Original Article

Surgical Success and Predictive Factors in Patients Undergoing Gonioscopy-Assisted Transluminal Trabeculotomy

Gülşah Gümüş Akgün, Gizem Taşkın, Neşe Alagöz, İhsan Çakır, Çiğdem Altan, Başak Saraçoğlu Yılmaz, Tekin Yaşar

University of Health Sciences Türkiye, Beyoğlu Eye Training and Research Hospital, Clinic of Ophthalmology, İstanbul, Türkiye

Abstract

Objectives: This retrospective study aimed to evaluate the one-year surgical success of gonioscopy-assisted transluminal trabeculotomy (GATT) and identify prognostic factors influencing surgical outcomes in eyes diagnosed with open-angle glaucoma.

Materials and Methods: A total of 225 eyes (214 patients) treated with GATT between March 1, 2018, and June 1, 2024, were included in the study. Preoperative and postoperative data were analyzed. Complete surgical success (Criterion A) was defined as having an intraocular pressure (IOP) between 5 and 18 mmHg or at least a 30% reduction in IOP without the need for additional surgery. Overall success referred to achieving the same IOP with or without glaucoma medications. Surgical failure was defined as IOP >18 mmHg or <5 mmHg, significant vision loss, or the need for additional surgical intervention.

Results: The mean age of patients was 64.4±11.9 years, and the mean axial length (AL) was 24.0±2.0 mm. The mean preoperative IOP was 26.7±7.3 mmHg, which decreased to 14.3±6.5 mmHg at 12 months postoperatively ($p<0.05$). The rate of complete success according to Criterion A was 41.3%, while the rate of overall success was 87.6%. Multivariate analysis revealed that higher preoperative IOP (odds ratio [OR]: 1.07; $p=0.02$), longer AL (OR: 1.3; $p<0.01$), and postoperative IOP spikes (OR: 5.18; $p<0.01$) were significantly associated with surgical failure. Patients who underwent circumferential (360°) GATT had significantly higher success rates compared to those who received hemi-GATT (OR: 4.69; $p=0.01$). Glaucoma stage, presence of pseudoexfoliation glaucoma, history of prior trabeculectomy, and vitrectomy were not significantly associated with surgical outcomes ($p>0.05$ for all).

Conclusion: GATT is an effective and safe surgical option for various types of glaucoma. Higher preoperative IOP, longer AL, and postoperative IOP spikes increase the risk of surgical failure, whereas circumferential GATT is associated with improved success rates. GATT can also be considered as a potential alternative for patients with prior glaucoma surgery or advanced-stage glaucoma.

Keywords: Open-angle glaucoma, surgical success, gonioscopy-assisted transluminal trabeculotomy

Cite this article as: Gümüş Akgün G, Taşkın G, Alagöz N, Çakır İ, Altan Ç, Saraçoğlu Yılmaz B, Yaşar T. Surgical Success and Predictive Factors in Patients Undergoing Gonioscopy-Assisted Transluminal Trabeculotomy. Turk J Ophthalmol. 2025;55:314-320

Address for Correspondence: Gülşah Gümüş Akgün, University of Health Sciences Türkiye, Beyoğlu Eye Training and Research Hospital, Clinic of Ophthalmology, İstanbul, Türkiye

E-mail: gumus_118_@hotmail.com **ORCID-ID:** orcid.org/0000-0003-1954-2400

Received: 08.07.2025
Revision Requested: 27.08.2025
Last Revision Received: 01.09.2025
Kabul Tarihi/Accepted: 18.09.2025
Publication Date: 25.12.2025

DOI: 10.4274/tjo.galenos.2025.70194

Introduction

Glaucoma is a leading cause of irreversible blindness.[1] While medical treatment is the initial approach in managing glaucoma, surgical intervention should be considered when intraocular pressure (IOP) cannot be controlled with maximal medical treatment. Trabeculectomy continues to be regarded as the gold standard surgical procedure for treating glaucoma.[2] However, it is associated with potential intraoperative and postoperative complications, including bleb-related problems, suprachoroidal hemorrhage, and ocular hypotony, which in some cases may necessitate additional surgical intervention during the postoperative period.

Minimally invasive glaucoma surgery (MIGS) has steadily gained recognition as a safer operative alternative to trabeculectomy, while also enabling a swifter postoperative recovery.[3] Gonioscopy-assisted transluminal trabeculotomy (GATT) is an increasingly common surgical option for managing open-angle glaucoma (OAG).[4] Reports indicate that GATT can achieve success rates as high as 80% in patients with OAG.[4,5] Elucidating the prognostic factors that moderate

surgical outcomes remains essential. Therefore, in this study we investigated predictors of operative success in suture-based GATT surgery.

