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Original Article

Long-term effects of phacoemulsification surgery on intraocular pressure in patients with primary open-angle glaucoma and pseudoexfoliation glaucoma

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Abstract

Aim: To compare the long-term effects of phacoemulsification surgery on intraocular pressure (IOP) in primary open-angle glaucoma (POAG) and pseudoexfoliation glaucoma (PXG) patients.

Material and Methods: This is a retrospective-comparative study. The data of the patients who underwent phacoemulsification surgery by the same surgeon between 2010 and 2016 and followed up more than 24 months postoperatively were collected. While group 1 consisted of 24 patients with POAG group 2 consisted of 16 patients with PXG. Preoperative, postoperative 1st day, 1st, 12th, 18th, 24th, 36th and 48th months IOP and best corrected visual acuity (BCVA) were enrolled.

Results: The mean follow-up time of group 1 was 44.17 ± 17.8 months and 43.13 ± 19.4 months for group 2 (p= 0.86). There was no statistically significant difference between the groups in the preoperative, postoperative 1st day, 1st, 12th, 18th, 36th and 48th months IOP (p>0.05). There was a statistically significant difference for the IOP value measured postoperative 24th month between the groups (p= 0.005). There was a statistically significant difference between preoperative and postoperative 1st, 12nd months IOP measurements in group 1 (p= 0.02; p= 0.009, respectively). There was a statistically significant difference between preoperative and postoperative 24th months IOP measurements in group 2 (p=0.01).

Conclusion: Although phacoemulsification surgery may cause an increase (14-19 %) in IOP early postoperative period in eyes with POAG and PXG, may provide a modest level decreases (19-18 %) in the long term.

Keywords: Cataract; Intraocular pressure; Phacoemulsification; Primary open-angle glaucoma; Pseudoexfoliation glaucoma

INTRODUCTION

Glaucoma and cataract are common causes of vision loss. Both diseases often accompany each other, and the prevalence increases with aging. Currently, the phacoemulsification technique is the gold standard in cataract surgery (1). It has demonstrated that phacoemulsification surgery decreases intraocular pressure (IOP) and number of antiglaucomatous medication, especially in lens-induced glaucoma, angle-closure glaucoma, and PXG patients (2-4). Intraocular pressure is the primary treatable risk factor for glaucoma. Determination of the reduction level in IOP after phacoemulsification surgery can help the clinician decide whether to perform cataract surgery, incisional glaucoma surgery, or combined surgery (5, 6).

There are various types of glaucoma, generally classified by the anterior chamber angle. Open-angle glaucoma is the most common type of glaucoma among populations of European or African descent (7, 8). Primary open-angle glaucoma (POAG) is a chronic, progressive optic neuropathy that is characterized by acquired optic atrophy and loss of retinal ganglion cells and their axons (9). This disease is associated with an open anterior chamber angle by gonioscopy. POAG is generally bilateral, but often asymmetric (10).

Pseudoexfoliation syndrome is a disease with unknown etiology and may cause multi-systemic and ocular complications (11). Pseudoexfoliation is characterized by the production and accumulation of age-related abnormal fibrillary material in different eye tissues (12).

The diagnosis of pseudoexfoliation syndrome is made by observing gray-white fibrogranular pseudoexfoliation material on the lens anterior capsule or pupil edge during anterior segment examination (13). Pseudoexfoliation glaucoma (PXG) results from pseudoexfoliation material and is the most common type of secondary open-

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angle glaucoma (14). POAG and PXG are the two most common causes of chronic open-angle glaucoma in the world (15). It has demonstrated that antiglaucomatous medication and IOP have decreased after uneventful phacoemulsification surgery and posterior chamber intraocular lens implantation in both glaucoma types (16).

The aim of this study was to evaluate and compare the early postoperative and long-term effects of phacoemulsification surgery on IOP in both POAG and PXG patients.

MATERIALS AND METHODS

This comparative study was performed retrospectively at the Ophthalmology Department. The tenets of the Declaration of Helsinki were followed with at all step of the study. The study was reviewed and approved by the local Ethics Committee.

