Trabeculectomy Outcomes with and without Phacoemulsification in Pseudoexfoliative Glaucoma and Primary Open-Angle Glaucoma

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ABSTRACT

Introduction: This study investigated whether trabeculectomy and phacoemulsification surgeries should be performed together or separately, focusing on how the timing and presence of phacoemulsification affect trabeculectomy success in open-angle glaucoma (OAG) patients, both with and without pseudoexfoliation (PEX).

Methods: Patients were categorized into three groups: Group 1 underwent combined surgery, Group 2 had trabeculectomy alone, and Group 3 received phacoemulsification and trabeculectomy at separate times. Surgical success was defined as complete if IOP was 5–21 mmHg without medication, and partial if within the same range with medication.

Results: The complete success rates for Groups 1, 2, and 3 were 38 (60.3%), 87 (58.4%), and 34 (49.3%), respectively, while partial success rates were 21 (33.3%), 29 (19.5%), and 17 (24.6%), respectively. Group 1 showed the highest overall success rate. The presence of PEX did not impact the success rates. Higher success was observed in patients with lower IOP both before and after surgery, whereas success rates were lower in groups that required needling. The presence of complications did not affect the success rates. Factors such as patient age, gender, type of surgery, number of preoperative medications, complications, and PEX status were not found to be associated with either complete or partial success during the follow-up period.

Conclusions: Phacotrabeculectomy has been shown to achieve similar success rates to trabeculectomy, with the added benefit of allowing for earlier visual recovery.

Keywords: Phacotrabeculectomy, Trabeculectomy, Phacoemulsification, Pseudoexfoliation

INTRODUCTION

The overall yearly incidence of open-angle glaucoma (OAG) was 0.9% (95% CI: 0.6–1.3). When stratified by the presence of pseudoexfoliation (PEX), the incidence was 0.5% (95% CI: 0.2–0.9) in individuals without PEX and 2.1% (95% CI: 1.2–3.3) in those with PEX. The presence of PEX was associated with a fourfold increase in glaucoma risk, regardless of sex[1]. Older glaucoma patients often develop coexisting cataracts, which may impede visual rehabilitation, particularly in those with PEX [2]. This study aims to evaluate how the timing and performance of phacoemulsification surgery affect the outcomes of trabeculectomy in patients with pseudoexfoliation glaucoma (PEXG) and those with primary open-angle glaucoma (POAG) without pseudoexfoliation.

METHODS

In this retrospective study, we accessed the electronic medical records of glaucoma patients from the clinic's database, who underwent trabeculectomy, cataract surgery,

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or combined surgery (simultaneous trabeculectomy and phacoemulsification) between 2013 and 2020. The decision regarding which surgical approach to use was based on the severity of glaucoma, the presence and extent of visually significant cataracts, and the patient's ability to adhere to postoperative follow-up. The inclusion criteria were a preoperative diagnosis of either PEXG or POAG without pseudoexfoliation; absence of secondary glaucoma due to neovascularization, inflammation, or pigment dispersion; no history of ocular trauma; and no systemic diseases other than hypertension. Although the study was retrospective, patients at the glaucoma clinic were informed that their data would be archived for scientific purposes, and consent forms were obtained. Specifically, patients with advanced cataracts and medically uncontrolled glaucoma underwent combined surgery (Group 1). Patients with uncontrolled glaucoma but without significant cataracts received trabeculectomy alone (Group 2). Patients who initially underwent trabeculectomy and later developed visually significant cataracts were assigned to Group 3, undergoing phacoemulsification at a later time. In Group 3, phacoemulsification surgery was performed approximately 18 months after trabeculectomy on average. The earliest cataract surgery was conducted as early as the first postoperative month. The study protocol was approved by the local institutional review board (faculty ethics committee, number 2019/900/25, dated April 17, 2019) and adhered to the Declaration of Helsinki.

