Comparison of Gonioscopy-assisted Transluminal Trabeculotomy Versus Trabeculectomy With Mitomycin C in Patients With Open-angle Glaucoma

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Précis: Trabeculotomy (TRAB) lowers the intraocular pressure (IOP) more than gonioscopy-assisted transluminal trabeculotomy (GATT) at 18 months, with a reduction in IOP of 30% or more and a significant reduction in the number of glaucoma medications compared with baseline.

Purpose: To compare the IOP-lowering efficacy of GATT with mitomycin-C augmented TRAB in patients with uncontrolled open-angle glaucoma.

Methods: Single-center, retrospective, comparative cohort study. One hundred ten consecutive patients (110 eyes) underwent GATT (n = 61) or TRAB (n = 49). The primary outcome measure was IOP reduction, defined as a percentage decrease ≥ 30% and absolute IOP ≤ 18 mm Hg at 18 months with (qualified) or without (complete) medications. Secondary outcomes were visual field change, number of glaucoma medications, complications, and reintervention.

Results: The mean ± SD baseline IOP was 30.04 ± 7.5 and 27.59 ± 4.70 (P = 0.072) with the mean number of medications of 3.08 ± 0.73 and 2.92 ± 0.91 (P = 0.310) in TRAB and GATT, respectively. At 18 months, the mean ± SD IOP was 15.26 ± 3.47 mm Hg and 12.48 ± 4.58 mm Hg after TRAB and GATT, respectively (P = 0.002). The percentage of IOP lowering from baseline was 56.05 ± 17.72 after TRAB and 42.04 ± 15.56 after GATT (P < 0.001). Percentages of complete and qualified success were 59% and 27% after TRAB and 46% and 31% after GATT (P = 0.353). No change in visual field loss was observed in both groups. The mean reduction in medications was 2.3 ± 1.4 and 2.1 ± 1.5 in TRAB and GATT, respectively (P = 0.493). The most frequent complication after TRAB was hypotony and after GATT hyphema. Reintervention occurred in 8.2% of cases after TRAB and in 14.8% after GATT (P = 0.341).

Conclusions: IOP lowering was greater after TRAB than after GATT at 18 months with a significant reduction in the number of medications after both procedures. Complications and reintervention occurred equally in both groups but differed in type.

Key Words: trabeculotomy, gonioscopy-assisted transluminal trabeculotomy, trabeculectomy, glaucoma surgery, learning curve (J Glaucoma 2021;30:101–108)

G laucoma is the second most prevalent cause of blindness worldwide.1 Medical therapy, by reducing aqueous production or enhancing aqueous outflow, is the primary treatment modality in glaucomatous patients.2 In case of inadequate intraocular pressure (IOP) controls despite treatment, filtration surgery by trabeculectomy (TRAB), with or without wound-healing modulation, is considered the gold standard surgical procedure.3 Numerous studies demonstrated the good efficacy outcomes of this procedure,4–6 still the risk of early and late complications7 has stimulated the glaucoma community to search for a novel surgical approach for the management of these patients. In the last few years, minimally invasive glaucoma surgery (MIGS) collected an increasing interest thanks to the conjunctival sparing ab interno approach, high safety profile, absence of a filtering bleb, and rapid recovery after surgery.4 MIGSs determine IOP lowering with different mechanisms of action5: enhancing the trabecular meshwork outflow, and promoting the uveoscleral or the subconjunctival drainage, with or without the implantation of a device.6

Gonioscopy-assisted transluminal trabeculotomy (GATT) is a recently developed clear corneal anterior segment and bleb-less approach introduced by Grover et al.9 With this technique, an ab interno 360-degree trabeculotomy, that spares conjunctival and scleral dissection, is performed by direct visualization of the trabecular meshwork using a goniolens. This procedure has shown success in decreasing both IOP and number of glaucoma medications in primary, pediatric, and secondary types of open-angle glaucoma, including uveitic, steroid-induced, traumatic, pigmentary, and pseudoexfoliation.10,11

As this technique is still novel, there is a lack of studies comparing the outcomes of GATT to the gold standard filtration surgery. This study aimed to compare the IOP-lowering effect of GATT to mitomycin C (MMC) augmented TRAB, during a postoperative follow-up of 18 months, in patients with open-angle glaucoma.

