

Effect of Phacoemulsification on Bleb Type and Intraocular Pressure in Eyes with Pseudoexfoliative Glaucoma and Filtering Blebs

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ABSTRACT

Purpose: To evaluate the effect of phacoemulsification (PE) on intraocular pressure (IOP) control and bleb type in pseudoexfoliative glaucoma (PXG) patients with filtering blebs.

Materials and Methods: Thirty-one PXG patients with filtering blebs who underwent uncomplicated PE were evaluated. Those with less than 2 years between trabeculectomy and phacoemulsification surgeries were classified as group 1, those with more than 2 years were classified as group 2. The study evaluated the patients' IOP and glaucoma medication use before and after surgeries, including measurements taken at various intervals up to three years post-surgery. Bleb types and surgical success were evaluated at before and 1 year after PE. Surgical success was defined as IOP levels between 5 and 18 mmHg without the use of any antiglaucoma medication (complete success) or with the use of antiglaucoma medications (qualified success). Patients who underwent glaucoma surgery after PE were considered unsuccessful.

Results: Statistically significant differences were found between the first month after PE and the last visit in terms of IOP and medications ($p=0.010$; $p<0.001$). Complete and qualified success was higher in Group 2 at the last visit. The most common bleb type before PE was diffuse (58.1%), while after PE it was flat (51.6%).

Conclusions: Early cataract surgery may be a better option for PXG patients with filtering blebs before the need for trabeculectomy arises, as cataract surgery can negatively impact the functioning of the bleb. Careful management of cataract progression is crucial in optimizing long-term visual and glaucoma management outcomes in these patients.

Keywords: Pseudoexfoliative glaucoma, Phacoemulsification, Trabeculectomy

INTRODUCTION

Pseudoexfoliation (PXF) is the most common cause of secondary open-angle glaucoma, leading to pseudoexfoliative glaucoma (PXG), which is characterized by higher presenting intraocular pressure (IOP) and diurnal fluctuations.^{1,2} Additionally, visual field defects tend to progress faster in PXG compared to primary open-angle glaucoma (POAG).³ Due to its resistance to medical treatment and its occurrence in the elderly age group, cataract and glaucoma coexistence is frequent, requiring careful surgical considerations.⁴ In such cases, the timing of cataract surgery is a critical factor in evaluating surgical options like selective laser trabeculoplasty, bleb-dependent,

or bleb-independent surgery. Trabeculectomy is the most frequently preferred surgical method for cases where sufficient IOP reduction cannot be achieved with medical treatment.⁵⁻⁶ While cataracts become more prevalent in PXG, studies have shown a significant decrease in IOP following phacoemulsification.⁷⁻⁹ However, in evaluating the effect of sequential cataract surgery on bleb functions, some studies show a negative effect on IOP control, while others indicate no impact.¹⁰⁻¹³ Therefore, careful planning and individualized treatment plans should be considered while evaluating surgical options in PXG patients with coexisting cataracts.

The objective of this study was to assess the impact of

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phacoemulsification (PE) surgery on both intraocular pressure (IOP) and bleb morphology, as well as the influence of the time interval between surgeries on surgical success, in patients diagnosed with PXG and filtering bleb.

MATERIALS AND METHODS

A total of 31 eyes from 31 patients who underwent trabeculectomy followed by PE for the treatment of PXG were retrospectively evaluated. Patients were identified from a single center in Turkey. The diagnosis of PXG was made based on clinical observations that included the identification of pseudoexfoliation material on the lens and pupil, increased patchy pigmentation at the angle, as well as elevated IOP and/or visual field defects associated with glaucomatous optic neuropathy. The present study includes patients with PXG who underwent a successful phacoemulsification procedure and in-the-bag intraocular lens implantation, following a single trabeculectomy. Specifically, the study evaluated the outcomes of this surgical approach in patients with senile cataracts of stages 2, 3, and 4. Patients were divided into two groups based on the duration between the two surgeries. Group 1 comprised patients with a duration of less than two years, whereas group 2 included those with a longer duration. Since few cases had a time interval of less than 6 months between surgeries, a two-year period was chosen for statistical analysis. Patients who underwent another surgery during the follow-up period between trabeculectomy and lens extraction, had diabetic retinopathy, ocular inflammation, trauma, laser or intravitreal injection history, or had phacomorphic glaucoma were excluded. All patients underwent a complete preoperative ophthalmic examination, including applanation tonometry, ophthalmoscopy, and gonioscopy. Trabeculectomy was performed with 0.04% mitomycin C (MMC) using a fornix-based conjunctival incision. Clear corneal incisions for PE surgeries were made in a quadrant distinct from that of the trabeculectomy side. Bleb morphology and surgical success were evaluated before and 1 year after PE. The blebs were categorized based on biomicroscopic findings without using any accepted scoring system. IOP and medical treatments were evaluated before and after trabeculectomy at 1st month, 3rd month, 6th month, 1st year, and 3rd year, and after PE at 1st month, 3rd month, 6th month, and 1st year. Complete success was defined as an IOP of >5 mmHg and ≤ 18 mmHg without any antiglaucoma medication, while qualified success was defined as an IOP within the same range with the use of antiglaucoma medications. Failure was determined by an IOP outside the range of >18 mmHg

