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Comparative Analysis of Filtering Surgery Approaches in Non-Granulomatous Uveitic Glaucoma: Combined or Standalone?

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Abstract

Objectives: To compare the 36-month outcomes of trabeculectomy alone versus combined phacotrabeculectomy in patients with non-granulomatous uveitic glaucoma (UG), focusing on intraocular pressure (IOP) control, surgical success, and postoperative intervention requirements.

Methods: In this retrospective cohort study, 62 eyes with medically uncontrolled non-granulomatous UG were included. Patients were divided into two groups: Group 1 underwent combined phacoemulsification and trabeculectomy, while Group 2 underwent trabeculectomy alone. Preoperative and postoperative IOP measurements were evaluated over 36 months. Surgical success was defined as IOP between 5 and 21 mmHg, without additional glaucoma procedures or significant vision loss. Postoperative complications, medication requirements, and needling rates were also assessed.

Results: The mean follow-up period was 36 months. The cumulative surgical success rate was higher in the combined group (88.2%) than in the trabeculectomy-alone group (71.1%), although the difference was not statistically significant ($p > 0.05$). Needling was significantly more frequent in Group 2 ($p < 0.05$), and more patients in Group 2 required antiglaucomatous medications postoperatively. No significant differences in complication rates or visual outcomes were observed between the groups.

Conclusion: Both surgical approaches provide effective IOP control in uveitic glaucoma; however, combined surgery may result in fewer postoperative interventions and a trend toward improved 36-month surgical success. Careful patient selection and inflammation control remain crucial in optimizing outcomes.

Keywords: Uveitic glaucoma; Trabeculectomy; Phacotrabeculectomy; Intraocular pressure; Surgical outcome.

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Granülomatöz Olmayan Üveitik Glokomda Filtreleme Cerrahisi Yaklaşımlarının Karşılaştırmalı Analizi: Kombine, Tek Başına?

Öz

Amaç: Granülomatöz olmayan üveitik glokom (ÜG) hastalarında yalnız trabekülektomi ile kombine fakotrabekülektomi cerrahisinin 36 aylık sonuçlarını karşılaştırmak; özellikle göz içi basıncı (GİB) kontrolü, cerrahi başarı oranı ve postoperatif müdahale gereksinimlerine odaklanmak.

Yöntemler: Bu retrospektif kohort çalışmaya, medikal tedaviye dirençli granülomatöz olmayan ÜG tanısı almış 62 göz dâhil edildi. Hastalar iki gruba ayrıldı: Grup 1'e kombine fakoemülsifikasyon ve trabekülektomi uygulandı, Grup 2'ye yalnız trabekülektomi yapıldı. Preoperatif ve postoperatif GİB ölçümleri 36 ay boyunca izlendi. Cerrahi başarı, GİB'in 5–21 mmHg aralığında olması, ek glokom cerrahisi ihtiyacının olmaması ve belirgin görme kaybının gelişmemesi kriterleriyle tanımlandı. Postoperatif komplikasyonlar, medikal tedavi ihtiyacı ve needling oranları da değerlendirildi.

Bulgular: Ortalama takip süresi 36 ay idi. Kümülatif cerrahi başarı oranı kombine grupta (%88,2), yalnız trabekülektomi grubuna (%71,1) kıyasla daha yüksek olmakla birlikte, bu fark istatistiksel olarak anlamlı değildi ($p > 0,05$). Needling uygulaması Grup 2'de anlamlı düzeyde daha sık gözlendi ($p < 0,05$) ve bu gruptaki hastaların daha fazla kısmı postoperatif dönemde antiglaukomatöz tedaviye ihtiyaç duydu. Gruplar arasında komplikasyon oranları ve görsel sonuçlar açısından anlamlı fark saptanmadı.

Sonuç: Her iki cerrahi yöntem de üveitik glokomda etkili GİB kontrolü sağlamaktadır. Bununla birlikte, kombine cerrahi daha az postoperatif müdahale gereksinimi ve 36 aylık dönemde daha yüksek cerrahi başarı eğilimi göstermektedir. Uygun hasta seçimi ve inflamasyonun optimal kontrolü, cerrahi başarının artırılmasında kilit öneme sahiptir.

Anahtar kelimeler: Üveitik glokom; Trabekülektomi; Fakotrabekülektomi; Göz içi basıncı; Cerrahi sonuç.

INTRODUCTION

Uveitic glaucoma (UG), a secondary glaucoma subtype, is a significant cause of visual morbidity in patients with uveitis, with prevalence estimates ranging from 10% to 20% depending on uveitis type and chronicity[1]. The pathophysiology of UG is multifactorial and involves inflammation-induced trabecular meshwork damage, synechial angle closure, and corticosteroid-related intraocular pressure (IOP) elevation[2]. Surgical treatment is often required in refractory cases, with trabeculectomy and tube shunt surgeries being among the most commonly preferred approaches[3].

While trabeculectomy remains the standard filtering procedure, its outcomes in UG are limited by postoperative inflammation, bleb failure, and hypotony[3]. Combining trabeculectomy with phacoemulsification in visually significant cataracts is clinically desirable, but outcomes remain controversial. Some studies suggest a higher risk of surgical failure when cataract surgery follows trabeculectomy[4], while others support simultaneous surgery for improved control[5]. Recent data have highlighted the benefits of anti-fibrotic modulation (e.g., mitomycin-C) and meticulous postoperative care in enhancing surgical success rates in UG patients[6].