Materials and Methods

This retrospective review included patients who underwent GATT surgery for OAG between 1 March 2018 and 1 June 2024 and completed at least 12 months of postoperative follow-up. All participants provided written informed consent for the use of their data in accordance with the principles outlined in the Declaration of Helsinki. This study received ethical approval from the University of Health Sciences Hamidiye Scientific Research Ethics Committee (decision date: 15/5/2025, decision number: 11/37).

Each patient underwent preoperative assessments including IOP, cup-to-disc ratio, number of glaucoma medications used, best corrected visual acuity, retinal nerve fiber layer (RNFL) thickness, axial length (AL), and glaucoma type (primary or secondary). Intraoperative and postoperative data included the extent of GATT (360° circumferential or 180° hemispheric [hemi]), presence of postoperative fibrin reaction, presence and timing of IOP spikes, presence and duration of hyphema, as well as any intraoperative or postoperative complications.

Peripapillary RNFL thickness was measured after pupil dilation, using a Spectralis optical coherence tomography (OCT) device (Heidelberg Engineering, Heidelberg, Germany). Visual field tests were conducted using the Humphrey Visual Field Analyzer (HFA II 750; Carl Zeiss Meditec Inc., Dublin, CA, USA) with the 30-2 Swedish Interactive Thresholding Algorithm. Mean deviation (MD) values were documented and used to stratify glaucoma severity: mild disease corresponded to an MD greater than -6 decibels, moderate disease to an MD between -6 and -12 decibels, and severe disease to an MD below -12 decibels.

Complete success was defined as attaining an IOP greater than 5 mmHg and ≤18 mmHg (Criterion A), greater than 5 mmHg and ≤15 mmHg (Criterion B), or a reduction of at least 30% from baseline IOP, without requiring additional glaucoma medications or further surgical intervention. Overall success was defined as achieving the same IOP targets, either with or without the use of glaucoma medications. Surgical failure was defined as an IOP above the target range specified by Criterion A or B, or below 5 mmHg, a complete loss of visual acuity due to glaucoma progression or surgical complications, or the need for additional glaucoma surgeries, including trabeculectomy, seton implantation, or cyclodestructive procedures.

Surgical Technique

All surgeries were performed by four glaucoma specialists following a standardized surgical technique, in accordance with the institution's established protocols, as outlined below:

GATT: A temporal main incision was made with a 23-gauge blade, after which 1.6% sodium hyaluronate was injected into the anterior chamber. A tangential side-port incision was then created with the same 23-gauge blade in the superonasal or inferonasal quadrant to allow introduction of the polypropylene suture. To visualize the nasal angle, the surgical microscope and the patient's head were tilted in opposite directions, and a Swan-Jacob goniolens was used. Through the temporal incision, a 1-2 mm goniotomy was performed with the 23-gauge blade to expose Schlemm's canal (SC). The tip of a 5-0 polypropylene suture was cauterized to create a blunt end, introduced into the SC with 23-gauge microforceps, and advanced around the canal. For circumferential GATT, the distal portion of the suture was grasped and the proximal end was pulled to accomplish a complete 360° circumferential goniotomy. For 180° hemi-GATT, the suture was advanced only 180 degrees and then pulled to complete the procedure. Afterwards, the suture was removed.

Postoperative Follow-up

Postoperatively, patients were prescribed a two-week course of moxifloxacin 0.5% eye drops (Moxai; Abdi İbrahim Pharmaceuticals, İstanbul, Türkiye) five times daily, as well as topical prednisolone acetate 1% eye drops (Pred Forte; Allergan, Irvine, CA, USA) six times per day for the first two weeks and then progressively tapered over the subsequent four weeks.

Statistical Analysis

All statistical analyses were conducted using SPSS version 20.0® for Windows (IBM Corporation, Armonk, NY, USA). The Kolmogorov-Smirnov test was applied to assess the normality of data distribution. Continuous variables were summarized as means ± standard deviations or as medians with interquartile ranges, as appropriate. Independent t-tests were used to assess differences in continuous variables between groups, while categorical variables were analyzed using two-sided chi-square tests. Potential risk factors for failure were identified in univariate analyses, and variables with $p<0.05$ were included in the multivariate analysis to identify prognostic factors. A p value of <0.05 was considered statistically significant.

Results

A total of 225 eyes from 214 patients (142 males, 72 females) were included in the study. Among the patients, the mean age was 64.4±11.9 years, and the mean AL was 24.0±2.0 mm. The mean follow-up time was 18.6±7.0 months (range, 12-48). Of the eyes, 118 (52.4%) were phakic and 107 (47.6%) were pseudophakic. Phacoemulsification (phaco)-combined surgery was performed in 9 eyes (4%). The indication for surgery was primary OAG (POAG) in 69 eyes (30.7%), pseudoexfoliation glaucoma (PEXG) in 103 eyes (45.8%), uveitic glaucoma in 16 eyes (7.1%), pigment dispersion syndrome in 4 eyes (1.8%), secondary glaucoma after intraocular surgery in 30 eyes (13.3%), steroid responder glaucoma in 2 eyes (0.9%), and traumatic glaucoma in 1 eye (0.4%, Table 1).

