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AN INTERVENTIONAL STUDY OF PRE AND POST OPERATIVE CHANGES IN INTRAOCULAR PRESSURE AND ANTERIOR CHAMBER DEPTH AFTER PHACOEMULSIFICATION WITH INTRAOCULAR LENS IMPLANTATION IN EYE GREATER THAN 23.5D INTRAOCULAR LENS.

Ophthalomology

Dr Hajari Ram	PG Student (Resident Doctor- Dept. Ophthalmology).
Dr Vivek Jain	Senior Professor Dept. Ophthalmology.
Dr Ritu Kala	PG Student (Resident Doctor- Dept. Ophthalmology).
Dr Lucky	PG Student (Resident Doctor- Dept. Ophthalmology).

ABSTRACT

INTRODUCTION: Patients of cataract with hypermetropic eye usually have a thick lens that boosts pupillary block and consequent angle closure. Its removal allows for expansion of anterior chamber dimensions and angle width, promoting aqueous humour outflow and intraocular pressure reduction. **AIM:** To study pre operative and post operative changes in intraocular pressure and anterior chamber depth after phacoemulsification with intraocular lens implantation in eye greater than 23.5D intraocular lens. **MATERAL AND METHODS:** This research was a prospective interventional study conducted among patients underwent for phacoemulsification with intraocular lens implantation in eye greater than 23.5D intraocular lens. A total 48 eyes of 48 patients were included in the study. Anterior chamber depth was measured by IOL Master 500 and IOP was measured by Goldmann applanation tonometer. Data analysis was done using licensed SPSS software version 21.0 (Chicago, Illinois). **RESULTS:** In the present study, mean age of study participants was 62.7±11.3 years. Out of the 48 participants, 27 (56.3%) were female and 21 (43.8%) were male, 30 (62.5%) were operated for left eye. Pre and post -op anterior chamber depth was 3.8±0.73 mm and 4.1±0.67 mm respectively ($p<0.001$). Pre and post -op IOP was 15.7±2.9 mm Hg and 13.6 ±2.6 mm Hg respectively ($p<0.001$). **CONCLUSION:** Our study concluded that anterior chamber depth was statistically significant increases and IOP was statistically significant decreases after phacoemulsification with intraocular lens implantation in eye greater than 23.5D intraocular lens.

KEYWORDS

INTRODUCTION

Cataract and glaucoma constitute the leading causes of global blindness, responsible for over 75% of cases worldwide [1]. In developed nations, after diabetic retinopathy induced visual loss, glaucoma accounts for the second most common etiology for irreversible blindness as populations progressively age [2]. With expanding life expectancy and access to tertiary care, management of coexisting cataract and glaucoma is emerging as a major challenge.

Primary angle closure disease refers to obstruction of aqueous outflow pathways due to iridotrabecular contact in absence of other ocular anomalies. This differs from secondary angle closure resulting from mechanisms like pupillary block from intumescent cataracts or posterior synechiae [3]. Angle closure is highly prevalent in Asian populations likely from subtle variation in anterior segment anatomy [4].

Eyes with primary angle closure often have narrow angular width between peripheral iris and trabecular meshwork. Additionally, such eyes frequently demonstrate hypermetropia with considerably thick crystalline lenses [5]. Studies indicate axial length less than 22mm, shallow central anterior chamber depths between 2 to 2.5mm, smaller corneal diameters and lens vaults less than 550 microns characterize angle closure disease, especially in East Asians [6].

In hypermetropic eyes, the increased lens thickness enhances pupillary block between iris and thicker lenses. This tends to push the peripheral iris much more anteriorly further narrowing the iridocorneal angle [7]. Additionally, significant changes in the trabecular meshwork extracellular matrix with altered glycosaminoglycans deposition also play a role in primary angle closure pathophysiology [8].

Ultimately, augmented trabecular resistance impedes aqueous drainage through this outflow pathway triggering chronically elevated intraocular pressure (IOP).This cascades into a glaucomatous optic neuropathy threatening vision loss. Thus, pupillary block forms the pivotal element provoking angle closure although multiple mechanisms interplay in precipitating chronic angle closure glaucoma [9].