Surgical records were reviewed, noting that separate incisions were used for each procedure in the combined surgery group. A superior fornix-based rectangular bleb measuring 4 x 3 mm was created during trabeculectomy, and all patients received 0.02% Mitomycin C applied under the conjunctiva for five minutes during the procedure. Nylon sutures (Ethilon; Ethicon Inc., Somerville, NJ) were placed at the corners and center of the flap. Phacoemulsification was performed using a temporal corneal incision, avoiding contact with the conjunctiva.

All patients' files were reviewed for a comprehensive examination conducted between 2013 and 2020. This included preoperative and postoperative IOP measurements at 1st, 6th, 18th, 36th, and 48th months using a Goldmann applanation tonometer, assessments of best-corrected visual acuity with Snellen charts, slit lamp biomicroscopy findings, and dilated fundus evaluations. Phacoemulsification was recommended if the best-corrected visual acuity was worse than 20/40, if fundus examinations and follow-up tests could not be performed, or if patients reported difficulties with daily living activities [3].

Complications frequently reported in the literature, such as choroidal detachment, anterior chamber hemorrhage, anterior chamber shallowness, bleb leak, and endophthalmitis [4], were considered in this study . After trabeculectomy, patients received topical antibiotics (ofloxacin) five times a day for two weeks, along with topical corticosteroids (dexamethasone) six to eight times a day, which were gradually tapered and discontinued over two months. Preoperative and postoperative antiglaucomatous medications were documented. Success was measured using two criteria: complete success was defined as IOP between 5-21 mmHg without anti-glaucoma medication, while partial success was defined as IOP in the same range with medication [5]. Surgical failure was determined by the need for additional interventions (excluding needling) or vision-threatening complications within four years of follow-up. Laser suture lysis or bleb needling within six months after trabeculectomy was not considered a surgical failure, as it was part of postoperative management [5].

Statistical analysis

Statistical analysis was performed using NCSS (Number Cruncher Statistical System) 2020 software. The Kolmogorov-Smirnov test was employed to assess the normality of data distribution. Descriptive statistics were presented as mean, standard deviation, minimum, and maximum for continuous variables, and as frequencies and percentages for categorical variables. For comparisons between categorical variables, the Chi-square test was used. For continuous variables, One-Way ANOVA was used when assumptions of normality were met, and the Kruskal-Wallis test was used when they were not. Post hoc comparisons following ANOVA were conducted using the Tukey HSD test. When the Kruskal-Wallis test was applied, pairwise comparisons were conducted using the Dunn test with Bonferroni correction. Pairwise comparisons between two groups were analyzed with the Mann-Whitney U test. A Cox proportional hazards regression model was used to identify independent predictors of complete and partial surgical success. A p-value of less than 0.05 was considered statistically significant.

RESULTS

In this study, 43.2% (n = 121) of the 281 patients were female, and 56.8% (n = 160) were male. Patients' ages ranged from 28 to 94 years, with a mean age of 68.13 ± 0.68 years; 183 had PEX and 98 did not. The mean follow-up period was 41.79 ± 14.11 months. Demographic and baseline clinical data for all groups, including age, sex, preoperative IOP, number of antiglaucoma medications, and duration of treatment, are shown in Table 1. Group 2 had younger patients than the other groups ($p < 0.05$), and the interval between trabeculectomy and initial diagnosis was shorter in Group 2 ($p < 0.05$). The highest number of PEX patients was in Group 3 ($p < 0.05$). Preoperative and postoperative IOP values at 1st, 6th, 18th, 36th, and 48th months are in Table 2. Group 2 had the highest preoperative IOP ($p < 0.05$), but no significant differences were found in postoperative IOP measurements. All groups demonstrated reduced IOP after surgery, particularly Group 2, although a slight increase in IOP was noted over time in all groups.

Table 3 presents the use of anti glaucomatous medications after surgery. The number of medications used preoperatively was similar across groups ($p > 0.05$), with the trabeculectomy-only group requiring the least medication postoperatively ($p < 0.05$).

