Cataract Surgery and Intraocular Pressure

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ABSTRACT

Objectives: To analyze the effect of cataract surgery on intraocular pressure (IOP) in patients diagnosed with ocular hypertension (OHT), glaucoma (mild, moderate, and severe),and those without glaucoma (controls).

Methods: In this retrospective study, 236 controls (Group A), 39patients with OHT (Group B), and 101 patients with POAG (mild, moderate, severe; Groups C-E) were recruited at a university eye clinic. Exclusion criteriawere:<18 years, secondary glaucoma, one functional eye, or follow-up <3 months. Postoperative IOP was measured at several intervals. Statistical analyses included linear trends,Chi-squared analyses, Wilcoxon Rank-Sum test for postoperative changes, andmultiple linear regression for predictors of IOP change.

Results: IOP reduction at one year in Groups A-Ewas 8.6% (p<0.001), 8.1% (p=0.061), 10.8% (p=0.047), 18.3% (p=0.135), and 9.1% (p=0.259), respectively. In Group A, higher preoperative IOP and thicker CCT were predictive of IOP reduction (β= -0.53, -0.02, respectively; p<0.05). Group B did not show any predictive factors. In Groups C-E combined, higher preoperative IOP and more glaucoma medications were predictive of IOP reduction at one year (β= -0.66, -1.68, respectively; p<0.05).Medication burdenremained unchanged.

Conclusion: In our population, all groups showed reduction of IOP after cataract surgery at one year.Influential factors in glaucomatous eyes were higher preoperative IOP and increased number of anti-glaucoma medications; higherpreoperative IOP and thicker CCT were significantin controls. No factors were found to determine IOP reduction in patients with OHT.

Key words: primary open angle glaucoma (POAG), intraocular pressure (IOP), cataract surgery, ocular hypertension (OHT).

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Introduction

Cataract surgery has been reported to reduceintraocular pressure (IOP)and improve visual acuity in both non-glaucomatous and glaucomatous eyes.[1-2] Although the pathogenesis of IOP reduction following cataract surgery is not entirely known, several mechanisms have been suggested:deepening of the anterior chamber may lead to widening of the anterior chamber angle, allowing for improved aqueous flow across the trabecular meshwork;[3] postoperative prostaglandin $F_2$and cytokine release may improve uveoscleral flow;[4]and possible trabecular meshwork remodeling may occur.[5]

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Known preoperative predictive factors that may influence postoperative IOP in non-glaucomatous eyes are:higher preoperative IOP,[1]greater central corneal thickness (CCT),[1]older age,[6] female gender,[6]shallower anterior chamber depth (ACD),[7]shorter axial length (AXL),[7]and greater lens thickness (LT);[7]whilepredictive factors identified in eyes with primary open angle glaucoma (POAG) are IOP[8] and ACD.[9]

Preoperative patientcharacteristicssuch as ethnicity, family history of glaucoma,diabetes, hypertension, body mass index (BMI), stage of glaucoma damage (mild, moderate, or severe), CCT, visual acuity, spherical equivalent, refractive errors, cup-to-disc (C/D) ratio,preoperative glaucoma filtering or laser procedures, type of cataract surgery, and number of anti-glaucoma medications have not been widely studied.

Therefore, this retrospective study was designed to analyze fluctuations in IOPin patients without glaucoma, those with ocular hypertension, and those with medically-controlled primary open angle glaucoma (POAG;mild, moderate, and severe) undergoing cataract surgery by standard phacoemulsification or femtosecond laser-assisted cataract surgery (FLAC) in a well-diversified population. Secondly, we investigatedthe influence of other ocular and systemic parameters on IOP outcomes after cataract surgery.