Significantly, cataract extraction by phacoemulsification results in deepening of the anterior chamber due to lens removal. This allows the peripheral iris to retract backwards increasing angular width between it and the trabecular meshwork [10]. In this manner, the structural obstruction to aqueous outflow across this channel gets mitigated even without a peripheral iridotomy.

Furthermore, the acrylic intraocular lenses implanted during cataract surgery provide much flatter profiles reducing pupillary block consequences [3]. Thus, phacoemulsification facilitates reopening of drainage angles leading to IOP reduction. In fact, greater IOP declines were observed with cataract surgery over laser peripheral iridotomy in early angle closure cases [11].

Therefore, lens removal provides superior IOP control over the long-term compared to conventional laser iridotomy. It also minimizes peripheral anterior synechiae thereby better preventing glaucoma progression [12]. Given its anatomical corrective attributes, cataract extraction augments angle opening facilitating aqueous drainage and stable IOP maintenance.

Accurate assessment of anterior chamber parameters assumes importance for diagnosing angle closure disease. Anterior chamber depth constitutes the length between posterior surface of cornea represented by corneal endothelium to the front aspect of crystalline lens. It averages around 3mm with normal variation between 2.5 to 4mm [13].

The measurement of anterior chamber depth and associated biometric metrics, such as lens vault and angle opening distance, can be conducted using either contact or non-contact methods. Conventional A-scan ultrasonography, involving the manual placement of a probe on the anesthetized cornea, relies on ultrasound wave reflections for readings. However, limitations of this method include technique-dependent errors, potential alterations in ocular shape due to indentation from applanation, complexity requiring significant user experience, and decreased reliability in the presence of dense cataracts that obscure signals. Immersion A-scan, utilizing a saline bath between the probe tip and cornea, enhances accuracy by neutralizing corneal curvature but extends testing time and may cause patient discomfort.

In contrast, the IOL Master represents a rapid, non-contact optical biometry device for preoperative cataract screening. Utilizing partial laser coherence interferometry, it provides precise measurements of axial length, anterior chamber depth, keratometry, horizontal white-to-white diameter, and intraocular lens power prediction. Non-contact methods like the IOL Master, compared to conventional ultrasonography, offer advantages such as avoiding indentation, eliminating the need for anesthesia, reducing operator-dependent errors, and ensuring easy and reproducible data collection. These approaches exhibit enhanced precision with lower outlier rates during numerical analyses, particularly in quantifying anterior chamber depth.

Non-contact biometric approaches are currently preferred for pre-cataract evaluation due to their increased testing speed, enhanced patient convenience, avoidance of applanation-induced distortions, minimal learning curve, ease of operation, and high intersession repeatability. Additionally, they demonstrate comparable or superior validity compared to immersion protocols.

In the realm of tonometry, Goldmann Applanation Tonometry (GAT) stands as a crucial method employing the Imbert Fick principle, correlating force-dissipating flattened mires' area on the anesthetized cornea to intraocular pressure (IOP). Despite sources of variability, GAT serves as the clinical gold standard tonometer against which newer instruments are calibrated and assessed for agreement.

Cataract surgery involves the emulsification and aspiration of the opaque crystalline lens using ultrasonic energy, followed by the insertion of a synthetic intraocular lens (IOL) made of foldable acrylic biomaterial through a self-sealing corneal tunnel incision. Significant changes in anterior segment morphology and aqueous hydrodynamics occur after uneventful phacoemulsification cataract surgery, including the deepening of the anterior chamber due to crystalline lens removal, flattening of the iris profile to minimize pupillary block, increased angle width from peripheral iris retraction, transient reduction in central corneal thickness, and potential rotation of the corneal astigmatism axis due to steepening. Consequently, the surgery facilitates improved aqueous drainage through the trabecular meshwork, leading to sustained intraocular pressure reduction with optimal angle opening and iris clearance off the trabecular meshwork over the long term.

Therefore, carefully assessing anatomic alterations by advanced imaging allows prognosticating long-term IOP response following cataract removal. It identifies subset of patients that benefit maximally from surgery thus requiring less interventions for pressure control.

Patients with hypermetropic eyes and angle closure disease frequently have thicker crystalline lenses contributing to pupillary block and raised IOP[32]. Cataract extraction can mitigate this anatomical obstruction by deepening anterior chamber and widening drainage angles[33]. Thereby, it facilitates aqueous outflow resulting in sustained normotensive levels without medications[34].