To date, few studies have directly compared 36-month outcomes between trabeculectomy alone and phacotrabeculectomy in UG. When the above-mentioned literature is reviewed it becomes evident that uveitic glaucoma represents one of the most challenging forms of secondary glaucoma due to its complex pathophysiology, fluctuating inflammatory activity, and variable response to both medical and surgical treatment. Despite its clinical

significance, there is limited evidence directly comparing surgical strategies—particularly trabeculectomy and combined phacotrabeculectomy—in non-granulomatous uveitic glaucoma, which is the most prevalent subtype[1-6]. Previous reports have provided heterogeneous outcomes, often confounded by differences in uveitis type, surgical technique, and follow-up duration. By analyzing a well-defined cohort with consistent surgical protocols and a 36-month follow-up, this study provides robust comparative data on intraocular pressure control, surgical success, and complication profiles. These findings are clinically relevant because they can guide ophthalmic surgeons in tailoring surgical approaches to optimize outcomes in this high-risk population, where timely and individualized decision-making is critical to preserving vision. This study seeks to fill an existing gap in the literature by evaluating a well-defined cohort of patients with non-granulomatous uveitic glaucoma managed under standardized surgical protocols. Specifically, it compares the 36-month outcomes of trabeculectomy alone and combined phacotrabeculectomy, with emphasis on intraocular pressure (IOP) control, surgical success, adjunctive postoperative procedures, and complication rates, thereby providing evidence to inform optimal surgical decision-making in this complex patient population.

METODS

This retrospective study scanned 450 eyes that underwent trabeculectomy or combined surgery for glaucoma at Maltepe University glaucoma clinic and Eskişehir Osmangazi University glaucoma clinic between 2005 and 2022. Maltepe University institutional review board approved the study protocol (number 2019/900/25; date 17.04.2019), which adhered to the tenets of the Declaration of Helsinki. Although the study was retrospective, patients who applied to the glaucoma clinic knew that their information would be archived for scientific purposes, and consent forms were obtained from the patients.

The inclusion criteria: preoperative diagnosis of uveitic glaucoma and no glaucoma secondary (neovascularization, tumor, pseudoexfoliation, or pigmentation, etc.), and no previous history of trauma to the eye.

The exclusion criteria: patients who had undergone glaucoma surgery previously (e.g., trabeculectomy, micro-invasive surgery, glaucoma device surgery, or diode laser), cataract surgery, or vitrectomy before or after trabeculectomy surgery; patients with glaucoma before diagnosis of uveitis.

According to the International Uveitis Study Group criteria[7], all patients were diagnosed with non-granulomatous anterior uveitis (fine keratic precipitates without iris or choroidal nodules). Subtypes were further classified as HLA-B27–associated, viral, or idiopathic anterior uveitis, Fuchs uveitis, and Behçet uveitis based on clinical features and laboratory work-up when available.

Overall, sixty-two patients were evaluated. demographic and clinical data were recorded, including sex, age, preoperative IOP, number of antiglaucoma medications, and presence of PAS. In addition, the use of systemic immunosuppressive therapy (type, dose, and any perioperative adjustments) was documented. These patients were divided into two groups: Group 1, the combined-surgery group (both phacoemulsification surgery and trabeculectomy were performed in the same surgical session); and Group 2, the trabeculectomy alone group, which was considered the control group.

Patient records were reviewed for surgical procedures. Surgical indication was established in eyes with uncontrolled IOP despite maximally tolerated medical therapy, documented functional progression on standard automated perimetry and/or

structural progression on OCT of the RNFL/optic nerve, or in the presence of synechial angle compromise, consistent with prior literatüre[2]. Surgery was scheduled during quiescence to minimize the risk of postoperative flare; all patients underwent surgery during a quiescent period of at least six months without active anterior chamber inflammation[8].

However, due to practical limitations, these criteria could not be uniformly applied to all patients. Visual field testing was not feasible in some individuals, Optical Coherence Tomography was not available in our clinic until 2008, and in certain cases, insufficient patient cooperation prevented reliable assessment. Herefore, although not every criterion was fulfilled in all patients, surgical decisions were made on a case-by-case basis by the glaucoma unit supervisors, taking into account the available clinical data, particularly in eyes with intraocular pressure that was not adequately reduced despite medical therapy.

Perioperative management included standard topical corticosteroid prophylaxis[8], but no additional systemic immunosuppressive therapy was initiated solely for the purpose of surgery. Patients with presumed herpes-related anterior uveitis received oral antiviral therapy (acyclovir 400 mg), whereas those with presumed CMV-associated uveitis did not undergo systemic antiviral treatment[9]. Separate incisions were used for each procedure for patients undergoing combined surgery. A superior fornix-based rectangular bleb 4 × 3 mm was created for trabeculectomy. 0.02% Mitomycin C was applied under the bleb to all patients for five minutes during surgery.

Indications for phacoemulsification in our cohort included visually significant lens opacity, affecting daily activities or precluding fundus/glaucoma evaluation, cataract contributing to angle compromise or elevated IOP, and eyes in which inflammation had been quiescent for at least six months under

appropriate medical therapy, consistent with previously published recommendations[10]. The phacoemulsification surgery procedure was performed using a temporal precise corneal incision, and the patient's conjunctiva was not touched. A hydrophobic acrylic posterior chamber intraocular lens (IOL) was implanted in all cases undergoing combined surgery.

Gonioscopic examinations were performed using the Goldman lens at each visit to assess the angle, the presence of peripheral anterior synechia (PAS), and the number of quadrants involved by PAS at the angle. Trabeculectomy surgery was not preferred preoperatively for patients with PAS in the superior half, especially those who would undergo combined surgery. Preoperative, postoperative 1st, 6th, 12th, 24th, and 36th month IOP values were measured by Goldman applanation tonometer. Vision was assessed using the Snellen chart.

After trabeculectomy, patients were prescribed topical antibiotics (ofloxacin drops) five times a day for two weeks and topical corticosteroids (dexamethasone drops) eight to six times for two months. The steroid was tapered down and then stopped. Intraoperative and postoperative surgical complications were reviewed. Complications often described similarly in the literature, such as hyphema, choroid effusion, subrachoroidal hemorrhage, early hypotonia, late wound leakage, and endophthalmitis were noted[11].