METHODS

Study Design

In this retrospective, comparative, interventional study, medical records of all consecutive patients undergoing cataract surgery performed by Karanjit Kooner (KK) and four other full-time surgeons at the University of Texas Southwestern Medical Center (UTSW) between January 2013 and September 2017 were reviewed. The patient list was generated from the electronic medical records using search keywords “cataract surgery,” “cataract surgery and glaucoma,” and “cataract surgery and ocular hypertension.” Patients were divided into five groups: those without glaucoma (controls, Group A), patients with ocular hypertension (OHT, Group B), and patients with mild, moderate, and severe POAG (Groups C-E).Approval by the Institutional Review Board of UTSW was obtained, and we followed the tenets of the United States Health Insurance Portability and Accountability Act of 1996 (HIPAA) and the Declaration of Helsinki. All patients provided written informed consent prior to surgery.

Selection of Patients

Patients undergoing cataract surgery as a sole procedure and at least 18 years old were included. Patients were excluded if they had postoperative follow-up less than 3 months, other intraocular surgery within 3 months of cataract surgery, angle closure glaucoma, secondary glaucoma, traumatic cataract, only one functional eye, no light perception vision, prior corneal opacity or edema, adjunct glaucoma surgery, intraoperative complications (vitreous loss requiring vitrectomy, capsular rupture, or anterior chamber intraocular lens placement), conversion to extra capsular cataract extraction, or postoperative complications (endophthalmitis or cystoid macular edema).

Group A (controls), as per medical records, showed normal C/D ratio, no evidence of IOP $\geq$ 21 mmHg, and were not using any anti-glaucoma medications. However, these patients did not have visual field (VF) tests performed. Group B (OHT) patients had IOP $\geq$21 mmHg at diagnosis, had suspicious optic discs but no VF loss, and were using anti-glaucoma medications. The diagnosis of POAG (Groups

C-E) was based on open iridocorneal angle confirmed by gonioscopy, characteristic signs of glaucomatous optic nerve changes (cupping, notching), and corresponding VF defects. Patients with POAG were divided into three groups (mild, moderate, and severe) based on modified Hodapp-Parrish-Anderson classification[10]with mean deviation index (MD) < -6 dB, between -6 dB and -12 dB, and> -12 dB, respectively.

Data Collection

Data collectors were masked to the pre-operative diagnosis. All patients had complete ophthalmic examination preoperatively including medical history, slit-lamp examination, best corrected visual acuity (BCVA measured in LogMAR units),spherical equivalence, refractive errors, CCT in micrometers (Corneo-Gage Plus Sonogage Pachymeter; Sonogage, Inc., Cleveland, Ohio, USA), IOP in mm Hg obtained by Goldman Applanation Tonometer (Haag-Streit, Inc., Koeniz, Switzerland) and recorded by averaging the values of the last 3 visits prior to cataract surgery, C/D ratio, number of anti-glaucoma medications, VF test with Humphrey Field Analyzer 3 (Humphrey Instruments, California, USA), AXL in millimeters, ACD in millimeters, and LTin millimeters(LENSTAR 900; Haag-Streit, Inc., Koeniz, Switzerland).

Systemic characteristics recorded were age, gender, ethnicity, presence of systemic hypertension or diabetes, family history of glaucoma, and BMI. Additionally, we recorded type of cataract surgery performed either by phacoemulsification (Centurion; Alcon Laboratories, Inc., Fort Worth, Texas, USA) or FLAC (LenSx; Alcon Laboratories, Inc., Fort Worth, Texas, USA), past glaucoma procedures (laser, filters, and/or cyclodestruction), and intraoperative or postoperative complications (transient rise in IOP ≥5 mmHg, iritis, peripheral anterior synechiae, corneal edema, loss of vision, persistent elevated IOP > 3 months, and/or persistent hypotony > 3 months).

Data collected during postoperative follow-up visits included IOP, BCVA, and number of anti-glaucoma medications measured at 1 day, 1 week, 1 month, 3 months, 6 months, and every 6 months thereafter. Postoperative data collection was stopped if a study end-point was met: additional anti-glaucoma medications or glaucoma surgery.