Patients followed with POAG and PXG at glaucoma section who underwent uneventful phacoemulsification surgery, and intraocular lens implantation between 2010 and 2016 by an experienced glaucoma-cataract surgeon (Dr. PGF) was included in the study (Figure 1). While Group 1 consisted of 24 patients with POAG Group 2 consisted of 16 patients with PXG. In patients who had surgery on both eyes, the eye that was followed for a longer period was included in the study. All participants gave informed consent before the surgery.

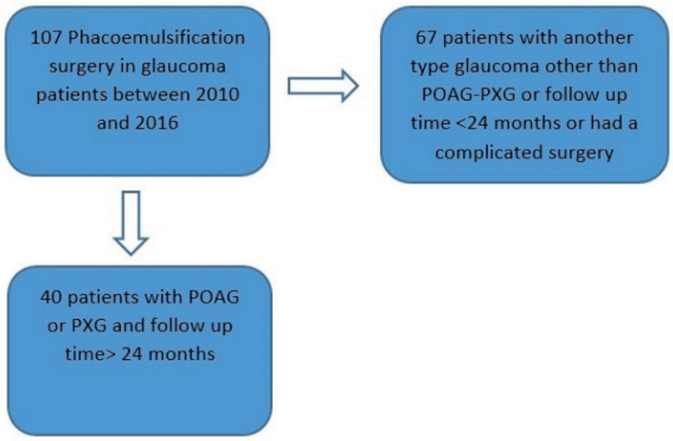

Figure 1. Patient selection

The diagnosis of POAG was made by determining IOP> 21 mm HG and having glaucomatous optic nerve damage with an open anterior chamber angle at the gonioscopy, without any secondary reasons which may cause glaucoma. The diagnosis of PXG was made by determining IOP> 21 mm HG and having glaucomatous optic nerve damage with an open anterior chamber angle and detected pseudoexfoliation syndrome. Furthermore, the diagnosis was supported by perimetry for demonstrating functional changes and spectral-domain optical coherence tomography for describing structural changes.

Age, gender, best corrected visual acuity (BCVA) and IOP in all controls, type of anesthesia used during surgery, axial length (AL), central corneal thickness (CCT), anterior chamber depth (ACD), medications change, additional systemic disease, and postoperative follow-up time were recorded. Preoperative BCVA using the Snellen chart, slit-lamp evaluation under pharmacological dilatation, IOP measurement with Goldmann applanation tonometry, and fundus evaluation with 90 diopters were performed in all patients. Exclusion criteria were: glaucoma disease other than POAG and PXG, previous incisional intraocular surgery history, patients with complicated phacoemulsification, and postoperative follow up time of fewer than 24 months. Phacoemulsification surgery and IOP measurements of all patients were performed by the same ophthalmologist.

Surgical technique: All patients underwent standard quick chop technique under general or local anesthesia. 2.2 mm corneal incision and 5.0-5.5 mm capsulorhexis were performed in all surgeries. Device parameters: vacuum limit 300, aspiration flow rate 40 ml/min, and ultrasound power were adjusted according to the type and density of the cataract. The cortical material was removed after phacoemulsification. Monofocal Acriva UD 613 (VSY biotechnology) intraocular lens was implanted into the capsular bag. Surgery was ended after viscoelastic removal in the anterior chamber.

Statistical analysis: SSPS for Windows statistical software (ver. 22.0; IBM Corp., Armonk, NY, USA) was used for the analysis. The results are expressed as means ± standard deviation (SD). Shapiro-Wilk test was used to determine the consistency of continuous variables to normal distribution. In order to investigate the differences between the two groups, t-test, and Mann-Whitney U were used for quantitative data, and Chi-Square test was used for the qualitative data. The statistical significance of changes in IOP was determined by a Wilcoxon matched pairs signed rank test. The statistical significance in repeated measurements was determined by the Friedman test. A value of $p<0.05$ was considered statistically significant.