One eye (0.4%) had previously undergone penetrating keratoplasty, 29 eyes (12.9%) had a history of prior vitrectomy, 43 eyes (19.1%) had previously undergone trabeculectomy, 1 eye (0.4%) had a prior Ahmed glaucoma valve implantation, and 1 eye (0.4%) had undergone goniotomy (Table 1).

Change in Intraocular Pressure and Success

Preoperatively, the mean IOP was 26.7±7.3 mmHg, and the patients used an average of 3.6±1.1 glaucoma medications. At 12 months postoperatively, the mean IOP had decreased to 14.3±6.5 mmHg (p<0.05), with a corresponding decrease in the average number of medications to 1.5±1.5 (p<0.05). According to Criterion A, complete success (IOP controlled without the use of glaucoma medications) was observed in 93 eyes (41.3%), whereas 197 eyes (87.6%) achieved overall success and 28 eyes (12.4%) were considered surgical failures. According to Criterion B, complete success was observed in 75 eyes (33.3%), overall success in 173 eyes (76.9%), and surgical failure in 52 eyes (23.1%).

Predictors of Surgical Outcome

Factors related to decreased likelihood of success in univariate analysis were: previous vitrectomy (overall success 75.9%, compared to 89.3% in eyes without vitrectomy, p=0.06; odds ratio [OR]: 2.65, 95% confidence interval [CI]: 1.01-6.94, p=0.04), higher preoperative IOP (OR: 1.07, 95% CI: 1.02-1.13, p=0.01), longer AL (OR: 1.35, 95% CI: 1.16-1.57, p<0.01), and postoperative IOP spike (overall success 73.2%, compared to 94.2% in eyes without spike, p<0.01; OR: 5.89, 95% CI: 2.51-13.83, p<0.01). In contrast, circumferential trabeculotomy was associated with increased likelihood of surgical success (overall success 90.5% in 360° GATT vs. 64% in 180° GATT, p<0.01; OR: 5.36, 95% CI: 2.09-13.77, p<0.01) (Tables 2 and 3).

Complete surgical success was achieved in 12% and overall success in 64% in the hemi-GATT group. In contrast, in the circumferential GATT group, complete success was observed in 45% and overall success in 90.5% (p=0.01 for both). The mean number of glaucoma medications was 2.76±1.4 in the hemi-GATT group and 1.4±1.4 in the circumferential GATT group (p=0.01). The distribution of glaucoma types between the two surgical groups was not statistically significant (p=0.6).

In the multivariate regression model, preoperative IOP, AL, presence of postoperative IOP spike, and the extent of trabeculotomy were found to be related to final surgical success (Table 4). Lower preoperative IOP and shorter AL were associated with a higher chance of surgical success (adjusted OR: 1.07; 95% CI: 1.01-1.13; p=0.02 and adjusted OR: 1.30; 95% CI: 1.09-1.58; p<0.01, respectively). The occurrence of an IOP spike increased the likelihood of surgical failure fivefold (adjusted OR: 5.18; 95% CI: 1.6-15.69; p<0.01), while circumferential trabeculotomy increased the likelihood of surgical success by 4 times (adjusted OR: 4.69; 95% CI: 1.56-14.18; p=0.01).

Complications

Postoperative complications included fibrin reaction in 65 eyes (28.9%), hyphema in 114 eyes (50.7%), and intravitreal hemorrhage in 12 eyes (5.3%). A total of 29 eyes (12.9%) received subconjunctival dexamethasone for fibrin reaction, of which 5 were phaco-combined cases. Anterior chamber washout was performed in 9 eyes (4%) due to prolonged hyphema, and vitrectomy was performed in 1 eye (0.4%) due to intravitreal

Table 1. Baseline demographic and clinical characteristics of patients undergoing gonioscopy-assisted transluminal trabeculotomy