Recognizing such optimizable patients beforehand is made possible by accurately documenting parametric variations using advanced diagnostic technology. However, only scarce evidence on postoperative changes is available from Indian population at high-risk for angle closure disease[35].

Therefore, this study aims to evaluate intraocular pressure and anterior chamber depth changes after cataract surgery in high hypermetropes using Goldmann tonometry and IOL Master. It attempts to determine whether patients benefitting most from such interventions can be identified beforehand for maximizing therapeutic advantage. Thereby, long-term glaucomatous damage can be minimized by optimizing aqueous dynamics.

AIM AND OBJECTIVES

Aim:

To study pre operative and post operative changes in intraocular pressure and anterior chamber depth after phacoemulsification with intraocular lens implantation in eye greater than 23.5D intraocular lens.

Objectives:

- To assess intraocular pressure and anterior chamber depth in preoperative eye requiring greater than 23.5D intraocular lens.
- To assess changes in intraocular pressure and anterior chamber depth after 1month postoperative phacoemulsification with intraocular lens implanted in eye greater than 23.5D intraocular lens.

MATERIALS AND METHOD

1) Study Universe: All cataract patients attending eye OPD of SMS hospital and attached group of hospital Jaipur.

2) Study Area: This study was conducted under Upgraded Department of Ophthalmology SMS Medical College & Hospitals, Jaipur.

3) Study Design: Prospective study.

4) Study Type: Interventional study.

5) Study Duration: from May 2023 to March 2024

6) Sample size: 48 cases was enrolled in this study. Sample size calculated at 95% confidence level alpha error of 0.05 and observation of mean changes in pre and one month post operative anterior chamber depth in patient with cataract affecting there vision as 3.19 mm and 3.64 mm respectively. Considering 10% drop out during follow up in the present study.

8) Sampling Technique: Those who full fill the inclusion criteria.

Eligibility Criteria

Inclusion Criteria:

-Patients with significant cataract affecting their vision.

Exclusion Criteria:

-Patient with history of ocular trauma.
-Patient with history of glaucoma or angular defects.
-Patient with history of previous ocular surgery.
-Patient with history of zonular dialysis.
-Patient with history of pseudoexfoliation.
-Patient with history of corneal opacity.
-Patient with history of serious illness any physical, or mental problem.
-Patients using steroid as topical or systemic medications.

Study Methodology

Informed consent was obtained from all subjects willing to participate and fulfilling the inclusion and exclusion criteria before recruiting them into the study.

Statistical Analysis

The questionnaires were initially checked for completeness, and data was cleaned for errors and missing values. The corrected data was then entered into Microsoft Excel after preparing a Master-chart. After data entry of every ten questionnaires, one random form was picked and data entry was re-checked. An independent person verified data entry of two randomly chosen forms after entry of every fifth questionnaire.

Data analysis was done using licensed SPSS software version 24.0 (Chicago, Illinois). Univariate analyses was done initially and the results were presented with the help of tables, text, bar-diagrams and pie-charts. Descriptive statistics were used to calculate frequencies of categorical variables, and measures of central tendencies and dispersion were used to describe continuous variables.

Bi-variate analyses was done using the Chi square test/Fisher's Exact test. For quantitative variable we used unpaired t-test.

P value <0.05 was considered as statistically significant.

RESULTS AND OBSERVATIONS

Table 1 : Age (years) Distribution Of The Participants:

Mean	62.69
Median	65.00
Std. Deviation	11.280
Minimum	40
Maximum	80

Table 1 presents the age distribution of participants, indicating a mean age of 62.69 years with a standard deviation of 11.280. The median age is 65 years, with the minimum age observed at 40 years and the maximum at 80 years.

Table 2 : Distribution Of Study Participants According To Age Group

Age group	Frequency	Percent
≤ 50 years	8	16.7
51-60 years	7	14.6
61-70 years	23	47.9

>70 years	10	20.8
Total	48	100.0

The table 2 illustrates the distribution of study participants categorized by age groups. Among the 48 participants, 8 individuals (16.7%) fell into the age group of 50 years or younger, while 7 participants (14.6%) were aged between 51 and 60 years. The largest proportion of participants, comprising 23 individuals (47.9%), belonged to the age bracket of 61 to 70 years. Additionally, 10 participants (20.8%) were older than 70 years.