Statistical Analyses

Statistical analyses were performed with IBM SPSS Statistics (IBM SPSS, Inc., New York, NY USA). In patients undergoing cataract surgery in both eyes, one eye was randomly selected. Linear trends over the five patient groups were made with a Jonckheere-Terpstra test. Chi-square analyses were used to evaluate differences between the groups, while Wilcoxon Rank-Sum test was used to evaluate postoperative changes at one year. Multiple linear regression was used to evaluate predictors of IOP change at one year for all patients. A p-value < 0.05 was considered statistically significant.

RESULTS

Baseline Characteristics

From an initial patient population of 518 patients, 142 (27.4%) patients were excluded. Baseline patient characteristics and ocular parameters for Groups A-E are summarized in Table I. The mean age of the study population was 73.7± 8.5 years. Sixty percent of patients were female. The patient population was well-diversified and consisted of 70.2% white, 13.3% black, and 6.9% Hispanic patients. White patients were significantly older than black patients (74.7± 8.3 years and 71.1 ± 10.4 years, respectively; p = 0.006).

Table I: Baseline demographics and pre-operative descriptive statistics.

Variable	Group A* N = 236	Group B* N = 39	Group C* N = 54	Group D* N = 26	Group E* N = 21	*p*
Mean age (y)	72.8 ± 8.5	75.9 ± 9.0	76.9 ± 6.6	74.0 ± 8.8	71.8 ± 9.6	0.013**
Gender						
Female%	140 (59.3%)	24 (61.5%)	37 (68.5%)	15 (57.7%)	10 (47.6%)	0.539‡
Male%	96 (40.7%)	15 (38.5%)	17 (31.4%)	11 (42.3%)	11 (52.4%)	0.539‡
Ethnicity						
White%	164 (69.5%)	32 (82.0%)	43 (79.6%)	16 (61.5%)	9 (42.9%)	0.009‡
Black%	27 (11.4%)	4 (10.3%)	5 (9.3%)	7 (26.9%)	7 (33.3%)	0.010‡
Hispanic%	21 (8.9%)	2 (5.1%)	2 (3.7%)	0 (0%)	1 (4.8%)	0.333‡
Other%	24 (9.3%)	1 (2.6%)	4 (7.4%)	3 (11.5%)	4 (19.0%)	0.298‡
BMI (kg/m^2)	28.6 ± 6.4	27.0 ± 3.7	28.0 ± 5.9	28.0 ± 5.1	28.7 ± 6.0	0.527**
Hypertension%	124 (52.5%)	13 (33.3%)	25 (45.4%)	16 (61.5%)	13 (61.9%)	0.102‡
Diabetes %	58 (24.6%)	7 (18.0%)	7 (13.0%)	7 (26.9%)	6 (28.6%)	0.333‡
Family history of glaucoma %	17 (7.2%)	9 (23.1%)	14 (26.0%)	8 (30.8%)	7 (33.3%)	0.003‡
Past glaucoma treatment %	0 (0%)	3 (7.7%)	7 (13.0%)	4 (15.4%)	12 (42.9%)	<0.001‡
Myopia %	108 (52.5%)	16 (51.6%)	26 (52.0%)	15 (65.2%)	11 (64.7%)	0.012‡
Hyperopia %	98 (47.6%)	14 (45.2%)	21 (43.8%)	7 (30.4%)	5 (29.4%)	0.030‡
Cataract surgery						
Phaco %	193 (82.1%)	19 (48.7%)	24 (44.4%)	14 (58.3%)	15 (71.4%)	<0.001‡
FLAC %	42 (17.9%)	20 (51.3%)	30 (55.6%)	10 (41.7%)	6 (28.6%)	<0.001‡
Vision (LogMar)	0.3	0.2	0.3	0.4	0.3	0.072**
# of glaucoma meds	0	1.1 ± 0.41	1.4 ± 0.66	1.7 ± 0.81	2.1 ± 0.82	<0.001**
IOP (mm Hg)	16.8 ± 2.9	16.1 ± 2.8	15.0 ± 3.0	17.2 ± 4.7	15.7 ± 2.5	0.001**
CCT (µm)	549.2 ± 40.3	540.4 ± 30.9	525.4 ± 28.5	536.8 ± 31.8	515.8 ± 39.2	<0.001**
AXL (mm)	24.1 ± 1.3	24.2 ± 1.4	24.3 ± 1.6	24.3 ± 1.2	24.5 ± 1.4	0.135**
ACD (mm)	3.2 ± 0.39	3.2 ± 0.40	3.1 ± 0.35	3.3 ± 0.29	3.2 ± 0.42	0.235**
LT (mm)	4.5 ± 0.41	4.7 ± 0.53	4.7 ± 0.41	4.6 ± 0.50	4.4 ± 0.47	0.012**
C/D ratio	0.37 ± 0.16	0.54 ± 0.18	0.65 ± 0.21	0.71 ± 0.15	0.83 ± 0.14	<0.001**