Age (years), mean ± SD	64.4±11.9
Median (IQR)	67 (58.5-73.0)
BCVA (Snellen decimal), mean ± SD	0.32±0.28
Median (IQR)	0.3 (0.05-0.5)
IOP (mmHg), mean ± SD	26.7±7.3
Median (IQR)	26 (22-30)
Number of glaucoma medications, mean ± SD	3.6±1.1
Median (IQR)	4 (3-4)
Cup-to-disc ratio, mean ± SD	0.85±0.2
Median (IQR)	0.9 (0.8-1.0)
RNFL thickness (µm), mean ± SD	64.3±18.7
Median (IQR)	62 (50-76)
Axial length (mm), mean ± SD	24.0±2.0
Median (IQR)	23.4 (23.0-24.2)
Type of glaucoma, n (%)	
Primary OAG	69 (30.7)
Secondary OAG	156 (69.3)
PEX	103 (45.8)
Post-IO surgery	30 (13.3)
Uveitic	16 (7.1)
PDS	4 (1.8)
Steroid responder	2 (0.9)
Traumatic glaucoma	1 (0.4)
Glaucoma stage, n (%)	
Mild	43 (19.1)
Moderate	47 (20.9)
Severe	135 (60)
Previous surgeries, n (%)	
Trabeculectomy	43 (19.1)
Vitrectomy	29 (12.9)
Keratoplasty	1 (0.4)
Goniotomy	1 (0.4)
AGV implantation	1 (0.4)
Extent of GATT, n (%)	
360° circumferential	200 (88.9)
180° hemi-GATT	25 (11.1)
Postoperative fibrin reaction, n (%)	65 (28.9)
Presence of IOP spike, n (%)	71 (31.6)
Timing of IOP spike (days postop), mean ± SD	12.7±12.5
Median (IQR)	8 (1-22)
Mean IOP during spike (mmHg), mean ± SD	32.9±6.7
Median (IQR)	30 (28-38)
Presence of hyphema, n (%)	114 (50.7)
Duration of hyphema (days), mean ± SD	7.9±8.9
Median (IQR)	5 (2-10)

SD: Standard deviation, IQR: Interquartile range, BCVA: Best-corrected visual acuity, IOP: Intraocular pressure, RNFL: Retinal nerve fiber layer, OAG: Open-angle glaucoma, PEX: Pseudoexfoliation syndrome, PDS: Pigment dispersion syndrome, IO: Intraocular, AGV: Ahmed glaucoma valve, GATT: Gonioscopy-assisted transluminal trabeculotomy, postop: Postoperative

Table 2. Results of univariate logistic regression analysis of factors associated with surgical success		
	p value	**OR (95% CI)**
Preoperative IOP	**0.01**	1.07 (1.02-1.13)
Axial length	**<0.01**	1.35 (1.16-1.57)
Glaucoma stage	0.5	1.46 (0.46-4.5)
Previous vitrectomy	**0.04**	2.65 (1.01-6.94)
Pseudoexfoliation glaucoma	0.3	0.62 (0.27-1.41)
Previous trabeculectomy	0.15	1.9 (0.79-4.81)
Extent of trabeculotomy	**<0.01**	5.36 (2.09-13.77)
IOP spike	**<0.01**	5.89 (2.51-13.83)
Postoperative fibrin reaction	0.18	0.49 (0.18-1.37)
Postoperative hyphema	0.9	0.97 (0.44-2.14)
Lens status	0.78	1.12 (0.51-2.47)
IOP: Intraocular pressure, OR: Odds ratio, CI: Confidence interval		

hemorrhage. An IOP spike was observed in 71 eyes (31.6%) at a mean of 12.7±12.5 days, with a mean IOP of 32.9±6.37 mmHg. Transient hypotony was observed in 9 eyes (4.0%), none of which persisted beyond postoperative month 3.

Discussion

Traditional glaucoma surgeries such as tube implantation and trabeculectomy have long been associated with a considerable risk of serious complications.[6] In recent years, conjunctiva-sparing techniques have become increasingly popular in glaucoma surgery to reduce the risk of major complications. These methods are classified as MIGS by the European Glaucoma Society.[7] GATT is a minimally invasive, ab-interno cannulation of the SC that opens the trabecular meshwork (TM) and SC wall to improve aqueous outflow.[8] It provides effective IOP control in primary and secondary OAG, uveitic glaucoma, steroid-induced glaucoma, and pediatric as well as juvenile glaucoma,

Table 3. Relationships between baseline characteristics, predictive factors, and postoperative outcomes			
	Overall success (Criterion A), n (%)	**Number of AGM (mean ± SD)**	**Complete success (Criterion A), n (%)**
Preoperative IOP ≥30 mmHg <30 mmHg	 52 (77.6) 145 (91.8) **p<0.001**	 1.8±1.5 1.46±1.5 p=0.11	 17 (25.4) 76 (48.1) **p<0.001**
Axial length ≥26 mm <26 mm	 6 (66.6) 191 (90.4) **p=0.01**	 2.7±1.6 1.43±1.4 **p=0.001**	 2 (22.2) 91 (43.1) p=0.12
Glaucoma stage Mild Moderate Severe	 38 (88.4) 40 (85.1) 119 (88.1) p=0.9	 1.3±1.5 1.4±1.5 1.6±1.5 p=0.35	 22 (51.2) 21 (44.7) 50 (37.0) p=0.1
Previous vitrectomy + -	 22 (75.9) 175 (89.3) p=0.06	 1.93±1.5 1.5±1.5 p=0.15	 9 (31.0) 84 (42.9) p=0.3
Pseudoexfoliation glaucoma + -	 93 (90.3) 104 (85.2) p=0.3	 1.49±1.5 1.6±1.5 p=0.5	 47 (45.6) 46 (37.7) p=0.3
Revious trabeculectomy + -	 35 (81.4) 162 (89.5) p=0.2	 1.88±1.7 1.47±1.4 p=0.1	 16 (37.2) 77 (42.5) p=0.6
Extent of trabeculotomy Hemi-GATT Circumferential	 16 (64) 181 (90.5) **p=0.001**	 2.76±1.4 1.4±1.4 **p<0.001**	 3 (12) 90 (45) **p=0.00**1
IOP spike + -	 52 (73.2) 145 (94.2) **p<0.001**	 2.2±1.4 1.3±1.4 **p<0.001**	 13 (18.3) 80 (51.9) **p<0.001**
Comparisons were made between subgroups using chi-square or Fisher's exact test, with a significance threshold of p<0.05 AGM: Antiglaucoma medications, SD: Standard deviation, IOP: Intraocular pressure, GATT: Gonioscopy-assisted transluminal trabeculotomy			