or <5 mmHg, or requiring further glaucoma surgery, except for laser suturolysis. This study adhered to the Declaration of Helsinki and was approved by the institutional review board of Ankara Training and Research Hospital (E-22-912/02-24-2022).

Statistical Analysis:

Data analyses were performed by using SPSS for Windows, version 22.0 (SPSS Inc., Chicago, IL, United States). Whether the distribution of continuous variables were normal or not was determined by Kolmogorov Smirnov test. Levene test was used for the evaluation of homogeneity of variances. Unless specified otherwise, continuous data were described as mean \pm SD and median (minimum-maximum value) for skewed distributions. Categorical data were described as number of cases (%). Statistical analysis differences in not normally distributed variables between more than two dependent groups were compared by fried man test. Independent categorical variables were compared using Pearson's chi-square test or fisher's exact test. Dependent categorical variables were compared using mc nemar test. It was accepted p-value <0.05 as significant level on all statistical analysis.

RESULTS

This retrospective study included 31 eyes of 31 patients with PXG who underwent trabeculectomy followed by PE. The mean age of the patients was 63.26 ± 6.32 years, and 64.5% (n=20) of them were male. The right eye was analyzed in 51.6% (n=16) of the patients, and the left eye was analyzed in 48.4% (n=15). The mean visual acuity, cup to disc ratio (C/D) and retinal nerve fiber layer (RNFL) value before cataract surgery were 0.3 ± 0.2 , 0.7 ± 0.3 , and 60 ± 32 μ m, respectively. Table 1 shows the mean IOP and number of medications, and Figure 1 shows the distribution of glaucoma medications. Patients were followed up for a mean period of 3.67 ± 2.00 (IQR:3) years after PE. At the last visit, the mean IOP and number of medications were significantly increased compared to the values at 1 month after PE (p=0.010; p<0.001, respectively). The study found that the rate of diffuse blebs decreased significantly from 58.1% (n=18) before PE to only 9.7% (n=3) at the 1-year follow-up after PE. The types of blebs were documented and presented in Table 2. One case was noted to have closure of the iridectomy area by the iris at the 3rd month after PE, which was managed successfully with medical treatment as shown in Figure 2. Prior to PE surgery, 21.4% (n=6) of cases were deemed unsuccessful, whereas complete surgical success and qualified success were achieved in