RESULTS

In our study, no statistically significant difference was observed between Group 1 and Group 2 in terms of mean age, gender distribution, follow up time, AL, CCT, systemic disease, but there was a statistically significant difference for ACD (Table 1). Hypertension, coronary artery disease, and diabetes mellitus were the most common diseases in group 1, whereas diabetes mellitus and lung diseases (COPD, asthma) were the most common in group 2. There was no statistically significant difference between the groups in the preoperative and postoperative BCVAs ($p> 0.05$) (Table2). There was a statistically significant difference between preoperative and postoperative BCVAs in both groups ($p< 0.001$ at both groups) (Figure 2).

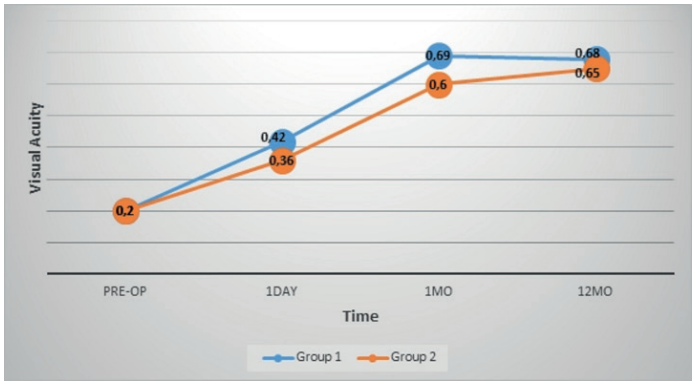

Figure 2. Comparison of preoperative- postoperative BCVA between groups

In Group 1, the mean intraocular pressure in the preoperative, postoperative 1st day, 1st month, 12th month, 18th month, 24th month, 36th month and 48th month were determined as 16.11 mm Hg, 18.54 mm Hg, 14.33 mm Hg 13.27 mm Hg, 14.14 mm Hg, 14.14 mm Hg, 15.29 mm Hg and 13.13 mm Hg, respectively. In Group 2, the mean intraocular pressure in the preoperative, postoperative 1st day, 1st month, 12th month, 18th month, 24th month, 36th month and 48th month were determined as 16.38 mm Hg, 19.50 mm Hg, 16.50 mm Hg 13.25 mm Hg, 13.13 mm Hg, 11.67 mm Hg, 15.90 mm Hg and 15.50 mm Hg, respectively (Figure 3).

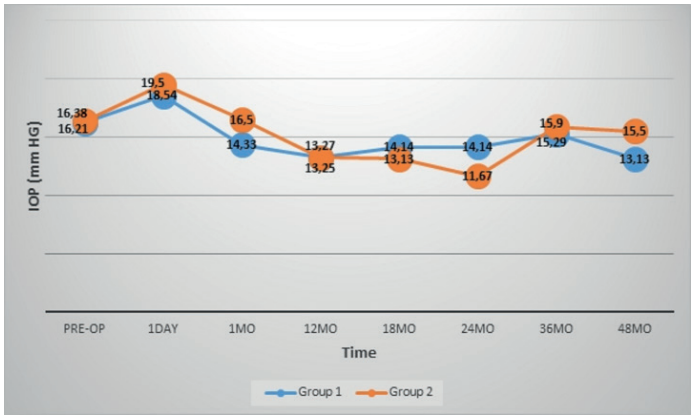

Figure 3. Comparison of preoperative- postoperative IOP values between groups

There was no statistically significant difference between the groups in the preoperative, postoperative 1st day, 1st, 12th, 18th, 36th and 48th months IOP (p= 0. 88; p= 0.96; p= 0.74; p= 0.35; p= 0.26; p= 0.90; p= 0.41 respectively). There was a statistically significant difference in the postoperative 24th month (p= 0.005). There was no statistically significant difference between preoperative and postoperative 1st day, 18th, 24th, 36th and 48th months IOP in group 1 (p= 0.132; p= 0.62; p= 0.10; p= 0.43; p= 0.07, respectively). There was a statistically significant difference between preoperative and postoperative 1st,12nd months IOP in group 1 (p= 0.02; p= 0.009, respectively). There was no statistically significant difference between preoperative and postoperative 1st day, 1st, 12nd, 18th, 36th and 48th months IOP in group 2 (p= 0.36; p= 0.96; p= 0.11; p= 0.23; p= 0.93; p= 0.34, respectively). There was a statistically significant difference between preoperative and postoperative 24th months IOP in group 2 (p= 0.01).