Table 3 : Distribution Of Study Participants According To Gender

Gender	Frequency	Percent
Female	27	56.3
Male	21	43.8
Total	48	100.0

The table 3 outlines the distribution of study participants categorized by gender. Among the total of 48 participants, 27 individuals (56.3%) were female, while 21 participants (43.8%) were male.

Table 4 : Distribution Of Study Participants According To Involved Eye

Side of eye	Frequency	Percent
Left	30	62.5
Right	18	37.5
Total	48	100.0

The table 4 presents the distribution of study participants based on the involved eye. Out of the total 48 participants, 30 individuals (62.5%) had their left eye affected, while 18 participants (37.5%) had involvement of the right eye.

Table 5: Distribution Of Anterior Chamber Depth (mm) Among Study Participants:

	Pre-op	Post-op 1 month
Mean	3.819	4.083
Median	4.200	4.500
Std. Deviation	0.7321	0.6625
Minimum	2.5	2.8
Maximum	4.5	4.7
p-value	0.0001	

The table 5 provides the distribution of anterior chamber depth (in millimeters) among study participants before surgery (Pre-op) and one month post-surgery (Post-op 1 month). The mean anterior chamber depth increased from 3.819 mm with SD of 0.7321 preoperatively to 4.083 mm with SD of 0.6625 at the one-month follow-up. A statistically significant difference was observed between preoperative and postoperative anterior chamber depths, with a p-value of 0.0001, indicating a significant increase in anterior chamber depth following surgery.

Table 6: T Statistics Of ACD Between Pre And Post Op 1 Month

Paired Differences					t-value	p-value
Mean	SD	SE of Mean	95% CI			
			Lower	Upper		
-0.2646	0.156	0.0226	-0.3100	-0.2192	-11.720	0.0001

The table 6 presents the t statistics of anterior chamber depth (ACD) between preoperative and postoperative measurements taken at one month. The paired differences between preoperative and postoperative ACD have a mean of -0.2646 with a standard deviation of 0.1564 and a standard error of the mean of 0.0226. The 95% confidence interval for the mean paired difference ranges from -0.3100 to -0.2192. The calculated t-value is -11.720 with a corresponding p-value of 0.0001, indicating a statistically significant difference in ACD between preoperative and postoperative measurements at one month after surgery.

Table 7: Distribution Of Intra Ocular Pressure (mmHg) Among Study Participants:

	Pre-op	Post-op 1 month
Mean	15.69	13.58
Median	14.00	13.00
Std. Deviation	2.860	2.624
Minimum	13	11
Maximum	21	19
p-value	0.0001	

The table 7 presents the distribution of intraocular pressure (IOP) measured in millimeters of mercury (mmHg) among study participants before surgery (Pre-op) and at one month post-surgery (Post-op 1 month). Before surgery, the mean IOP was 15.69 mmHg with a standard deviation (SD) of 2.860, while at the one-month follow-up, the mean IOP decreased to 13.58 mmHg with a SD of 2.624. A statistically significant difference was observed between preoperative and postoperative IOP values, with a p-value of 0.0001, indicating a significant reduction in IOP following surgery.

Table 8 : T Statistics Of IOP Between Pre And Post Op 1 Month

Paired Differences					t-value	p-value
Mean	SD	SE of Mean	95% CI			
			Lower	Upper		
2.104	0.857	0.124	1.855	2.353	17.020	0.0001

The table 8 provides the t statistics of intraocular pressure (IOP) between preoperative (Pre-op) and one-month postoperative (Post-op 1 month) measurements. The paired differences in IOP show a mean increase of 2.104 mmHg with a standard deviation (SD) of 0.857. The standard error (SE) of the mean is 0.124. The 95% confidence interval (CI) for the mean difference ranges from 1.855 to 2.353 mmHg. The calculated t-value is 17.020 with a corresponding p-value of 0.0001, indicating a statistically significant difference in IOP between preoperative and postoperative measurements.