METHODS

Study Design
We conducted a retrospective comparative cohort study, enrolling all patients who underwent GATT or
TRAB at the Ophthalmology Unit of the Azienda USL—IRCCS di Reggio Emilia, (Reggio Emilia, Italy), between January 2014 and September 2016. The study was retrospectively approved by the local Institutional Review Board (registration number: 2016/0010904) for the collection of clinical data, and was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all patients.

Participants
The study included patients aged 18 years and above with the diagnosis of primary open-angle glaucoma (POAG), pseudoxfoliative glaucoma (PXF), or uveitic glaucoma (UG), with inadequately controlled IOP, despite maximum tolerated medical therapy, or intolerant to glaucoma medications, therefore requiring surgical intervention.

Patients with normal-tension glaucoma, neovascular glaucoma, pigmentary glaucoma, steroid-induced glaucoma, glaucoma associated with ocular dysgenesis, congenital glaucoma, history of ocular trauma, or previous glaucoma surgery, including laser trabeculoplasty, in the study eye, were excluded from this study.

Preoperative Assessment
Before surgery, a complete ophthalmic evaluation was conducted, including slit-lamp examination, gonioscopy to confirm open-angle and visible trabecular meshwork, IOP measurement by Goldman applanation tonometer (Haag-Streit, Koeniz, Switzerland), and visual field (VF) examination with the Humphrey Visual Field 30-2 (HFA II 750, Carl Zeiss Meditech Inc., Dublin, CA). The choice for performing a TRAB or GATT was left to the surgeon’s discretion according to some parameters such as angle morphology and visibility, patient cooperation on maintaining the head position during surgery, and the lens status. Patients with clinically significant cataracts were preferably addressed to GATT combined with cataract extraction (CE).

Baseline demographic information such as sex and age were documented, together with the number of glaucoma medications and their duration.

Surgical Techniques
Both surgical procedures were carried out by a single surgeon (L.F.), experienced with TRAB, but novice with GATT. Patients underwent GATT in isolation, or in combination with CE, if visually significant. In these cases, standard phacoemulsification with IOL implantation was performed first, followed by trabeculotomy. TRAB procedures were not associated with cataract surgery in any case. Anticoagulant therapies were suspended before surgery.

GATT was performed, as illustrated by Grover et al. In brief, a 2.2 mm limbal incision was created at the clear temporal cornea; the surgeon visualized the nasal angle using a Swan-Jacob goniolens by proper orientation of the microscope and the patient’s head. The anterior chamber was filled with cohesive viscoelastic (Healon GV Pro, Johnson & Johnson Vision, New Brunswick, NJ). A 1 to 2 mm goniotomy was performed at the nasal angle using a 20-gauge sclerotome. The distal tip of an illuminated microcatheter (iTRACK, Ellex iScience Inc., Fremont, CA) was inserted into the Schlemm’s canal at the goniotomy site and advanced along the canal circumferentially in a clock-wise direction in right eyes and a counter-clockwise direction in left eyes. Once the distal tip of the catheter circumnavigated the canal for 360 degrees, the catheter was retrieved and externalized, creating an ab interno complete trabeculotomy. The viscoelastic was rinsed, and the anterior chamber was half-filled with dispersive viscoelastic (Eyefill, Bausch & Lomb, Bridgewater, NJ) to tamponade bleeding from the angle. In cases where the catheter could not be passed through the Schlemm’s canal for 360 degrees, a less extensive trabeculotomy was created by cutting ab interno the trabecular meshwork in correspondence to the point of blockage. In all cases, the extension of the trabeculotomy achieved was recorded.

A “safe” MMC-augmented trabeculectomy was performed in the superior quadrant. In brief, after creating a fornix-based conjunctival flap of 6 to 8 mm, a rectangular partial-thickness scleral flap (3.5×4.5 mm) was constructed, followed by dissection into the clear cornea. A surgical sponge soaked in MMC 0.4 mg/mL was applied for 3 minutes and then thoroughly rinsed. After the sclerostomy was created, a peripheral iridectomy was performed to prevent iris incarceration. Two releasable sutures were placed at the posterior corners of the scleral flap using a 10-0 nylon suture.

Subconjunctival steroids and intracameral antibiotics were injected according to the surgeon’s discretion at the end of both procedures.