All values are mean ± standard deviation or percentages.
* Groups are defined as follows: Group A (controls), Group B (ocular hypertension), Group C (mild POAG), Group D (moderate POAG), Group E (severe POAG).
** Statistical analysis done with Jonckheere-Terpstra test for linear trend.
‡Statistical analysis done with Chi-square.

Controls (Group A, N = 236)

Patients in this group were significantly younger than patients in Groups B-E (72.8 ± 8.5 years and 75.1 ± 8.1 years, respectively; *p*= 0.022). They also had the lowest prevalence of glaucoma family history (7.2%) but the greatest prevalence of hyperopia (47.6%). A higher number of patients in Group A (82.1%) underwent a non-FLAC surgery than patients in Groups B (48.7%), C (44.4%), and D (58.3%).

OHT (Group B, N = 39)

Compared to Groups C-E, patients in Group B had a thicker CCT (*p* = 0.033) and lower C/D ratio (*p*< 0.001). Over fifty percent of Group B had cataract removal with FLAC (51.3%) than patients in Group A (17.9%; *p*= 0.01).

POAG (Groups C-E, N = 101)

Within the POAG group, patients in Group C were significantly older than patients in Group E (76.9 ± 6.6 years and 71.8 ± 9.6 years, respectively; *p* = 0.01). Additionally, mild POAG was more prevalent in white than black patients (16.3% and 10.0%; *p*= 0.03), while a greater proportion of black patients had severe POAG than white patients (14.0% and 3.4%; *p* = 0.0068).Family history of glaucoma was more prevalent in Groups C-E than in Group A (28.7% and 7.2%, respectively; *p*< 0.001).

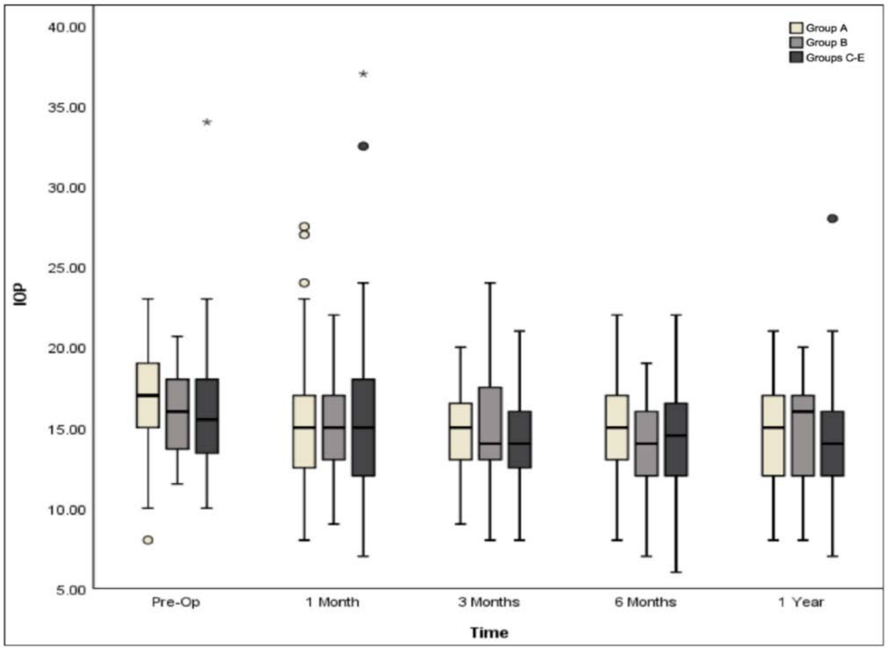
Understandably, Group E had more laser and interventional surgeries than any other group (42.9%). Furthermore, myopia was more prevalent in Group D (65.2%) and Group E (64.7%) than other groups. Additionally, compared to Group C, patients in Group E were on greater number of preoperative medications (*p* < 0.001) and displayed larger C/D ratio (*p* < 0.001).