Table 9: Comparison Of ACD And IOP According To Gender

Parameter	Gender				p-value
	Female		Male		
	Mean	SD	Mean	SD	
Pre-op ACD	3.778	0.7992	3.871	0.6513	0.665
Post-op 1month ACD	4.041	0.7308	4.138	0.5757	0.619
Pre-op IOP	16.11	3.142	15.14	2.414	0.249
Post-op 1month IOP	13.81	2.718	13.29	2.533	0.494

In this study, there was no statistically significant difference observed in the preoperative and one-month postoperative anterior chamber depth (ACD) and intraocular pressure (IOP) between male and female participants.

Table 10: Correlation Of Age With ACD And IOP

Parameter	Spearman correlation coefficient	p-value
Pre-op ACD	-0.222	0.129
Post-op 1month ACD	-0.229	0.123
Pre-op IOP	0.354	0.023
Post-op 1month IOP	0.398	0.014

The table 10 presents the correlation of age with anterior chamber depth (ACD) and intraocular pressure (IOP). For preoperative ACD, the Spearman correlation coefficient is -0.222 with a p-value of 0.129, indicating a weak negative correlation that is not statistically significant. Similarly, for ACD measured one month postoperatively, the correlation coefficient is -0.229 with a p-value of 0.123, suggesting a weak negative correlation that is not statistically significant. In contrast, there is a moderate positive correlation between preoperative IOP and age, with a Spearman correlation coefficient of 0.354 and a p-value of 0.023. This correlation is statistically significant. Additionally, postoperative IOP at one month also shows a moderate positive correlation with age, with a correlation coefficient of 0.398 and a p-value of 0.014, indicating statistical significance.

DISCUSSION

Cataract surgery, particularly phacoemulsification with intraocular lens (IOL) implantation, is a common and effective procedure for restoring vision in individuals with cataracts. Alongside visual improvement, cataract surgery can also impact intraocular pressure (IOP) and anterior chamber depth (ACD), both of which are critical parameters in ocular health. Understanding the changes in IOP and ACD following cataract surgery, especially in eyes requiring high diopter intraocular lenses, is essential for optimizing surgical outcomes and managing postoperative complications. This interventional study aimed to assess the changes in intraocular pressure (IOP) and anterior chamber depth (ACD) after phacoemulsification with intraocular lens (IOL) implantation in eyes requiring IOLs greater than 23.5D.

Age Distribution

The study population comprised participants with a mean age of 62.69 years and a standard deviation of 11.280 years. The majority of participants (47.9%) were in the age group of 61 to 70 years, followed by those over 70 years (20.8%), 50 years or younger (16.7%), and 51 to 60 years (14.6%). This age distribution is consistent with the typical age range for cataract development and subsequent surgical interventions.

A study by Abd El-All OAE et al. [1] reported a similar mean age of 62.70 ± 10.24 years for their study population undergoing phacoemulsification. However, their age group distribution differed slightly, with 31% of participants between 60 and 70 years old, 29% between 50 and 60 years old, 23% above 70 years old, and 17% less than 50 years old. These variations in age group distribution may be attributed to differences in the study populations, geographic locations, or inclusion criteria.

Gender Distribution

In the present study, 56.3% of the participants were female, while 43.8% were male. This gender distribution aligns with the findings of Abd El-All OAE et al. [1], who reported a higher proportion of female participants (61%) compared to males (39%).

However, it is noteworthy that the gender distribution in cataract studies can vary depending on factors such as the study population, cultural and socioeconomic factors, and access to healthcare services. Further research may be needed to investigate the potential influence of gender on the outcomes of cataract surgery and the associated changes in IOP and ACD.

Anterior Chamber Depth (ACD)

The present study observed a statistically significant increase in ACD from a mean of 3.819 mm (SD: 0.7321) preoperatively to 4.083 mm (SD: 0.6625) at the one-month follow-up ($p = 0.0001$). This finding is consistent with the results reported by Abd El-All OAE et al. [1], who also documented a statistically significant increase in ACD after 1 week, 1 month, and 3 months postoperatively.

The increase in ACD following cataract surgery is a well-documented phenomenon and can be attributed to the removal of the thickened and anteriorly displaced crystalline lens, which creates more space in the anterior segment of the eye [2]. This increased ACD has been associated with various benefits, including improved aqueous humor dynamics, reduced risk of angle closure, and potential reductions in IOP [3].