Postoperatively, all patients were instructed to stop their previous glaucoma medications. Following surgery, therapy after GATT included pilocarpine 10 mg/dL eye drops TID for 2 weeks, dexamethasone 0.1% and tobramycin 0.3% eye drops combined QID for 2 weeks and then tapered progressively according to surgeon choice. Patients after TRAB received dexamethasone 0.1% and tobramycin 0.3% eye drops combined 6 times daily for 2 weeks, reduced to the only dexamethasone 0.1% eye drops QID for 1 month and then tapered progressively for a period of 2 months.

Statistical Analysis
In the absence of an a priori hypothesis, no formal sample size calculation was performed for this study. Clinical and demographic data were expressed in terms of frequency and percentage for categorical variables and number and percentage for continuous variables. The primary outcome was IOP measured at each study visit. Success was defined as IOP decrease ≥30% from baseline and an absolute IOP ≤18 mm Hg, complete without the use of glaucoma medications and qualified with the use of antiglaucoma drugs.

Secondary outcomes were:
- Visual field change, measured as the difference between MD value at baseline and after 18 months.
- The number of medications after surgery.
- Complications and reoperation.
- GATT learning, measured by the number of consecutive trabeculotomies completed for 360 degrees.

Outcomes
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mean ± SD for continuous numerical ones. In order to compare means and proportions among groups, we used independent samples t tests and χ² (or Fisher’s exact test, where appropriate) tests, respectively; furthermore, we used a test for trend in proportion to verify the percentage increase of 360 degrees GATT in consecutive procedures. Analysis of variance test was performed to evaluate normally distributed continuous variables and to test the overall statistical significance of the entire observation period. Kaplan-Meier survival curve analysis was used to evaluate the cumulative probability of success (IOP decrease ≥ 30% from baseline and an absolute IOP ≤ 18 mm Hg), and a log-rank test was used for comparison of groups. Failure was defined as postoperative IOP > 18 mm Hg and IOP decrease <30% despite medical therapy, measured at any time point.

A value of P < 0.05 was considered significant for all tests. The confidence interval (CI) was 2-tailed and calculated considering a 0.95 confidence level. Statistical analysis was performed using R for Windows (software release 3.5.2).

RESULTS

One hundred twenty consecutive patients underwent either TRAB or GATT during the time encompassed by this study. Six patients were lost during follow-up, and 4 had types of glaucoma reason for exclusion. One hundred and ten patients (110 eyes) completed the 18 months follow-up and, therefore, were included for the analysis. Of these, 49 received TRAB and 61 GATT.

A summary of patient demographics and baseline parameters is given in Table 1 (Supplemental Digital Content 1, http://links.lww.com/IJG/A479). GATT patients were older than TRAB patients (P = 0.04). Sex was equally distributed in the 2 groups. Percentage of phakic and pseudophakic eyes at the time of surgery, preoperative IOP value, number of glaucoma medications, treatment duration, and degree of VF loss were comparable in both groups. Twelve eyes in the GATT group (19.67%) underwent combined trabeculotomy and CE. There was a majority of POAG cases in both groups, patients with PXF were represented only in the GATT group, and UG cases were more frequent in the TRAB group.

Primary Outcome

IOP values and distribution at all time points are shown in Table 1. IOP reduction from baseline was achieved with both techniques from the first day of follow-up. A greater IOP-lowering effect was observed in patients who underwent TRAB compared with GATT, reaching a level of significance at several time points (Table 1). At the last follow-up visit the mean (± SD) IOP was 15.26 (± 3.47) mm Hg and 12.48 (± 4.58) mm Hg in the GATT and TRAB group, respectively (P = 0.002). Likewise, the percentage of IOP reduction from baseline was statistically higher after TRAB than GATT starting from week 1 (Fig. 1). At 18 months, the mean (± SD) IOP lowering was 11.64 (± 5.34) mm Hg, corresponding to a percentage reduction of 42.04 (± 15.56) after GATT and 16.98 (± 8.13) mm Hg, corresponding to a percentage reduction of 56.05 (± 17.72) after TRAB (P < 0.001). The cumulative probability of success during the observation period is shown in Figure 2. The probability of being in response after 18 months was 62.1% (95% CI, 49.7%-77.6%) and 43.3% (95% CI, 30.7%-61.1%) for TRAB and GATT, respectively. The response duration seemed to be longer in the TRAB group, though the difference was not