As shown in Table 4 and 5, complications and rates were consistent across all three groups. No significant difference was found in terms of complications. Upon examination of Table 4 the need for needling was most common in group 3, followed by groups 2 and 1 ($p < 0.05$). It is statistically significant.

The overall complete success rate after surgery was 56.6%, while the partial success rate was 23.8%. The success rates for each group are detailed in Table 6 with the combined surgery group achieving the highest success, both complete and partial.

Table 7 indicates that both complete and partial successes were more prevalent among patients with lower preoperative IOP values ($p < 0.05$) and among females ($p < 0.05$). The needling rate was lowest in the complete success group ($p < 0.05$).

Cox regression analysis in Table 8 revealed that factors such as patient age, gender, type of surgery, number of preoperative medications, presence of complications, needling, and PEX association did not correlate with complete or partial success during the follow-up period.

The survival graph is illustrated in Figure 1. The Kaplan-Meier survival curves demonstrate the cumulative survival rates over the follow-up period (in months) for three patient groups. The top curve corresponds to Group 1, indicating the highest survival probability throughout the follow-up. The middle curve represents Group 2, while the bottom curve shows the outcomes for Group 3, which had the lowest cumulative survival. The x-axis indicates follow-up time in months, and the y-axis displays the cumulative probability of survival. Tick marks on the curves represent censored cases. These findings suggest a trend of decreasing survival among the groups, with Group 3 showing the poorest long-term outcomes.

Table 1. *Demographic characteristics of patients.*				
	Group 1	**Group 2**	**Group 3**	**P value**
Gender (n)	Male 28 Famale 35 63 (total)	Male 63 Famale 87 150(total)	Male 30 Famale 38 68(total)	> 0,05
Age (year)	73,41±1,24	65,02±0,98	70,11±1,06	<0,05
Preoperative IOP (mmHg)	21,31±0,94 mmHg	28,06±0,82 mmHg	25,88±1,06 mmHg	<0,05
Number of Antiglaucoma Drugs Prescribed Before Surgery	3,30 ± 1,00	3,20 ±0,90	3,30±0,80	>0,05
Monotherapy (One Antiglaucoma Agent) Before Surgery	4 (6,3%)	7 (4,7%)	2 (2,9%)	>0,05
Dual Therapy (Two Antiglaucoma Agents) Before Surgery	6 (9,5%)	22 (14,8%)	7 (10,1%)	>0,05
Triple Therapy (Three Antiglaucoma Agents)	7 (%11,1)	11 (%7,4)	9 (%13,0)	>0,05
Maximal Medical Therapy (Four Antiglaucoma Agents)	6 (%9,5)	5 (%3,4)	4 (%5,8)	>0,05
Interval Between Trabeculectomy and Phacoemulsification Surgeries (months)	-	-	23,30±22,90	-
Presence of Pseudoexfoliation (PEX)	44 (69,8%)	85 (56,7%)	54 (79,4%)	p<0,05
n,number; IOP, intra ocular pressure. Monotherapy refers to the use of a single antiglaucoma agent (prostaglandin analogue, beta-blocker, alpha-2 agonist, carbonic anhydrase inhibitor, or oral carbonic anhydrase inhibitor). Dual therapy involves a combination of any two of these agents. Triple or maximal therapy to treatment regimens combining more than two different antiglaucoma agents				

Table 2. *Preoperative and postoperative IOP values of patients.*				
	Group 1	**Group 2**	**Group 3**	**P**
Baseline IOP Before Surgery (mmHg)	21,31±0,94	28,06±0,82	25,88±1,06	<0,05
IOP at 1 Months Postoperatively(mmHg)	13,06±0,52	13,06±0,45	12,98±0,88	>0,05
IOP at 6 Months Postoperatively(mmHg)	13,53±0,44	13,05±0,41	12,95±0,66	>0,05
IOP at 18 Months Postoperatively(mmHg)	13,82±0,46	13,33±0,34	13,82±0,69	>0,05
IOP at 36 Months Postoperatively(mmHg)	13,95±0,60	13,84±0,37	13,81±0,65	>0,05
IOP at 48 Months Postoperatively(mmHg)	13,47±0,45	13,63±0,35	13,39±0,74	>0,05
IOP, intra ocular pressure				