Table 1: Intraocular pressures and number of medications

	IOP (mmHg)		Number of Medications	
	$\bar{x}\pm SD$	Med (IQR)	$\bar{x}\pm SD$	Med (IQR)
Pre-trabeculectomy	34.44±9.86	32(17)	1.88±1.36	2(3)
Post-trab 1 st month	13.90±5.07	12(7)	0.13±0.57	0(0)
Post-trab 3 rd month	13.97±6.87	13(7)	0.20±0.77	0(0)
Post-trab 6 th month	15.30±4.18	16(6)	0.60±1.07	0(1)
Post-trab 1 st year	14.42±5.59	14(6)	0.96±1.27	0(2)
Post-trab 3 rd year	14.40±3.73	14(6)	1.13±1.29	1(2)
Pre-phaco	14.43±5.23	14(6.5)	1.43±1.37	1(3)
Friedman test p	<0.001		<0.001	
Post hoc	Pre-trabeculectomy- Post-trab 1 st month Pre-trabeculectomy-Post-trab 3 rd month Pre-trabeculectomy-Post-trab 6 th month Pre-trabeculectomy-Post-trab 1 st year Pre-trabeculectomy-Post-trab 3 rd year Pre-trabeculectomy-Pre-phaco		Pre-trabeculectomy- Post-trab 1 st month Pre-trabeculectomy-Post-trab 3 rd month	
Pre-phaco	14.43±5.23	14(6.5)	1.43±1.37	1(3)
Post-phaco 1 st month	14.19±7.90	14(9)	1.23±1.25	1(2)
Post-phaco 3 rd month	15.63±7.34	15(9)	1.50±1.25	1(2)
Post-phaco 6 th month	15.82±5.76	16(6.5)	1.54±1.32	1.5(2)
Post-phaco 1 st year	16.57±5.29	17(7)	2.00±1.33	2(2)
Last visit	16.70±5.63	16(7)	2.27±1.23	3(2)
Friedman test p	0.010		<0.001	
Post hoc	Post-phaco 1 st month- Last visit		Post-phaco 1 st month- Last visit	

IOP: Intraocular pressure; trab: trabeculectomy; phaco: phacoemulsification

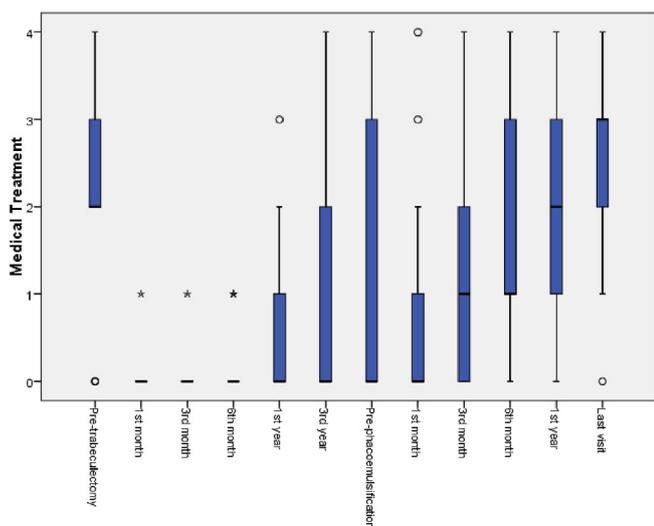


Figure 1: Glaucoma medications

35.7% (n=10) and 42.9% (n=12) of cases, respectively. At the last follow-up visit after PE, the percentage of unsuccessful cases decreased to 10.0% (n=3), while the percentage of complete and qualified success increased to 60.0% (n=18) and 30.0% (n=9), respectively. The mean

time between the two surgeries was 49.87±41.58 months, with 11 (35.5%) patients in Group 1 (interval less than 2 years) and 20 (64.5%) patients in Group 2 (interval more than 2 years). Although no significant correlation was found between the interval between procedures and surgical success, the most recent follow-up visit revealed higher complete and qualified success rates in Group 2 (Table 3). Figure 3 visually depicts the difference in surgical success rates between just before PE surgery and the most recent follow-up visit.

DISCUSSION

Compared to POAG, PXG tends to be more resistant to medical treatment, necessitating frequent surgical intervention. However, one of the potential long-term side effects following filtration surgery is the emergence of cataract.¹⁴ Patients' age and the presence of PSX are both significant risk factors for the acceleration of cataract progression.¹⁵ On a positive note, studies have shown that cataract surgery can lower IOP in healthy eyes,

Table 2: Bleb types at just before phacoemulsification and last visit

	Pre-phaco n, %	Last visit n, %	P
Diffuse	18 (58.1 %)	3 (9.7%)	<0.001
Encapsulated	1 (3.2 %)	2 (6.5%)	0.999
Flat	2 (6.5%)	16 (51.6%)	0.001
Cystic	6 (19.4%)	6 (19.4 %)	0.999
Localized	4 (12.9%)	1(3.2%)	0.250
Vascularized	-	3 (9.7%)	0.999