Table 4. Results of multivariate logistic regression of factors associated with surgical success

	p value	OR (95% CI)
Preoperative IOP	**0.02**	1.07 (1.01-1.13)
Axial length	**0.004**	1.30 (1.09-1.58)
Previous vitrectomy	0.71	0.79 (0.23-2.67)
Extent of trabeculotomy	**0.01**	4.69 (1.56-14.18)
IOP spike	**<0.001**	5.18 (1.60-15.69)

IOP: Intraocular pressure, OR: Odds ratio, CI: Confidence interval

making it a versatile option for a broad range of patients.[8] Since its introduction, some prognostic factors influencing surgical outcomes have been identified.[9,10,11] However, our study examined the largest cohort and the most diverse spectrum of cases among the studies conducted to date.

Previous studies suggest that GATT effectively lowers IOP and decreases reliance on glaucoma medications.[4,9,12,13] At 1-year follow-up, we noted a marked decrease in both IOP and the required number of glaucoma medications, achieving an overall success rate of 87.6%. We found that higher preoperative IOP, longer AL, and the occurrence of postoperative IOP spikes negatively impacted the success of GATT. In contrast, circumferential-GATT was associated with better outcomes compared to hemi-GATT. Furthermore, our analysis did not show any association between success and the presence of PEXG, prior trabeculectomy, or glaucoma stage.

One of the key factors influencing the success of procedures like GATT, which bypass trabecular resistance, is proper functioning of the distal outflow pathway. However, there is currently no easy, objective, and non-invasive method to assess distal outflow function preoperatively. As a result, it remains challenging to predict which patients are more likely to experience surgical failure. Therefore, identifying clinical risk factors is crucial for enhancing patient selection and outcomes.

Greater preoperative IOP demonstrated an inverse association with surgical success in our study. As there are no studies in the current literature evaluating the association between preoperative IOP and surgical success rates, the underlying mechanism of surgical failure remains speculative and cannot be thoroughly discussed. However, although a ≥30% reduction in IOP, our primary criterion for surgical success, was achieved in cases with high preoperative IOP, most of these eyes remained above the target IOP levels during follow-up. Furthermore, eyes with a preoperative IOP of <30 mmHg demonstrated higher rates of both complete and overall surgical success, suggesting a more favorable postoperative outcome in our study. The need for additional surgical intervention was significantly higher, indicating a higher rate of surgical failure among eyes with high baseline IOP (≥30 mmHg). Our results indicate that eyes with high preoperative IOP have notably lower success rates following GATT surgery.

It has been previously proposed that advanced stages of glaucoma may lead to structural distortion of the collector channels, SC, and TM, potentially compromising aqueous outflow.[14] This condition has been thought to negatively affect the outcomes of surgeries involving the SC. However, in our study, we observed that glaucoma stage, whether mild, moderate or advanced, did not have an impact on surgical outcome. Grover et al.[15] indicated that eyes with an MD worse than -15 had a low likelihood of successful GATT due to possible atrophy of the collector channels. However, Aktas et al.[16] observed no direct association between glaucoma severity and surgical success among patients with advanced glaucoma. They concluded that while SC-based MIGS procedures may not be ideal for advanced-stage glaucoma, this limitation may not apply to circumferential angle surgeries such as GATT.[16] The results of our study, as well as previous studies, indicate that GATT is effective in advanced-stage glaucoma as well.[13,16,17]

High myopia has also been suggested as a contributing factor to collector channel distortion.[13,14] An elongated AL may lead to structural changes in the SC and TM.[18] A study assessing the efficacy of Kahook dual-blade trabeculotomy reported lower success rates in eyes with long AL and suggested that surgeries targeting the TM and SC may be less effective in such eyes.[19] Consistent with previous findings, our results demonstrated that higher AL correlated with lower surgical success and a greater need for glaucoma medication.