Success was defined as an IOP between 5–21 mmHg without or with medications, no loss of vision due to glaucoma, no postoperative vision-threatening complications, and no need for additional glaucoma procedure to control the IOP (such as seton implant or other glaucoma devices, trabeculectomy, diode laser, etc.) at the end of 3 years. Laser suture lysis or bleb needling within 6 months was not

considered a surgical failure as it was a postoperative management[11].

Statistical Analysis

NCSS 2020 Statistical Software (NCSS LLC, Kaysville, Utah, USA) program was preferred for analysis. Quantitative variables were determined with mean, standard deviation, median, minimum and maximum values, qualitative variables were determined by descriptive statistical methods like frequency and percentage. Data for normal distribution, Shapiro-Wilks test and Box Plot plots were used. Student's t-test was preferred for quantitative two-group evaluations and normal distribution was checked. The Mann-Whitney-U test was used to measure the variables that were not normally distributed between the two groups. Friedman test was preferred for in-group evaluations. Chi-square and Fisher's Exact tests were preferred for the comparison of qualitative data. Kaplan-Meier curves and Log Rank test were used for survival data. Results were accepted at 95% confidence interval and $p < 0.05$ significance level.

RESULTS

In the current study, 46.8% (n = 29) of the patients were female, 53.2% (n = 33) were male, and the study was conducted with 62 cases. Among the study population, 37 patients were diagnosed with idiopathic anterior uveitis, while 10 patients had HLA-B27–associated uveitis, 5 patients Fuchs uveitis and 5 patients had Behçet's uveitis. In addition, viral etiology was suspected in 5 patients: three cases were clinically considered to represent herpes simplex/zoster–related anterior uveitis and two cases were presumed to have CMV-associated anterior uveitis. It should be noted that polymerase chain reaction (PCR) analysis was not performed; therefore, the diagnosis of viral uveitis in these cases was based on clinical findings rather than molecular confirmation. In the group 1, there were 9 patients with idiopathic uveitis, 3 patients with Fuchs' uveitis, and 5 patients with HLA-B27–associated uveitis.

The ages of the patients participating in the study ranged from 22 to 77, and the mean age was 47.40 ± 12.93 years. Patients' demographics and clinical characteristics are shown in Table 1. Among the 57 patients without viral uveitis, 11 individuals with idiopathic anterior uveitis did not receive any systemic therapy. The remaining patients were managed with conventional immunomodulatory agents, including azathioprine, methotrexate, mycophenolate mofetil, and cyclosporine, either as monotherapy or in combination. In addition, selected cases were treated with biologic agents such as adalimumab or infliximab, administered alone or alongside conventional therapies, depending on clinical response and disease severity. Patients with presumed herpes-related anterior uveitis received oral antiviral therapy (acyclovir 400 mg), whereas those with presumed CMV-associated uveitis did not undergo systemic antiviral treatment. All patients were in remission for at least six months prior to undergoing surgery. The vision was found to be 0.48 ± 0.36 in UG patients. PAS in the superior quadrant was not identified in any of the patients. 55 cases were of open-angle configuration, confirmed by gonioscopy, and that eyes with superior half peripheral anterior synechiae were excluded. PAS was located temporally or nasally in two patients in Group 1 and in five patients in Group 2. Post-operative new PAS formation was not observed in any of the patients.

Table I: Comparison of descriptive characteristics by groups

Variables	Combined Surgery (n=17)	Trabeculectomy (n=45)	p-value
Sex (Female), n (%)	10 (58.8)	19 (42.2)	0.243
Sex (Male), n (%)	7 (41.2)	26 (57.8)	
Age (Mean ± SD)	54.88 ± 11.46	44.58 ± 12.43	0.004
Age (Median, Range)	54 (40–77)	43 (22–71)	
Preoperative Number of Antiglaucoma Medications (Mean ± SD)	3.59 ± 1.87	3.53 ± 1.65	0.813
Preoperative Number of Antiglaucoma Medications (Median, Range)	3 (1–7)	3 (1–7)	
Presence of Postoperative Complications,n (%)	0 (0.0)	4 (8.9)	0.568
Absence of Postoperative Complications,n (%)	17 (100.0)	41 (91.1)	
Presence of Needling, n (%)	2 (11.8)	18 (40.0)	0.034
Absence of Needling, n (%)	15 (88.2)	27 (60.0)	
Cases with Surgical Success n (%)	15 (88.2)	32 (71.1)	0.200
Cases Without Surgical Success, n (%)	2 (11.8)	13 (28.9)	
Time to Surgery During Follow-up (months) (Mean ± SD)	17.29 ± 16.24	25.29 ± 20.62	0.113
Time to Surgery During Follow-up (Median, Range)	10 (5–50)	11 (5–57)	
Duration of Postoperative Follow-up (months) (Mean ± SD)	3.00 ± 2.83	20.00 ± 12.10	0.002
Duration of Postoperative Follow-up (months) (Median, Range)	3 (1–5)	24 (3–33)	

n;number of the cases; Success was defined as an IOP between 5–21 mmHg without or with medications, no loss of vision due to glaucoma, no postoperative vision-threatening complications, and no need for additional glaucoma procedure to control the IOP (such as seton implant or other glaucoma devices, trabeculectomy, diode laser, etc.) at the end of 3 years; 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

Patients were divided into two groups: Group 1, combined-surgery group; Group 2, trabeculectomy alone group. Seventeen of the patients were in Group 1 and 45 of patients in Group 2. The patients in Group 1 were older than Group 2 ($p < 0.05$). The time gap between trabeculectomy and the initial diagnosis was shorter in Group 1 but it was not statistically significant ($p > 0.05$). There was no difference between the groups in terms of preoperative anti-glaucomatous drug use. Early hypotonia was found in four patients in Group 2, but there was not a statistically significant difference between the two groups. Needling was higher in Group 2 ($p < 0.05$). Cataract development was observed in 15 (37.5%) patients within three years who had trabeculectomy.