Changes at One Year

Mean IOP at each follow-up visit for all groups is displayed in Figure 1 and Table II. The most significant reduction of IOP(pre-op vs. post-op at one year) was noticed in Group A (16.8 ± 2.9 vs. 15.7 ± 2.5; *p*< 0.001) and Group C (15.0 ± 3.1 vs. 14.3 ± 4.8 mmHg at one year; *p* = 0.047).Though not statistically significant, Group D exhibited the greatest overall reduction in IOP(18.3%),while Group B had the lowest overall reduction in IOP (8.1%). Reduction in mean IOP was not significant in Groups B, D, and E.

Medication load, across Groups B-E, at one year did not change significantly. In addition, type of cataract surgery performed either by a non-FLAC procedure (71%) or FLAC surgery (29%) or factors such as AXL, ACD, LT, C/D ratio, age, gender, ethnicity, and family history of glaucoma, hypertension, diabetes, and BMI did not affect postoperative IOP change.

Figure 1. Intraocular pressure pre- and post-cataract surgery.



* Groups are defined as follows: Group A – Controls; Group B – Ocular Hypertension; Group C-E – Primary Open Angle Glaucoma.

Table II: Pre- and post-operative intraocular pressure in Groups A-E.

	Preoperative	1 Month	3 Months	6 Months	1 Year
Group A*	**N = 236**	**N = 132**	**N = 92**	**N = 156**	**N = 73**
Mean IOP (mm Hg)	16.8 ± 2.9	15.3 ± 3.8	14.7 ± 2.7	15.2 ± 2.9	15.0 ± 3.1
Range	8.0 – 23.0	8.0 – 27.5	9.0 – 22.0	8.0 – 22.0	8.0 – 21.0
p-value**	–	<0.001	<0.001	<0.001	<0.001
Group B*	**N = 39**	**N = 35**	**N = 20**	**N = 30**	**N = 21**
Mean IOP (mm Hg)	16.1± 2.8	15.2± 3.0	15.3± 4.0	14.3± 3.3	14.6 ± 3.3
Range	11.5 – 21.7	9.0 – 22.0	8.0 – 24.0	7.0 – 21.5	8.0 – 20.0
p-value**	–	0.1743	0.3290	0.0158	0.0610
Group C*	**N = 54**	**N = 45**	**N = 37**	**N = 43**	**N = 30**
Mean IOP (mm Hg)	15.0± 2.9	14.8± 3.2	14.2± 2.7	14.0± 3.2	13.6± 3.0
Range	10.0 – 21.5	9.0 – 21.0	9.0 – 20.0	6.0 – 19.0	7.0 – 19.0
p-value**	–	0.7960	0.1718	0.1030	0.0468
Group D*	**N = 26**	**N = 25**	**N = 16**	**N = 19**	**N = 12**
Mean IOP (mm Hg)	17.2 ± 4.5	16.3 ± 4.4	14.1 ± 3.6	15.3 ± 3.2	14.9 ± 3.1
Range	11.0 – 34.0	8.0 – 37.0	8.0 – 24.0	9.0 – 22.0	10.0 – 21.0
p-value**	–	0.6178	0.0307	0.1385	0.1347
Group E*	**N = 21**	**N = 19**	**N = 13**	**N = 15**	**N = 14**
Mean IOP (mm Hg)	15.7 ± 2.5	16.1 ± 4.4	14.4 ± 4.2	13.7 ± 3.9	14.3 ± 4.8
Range	10.0 – 21.5	7.0 – 24.0	9.0 – 20.0	7.0 – 20.0	9.0 – 28.0
p-value**	–	0.7403	0.2546	0.0640	0.2586