Our analysis showed that the occurrence of postoperative IOP spikes is a contributing factor to surgical failure and greater need for glaucoma medications following GATT. Postoperative inflammation, peripheral anterior synechiae, and fibrotic closure of the TM have been suggested as potential causes of postoperative IOP spikes.[20] Our findings support those of Shi et al.,[21] who also reported that postoperative IOP spikes contribute to surgical failure.

We observed higher overall and complete surgical success rates and a lower average number of glaucoma medications in eyes that underwent circumferential GATT compared to those that underwent hemi-GATT. These findings indicate that circumferential GATT provides better IOP control and medication independence. A study comparing 360° GATT with the 90° ab-interno needle goniectomy found that 360° GATT produced a greater, more sustained reduction in IOP and achieved higher long-term success rates. The authors attributed these superior outcomes to GATT's full circumferential trabeculotomy, which removes resistance along the entire SC.[22] Alagoz et al.[23] noted that over prolonged follow-up, the trabecular flap re-approximated portions of the incision site, leading to a closed cleft appearance on gonioscopy, which was further supported by anterior segment OCT findings. Peripheral anterior synechiae also mainly formed in the regions where the cleft appeared closed, suggesting a potential role of postoperative tissue adhesion in limiting long-term outflow. In their study, with a follow-up of up to 78 months, the median extent of the open cleft was longer in the circumferential GATT group than in the hemi-GATT group. As portions of the treated TM may gradually re-close over time and compromise long-term efficacy, a complete 360° trabeculotomy should be the primary goal in the GATT procedure.

Studies evaluating the success of GATT in patients with a history of previous unsuccessful incisional glaucoma surgery have reported satisfactory success rates, showing that GATT represents a safe and efficacious surgical option for managing refractory OAG.[5,24] In one such study, Wang et al.[24] reported that 82.1% of these eyes had an IOP of ≤18 mmHg at 24 months postoperatively. Consistent with previous reports, our findings indicated that prior trabeculectomy was not significantly associated with worse surgical outcomes following GATT. Given the increased risk of bleb fibrosis after repeated filtering surgeries,[25] GATT presents a potentially valuable alternative approach in patients with prior surgical failure.[24]

Some studies have reported higher success rates in the PEXG group.[4,12] However, others indicate that this advantage diminishes after 6 months, with outcomes becoming comparable to those in POAG.[9,10] Our analysis likewise indicated that PEXG had no statistically significant effect on surgical outcomes at one year.

Secondary glaucoma is a common complication following vitrectomy, ranging from 8.4% to 14.8% after vitreoretinal procedures.[26] However, there is a lack of data in the literature regarding the success of MIGS procedures targeting the SC in vitrectomized eyes. Nonetheless, previous studies on vitrectomized patients with secondary glaucoma have shown that GATT is both effective and safe.[27,28] In our study, we found that a history of vitreoretinal surgery did not significantly affect the success of GATT. Since the success of trabeculectomy is often limited by conjunctival scarring in eyes with a history of vitrectomy, GATT may serve as a viable alternative, provided that gonioscopic evaluation confirms a favorable angle anatomy.

Trabeculectomy, the most frequently performed conventional glaucoma surgery, carries a considerable risk of complications, including ocular hypotony, hypotony maculopathy, choroidal detachment, suprachoroidal hemorrhage, and bleb-related problems such as infections and endophthalmitis.[29] In our study group, 4% of patients experienced transient hypotony which lasted 3 months. None of the other complications related to trabeculectomy were encountered.

The most common complication associated with GATT has been reported as transient hyphema, which may occur in up to 55% of cases during or after GATT surgery.[8,30] In our study, the most frequently observed complication was hyphema, occurring in 50.7% of cases.

In a study evaluating GATT outcomes in POAG and PEXG, 19.4% of the overall cohort experienced a fibrin reaction.[31] Notably, fibrin formation was observed in all eyes that underwent phaco-combined GATT.[31] In our study, fibrin reaction was observed in 28.9% of the eyes, including 5 of the 9 eyes that underwent phaco-combined GATT. We believe several factors may have contributed to the relatively high rate of fibrin reaction. First, circumferential GATT was performed in 88.9% of cases. Additionally, in eyes with clotted hyphema, the coagulum was also counted as fibrin for the purpose of complication analysis.

Zeng et al.[32] reported that IOP spikes occurred in about 40% of patients with OAG. Consistent with the previous reports, we observed IOP spikes in 31.6% of cases, and this was found to be associated with surgical failure.

Study Limitations

The primary limitations of this study are its retrospective design and the comparatively small sample sizes in specific subgroups. Moreover, the heterogeneity of glaucoma etiologies within the study population may introduce confounding factors. However, this diversity reflects the spectrum of patients commonly encountered in real-world glaucoma practice and thus adds value by providing clinically relevant, real-life data. Further prospective studies involving more diverse and balanced subgroup distributions are needed to validate these findings.