Preoperative and postoperative 1st, 6th, 12th, 24th, and 36th-month IOP values are shown in Table 2 and figure 1. There was no difference between the two groups for preoperative IOP values. Postoperative IOP values were higher in Group 2 ($p > 0.05$). The most significant IOP reduction was seen in Group 2, but as seen in Figure 1, after one month, IOP values remained close to each other for both groups ($p > 0.05$).

Table II: Comparison of IOP Follow Up by Groups

IOP	Combined Surgery Mean±SD	Trabeculectomy Mean±SD	p
Preoperative Measurement	27.41±8.37	29.47±10.56	0.474
1. month	16.65±3.64	13.53±4.86	0.020
6. month	14.24±3.51	15.71±4.37	0.218
12. month	13.88±3.00	16.18±5.71	0.105
24. month	12.94±2.79	14.89±7.44	0.578
36. month	13.41±3.79	16.44±7.53	0.119

IOP,Intra ocular preessure

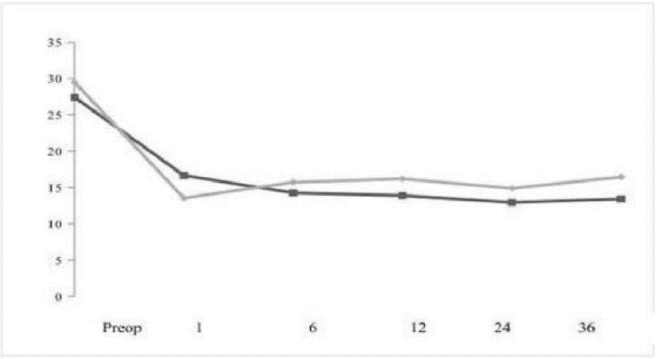

Figure 1. Changes of IOP measurements over time

The surgical success rate was higher in Group 1 ($p > 0.05$). The surgical success rate was 71.1% for trabeculectomy alone and 88.2% for combined surgery at the end of 36 months. While the one-year cumulative success rates were similar for the two groups, the success rates in Group 2 decreased after one year, but were not found to be statistically significant (Log Rank test, $p = 0.204$).

As seen Table 3, the number of patients whose follow-up was completed was higher in Group 2 ($p < 0.01$). When the success rates according to the groups were evaluated with the Log Rank test, there was no statistically significant difference between the groups for 3-year success rates. Survival analyses (Kaplan-Meier) are also shown in figure 2.

Table III: Survival Analysis by Groups

Group	Number of Patients Included in Follow-up	Cases Without Surgical Success (n)	Cases with Surgical Success(n)	Survival Rate	Avg. Survival (mo)	95% CI
Combined Surgery	17	2	15	88.2%	32.12±2.58	27.05 - 37.18
Trabeculectomy	45	13	32	71.1%	31.08±1.43	28.20 - 33.97

n;number of the cases

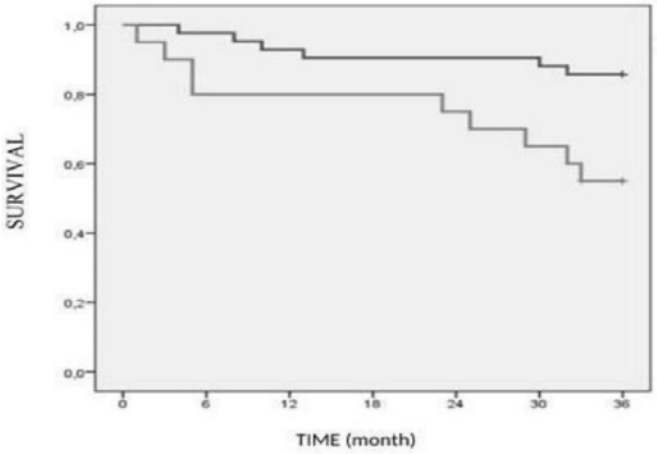

Figure 2. Survival analysis by groups

As seen in Table 4 and 5 for each group, the only factor affecting surgical success was the need for postoperative needling ($p < 0.05$). Age, gender, time for trabeculectomy, preoperative drug use, and the presence of complications did not affect the surgical success ($p > 0.05$).

Table IV: Comparison of Descriptive Characteristics by Surgical Success

Variable	Cases with Surgical Success	Cases Without Surgical Success	p
Sex Distribution (Female/Male) (n)	20/27	9/6	0.238
Age (Mean±SD)	46.19±12.83	51.2±12.95	0.220
Postoperative Number of Antiglaucoma Medications (Mean ± SD)	3.66±1.71	3.20±1.66	0.099
Postoperative Complication Status (Present/Absent)	3/44	1/14	1.000
Postoperative Needling Status (Present/Absent)	11/36	9/6	0.012
Time to Surgery During Follow-up (months)	24.72±20.71	18.00±15.74	0.364
Duration of Postoperative Follow-up (months)	33.00±0.00	16.87±12.46	-

n;number of the cases

Survival Analysis acording to needling are shown figure 3. During the three-year follow-up of the patients, no uveitis flare, cystoid macular edema, or posterior subcapsular opacity developed. During the postoperative follow-up, IOP-lowering agents were required in three patients in Group 1 and in twelve patients in Group 2. Surgical failure was observed in seven patients under medical therapy, all of whom were in Group 2.