Table 3. *Distribution of Patients by Number of Postoperative Antiglaucoma Medications*

Number of Antiglaucoma Drugs Prescribed After Surgery	Group 1(n)	Group 2(n)	Group 3(n)	p
Monotherapy (One Antiglaucoma Agent)	1 (1,6%)	7 (4,7%)	1 (1,4%)	<0,05
Dual Therapy (Two Antiglaucoma Agents)	11 (17,5%)	16 (10,7%)	17 (24,6%)	<0,05
Triple Therapy (Three Antiglaucoma Agents)	7 (11,1%)	11 (%7,4%)	9 (13,0%)	<0,05
Maximal Medical Therapy (Four Antiglaucoma Agents)	6 (9,5%)	5 (3,4%)	4 (5,8%)	<0,05

n,number. Monotherapy refers to the use of a single antiglaucoma agent (prostaglandin analogue, beta-blocker, alpha-2 agonist, carbonic anhydrase inhibitor, or oral carbonic anhydrase inhibitor). Dual therapy involves a combination of any two of these agents. *Triple or maximal therapy* to treatment regimens combining more than two different antiglaucoma agents

Table 4. *Complication and needing rates of patients*

		Patients	Group 1(n)	Group 2(n)	Group 3(n)	p
Complication						
	-	261 (92,9%)	60 (95,2%)	138 (92,6%)	63 (%91,3%)	>0.05
	+	20 (7,1%)	3 (4,8%)	11 (7,4%)	6 (%7,1%)	>0.05
Needling						
	-	238 (84%)	59 (93,7%)	125 (83,2%)	54 (76,8%)	<0.05
	+	43 (16%)	4 (6,3%)	24 (16,8%)	15 (23,2%)	<0.05

Complication -,patients without complications; Complication +, patients with complications; Needling-, patients without needling; Needling +, patients with needling;n, number

Table 5. Postoperative Complication Types Observed in Each Group

Group	Choroidal Detachment (n)	Anterior Chamber Hemorrhage(n)	Anterior Chamber Shallowness(n)	Total (n)
Group 1	2	1	-	3
Group 2	3	7	1	11
Group 3	1	3	2	6

n; number of the patients

Table 6. Success rates of patients						
Success	**Total(n)**	**Group 1(n)**	**Group2(n)**	**Group 3(n)**	**Avarege success times (month)**	**p**
Complete Success	159 (56,6%)	38 (60,3%)	87 (58,4%)	34 (49,3%)	46,88±0,80	<0.05
Partial success	67 (23,8%)	21 (33,3%)	29 (19,5%)	17 (24,6%)	41,42±1,20	<0.05
Unsuccess	55 (19,6%)	4 (6, %3)	33 (22,1%)	18 (26,1%)	38,38±2,05	<0.05

n, number; Complete success was defined as an intraocular pressure (IOP) between 5 and 21 mmHg without the use of any antiglaucoma medication. Partial success was defined as IOP in the same range with the use of antiglaucoma drugs. Failure was defined as IOP outside the target range, the need for additional surgery (excluding needling), or vision-threatening complications during the follow-up period; *Monotherapy refers to the use of a single antiglaucoma agent (*prostaglandin analogue, beta-blocker, alpha-2 agonist, carbonic anhydrase inhibitor, or oral carbonic anhydrase inhibitor*).* Dual therapy involves a combination of any two of these agents. Triple or maximal therapy to treatment regimens combining more than two different antiglaucoma agents