There were no statistically significant differences between the groups in terms of the number of medications used preoperatively and the number of medications at the last control (p= 0.50 at group 1; p= 0.42 at group 2) (Table 3). When the number of medications used preoperatively and the number of medications used postoperatively was compared, a statistically significant difference was observed in group 1, while no statistically significant difference was observed in group 2 (p= 0.046; p= 0.93, respectively). Furthermore, one patient in each group underwent trabeculectomy surgery during follow-up.

Table 1. General characteristics of groups

Characteristic	Group 1 (n:24)	Group 2 (n:16)	P value
Age (year ± sd*)	66.46 ± 10.24	67.56 ± 8.3	0.71
Gender (n)			0.37
Female	6	7	
Male	18	9	
Follow up time (month ± sd)	44.17 ± 17.8	43.13 ± 19.4	0.86
Axial length (mm ± sd)	24.4 ± 1.6	24.6 ± 1.7	0.59
Anterior chamber depth (mm ± sd)	3.15 ± 0.24	3.29 ± 0.25	0.01
Systemic disease (n)	12	6	0.20

*Sd: Standart deviasyon

Table 2. Preoperative and postoperative BCVAs of groups

BCVA*	Group 1(n:24)	Group 2(n:16)	P value
Preoperative(mean ± sd**)	0.20±0.18	0.20±0.13	0.90
Postoperative 1st day			
(mean ± sd)	0.42±0.31	0.36±0.26	0.52
Postoperative 1st month			
(mean ± sd	0.69±0.22	0.60±0.29	0.34
Postoperative 12nd month			
(mean ± sd	0.68±0.24	0.65±0.32	0.94
P value	<0.001	<0.001	

*Best corrected visual acuity
**Standart deviasyon

Table 3. The number of medications used preoperatively and postoperatively

Number of medication	Group 1(n:24)	Group 2(n:16)	P value
Preoperative(mean ± sd*)	1.54±0.93	1.75±0.85	0.50
Postoperative(mean ± sd)	2.04±0.91	1.75±1.06	0.42
P value	0.046	0.93	

*Standard deviation

DISCUSSION

In this current study, we investigated the long term effect of phacoemulsification on IOP. In group 1, IOP increased on the first postoperative day according to preoperative values, and IOP decreased at the postoperative first month, 18th, 24th, 36th and 48th months postoperatively. It was observed that this decrease in the first and 12th months was statistically significant. In group 2, IOP increased in the postoperative first day and first month according to preoperative values, and IOP decreased in the postoperative 12th, 18th, 24th, 36th, and 48th months. It was observed that this decrease at 24th month was statistically significant. When group 1 and group 2 were compared, the only statistically significant difference was observed in the postoperative 24th month. When the number of medications used preoperatively and the number of medications used postoperatively was compared, a statistically significant difference was observed in group 1, while no statistically significant difference was observed in group 2. Furthermore, no statistically significant difference was observed in the number of medications at preoperatively and postoperatively between the groups.

Phacoemulsification surgery may provide an IOP increase in the early postoperative period at healthy and glaucoma patients (17). In 46.4% of high-risk patients, IOP> 28 mm Hg was observed in the early postoperative period (18). This increase typically peaks in postoperative 3-7 hours and can last up to 24 hours (19). In our study, it was observed that IOP increased in the early postoperative period in both groups, but this is not statistically significant. Slabaugh et al. reported that early postoperative IOP elevation associated with long AL, deep anterior chamber, and the number of preoperative medication (20). The mean of AL and ACD of our patients were similar to IOP elevation group in Slabaugh et al.'s study, but the number of preoperative medications was lower in our study.

Engin et al. investigated the effects of phacoemulsification surgery on anterior segment parameters in POAG and PXG patients. They reported that preoperative central corneal thickness and ACD were significantly lower in the PXG group, and no significant difference was observed for AL (16). In our study, while there was no difference between the groups in terms of preoperative AL and CCT, the ACD was significantly higher in PXG patients. This difference may be due to the low number of cases in both studies.