Table V: Survival Analysis by Needling

Group	n	Number of Patients Included in Follow-up (n)	Cases Without Surgical Success (n)	Survival Rate	Avg. Survival (mo)	95% CI
Presence of Needling, n	42	6	36	85.7%	33.17±1.24	30.73-35.60
Absence of Needling, n	20	9	11	55.0%	27.60±2.82	22.07-33.13

n;number of the cases

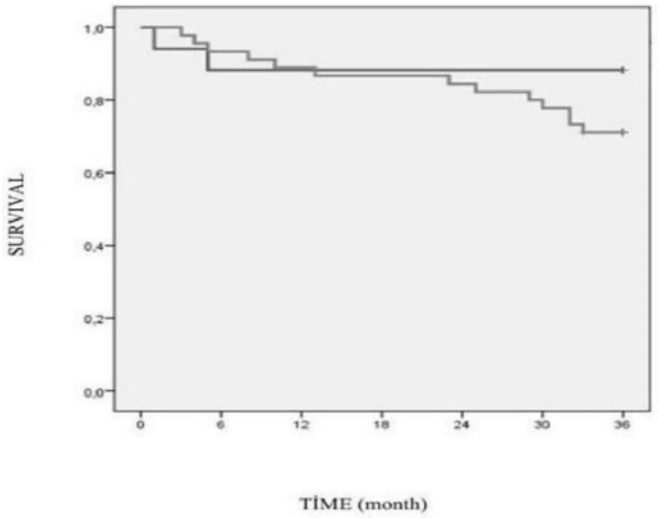

Figure 3. Survival analysis according to Needling

DISCUSSION

Surgical intervention in uveitic glaucoma (UG) (particularly when concomitant visually significant cataract mandates combined surgery) remains one of the most technically and clinically demanding domains of glaucoma care[11]. In the current study, both trabeculectomy alone and combined phacotrabeculectomy achieved meaningful intraocular pressure (IOP) reduction and durable control at 36 months. Surgical success was 88.2% in the combined group (Group 1) and 71.1% in the trabeculectomy-only group (Group 2), with early postoperative hypotony observed only in Group 2 and resolving without sequelae. No intraoperative or postoperative complications were recorded in Group 1. These findings, interpreted alongside the etiologic and clinical profile of the cohort (predominantly idiopathic anterior uveitis with additional HLA-B27–associated, Fuchs, Behçet, and a small subset of clinically diagnosed viral anterior uveitis) support the feasibility of both surgical strategies when meticulous perioperative inflammation control is ensured.

The burden and natural history of UG contextualize these observations. Large epidemiologic analyses indicate that approximately 15–20% of uveitis patients develop ocular hypertension or glaucoma over a decade, with the risk highest in anterior disease[12,13]. Moreover, UG is frequently the secondary glaucoma subtype that progresses to surgical management because medical therapy alone often fails to provide stable control amidst inflammatory fluctuations, steroid responsiveness, and synechial sequelae[14,15]. A recent national cohort estimated that roughly one in five uveitic patients ultimately undergoes a pressure-lowering procedure, underscoring the substantial surgical demand that UG imposes on tertiary services[13]. The present results align with this literature and reinforce that individualized planning (anchored in uveitis subtype, angle status, inflammatory activity, and lens status) is central to optimizing outcomes.

When benchmarked against prior series, the 36-month success rates fall within the reported ranges for UG filtering surgery. Early success rates for mitomycin-C (MMC)–augmented trabeculectomy in UG often approach 75–90%, but attrition over time yields long-term survival nearer to 44–79%, reflecting the cumulative impact of inflammatory and wound-healing biology on bleb function[3,16-19]. In this study, combined surgery achieved numerically higher survival at three years. Several features of the surgical protocol likely contributed: operations were scheduled during quiescence of at least six months; perioperative corticosteroid prophylaxis was standardized; conjunctival

manipulation during combined cases was minimized; and hydrophobic acrylic posterior chamber intraocular lenses were used, consistent with best-practice recommendations for uveitic cataract surgery[8-10]. These elements align with contemporary guidance that emphasizes aggressive inflammation control, careful IOL selection, and wound-healing modulation in UG[1,2,5,6,20].

The appropriate role of combined phacotrabeculectomy in UG remains debated. Some studies have linked simultaneous lens extraction to enhanced subconjunctival fibrosis, bleb encapsulation, and greater long-term failure risk, possibly because phacoemulsification-related cytokine release adds to the profibrotic milieu already primed by uveitis[6,21-25]. Conversely, others have observed comparable outcomes to staged approaches when inflammation is tightly controlled[26-28]. A large CBIITS-based analysis reported significantly lower five-year cumulative success in simultaneous phacotrabeculectomy (43%) compared with trabeculectomy followed by later cataract surgery (66.7%), and identified combined surgery as an independent risk factor for failure[29]. The three-year data presented here, which favored the combined group, should therefore be interpreted as products of stringent perioperative suppression and standardized technique; they do not preclude the possibility that with longer follow-up the balance may shift toward higher attrition due to bleb fragility and fibrosis, as suggested by prior work on bleb survival after cataract extraction[21,23-25,30]. Clinically, these nuances argue for tailoring the sequence of procedures to the patient: when cataract is visually limiting and inflammation is quiescent, combined surgery can be justified; otherwise, trabeculectomy followed by deferred cataract extraction may better preserve long-term bleb function.

The literature on cataract surgery's effect on IOP adds further context. A large IRIS® Registry analysis demonstrated that stand-alone phacoemulsification yields a small but statistically significant reduction in mean IOP from postoperative day 13 through day 90 in both glaucomatous and nonglaucomatous eyes[31]. However, uveitic cataract cohorts (particularly those undergoing manual small-incision cataract surgery (MSICS)) report nontrivial rates of postoperative glaucoma development and inflammatory complications, such as recurrent uveitis, cystoid macular edema (CME), and posterior capsule opacification (PCO), that may indirectly jeopardize pressure control[31]. These apparently conflicting signals likely reflect differences in patient selection (open vs compromised angle, synechiae), timing relative to inflammatory activity, and surgical technique. The methodology in this study, which mandated at least six months of remission and used standardized steroid prophylaxis[8-10], likely mitigated these risks.