Table 7. *Comparison of patient data according to success status*

		Unsuccess	**Partial Success**	**Complete Success**	**p**
Age (year)		67,22± (34-86)	68,85±1,33 (33-88)	68,15±0,96 (28-94)	p>0.05
Baseline IOP Before Surgery (mmHg)		29,25±1,35 (12-54)	24,53±1,05[a] (8-49)	25,51±0,76[a] (10-58)	p<0.05
IOP at 1 Months Postoperatively (mmHg)		17,21±1,14 (2-41)	12,50±0,50[a] (3-21)	11,83±0,35[a] (2-23)	p<0.05
IOP at 6 Months Postoperatively (mmHg)		16,81±0,98 (6-36)	12,53±0,42[a] (3-20)	12,11±0,29[a] (5-20)	p<0.05
IOP at 18 Months Postoperatively (mmHg)		18,12±0,86 (5-40)	12,56±0,35[a] (5-22)	12,44±0,25[a] (1-20)	p<0.05
IOP at 36 Months Postoperatively (mmHg)		18,44±1,01 (7-45)	13,14±0,34[a] (5-19)	12,60±0,24[a] (1-19)	p<0.05
IOP at 48 Months Postoperatively (mmHg)		16,50±1,04 (5-45)	13,52±0,35 (6-19)	12,51±0,25[a] (5-19)	p<0.05
Gender	Female	10 (%18,2)	31 (%46,3)	80 (%50,3)	p<0.05
	Male	45 (%81,8)	36 (%53,7)	79 (%49,7)	
Presence of Pseudoexfoliation (PEX)	-	15 (%27,3)	23 (%34,3)	60 (%37,7)	p>0.05
	+	40 (%72,7)	44 (%65,7)	99 (%62,3)	
Complication	-	50 (%90,9)	65(%97)	146 (%91,8)	p>0.05
	+	5 (%9,1)	2 (%3)	13 (%8,2)	
Needling	-	23 (%41,8)	62 (%92,5)	151 (%95)	p<0.05
	+	32 (%58,2)	5 (%7,5)	8 (%5)	

Table 7. *Comparison of patient data according to success status*

		Unsuccess	Partial Success	Complete Success	p
Number of Antiglaucoma Drugs Prescribed Before Surgery	Monotherapy (One Antiglaucoma Agent)	1 (%1,6)	7 (%4,7)	1 (%1,4)	p>0.05
	Dual Therapy (Two Antiglaucoma Agents)	11 (%17,5)	16 (%10,7)	17 (%24,6)	p>0.05
	Triple Therapy (Three Antiglaucoma Agents)	7 (%11,1)	11 (%7,4)	9 (%13,0)	p>0.05
	Maximal Medical Therapy (Four Antiglaucoma Agents)	6 (%9,5)	5 (%3,4)	4 (%5,8)	p>0.05
Number of Antiglaucoma Drugs Prescribed After Surgery	Monotherapy (One Antiglaucoma Agent)	1 (%1,6)	7 (%4,7)	1 (%1,4)	p<0.05
	Dual Therapy (Two Antiglaucoma Agents)	11 (%17,5)	16 (%10,7)	17 (%24,6)	p<0.05
	Triple Therapy (Three Antiglaucoma Agents)	7 (%11,1)	11 (%7,4)	9 (%13,0)	p<0.05
	Maximal Medical Therapy (Four Antiglaucoma Agents)	6 (%9,5)	5 (%3,4)	4 (%5,8)	p<0.05

PEX:,pseudoexfoliation; PEX -, patients without PEX; PEX +, patients with PEX; Complication -,patients without complications; Complication +, patients with complications; Needling-, patients without needling; Needling +, patients with needling; IOP, intraocular pressure ;Complete success was defined as an intraocular pressure (IOP) between 5 and 21 mmHg without the use of any antiglaucoma medication. Partial success was defined as IOP in the same range with the use of antiglaucoma drugs. Failure was defined as IOP outside the target range, the need for additional surgery (excluding needling), or vision-threatening complications during the follow-up period ; Post hoc comparisons were performed using the Tukey HSD test following ANOVA, and the Dunn test with Bonferroni correction following the Kruskal-Wallis test where applicable. A p-value < 0.05 was considered statistically significant