Conclusion

In conclusion, higher preoperative IOP, longer AL, and the occurrence of postoperative IOP spikes were negatively associated with surgical success, whereas circumferential GATT was associated with more favorable outcomes than hemi-GATT. Since our analysis showed no significant association between surgical success and the presence of PEXG, prior trabeculectomy, history of pars plana vitrectomy, or glaucoma stage, GATT should be considered a valuable surgical option in eyes with a history of trabeculectomy or vitrectomy, as well as in cases across all stages of glaucoma.

Ethics

Ethics Committee Approval: This study received ethical approval from the University of Health Sciences Hamidiye Scientific Research Ethics Committee (decision date: 15/5/2025, decision number: 11/37).

Informed Consent: All participants provided written informed consent for the use of their data in accordance with the principles outlined in the Declaration of Helsinki.

Declarations

Authorship Contributions

Surgical and Medical Practices: G.G.A., N.A., İ.Ç., Ç.A., Concept: G.G.A., N.A., T.Y., Design: G.G.A., N.A., T.Y., Data Collection or Processing: G.T., B.S.Y., Analysis or Interpretation: G.G.A., G.T., İ.Ç., Ç.A., T.Y., Literature Search: G.G.A., B.S.Y., G.T., Writing: G.G.A., N.A.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Tham YC, Li X, Wong TY, Quigley HA, Aung T, Cheng CY. Global prevalence of glaucoma and projections of glaucoma burden through 2040: a systematic review and meta-analysis. Ophthalmology. 2014;121:2081-2090.
2. The AGIS Investigators. The advanced glaucoma intervention study (AGIS): 7. the relationship between control of intraocular pressure and visual field deterioration. Am J Ophthalmol. 2000;130:429-440.