The present results also resonate with broader 36-month glaucoma surgery data. An eight-year study from Thailand reported cumulative MMC-trabeculectomy success around 65.9% overall, with secondary glaucomas—UG chief among them—faring worse than primary open-angle disease; secondary angle closure and the need for bleb needling emerged as failure correlates[32]. Yet, when inflammation is adequately controlled, UG outcomes can approximate those of primary open-angle glaucoma (POAG), as evidenced by Kanaya et al., who observed similar 10-year success probabilities between UG and POAG after MMC-trabeculectomy[33]. The current cohort—restricted to non-granulomatous, predominantly open-angle eyes, operated in sustained quiescence, and frequently receiving systemic immunomodulatory therapy—

conforms to the clinical phenotype most likely to achieve POAG-like trajectories[34].

A central and distinctive observation in this analysis is the prognostic weight of postoperative bleb needling. Needling was the only variable significantly associated with surgical success in both groups; where it was required, survival was reduced. Clinically, needling is a marker of subconjunctival fibrosis and a surrogate for an aggressive wound-healing response—mechanisms repeatedly implicated in filtering failure in inflamed eyes[22,35]. The association detected here is consonant with prior reports identifying scarring and bleb encapsulation as pivotal failure pathways[23]. Contemporary series suggest that while needling can restore function in selected blebs, its necessity often portends a more tenacious fibrotic diathesis and higher subsequent attrition[36]. Importantly, in this cohort, combined surgery did not appear to increase fibrosis-related events relative to trabeculectomy alone; if anything, the needling burden was higher in Group 2. This pattern suggests that quiescent-phase combined surgery—when performed with minimal conjunctival trauma and rigorous steroid cover—does not inevitably amplify scarring risk.

In contrast to some earlier studies, the current analysis did not find statistically significant associations between surgical outcome and age, gender, timing since uveitis diagnosis, number of preoperative antiglaucomatous medications, or the presence of perioperative complications. Several explanations are plausible. First, the population was intentionally homogeneous (non-granulomatous cases only), which reduces etiologic and inflammatory variability that might otherwise manifest as demographic or clinical risk signals[16,18]. Second, the requirement for at least six months of remission before surgery likely attenuated the deleterious effects of active inflammation on early wound healing, thus blunting the influence of baseline factors reported in more heterogeneous or less stringently controlled cohorts[3,17-19]. Third, uniform surgical technique—consistent flap design, MMC concentration and exposure, and perioperative protocols—may have minimized variability attributable to operator factors. Finally, the analysis horizon was three years; longer follow-up can unmask time-dependent effects of age and medication exposure, as suggested in longitudinal series[30,32]. Together, these considerations help reconcile these "negative" findings with reports linking younger age, male gender, or prolonged preoperative therapy to poorer outcomes in mixed populations[17-19,30,33].

Complication profiles in this study were favorable. Early hypotony occurred only in Group 2 and resolved without structural or functional sequelae, consistent with literature describing hypotony as a recognized but typically manageable early event after MMC-trabeculectomy in uveitic or complex glaucomas[25,37]. No differential complication burden attributable to the addition of phacoemulsification was observed, again likely reflecting operation during quiescence and careful technique. Over three years, cataract progression was common after trabeculectomy alone (37.5%), a finding harmonizing with prior work implicating steroid exposure, inflammation, and bleb-sparing constraints during later cataract surgery as drivers of functional decline[25,30]. These practical considerations argue that, in carefully selected patients, early combined surgery can avert bleb-compromising cataract surgery later while delivering comparable IOP control—an inference compatible with aspects of the Kaplan–Meier trends and with case-control data under robust anti-inflammatory cover[26-28].

Alternative surgical modalities merit brief consideration. Comparative studies and systematic reviews suggest that tube shunts

(Ahmed, Baerveldt) and non-penetrating procedures (NPDS) can achieve effective pressure control in UG, though differences in failure modes and complication spectra must guide selection[1,5,6,22]. A recent retrospective cohort reported lower failure hazards with NPDS and Ex-PRESS compared with trabeculectomy over three years, and highlighted reintervention needs in roughly one-third of eyes—figures that underscore both the potential and the fragility of long-term control in UG[38]. Cyclophotocoagulation (CPC) also retains a role, particularly for refractory or multiply operated eyes, though inflammation-related risks and hypotony must be weighed carefully[22]. Selective laser trabeculoplasty has shown promise in selected UG cases, yet its efficacy and safety remain contingent on inflammatory status and angle integrity[4]. In this study, no eye required secondary tube or CPC within 36 months, but the literature cautions that reoperations are more frequent in UG than in primary glaucomas: an institutional analysis reported an overall resurgery rate of 2.6% after primary glaucoma surgery, rising to 12.1% in UG; notably, trabeculectomy failures were the most common triggers for reintervention[39]. Pediatric data illustrate further complexity: while trabeculectomy outcomes can resemble those in steroid-induced pediatric glaucoma, phacotrabeculectomy in pediatric UG has been associated with higher final IOP and worse visual prognosis, and younger age independently predicts failure[40]. These observations counsel prudence in extending adult paradigms to pediatric UG.

This study has strengths and limitations germane to interpretation. Strengths include the focus on a well-defined non-granulomatous, predominantly open-angle population; strict remission-based timing for surgery; standardized MMC-augmented technique; and availability of consistent 36-month follow-up permitting survival analysis. Limitations include retrospective design, single-center setting, modest sample size (especially in the combined arm), and the three-year horizon that may not capture late bleb attrition. Furthermore, while perioperative protocols were standardized, small variations in technique or postoperative titration are unavoidable in real-world practice and could influence outcomes. Finally, conclusions pertain to non-granulomatous UG and may not generalize to granulomatous entities, in which profibrotic signaling and steroid dependence can differ materially[16,17,23].