Table II:
* Groups are defined as follows: Group A – Controls; Group B – Ocular Hypertension; Group C – Mild POAG; Group D – Moderate POAG; Groups E – Severe POAG.
** P-values are based on mean IOP change compared to preoperative IOP for each patient group.

Predictors of Intraocular Pressure

Variables correlated with absolute IOP change at one year are summarized in Table 3. Multiple linear regression analysis in Group A showed that higher preoperative IOP and thicker CCT were predictive of higher IOP reduction at one year following cataract surgery (β = -0.53, -0.02; $p< 0.001$). No predictors were found in Group B. Similar analyses in Groups C-E showed that higher preoperative IOP and a greater number of anti-glaucoma medications preoperatively were predictive of greater reduction in IOP at one year(β= -0.66, -1.68; $p < 0.001$).

When analyzing each POAG group individually, greater postoperative IOP reduction was predicted by higher preoperative IOP in Group C (β = -0.76; $p = 0.002$); higher preoperative IOP, thinner CCT, higher C/D ratio, and non-black ethnicity in Group D (β = -0.54, 0.09, -8.21, 3.12; $p< 0.001$); and higher number of preoperative medications in Group E (β = -3.78; $p < 0.001$).

DISCUSSION

This retrospective study analyzed the effect of cataract surgery on IOP at one year in controls, patients with OHT, and those with mild, moderate, and severe POAG. In addition, we studied which preoperative ocular and systemic factors were predictive of postoperative IOP reduction. Our study showed that all groups had IOP reduction after cataract surgery at one year. Overall, our patient population (N = 376) was well-diversified with 70.2% white patients, 13.3% black patients, and 6.9% Hispanic patients.

Controls

We found that controls were significantly younger than patients with POAG, and they showed a statistically significant reduction in mean IOP of 8.6% at one year (16.8 ± 2.9 vs 15.7 ± 2.5 at one year; $p< 0.001$).Our results confirmed findings of other investigators who have reported IOP reductions ranging from 9.1% to 20%.[6, 8, 11, 12] Robust aqueous outflow system may have a role in IOP reduction in this group.

In addition, higher preoperative IOP was predictive of lower postoperative IOP, which is also consistent with previous findings.[7, 13,14]We found that for every 1 mmHg increase in preoperative IOP, there was a 0.53 mmHg decrease in postoperative IOP (Table 3). However, the mechanism for this IOP lowering effect based on preoperative IOP is poorly understood.

Additionally, CCT was also predictive of postoperative IOP in control eyes only, such that for every 10 µm increase in CCT, there was a 0.20 mmHg decrease in postoperative IOP (Table III). Bilak et al. also found positive correlation between CCT and postoperative IOP reduction, although their postoperative follow-up period was only one month,[1]while we had a longer duration of one year.

However, we could not find a positive correlation between preoperative ACD and postoperative IOP reduction as observed by others[1, 7].