Jimenez-Roman et al. evaluated the effect of phacoemulsification surgery on IOP in 44 POAG and 44 PXG patients similar to our study; they showed that IOP decreased 20% in patients with POAG and 20.39% in PXG patients at the end of one-year follow-up (21). Mierzejewski et al. reported that there was a mean decrease of 4.43 mmHg in IOP after phacoemulsification surgery in open-angle glaucoma patients (22). We observed that there was a mean decrease of 3.11 mm Hg (18.9 %) at the 12th month and 2.24 mm Hg (13.6 %) at the 24th month in patients with POAG. In patients with PXG, there was a mean decrease of 2.96 mm Hg (18.2 %) at the 12th month and 4.54 mm Hg (28.0 %) at the 24th month. In our study, the decrease in IOP was similar to the study of Jimenez-Roman et al. and lower than the study of Mierzejewski et al. This difference may result from Mierzejewski et al. had higher preoperative IOP values than our study, different follow-up time (6-30 months) or different types of open-angle glaucoma patients.

Previous researches have shown that phacoemülsification surgery improves glaucoma control by decreasing IOP. Which mechanisms of cataract surgery influences IOP are not fully understood. Possible mechanisms can involve the following: diminished aqueous humor secretion, diminished resistance to aqueous humor efflux, changed biomechanical barrier, or blood-aqueous humor barrier (23). However, the dominant mechanism may differ across various types of glaucoma. The amount of IOP decrease following phacoemulsification is higher in patients with exfoliation syndrome compared with eyes without exfoliation syndrome (5, 24). Damji et al. reported that IOP response in patients with exfoliation syndrome correlated with the amount of irrigation fluid used intraoperatively (24). They thought that the procedure might remove pigment and exfoliation material from the outflow system, thus leading to more significant IOP reduction. Another important mechanism is releases of endogenous prostaglandin F2 after phacoemülsification surgery that is thought to enhance uveoscleral outflow (25, 26).

A meta-analysis showed that after phacoemulsification surgery, there was a slight reduction in IOP (13%) and the number of medication (12%) in patients with POAG who had 1 or 2 medications (5). Perasalo et al. reported that intraocular pressure decreased 17.1 mmHg from 15.3 mmHg at the first year follow-up after phacoemulsification surgery in a retrospective study of 102 eyes with POAG and 124 eyes with PxG (27). Furthermore, the mean number of medications used in this study decreased from 1.5 to 0.9 (40%), but 37% of the patients had increased the number of drugs used (27). Slabaugh et al. reported that the number of medications used in the postoperative 12th month increased from 1.85 to 1.92 (4 %) in POAG (28). In our study, the mean number of medications increased by

32% in POAG group and remained stable in PXG group. The increase in the number of medications in POAG group is higher from the other studies, and it may be due to the use of the number of medications at last control in the statistical analysis and accordingly the longer follow-up period than the other studies. As a matter of fact, 50% of the medication increase in patients was after the 24th month. Also, the reasons why there is no increase in the number of drugs in PXG patients may be related to the increased outflow facility in PXG cases owing to the clearance of the fibrillar material during aspiration (29).

This study has some limitations. There was a limited number of patients because of the long follow-up time. Due to the retrospective nature of this study, sufficient data on the use of preoperative prophylactic oral acetazolamide could not be obtained. There were no IOP values on the day of operation and early postoperative (4-12 hours). These complicate early postoperative IOP evaluation. Besides, the use of different viscoelastic during operation in patients prevented to compare the groups in the evaluation of early postoperative IOP increase.

CONCLUSION

In conclusion, although phacoemulsification surgery may cause an increase (14-19 %) in IOP early postoperative period in eyes with POAG and PXG, may provide a modest level decreases (19-18 %) in the long term. In the following periods, by increasing the number of drugs, IOP can be kept within reasonable limits, and the progression of glaucoma may be slowed down. Phacoemulsification surgery may be an adjunctive treatment modality in IOP reduction in patients without advanced glaucomatous damage and cataract.

Conflict of interest: The authors declare that they have no competing interest.

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Ethical approval: The study was approved by Inonu University Scientific Research and Publication Ethics Committee (Reference number: 2019/7-8).

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