Nevertheless, the current study adds pragmatic evidence to the question of combined versus staged surgery in non-granulomatous UG. In eyes operated during quiescence with rigorous anti-inflammatory cover, combined phacotrabeculectomy yielded three-year survival at least comparable (if not numerically superior) to trabeculectomy alone, without added complications. The singular prognostic salience of needling in this cohort underscores that fibrosis and wound-healing biology (not demographic or medication-count surrogates) ultimately dictate bleb longevity in this phenotype[22,24,35]. Together with the broader literature (spanning comparative procedure studies, meta-analyses, and guideline-level syntheses)[1-6,22,27,35], these findings support an individualized, remission-timed surgical strategy with strict IOP targets, close follow-up, and early intervention for bleb-related scarring. Where angle anatomy, synechiae, or prior surgery complicate the picture, tubes, NPDS, Ex-PRESS, or CPC may be judicious alternatives[1,5,6,22,37,38]. Ultimately, refining patient selection and perioperative wound-healing modulation—and extending follow-up beyond three years—are likely to yield the next increments in durable success for uveitic glaucoma surgery.

CONCLUSION

In the current study, both trabeculectomy and combined phacotrabeculectomy were shown to be effective surgical options for the management of non-granulomatous uveitic glaucoma when performed during periods of remission under strict perioperative inflammation control. At 36 months, cumulative surgical success was slightly higher in the combined group, although the difference was not statistically significant. Importantly, the need for postoperative needling emerged as the only factor significantly associated with reduced surgical survival, underscoring the central role of subconjunctival fibrosis and wound-healing processes in long-term outcomes.

These results suggest that combined phacotrabeculectomy can be safely considered in patients with visually significant cataract without compromising glaucoma control, provided that inflammation is adequately suppressed. Furthermore, demographic variables, timing of surgery, preoperative medication burden, and the presence of complications were not predictive of surgical success in this series, which may reflect the homogeneity of the study population and the rigorous remission-based surgical protocol.

Given the chronic and relapsing course of uveitic glaucoma, individualized surgical planning remains essential, integrating uveitis subtype, lens status, inflammation control, and systemic therapy. Future multicenter, prospective studies with longer follow-up are warranted to validate these findings and to refine the prognostic factors that can guide surgical decision-making in uveitic glaucoma.

Ethical approval: This retrospective study scanned 450 eyes that underwent trabeculectomy or combined surgery for glaucoma at Maltepe University glaucoma clinic and Eskişehir Osmangazi University glaucoma clinic between 2005 and 2022. Maltepe University institutional review board approved the study protocol (number 2019/900/25; date 17.04.2019), which adhered to the tenets of the Declaration of Helsinki.

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REFERENCES

1. Lee SY, Kim YH, Kim KE, Ahn J. Comparison of surgical outcomes between trabeculectomy with mitomycin C and Ahmed valve implantation with mitomycin C in eyes with uveitic glaucoma. J Clin Med 2022; 11(5): 1368.

2. Halkiadakis I, Konstantopoulou K, Tzimis V, et al. Update on diagnosis and treatment of uveitic glaucoma. J Clin Med 2024; 13(5): 1185.

3. Almobarak FA, Alharbi AH, Morales J, Aljadaan I. Intermediate and long-term outcomes of mitomycin C-enhanced trabeculectomy as a first glaucoma procedure in uveitic glaucoma. J Glaucoma 2017; 26(5): 478-85.

4. Suzuki M, Takeuchi M, Meguro A, et al. Efficacy and safety of selective laser trabeculoplasty for uveitic glaucoma. Sci Rep 2025; 15(1): 4077.

5. Serhan HA, Ba-Shammakh SA, Hassan AK, et al. Effectiveness and safety of trabeculectomy versus tube shunt implantation for uveitic glaucoma: a systematic review and meta-analysis. Am J Ophthalmol 2024; 268: 319-28.

6. Chow A, Burkemper B, Varma R, et al. Comparison of surgical outcomes of trabeculectomy, Ahmed shunt, and Baerveldt shunt in uveitic glaucoma. J Ophthalmic Inflamm Infect 2018; 8(1): 9.

7. Jabs DA, Nussenblatt RB, Rosenbaum JT; Standardization of Uveitis Nomenclature (SUN) Working Group. Standardization of uveitis nomenclature for reporting clinical data. Results of the First International Workshop. Am J Ophthalmol 2005; 140(3): 509-16.

8. Mora P, Menozzi C, Orsoni JG, et al. Perioperative prophylaxis to prevent recurrence following cataract surgery in uveitic patients: a two-centre, prospective, randomized trial. Acta Ophthalmol 2016; 94(6): e390-4.

9. Uchoa UB, Rezende RA, Carrasco MA, et al. Long-term acyclovir use to prevent recurrent ocular herpes simplex virus infection. Arch Ophthalmol 2003; 121(12): 1702-4.

10. Agrawal R, Murthy S, Ganesh SK, et al. Cataract surgery in uveitis. Int J Inflam 2012; 2012: 548453.

11. Lim R. The surgical management of glaucoma: a review. Clin Exp Ophthalmol 2022; 50(2): 213-31.

12. Marshall RF, Lee D, Thorne JE, Kaleem M, Berkenstock MK. Incidence and prevalence of glaucoma, corticosteroid response, and ocular hypertension in uveitis and its anatomical subtypes. Am J Ophthalmol 2025; 278: 13-21.

13. Esen Barış M, Ateş H, Güven Yılmaz S. Prevalence and prognosis of glaucoma/elevated intraocular pressure in patients with uveitis. Turk J Ophthalmol 2025; 55(4): 215-20.

14. Felfeli T, Rhee J, Eshtiaghi A, et al. Long-term outcomes of noninfectious uveitis treated with systemic immunomodulatory therapy: a retrospective case series. Can J Ophthalmol 2025; 60(1): e133-43.

15. Asfuroğlu M, Zeki Fikret C, Kılıç M, Nalçacıoğlu P. Predictive factors for ocular hypertension and glaucoma secondary to uveitis: insights from a tertiary referral hospital. Ocul Immunol Inflamm 2025; 33(1): 1-7.