Ocular Hypertension

Patients with OHT exhibited a marginally insignificant reduction in mean IOP of 8.1% at one year (16.1 ± 2.8 vs 15.7 ±2.5; p = 0.061). In comparison, Mansberger et al. [15]found a significant reduction in IOP in patients with OHT. While they only included patients with preoperative IOP between 24 mmHg and 32 mmHg with BCVA of at least 20/40 in both eyes, our study encompassed a greater range of all patients regardless of preoperative IOP and BCVA. Also, our patients were medically-controlled with lower mean preoperative IOP, while Mansberger et al. did not include patients on anti-glaucoma medications.[15]We did not detect ocular predictors of postoperative IOP change in this group.

Primary Open Angle Glaucoma

A statistically significant reduction in mean IOP (10.5%) was found overall in patients with POAG (15.7 ± 3.5 vs 14.1 ± 3.5; p= 0.006). Other studies have also shown IOP reduction ranging from 11% to 17%.[8,9,14] Additionally, in our study, the mean number of anti-glaucoma medications did not change.

Similarly, we found that a higher preoperative IOP was predictive of increased postoperative IOP reduction at one year, which is consistent with previous studies.[8,14] For every 1 mmHg increase in preoperative IOP, there was a 0.66 mmHg decrease in postoperative IOP (Table III). However, no mechanisms have been suggested to explain IOP reduction following cataract surgery based on preoperative IOP.

Interestingly, number of medications preoperatively was predictive of postoperative IOP reduction in glaucomatous eyes. Adding an additional anti-glaucoma medication after the first drug led to a 1.68 mmHg reduction in postoperative IOP (Table III). This finding is counterintuitive if we believe additional medications may be surrogate for poor outflow system. Further prospective studies controlling for categories of anti-glaucoma medications, such as prostaglandin analogs that improve uveoscleral outflow, may elucidate the mechanism behind our finding. Notably, prior studies assessing predictors of IOP have not divided patients into groups based on glaucoma severity (mild, moderate, or severe) as our study has done.

Mild POAG

Mean IOP reduction at one year in patients with mild POAG was 10.4% (15.0 ± 3.1 vs 14.3 ± 4.8; p = 0.047).Specifically, among all POAG groups, mild POAG was the only group with a significant lowering of IOP.This may be due to relatively healthy aqueous outflow system in patients with mild POAG, which may lead to greater improvements in trabecular outflow following cataract surgery. Previous studies have not compared IOP reduction in patients with POAG based on severity.

We also found that higher preoperative IOP was predictive of greater IOP reduction at one year. Postoperative IOP decreased by 0.76 mmHg for every 1 mmHg increase in preoperative IOP in patients with mild POAG (Table III).

Moderate POAG

Myopia was present in 65.2% of patients with moderate POAG. Although other investigations have studied myopia in patients with glaucoma,[16]they have not analyzed the prevalence of myopia based on glaucoma severity. Furthermore, patients with moderate POAG had a reduction in mean IOP of 18.3% at one year, though not statistically significant (17.2 ± 4.5 vs 14.9 ± 3.1 mmHgat one year; p = 0.135).

Ocular predictors of a reduction in postoperative IOP in patients with moderate POAG were higher preoperative IOP, thinner CCT, and higher C/D ratio, which are surrogate markers of increasing glaucoma damage. For every 1 mmHg increase in preoperative IOP, there was a 0.53 mmHg decrease in postoperative IOP. Additionally, a 10 µm decrease in CCT led to a 0.88 mmHg decrease in postoperative IOP, and an increase of C/D ratio by 0.1 led 0.82 mmHg reduction in postoperative IOP (Table III).

Severe POAG

A greater proportion of black patients had severe POAG than mild POAG, while the opposite was true for white patients. This finding is consistent with other studies.[17] Factors such as lower socioeconomic status and poor access to healthcare may be contributing factors [18]. Interestingly, 64.7% of patients had myopia.

Furthermore, at one year, the reduction in mean IOP was 9.1% (15.7 ± 2.5 vs 14.3 ± 4.8; p= 0.259). Greater number of preoperative anti-glaucoma medications was predictive of more postoperative IOP reduction. A decrease of 3.78 mmHg was seen with each additional preoperative anti-glaucoma medication (Table III).