Table 8. *Cox Regression Analysis of Factors Affecting Surgical Success*

Variable	Category	p for Complete Success	HR (95% CI) - Complete	p for Partial Success	HR (95% CI) - Partial
Groups	2	0.461	1.154 (0.788–1.689)	0.207	0.696 (0.397–1.221)
Groups	3	0.885	1.035 (0.652–1.644)	0.841	0.937 (0.494–1.775)
Interval Between Trabeculectomy and Phacoemulsification Surgeries (months)		0.569	0.996 (0.981–1.010)	0.422	1.007 (0.991–1.023)
Age (years)		0.891	0.999 (0.986–1.012)	0.688	1.004 (0.983–1.026)
Baseline IOP Before Surgery (mmHg)		0.698	1.003 (0.987–1.020)	0.542	0.992 (0.965–1.019)
Gender	Female	1	Reference	1	Reference
Gender	Male	0.637	1.078 (0.790–1.471)	0.720	0.916 (0.567–1.481)
Presence of Pseudoexfoliation (PEX)	No	1	Reference	1	Reference
Presence of PEX	Yes	0.757	0.951 (0.690–1.310)	0.704	1.103 (0.666–1.826)
Complication	No	1	Reference	1	Reference
Complication	Yes	0.428	1.258 (0.713–2.219)	0.246	0.435 (0.106–1.776)
Needling	No	1	Reference	1	Reference
Needling	Yes	0.544	0.802 (0.394–1.634)	0.660	1.227 (0.493–3.052)
Number of Antiglaucoma Drugs Prescribed Before Surgery	Monotherapy	1	Reference	1	Reference
	Dual Therapy	0.859	1143.500 (0.000–6616.000)	0.260	0.273 (0.028–2.622)
	Triple Therapy	0.862	983.032 (0.000–5677.000)	0.346	0.375 (0.049–2.884)
	Maximal Medical Therapy	0.859	1150.590 (0.000–6640.000)	0.198	0.268 (0.036–1.990)
Number of Antiglaucoma Drugs Prescribed After Surgery	Monotherapy	1	Reference	1	Reference
	Dual Therapy	0.887	38850.246 (0.000–8635.000)	0.755	0.000 (0.000–3.125)
	Triple Therapy	1.000	1.000 (0.000–4.191)	1.000	1.000 (0.351–2.851)
	Maximal Medical Therapy	0.917	2353.435 (0.000–5.265)	0.881	0.939 (0.414–2.133)

PEX: pseudoexfoliation; IOP: intraocular pressure ,Complication -: patients without complications, Complication +: patients with complications, Needling -: patients without needling, Needling +: patients with needling, Post hoc comparisons were performed using the Tukey HSD test following ANOVA, and the Dunn test with Bonferroni correction following the Kruskal-Wallis test where applicable. A p-value < 0.05 was considered statistically significant.

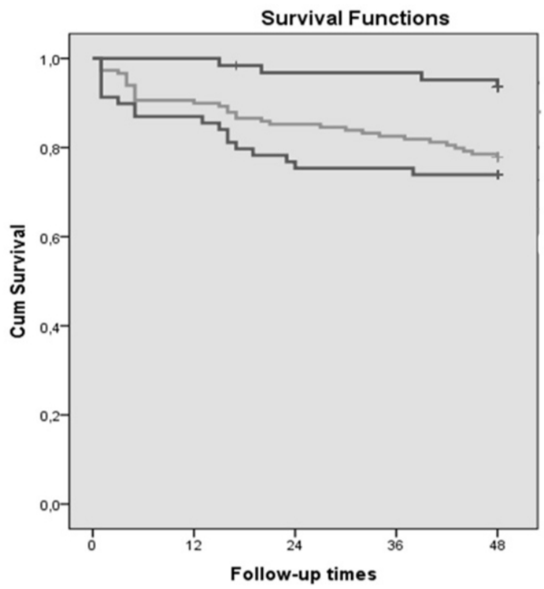

Figure 1: *Kaplan-Meier Survival Curves for Cumulative Survival*

The Kaplan-Meier survival curves illustrate the cumulative survival over the follow-up period (in months) for three different groups. The upper curve represents Group 1, the middle curve represents Group 2, and the lower curve represents Group 3. The y-axis shows the cumulative survival probability, while the x-axis indicates the follow-up time in months. Censored observations are marked with a tick on the curves.