16. Almobarak FA, Alharbi AH, Aljadaan I, Aldhibi H. Long-term outcomes of initial trabeculectomy in glaucoma associated with granulomatous and non-granulomatous uveitis. Int Ophthalmol 2021; 41(10): 3459-70.

17. Almobarak FA, Alharbi AH, Morales J, Aljadaan I. Outcomes of trabeculectomy with mitomycin-C in uveitis associated with Vogt-Koyanagi-Harada disease. J Glaucoma 2016; 25(6): 528-32.

18. Kaburaki T, Koshino T, Kawashima H, et al. Initial trabeculectomy with mitomycin C in eyes with uveitic glaucoma with inactive uveitis. Eye (Lond) 2009; 23(7): 1509-17.

19. Noble J, Derzko-Dzulynsky L, Rabinovitch T, Birt C. Outcome of trabeculectomy with intraoperative mitomycin C for uveitic glaucoma. Can J Ophthalmol 2007; 42(1): 89-94.

20. Muñoz-Negrete FJ, Moreno-Montañés J, Hernández-Martínez P, Rebolleda G. Current approach in the diagnosis and management of uveitic glaucoma. Biomed Res Int 2015; 2015: 742792.

21. Almobarak FA, Alharbi AH, Aljadaan I, Aldhibi H. Phacoemulsification after trabeculectomy in uveitis associated with Vogt-Koyanagi-Harada disease: intermediate-term visual outcome, IOP control and trabeculectomy survival. BMC Ophthalmol 2022; 22(1): 210.

22. Carreño E, Villarón S, Portero A, et al. Surgical outcomes of uveitic glaucoma. J Ophthalmic Inflamm Infect 2011; 1(2): 43-53.

23. Ng WS, Jayaram H. Adjunctive modulation of wound healing during cataract surgery to promote survival of a previous trabeculectomy. Cochrane Database Syst Rev 2021; 8(8): CD013664.

24. Ophir A, Ticho U. Delayed filtering bleb encapsulation. Ophthalmic Surg 1992; 23(1): 38-9.

25. Yalçınkaya G, Altan C, Çakmak S, et al. Effect of phacoemulsification surgery on intraocular pressure and function of bleb after trabeculectomy. Int Ophthalmol 2021; 41(1): 185-93.

26. Park UC, Ahn JK, Park KH, Yu HG. Phacotrabeculectomy with mitomycin C in patients with uveitis. Am J Ophthalmol 2006; 142(6): 1005-12.

27. Tanna AP, Rademaker AW, de Moraes CG, et al. Collagen matrix vs mitomycin-C in trabeculectomy and combined phacoemulsification and trabeculectomy: a randomized controlled trial. BMC Ophthalmol 2016; 16(1): 217.

28. Wadke V, Lingam V, George R, et al. Phacotrabeculectomy in eyes with uveitic glaucoma: a retrospective case-control study. J Glaucoma 2019; 28(7): 606-12.

29. Arimura S, Iwasaki K, Orii Y, Takamura Y, Inatani M. Comparison of 5-year outcomes between trabeculectomy combined with phacoemulsification and trabeculectomy followed by phacoemulsification: a retrospective cohort study. BMC Ophthalmol 2021; 21(1): 188.

30. Chen PP, Weaver YK, Budenz DL, Feuer WJ, Parrish RK. Trabeculectomy function after cataract extraction. Ophthalmology 1998; 105(10): 1928-35.

31. Bhargava R, Pandey K, Mehta B. Long-term outcomes of small-incision cataract surgery in patients with uveitis. Indian J Ophthalmol 2022; 70(11): 3927-32.

32. Arampinyokul P, Rojananuangnit K. Long-term surgical outcome of trabeculectomy with mitomycin C: a comparison between primary and secondary glaucoma in Thailand. Clin Ophthalmol 2025; 19: 1299-311.

33. Kanaya R, Kijima R, Shinmei Y, et al. Surgical outcomes of trabeculectomy in uveitic glaucoma: a long-term, single-center, retrospective case-control study. J Ophthalmol 2021; 2021: 5550776.

34. Pillai MR, Balasubramaniam N, Wala N, et al. Glaucoma in uveitic eyes: long-term clinical course and management measures. Ocul Immunol Inflamm 2024; 32(6): 1041-7.

35. Muñoz-Negrete FJ, Moreno-Montañés J, Hernández-Martínez P, Rebolleda G. Current approach in the diagnosis and management of uveitic glaucoma. Biomed Res Int 2015; 2015: 742792.

36. Tsai AS, Boey PY, Htoon HM, Wong TT. Bleb needling outcomes for failed trabeculectomy blebs in Asian eyes: a 2-year follow up. Int J Ophthalmol 2015; 8(4): 748-53.

37. Ozdal PC, Vianna RN, Deschênes J. Ahmed valve implantation in glaucoma secondary to chronic uveitis. Eye (Lond) 2006; 20(2): 178-83.

38. Aragón-Roca D, Oliver-Gutierrez D, Banderas García S, et al. Surgical outcomes in uveitic glaucoma: long-term evaluation of trabeculectomy, non-penetrating deep sclerectomy, Ex-PRESS shunt and Ahmed glaucoma valve. Ocul Immunol Inflamm 2024; 32(9): 2008-17.

39. Sharmila R, Siddharth K, Daniel RK, Mani I, Krishnadas SR. Analysis of resurgeries following primary glaucoma surgical intervention in a tertiary care center. Indian J Ophthalmol 2025; 73(Suppl 2): S232-9.

40. Balekudaru S, Shah D, Lingam V, et al. A comparative analysis of surgical outcome in uveitic and non-uveitic steroid-induced glaucoma in children. Indian J Ophthalmol 2022; 70(12): 4218-25.