Mc nemar test

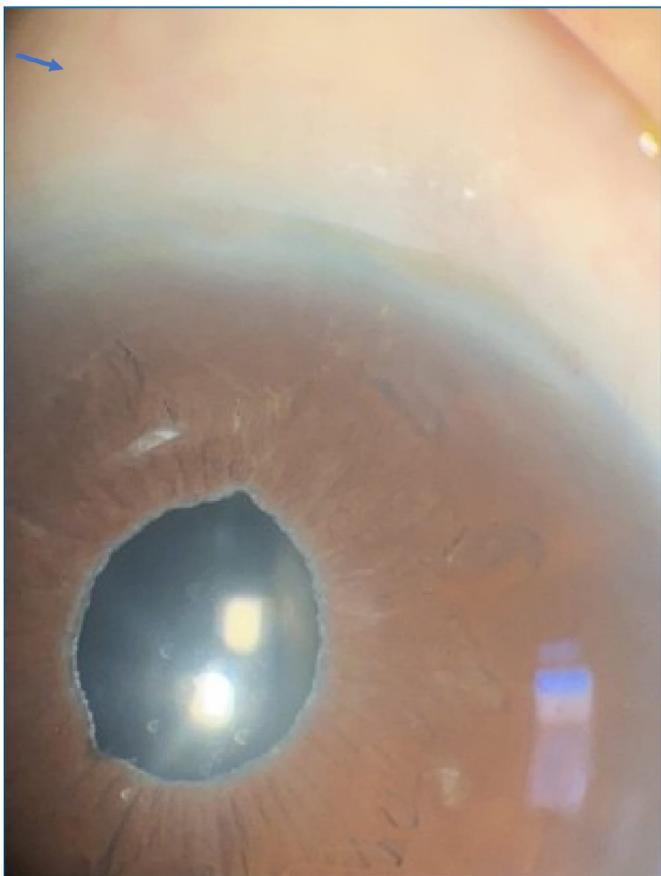


Figure 2: Iridectomy area plugged with iris

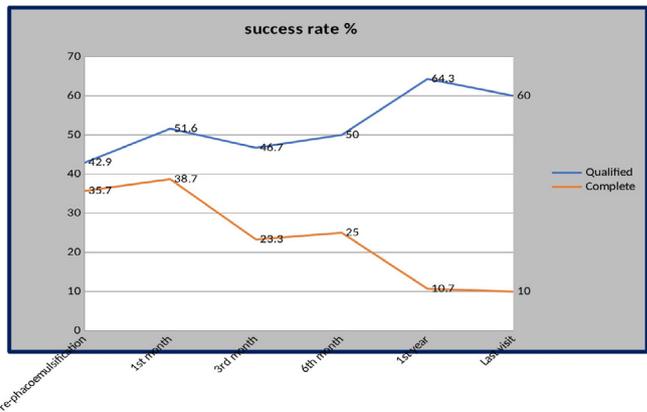


Figure 3: Surgical success rates after phacoemulsification.

with a more pronounced decrease in IOP observed in pseudoexfoliative eyes.^{16,17} However, some studies suggest that cataract surgery may have a detrimental impact on IOP control and the number of medical treatments required in trabeculectomy eyes.^{10,11} Conversely, other studies have found no significant influence on these variables.^{12,18}

Our study found that only 10.0% of patients maintained their full surgical success rate after PE, which was 35.7% before the procedure. In a study by Ehmrooth et al. on trabeculectomy cases, the complete success rate dropped

Table 3: Surgical success rates of groups

Surgical success rates		Group 1 (interval time less than 2 years)	Group 2 (interval time more than 2 years)	P
Pre-phaco	qualified	37.5%	45.0%	0.426
	complete	25.0%	40.0%	
	Failure	37.5%	15.0%	
Last visit	qualified	36.4%	73.7%	0.089
	complete	9.1%	10.5%	
	Failure	54.5%	15.8%	

pearson chi square test, fisher exact test

from 48% (22/46) before cataract surgery to 30% (14/46) after the procedure. The percentage of participants using two or more glaucoma medications also increased from 26% (12/46) to 52% (24/46) after cataract surgery. However, in a control group of 90 patients with trabeculectomy who did not undergo cataract surgery, only 24% (22/90) were using two or more glaucoma drugs.¹³ In another study comparing two groups with and without PE within 5 years following trabeculectomy, Arimura et al. identified that the shorter interval between trabeculectomy and PE, lower preoperative IOP, and lower preoperative visual acuity were risk factors for surgical failure. They suggested that prolonging the interval between the two procedures might improve outcomes.¹⁹ In our study, we also observed significant differences in IOPs and glaucoma medications between the first month after PE and the last visit, with an increase in the number of medications and compromised IOP regulation. However, Tekcan et al. reported that uncomplicated cataract surgery did not affect bleb function in eyes with PXG and could be safely performed when necessary.²⁰