3. Lavia C, Dallorto L, Maule M, Ceccarelli M, Fea AM. Minimally-invasive glaucoma surgeries (MIGS) for open angle glaucoma: a systematic review and meta-analysis. PLoS One. 2017;12:e0183142.
4. Grover DS, Godfrey DG, Smith O, Feuer WJ, Montes de Oca I, Fellman RL. Gonioscopy-assisted transluminal trabeculotomy, ab interno trabeculotomy: technique report and preliminary results. Ophthalmology. 2014;121:855-861.
5. Grover DS, Godfrey DG, Smith O, Shi W, Feuer WJ, Fellman RL. Outcomes of gonioscopy-assisted transluminal trabeculotomy (GATT) in eyes with prior incisional glaucoma surgery. J Glaucoma. 2017;26:41-45.
6. Gedde SJ, Herndon LW, Brandt JD, Budenz DL, Feuer WJ, Schiffman JC; Tube Versus Trabeculectomy Study Group. Postoperative complications in the tube versus trabeculectomy (TVT) study during five years of follow-up. Am J Ophthalmol. 2012;153:804-814.
7. No authors listed. European Glaucoma Society Terminology and Guidelines for Glaucoma, 5th Edition. Br J Ophthalmol. 2021;105(Suppl 1):1-169.
8. Aktaş Z, Dorairaj S, Sayed M, Sheybani A, Üçgül AY, Wagner I, Khodeiry M. Ab interno goniotomy/goniectomy techniques. Turk J Ophthalmol. 2025;55:159-170.
9. Cubuk MO, Unsal E. One-year results of gonioscopy-assisted transluminal trabeculotomy: evaluation of prognostic factors. Eur J Ophthalmol. 2021;31:460-468.
10. Bektas C, Aktas Z, Ucgul AY, Karamert SS. Prognostic factors affecting the surgical success of gonioscopy-assisted transluminal trabeculotomy. Indian J Ophthalmol. 2021;69:1425-1429.
11. Zhang X, Chow A, Chen E. Surgery outcomes of prolene suture gonioscopy-assisted transluminal trabeculotomy (GATT): up to 4 years follow-up and prognostic factors. J Glaucoma. 2024;33:645-651.
12. Rahmatnejad K, Pruzan NL, Amanullah S, Shaukat BA, Resende AF, Waisbourd M, Zhan T, Moster MR. Surgical outcomes of gonioscopy-assisted transluminal trabeculotomy (GATT) in patients with open-angle glaucoma. J Glaucoma. 2017;26:1137-1143.
13. Aktas Z, Ozmen MC, Atalay HT, Ucgul AY. Evaluation of episcleral venous fluid wave during gonioscopy assisted transluminal trabeculotomy in patients with advanced glaucoma. Eye (Lond). 2019;33:668-673.
14. Hann CR, Vercnocke AJ, Bentley MD, Jorgensen SM, Fautsch MP. Anatomic changes in Schlemm's canal and collector channels in normal and primary open-angle glaucoma eyes using low and high perfusion pressures. Invest Ophthalmol Vis Sci. 2014;55:5834-5841.
15. Grover DS, Smith O, Fellman RL, Godfrey DG, Gupta A, Montes de Oca I, Feuer WJ. Gonioscopy-assisted transluminal trabeculotomy: an Ab interno circumferential trabeculotomy: 24 months follow-up. J Glaucoma. 2018;27:393-401.
16. Aktas Z, Ucgul AY, Bektas C, Sahin Karamert S. Surgical outcomes of prolene gonioscopy-assisted transluminal trabeculotomy in patients with moderate to advanced open-angle glaucoma. J Glaucoma. 2019;28:884-888
17. Magacho L, Franco CGVS, I EA, Pereira ACA, Teno B, Lucena-Neto F, Faria BM, Vieira JM, Vianello MP, Kanadani FN. Gonioscopy-assisted transluminal trabeculotomy outcomes under different levels of glaucoma severity: a multicenter, comparative study. Am J Ophthalmol. 2024;264:75-84.
18. Chen Z, Song Y, Li M, Chen W, Liu S, Cai Z, Chen L, Xiang Y, Zhang H, Wang J. Schlemm's canal and trabecular meshwork morphology in high myopia. Ophthalmic Physiol Opt. 2018;38:266-272.
19. Yoshida T, Nomura T, Yoshimoto S, Ohno M, Ito T, Horie S, Ohno-Matsui K. Outcomes of standalone ab interno trabeculotomy in the treatment of open-angle glaucoma in eyes with high myopia. BMC Ophthalmol. 2023;23:261.
20. Rao A, Khan SM, Mukherjee S. Causes of immediate and early IOP spikes after circumferential gonioscopy-assisted transluminal trabeculotomy using ASOCT. Clin Ophthalmol. 2023;17:313-320.
21. Shi Y, Wang H, Oatts JT, Xin C, Yin P, Zhang L, Tian J, Zhang Y, Cao K, Han Y, Wang N. A prospective study of intraocular pressure spike and failure after gonioscopy-assisted transluminal trabeculotomy in juvenile open-angle glaucoma: a prospective study of GATT in JOAG. Am J Ophthalmol. 2022;236:79-88.
22. Üçgül AY, Kılıç Üçgül R, Aktaş Z. Gonioscopy-assisted transluminal trabeculotomy versus bent Ab interno needle goniectomy in patients with open-angle glaucoma. Turk J Ophthalmol. 2025;55:141-147.
23. Alagoz N, Cakir I, Altan C, Bozkurt E, Ipekli Z, Erdogdu E, Yasar T. Long-term structural changes observed on gonioscopy and anterior-segment OCT following gonioscopy-assisted transluminal trabeculotomy. Beyoglu Eye J. 2024;9:120-127.
24. Wang Y, Zhang W, Xin C, Sang J, Sun Y, Wang H. Gonioscopy-assisted transluminal trabeculotomy for open-angle glaucoma with failed incisional glaucoma surgery: two-year results. BMC Ophthalmol. 2023;23:89.
25. Law SK, Shih K, Tran DH, Coleman AL, Caprioli J. Long-term outcomes of repeat vs initial trabeculectomy in open-angle glaucoma. Am J Ophthalmol. 2009;148:685-695.
26. Kolipaka GP, Rao A. Secondary glaucoma following vitreo-retinal surgeries. Indian J Ophthalmol. 2023;71:18-25.
27. Aktas Z, Bölük CE, Gurelik G. Silicone oil droplets in the Schlemm's canal: a surprise during prolene hemi-gonioscopy-assisted transluminal trabeculotomy (Hemi-GATT). J Curr Glaucoma Pract. 2021;15:40-43.
28. Espinoza G, Pedraza-Concha A, Tello A, Galvis V, Rangel CM, Castellanos YA. Cystoid macular edema after an uncomplicated gonioscopy- assisted transluminal trabeculotomy on a previously vitrec- tomized patient. Clin Ter. 2022;173:198-202.
29. Rao A, Cruz RD. Trabeculectomy: does it have a future? Cureus. 2022;14:e27834.
30. Dar N, Naftali Ben Haim L, Yehezkeli V, Sharon T, Belkin A. Gonioscopy-assisted transluminal trabeculotomy in patients with advanced glaucoma. Indian J Ophthalmol. 2023;71:3024-3030.
31. Cakir I, Balci AS, Alagoz N, Yalcinkaya Cakir G, Altan C, Yasar T. Efficacy of gonioscopy-assisted transluminal trabeculotomy and trabeculectomy in patients with primary open-angle glaucoma and pseudoexfoliative glaucoma: a single surgeon's experience. Indian J Ophthalmol. 2024;72(Suppl 5):821-826.
32. Zeng LZ, He Y, Wang XQ, Xian YP, Fan HY, Jing L, Shu J, Li Q, Wang NL. Clinical significance of episcleral venous fluid wave in gonioscopy-assisted transluminal trabeculotomy. Int J Ophthalmol. 2023;16:1971-1976.