DISCUSSION

Many elderly patients with glaucoma also develop cataracts, complicating treatment; around 10% of individuals over 65 with glaucoma have cataracts [6]. When glaucoma patients are unresponsive to medical treatment, trabeculectomy may be necessary to enhance drainage and lower intraocular pressure, but this can be challenging in patients with concurrent cataracts or posterior cataract development following trabeculectomy delaying cataract surgery can hinder visual rehabilitation [6] . Thus, determining the most effective treatment strategy for these patients remains a significant concern in ophthalmology. Postoperative IOP tends to be lower in eyes that undergo phacoemulsification alone, and this decrease is more pronounced in glaucoma patients[7]. However, phacoemulsification alone may not effectively manage glaucoma, whereas combined surgeries generally yield better results. Studies from 2014 and 2015 indicate that patients undergoing combined surgery experience lower IOP compared to those receiving only phacoemulsification [8,9]. While both trabeculectomy and cataract surgery similarly reduce IOP [6], the absence of antimetabolites in the studied eyes raises questions about their potential influence on surgical success. Considering cataract surgery first could lead to unbalanced IOP changes, risking optic disc damage [10]. Both cataract surgery and other interventions can lead to prolonged inflammation and disrupt the blood-aqueous barrier, negatively affecting trabeculectomy outcomes [11]. Conversely, lens removal before trabeculectomy may enhance anterior chamber depth, improving surgical outcomes [6]. In combined surgeries, this depth can be maintained, and trabeculectomy can contribute to lower postoperative IOP. If IOP reduction is insufficient after phacoemulsification, preserving conjunctival integrity becomes crucial for successful trabeculectomy [12]. In this study, Group 1 achieved the highest success rates, while Group 3 exhibited the highest needling rates, marking it as the least successful group. The success of trabeculectomy can decline following phacoemulsification surgery[13], however, this decrease in success rate is not seen in every case [14]. Studies indicate that eyes with low visual acuity, low preoperative IOP, and shorter intervals between surgeries tend to experience worse outcomes after phacoemulsification following trabeculectomy[15]. Monitoring inflammation closely during the initial surgical phase is recommended to improve success rates, with literature suggesting a wait of at least one year between surgeries may be beneficial [16].

In our study, Group 3 demonstrated the lowest overall success rates. This finding may be attributed to the shorter interval between surgeries in some patients, potentially leading to incomplete resolution of postoperative inflammation before the second procedure. In our study, the lower success rate observed in Group 3 may be attributed to the early timing of phacoemulsification following trabeculectomy. Although the mean interval between surgeries was 22 months, some patients underwent cataract surgery as early as one month postoperatively. Previous studies have indicated that early phacoemulsification may compromise bleb function and increase the risk of trabeculectomy failure, particularly in eyes treated with mitomycin-C [17-19]. Our findings are consistent with these reports, suggesting that performing cataract surgery before sufficient bleb stabilization may negatively affect long-term outcomes.

In the current study, the small sample size might have made it more difficult to draw definitive conclusions.

Conversely, a recent study by Tekcan et al.[20] found that uneventful phacoemulsification after trabeculectomy did not significantly impair IOP control in eyes with PEXG or POAG . Moreover, in PEX patients, cataract surgery appeared to delay IOP deterioration and reduce the need for additional glaucoma interventions. Their findings also highlighted that the only independent risk factor for trabeculectomy failure was an IOP spike within the first 24 hours postoperatively.