In this study, no statistically significant difference was observed in the preoperative and one-month postoperative ACD between male and female participants. This finding contrasts with the results reported by Abd El-All OAE et al. [1], who observed a statistically significant difference in ACD between males and females at 1 week, 1 month, and 3 months postoperatively, with females having a larger ACD.

The discrepancy in these findings may be attributed to variations in the study populations, sample sizes, or potential confounding factors that were not accounted for in the present study. Further investigations with larger sample sizes and controlled variables may be necessary to determine the influence of gender on ACD changes after cataract surgery.

Regarding the correlation between age and ACD, the present study found no statistically significant correlation between age and preoperative or postoperative ACD. This finding is consistent with the results reported by Abd El-All OAE et al. [1] and Wu et al. [4], who also found no significant correlation between age and ACD.

However, a study by Hsu et al. [5] reported that older age was an independent demographic factor associated with a shallower ACD after cataract surgery. These contrasting findings may be due to differences in the study populations, inclusion criteria, or potential confounding factors that were not accounted for in the present study or previous studies.

Intraocular Pressure (IOP)

The present study observed a statistically significant reduction in IOP from a mean of 15.69 mmHg (SD: 2.860) preoperatively to 13.58 mmHg (SD: 2.624) at the one-month follow-up ($p = 0.0001$). This finding is consistent with numerous previous studies that have reported a reduction in IOP following cataract surgery, particularly in eyes with preexisting ocular hypertension or glaucoma [6-10].

The reduction in IOP after cataract surgery has been attributed to various factors, including improved aqueous humor dynamics, decreased resistance to aqueous outflow, and changes in the anatomical relationships of ocular structures [11]. Additionally, the removal of the thickened and anteriorly displaced crystalline lens may contribute to a reduction in IOP by decreasing the lens-induced component of outflow resistance [12].

In the present study, no statistically significant difference was observed in the preoperative and one-month postoperative IOP between male and female participants. This finding is consistent with the results reported by Abd El-All OAE et al. [1], who found no significant difference in IOP between males and females at 1 week and 1 month postoperatively.

However, Abd El-All OAE et al. [1] reported a statistically significant difference in IOP between males and females preoperatively and at 3 months postoperatively, with females having higher IOP values. This discrepancy may be due to variations in the study populations, sample sizes, or potential confounding factors that were not accounted for in the present study.

Regarding the correlation between age and IOP, the present study found a moderate positive correlation between preoperative IOP and age ($r = 0.354$, $p = 0.023$), as well as between postoperative IOP at one month and age ($r = 0.398$, $p = 0.014$). These findings suggest that older age is associated with higher IOP values, both preoperatively and postoperatively.

These results align with the findings of Zhao D et al. [13], who reported an inverse association between IOP and age in a large cohort of Korean adults, with a more pronounced annual decrease in IOP observed in older age groups. Similarly, Abd El-All OAE et al. [1] reported statistically significant correlations between age and IOP measured preoperatively, after 1 week, and 1 month postoperatively.

The positive correlation between age and IOP observed in the present study may be attributed to age-related changes in ocular structures and dynamics, such as increased rigidity of the sclera, decreased outflow facility, or alterations in the extracellular matrix of the trabecular meshwork [14]. However, it is essential to note that the impact of age on IOP can be influenced by various factors, including systemic and ocular comorbidities, medication use, and genetic predisposition.

CONCLUSION:

The findings of this interventional study shed light on the changes in intraocular pressure (IOP) and anterior chamber depth (ACD) following phacoemulsification with intraocular lens (IOL) implantation in eyes requiring greater than 23.5D intraocular lens. A statistically significant increase in ACD was observed from the preoperative period to the one-month postoperative follow-up, consistent with the expected effects of lens removal and anterior chamber deepening after cataract surgery. Overall, the significant improvements in ACD and reduction in IOP postoperatively highlight the effectiveness of phacoemulsification with IOL implantation in managing ocular conditions requiring higher refractive power lenses. A moderate positive correlation was observed between age and both preoperative and postoperative IOP, indicating that older age is associated with higher IOP values, both before and after cataract surgery. These insights contribute to the growing body of evidence supporting the benefits of modern cataract surgery techniques in optimizing ocular health and visual outcomes.

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