**TABLE 1. Postoperative IOP Values and IOP Reduction After TRAB and GATT at Each Time Point Interval of the Follow-up**

| Days | Postoperative IOP (Mean ± SD) | TRAB (n = 49) | GATT (n = 61) | P |
|------|-------------------------------|---------------|---------------|---|
| Day 1 | 16.33 ± 8.29 | 16.60 ± 7.02 | 0.854 |
| Week 1 | 15.56 ± 9.67 | 16.45 ± 8.64 | 0.624 |
| Month 1 | 11.71 ± 4.61 | 15.84 ± 6.92 | < 0.001 |
| Month 3 | 11.77 ± 5.88 | 13.45 ± 3.00 | 0.082 |
| Month 6 | 12.22 ± 7.20 | 14.41 ± 3.89 | 0.070 |
| Month 12 | 11.67 ± 3.99 | 15.29 ± 5.52 | < 0.001 |
| Month 18 | 12.48 ± 4.58 | 15.26 ± 3.47 | 0.002 |

| Follow-up | IOP Reduction (Preoperative-Postoperative) (Mean ± SD) | TRAB (n = 49) | GATT (n = 61) | P |
|-----------|-------------------------------------------------------|---------------|---------------|---|
| Day 1 | 13.71 ± 10.51 | 10.38 ± 7.65 | 0.068 |
| Week 1 | 14.48 ± 11.41 | 10.53 ± 8.99 | 0.055 |
| Month 1 | 18.33 ± 8.57 | 11.00 ± 7.99 | < 0.001 |
| Month 3 | 18.52 ± 8.42 | 13.43 ± 5.11 | < 0.001 |
| Month 6 | 17.24 ± 9.72 | 12.47 ± 5.33 | 0.004 |
| Month 12 | 17.79 ± 8.32 | 11.59 ± 6.51 | < 0.001 |
| Month 18 | 16.98 ± 8.13 | 11.64 ± 5.34 | < 0.001 |

GATT indicates gonioscopy-assisted translimbal trabeculotomy; IOP, intraocular pressure; TRAB, trabeculotomy.
FIGURE 2. Kaplan-Meier curve showing the probability of surgical success versus months of follow-up. Eyes were classified as failures if IOP decrease <30% from baseline and an absolute IOP >18 mm Hg. The black line and dashed line represent TRAB and GATT patients, respectively. GATT indicates gonioscopy-assisted transluminal trabeculotomy; IOP, intraocular pressure; TRAB, trabeculectomy.

statistically significant (log-rank test \( P = 0.194 \)). At the end of follow-up, percentages of complete and qualified success were comparable, being 59% (29 patients) and 27% (13 patients) after TRAB and 46% (28 patients) and 31% (19 patients) after GATT (\( P = 0.353 \)).

A subanalysis of GATT patients was conducted to determine the single effect of CE on IOP lowering. Patients who underwent GATT and CE combined surgery showed a greater IOP reduction at different time points, compared with the ones who underwent GATT only (Fig. 3).

Secondary Outcomes

Visual Field Stability

At month 18, the mean (± SD) MD was −18.48 (± 8.82) dB and −14.36 (± 8.24) dB in the TRAB and GATT groups, respectively. The difference between preoperative and postoperative MD was not significant in both groups (\( P = 0.177 \)).

Number of Medications

The mean reduction of medication burden after surgery was 2.3 ± 1.4 and 2.1 ± 1.5 in TRAB and GATT, respectively (\( P = 0.493 \)). At the last visit, 33 (67.3%) after TRAB and 38 (62.2%) patients after GATT were without IOP-lowering medications (\( P = 0.726 \)). The difference between groups was not significant (\( P = 0.493 \)).

GATT Learning

To assess our learning curve with GATT surgery, we divided consecutive procedures into 6 groups. Overall, a complete 360-degree trabeculotomy was achieved in 46 eyes (75.41%; 95% CI, 62.44%–85.15%), whereas incomplete trabeculotomies were recorded in 15 patients (24.6%; 95 CI, 14.5%–37.3%), mostly occurring in the first 20 procedures. In these cases, the recorded extension of the Schlemm’s canal opening ranged between 180 to 270 degrees. The IOP-lowering effect was comparable in patients after circumferential and sectorial trabeculotomy being 15.05 (± 3.29) and 16.11 (± 4.29) mm Hg, respectively (\( P = 0.417 \)).

A positive trend with time toward learning to perform a complete ab interno circumferential trabeculotomy was found (\( P < 0.001 \)) (Fig. 4).