Table III: Multiple linear regression analyses for absolute IOP change at 1 year.

	Independent Variable	Beta-coefficient (95% CI)	Pearson's correlation, r	*p*
Group A	Pre-op IOP CCT	-0.53 (-0.77, -0.28) -0.02 (-0.03, 0.00)	0.543	<0.001 0.045
Group C	Pre-op IOP	-0.76 (-1.21, -0.31)	0.578	0.002
Group D	Pre-op IOP CCT C/D ratio Black ethnicity	-0.54 (-0.67, -0.40) 0.09 (0.06, 0.12) -8.21 (-12.91, -3.51) 3.12 (1.52, 4.72)	0.989	<0.001 <0.001 0.005 0.003
Group E	Number of medications	-3.78 (-6.59, -0.97)	0.666	0.013
Groups C-E	Pre-op IOP Number of medications	-0.66 (-0.91, -0.40) -1.68 (-2.90, -0.46)	0.638	<0.001 0.008

Group A – Controls; Group C – Mild POAG; Group D – Moderate POAG; Groups E – Severe POAG; Groups C-E – All Patients with POAG.
Abbreviations: IOP – intraocular pressure (mmHg); CCT – central corneal thickness (micrometers); C/D ratio – cup-to-disc ratio.

Systemic Predictors

The only systemic predictor was black race in the moderate POAG group. Blackethnicity was predictive of less postoperative IOP reduction, such that black patients tended to have, on average, higher IOP by 3.12 mmHg, as compared to other ethnicities (Table III). Since black patients are more susceptible to developing POAG and exhibit higher IOP as compared to other ethnicities,[17,19] different genetic factors may be at play. However, it is unclear why black patients with moderate POAG had a poorer response to cataract surgery, as compared to those with mild or severe POAG.No systemic factors were found to be predictive of postoperative IOP reduction at one year in other groups.

Femtosecond Laser-Assisted Cataract Surgery (FLAC) vs. Non-FLAC

In our study, cataract surgery performed by FLAC or non-FLAC did not have an impact on IOP. While Abell et al. found no difference in IOP reduction at 3 weeks between patients with and without FLAC,[20] no studies have examined long-term IOP reduction based on the procedures. Our study has shown that patients with cataract may undergo either FLAC or a non-FLAC procedure with similar results in long-term postoperative IOP.

Limitations

Due to the retrospective nature of this study, one inherent limitation is possible selection bias. Patients included in the study were those who returned for follow-up visits. Also, our study lackedin sample size for moderate and severe POAG.Furthermore, our control group did not have preoperative visual field testing, and therefore, there may have been some patients with normal tension glaucoma in this group. Lastly, the study sample included patients with medically controlled glaucoma, which may have resulted in lower preoperative IOP and thus caused lower IOP reduction overall. However, our study explains the effect of cataract surgery on medically-controlled glaucoma, which is typically seen in the clinical setting.

Conclusion

In this study, all patients including controls, patients with OHT, and patients with POAG showed an overall reduction of IOP following cataract surgery. Cataract removal by FLACdid not affect IOP after cataract surgery. Other systemic variables like hypertension, diabetes, and family history did not play a role in determining post-operative IOP. In patients with concurrent cataract and glaucoma, higher preoperative IOP and greater number of anti-glaucoma medications may help determine higher IOP reduction. In controls, higher preoperative IOP and greater CCT may predict IOP reduction at one year. Determining predictors of IOP reduction based on glaucoma severity may help elucidate how different patients will respond following cataract surgery.

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Abbreviations

BMI – body mass index, Phaco – phacoemulsification.
FLAC – femtosecond laser-assisted cataract surgery.
IOP – intraocular pressure.
CCT – central corneal thickness.
AXL – axial length.
ACD – anterior chamber depth.
LT – lens thickness.
C/D ratio – cup-to-disc ratio.

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