The appearance of the trabeculectomy bleb is often used to evaluate the success of the procedure, but it is not always an accurate indicator of IOP control. Several studies have suggested that PE surgery can have a negative impact on the structure and function of trabeculectomy blebs. For instance, Inal et al. found that the height and width of the bleb decreased after cataract surgery in eyes that had undergone trabeculectomy.²¹ Similarly, Salaga-pylak et al. observed that these effects were most prominent during the first 6 months after PE.¹⁰ In our study, we found that the rate of flat bleb was higher after PE compared to before, despite a high rate of diffuse bleb before PE. This may be due to the fibrotic reaction induced by cytokines that penetrate into the bleb during PE surgery, which can lead to bleb malfunction and elevated anterior chamber flare for up to 6 months after the procedure.²²

In our study, we divided the time between surgeries into two groups based on a 2-year interval. Although not statistically significant, our results showed that patients who underwent PE more than 2 years after trabeculectomy had higher rates of complete and partial success at the last visit and lower rates of second glaucoma surgery compared to those who underwent PE within 2 years. However, Chen et al. found that a gap of less than 6 months between trabeculectomy and cataract extraction was a risk factor for IOP control loss.²³ In uveitic glaucoma, post-trabeculectomy PE within a year was a prognostic factor for failure to maintain

IOP below 15 mmHg after trabeculectomy with MMC.²⁴ Similarly, Yalçınkaya et al. reported increased medication usage and IOP after PE in 98 eyes, and like our study, they did not find a statistically significant effect of the time interval between surgeries on surgical success.²⁵ Another study using the same time classification as ours found no difference in IOP values before and after cataract surgery in cases where cataract surgery was performed more than 2 years after trabeculectomy.¹⁸

Our study has some limitations, including a small sample size and the absence of a widely accepted classification system for bleb evaluation. Additionally, we excluded cases that underwent interventions other than lasersuturolysis between two surgeries, and the challenges of follow-up in elderly patients may have contributed to the limited number of cases. Finally, due to the retrospective nature of our study, we relied on bleb classification data from patient files.

In general, the evidence shows that PE can effectively reduce IOP in eyes with glaucoma, especially those with PXF. Studies have suggested that a longer aspiration time during surgery can lead to a more significant decrease in IOP in PXF cases. In non-glaucomatous eyes, Altan et al. found an approximate 2 mmHg reduction in IOP following PE.²⁶ Additionally, Mathalone et al. observed a decrease in IOP after PE in both normal and glaucomatous eyes.²⁷ Furthermore, Shingleton et al. demonstrated that the decrease in IOP was more pronounced in cases with PXF.²⁸

Based on our observations, we suggest considering early cataract surgery in PSX patients who have not undergone filtration surgery, as we noticed that phacoemulsification surgery can have a negative impact on bleb morphology. However, it is important to note that careful consideration of the timing of cataract surgery is necessary in patients with PXG who have undergone filtration surgery. This is because the surgery can negatively affect IOP and bleb structure, and may lead to a reduction in complete surgical success. In these cases, medical treatment to control IOP may be a better option until the timing of cataract surgery can be carefully planned and executed. Therefore, it may be advisable to consider early cataract surgery as a more rational strategy for patients with PXG, as long as IOP remains under control with medical treatment. It should also be kept in mind that cataract development is known to accelerate in patients with PSX after trabeculectomy. Overall, individualized treatment plans should be developed for each patient with PSX, taking into account

factors such as the severity of the condition, the presence of glaucoma, and the timing of previous surgeries.

Competing interest: The authors whose names are listed above certify that they have no conflict of interest in this work.

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Author Contribution: All authors contributed to the study conception and design.

Data availability: The manuscript has no associated data in a data repository.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Precis: Patients who had cataract surgery more than two years following trabeculectomy had better surgical outcomes than those who had the procedure earlier.

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