease in intraocular pressure following phacoemulsification. Similarly, Issa *et al*., (2005) [13] found that the extent of postoperative IOP reduction was proportional to preoperative IOP (r=0.475, p-value 0.01).

Poley *et al*., (2009) [12] discovered that the decrease in IOP after phacoemulsification surgery was proportional to the preoperative IOP; eyes with the highest preoperative IOP experienced the greatest decrease, while eyes with the lowest preoperative IOP experienced a slight increase.

In our study, the change in mean intraocular pressure (IOP) is greater in older respondents. The decrease in IOP was less on the 10th postoperative day, compared to the 30th postoperative day. According to Issa *et al*., (2005), age had no effect on IOP reduction. In our study, it could be due to higher preoperative IOP in older patients and better control of intraocular inflammation on the 30th postoperative day.

Irrespective of race, primary angle closure has been documented to occur two to four times more frequently in females than in males. The findings of ocular biometry studies indicate that anterior segment and axial lengths are generally shorter in females compared to males. This disparity seems insufficient in magnitude to account for this sexual inclination. The study observed that the average anterior chamber angle was comparatively narrower in males. Potentially attributable to the advanced age of the male participants in our research, which is correlated with thicker lenses and crowding of the anterior segment [24].

Our research revealed that fifty percent of patients are sixty-plus years old. The participants' average age was 62.03±8.95 years. An analogous result was documented by Moghimi *et al*., (2015) [18] in Iran, where 50% were male and 50% were female. There were 85 patients under study, with a mean age of 62.2±8.9 years; of these, 35 were male and 50 were female. While the average age of the sample was identical to our own, the proportion of males and females varied.

Gender differences in IOP change following phacoemulsification surgery were not statistically significant in our study. In a similar vein, Issa *et al*., (2005) [23] found no significant association between sex and either ACD or IOP change.

According to the findings of the present study, a narrow-angle phacoemulsification cataract operation may reduce IOP by a significant amount.

CONCLUSION

In patients with narrow angles, phacoemulsification along with posterior chamber intraocular lens implantation can reduce intraocular pressure. It is concluded that phacoemulsification with foldable intraocular lens implantation is an effective method for reducing intraocular pressure (IOP) on the basis of these results.

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