A review of the literature reveals conflicting evidence regarding the outcomes of combined surgeries. While some studies have reported that combined procedures yield results comparable to trabeculectomy alone [9], others have suggested that the success rates may be lower with combined approaches [21] However, advancements in cataract surgery techniques have led to better postoperative inflammation control and have been associated with lower IOP levels in combined surgeries [22].Moreover, the development of cataracts following trabeculectomy can negatively affect patient comfort and visual quality, further supporting the potential advantages of addressing both conditions simultaneously when appropriate [9].In this study, some patients required phacoemulsification just one month after trabeculectomy.

Determining the most effective surgical procedure among the three discussed remains challenging due to the heterogeneity of existing studies. Variations in sample sizes, patient ages, follow-up durations, types of glaucoma, and the usage and dosage of anti-metabolites complicate direct comparisons [23]. Some studies classify postoperative antiglaucomatous medication and needling as failures, while others view them as standard outcomes. Success is often defined by maintaining IOP within a specific range, yet some studies fail to account for differing levels of postoperative medication across groups [13, 24, 25].

In elderly patients, bleb fibrosis may be less severe [23], allowing for a more significant reduction in IOP [5]; however, achieving lower IOP levels may not always halt glaucoma progression, especially in cases of severe optic nerve damage. Many studies also lack data on visual field and retinal nerve fiber layer (RNFL) assessments, hindering comprehensive evaluations of surgical outcomes [26]. Several factors, such as tight fornix-based conjunctival sutures, the use of mitomycin C, and the avoidance of hypotony, have been linked to enhanced surgical success [13, 25, 27]. Despite initial success, the potential for bleb function to deteriorate over time is a notable concern [23]. In a meta-analysis comparing complication frequencies in three groups, it was found that complications were less common in combined surgeries with a maximum of three procedures [28] and another study showed that combined surgeries did not increase complications [2]. The present study also supported this argue.

Although needling is often considered part of the surgical continuum,[5] it was also evaluated in terms of its association with surgical success. Given that needling is typically performed in cases of bleb fibrosis, it does not directly influence aqueous outflow through newly created drainage pathways[23]. Rather, the procedure aims to restore or enhance filtration in fibrotic, partially failing blebs. Therefore, blebs requiring needling are inherently more fibrotic and prone to failure [29]. In the current study, in groups where needling was performed more frequently, overall success rates tended to be lower compared to other groups. However, needling did not appear to significantly affect long-term disease progression.

The role of PEX in surgical success remains debated. While some studies suggest it does not impact outcomes[9, 30], others indicate it may influence surgical choice and effectiveness. PEX is often associated with cataract formation. Additionally, the occurrence of PEX can lead to complications, regardless of the type of surgery or surgical technique used [23, 25] . In patients with PEX who undergo combined surgery, there is a higher incidence of IOP peaks, secondary surgical interventions, and needling [27]. Furthermore, unlike patients with OAG those with PEX experience a shorter duration of accelerated IOP decrease over time [6]. This may also contribute to the higher postoperative drug use observed in patients with PEX [5, 24]. It is important to consider studies that offer a different perspective, as some have found that IOP decreases more in the occurrence of PEX, particularly in combined surgeries [2, 25]. In the present study, no effect of PEX on both success and survey was observed. However, although it was not statistically significant, the number of patients with PEX was higher in the least successful group.

Notably, bleb morphology was not evaluated via imaging techniques, limiting the understanding of the outcomes. High needling rates in the combined surgery group suggest a need for further exploration. Additionally, visual field testing and RNFL analyses were often unfeasible due to cataract presence, which restricted their inclusion in the evaluation criteria. Despite these limitations, the patient groups in this study exhibited similar characteristics and received consistent preoperative treatment, ensuring that the surgical techniques applied were uniform across all groups.

CONCLUSIONS

Phacotrabeculectomy demonstrated comparable success rates to trabeculectomy alone, with the additional benefit of faster visual recovery. Given its favorable safety profile and the efficiency of addressing both glaucoma and cataract in a single session, combined surgery should be considered a viable first-line option for patients with coexisting cataract and glaucoma. These findings support incorporating surgical planning tailored to the patient's visual needs and glaucoma severity, potentially improving long-term functional outcomes.

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