GATT learning was further assessed by calculating the surgery time of each surgical procedure. In cases of combined cataract and trabeculotomy (12 cases), only the glaucoma surgery time was considered. Surgical time shortened from mean 33 (± 8.29) minutes in the first 10 cases to 18.5 (± 6.24) minutes in the last 10 cases (\( P < 0.001 \)).

Complications and Reoperation

Complications and types of reintervention after GATT and TRAB are summarized in Table 2. None of the patients experienced severe events. Type of complications differed in 2 groups: following TRAB, hypotony (IOP < 6 mm Hg) was the most frequent complication, occurring early after surgery, whereas hemorrhagic events (hyphema and vitreous hemorrhage) happened more frequently after GATT during the first 2 postoperative weeks. In 11 cases, hyphema persisted for longer but spontaneously resolved within the first month after surgery. Indication for surgical reintervention was defined by uncontrolled IOP > 21 mm Hg 6 months postoperatively despite therapy. Bleb revision was required in 4 (8.2%; 95 CI, 2.6% to 20.5%) cases after TRAB and 9 patients (14.8%; 95 CI, 7.4% to 26.7%) after GATT underwent trabeculotomy+MMC (\( P = 0.443 \)).

DISCUSSION

Trabeculotomy is the gold standard filtration procedure by glaucoma surgeons, against which all types of glaucoma surgeries are compared.4 Trabeculotomy, during the last decade, has witnessed a progressive evolution13 from segmental to circumferential incision,14 from ab externo15 to ab interno,16 from the employment of metal instruments to modified monofilament sutures,11 and finally to a dedicated microcatheter.17,18

The current study retrospectively examined the outcomes of a consecutive series of adult patients with open-angle glaucoma who underwent GATT and MMC augmented TRAB followed for 18 months. Our results showed that TRAB lowered the IOP more than GATT, determining an average IOP reduction of 16.9 and 11.6 mm Hg, respectively. At last visit, the average postoperative IOP was in the low-teens (12.4 mm Hg) after TRAB and in the mid-teens (15.2 mm Hg) after GATT. This finding may be relevant to evaluate if GATT may be suited to patients with advanced glaucoma who require a very low IOP.19 Following TRAB, the IOP reduction from baseline was 49% at 18 months, the success rate (complete and qualified) was 86%, with 59% of the patients without treatment at the end of follow-up. After GATT, the IOP decrease was 47%, the success rate (complete and qualified) was 77%, with 46% of patients without medications. However, by the criteria used in this study to define success, the probability of being in response after 18 months was not statistically different between groups, though the response duration seemed to be longer in the TRAB group.

The success rate of GATT in our study compares to the ones of other reports if equivalent follow-up times are compared.20,21 Grover et al found an average percent IOP
lowering of 39.8% at 12 months and 37.3% at 24 months in POAG patients.10,22 Rahmatnejad and colleagues, in a retrospective chart review of PAOG patients who underwent GATT, reported an average IOP of 14.6 mm Hg with a 44% decrease at 12 months after surgery.23 Similarly, Aktas and colleagues observed a 40.1% IOP reduction at 19 months in a retrospective study conducted in PAOG patients who underwent GATT using a 6-0 prolene suture.24

Few studies have compared the outcomes of trabeculectomy and trabeculotomy in an adult population of POAG patients. In a long-term study, Bao et al25 found that patients after trabeculectomy with MMC maintained a lower IOP and required fewer glaucoma medications than patients after ab externo trabeculotomy. With both procedures, they observed a loss of efficacy with time and a greater percentage of VF progression in the trabeculotomy group, suggesting a careful selection of candidates for this procedure. Similarly, MMC-augmented trabeculectomy achieved a significantly greater IOP reduction, requiring fewer medications, compared with canaloplasty.26

Trabeculotomy lowers the IOP by facilitating the physiological aqueous reabsorption through the incision of

FIGURE 3. Boxplot representing the distribution of IOP in GATT patients at each time point depending on the lens status at the time of surgery. Bold lines within boxes represent the median (percentile 50%), upper and lower limits of the box represent the first (percentile 25%), and the third quartiles (percentile 75%) respectively, and bars represent the extreme values (maximum and minimum observations). Circles represent outliers. Asterisks represent statistical significance. CE indicates cataract extraction; GATT, gonioscopy-assisted transluminal trabeculotomy; IOP, intraocular pressure; pre, preoperative; TRAB, trabeculectomy.

FIGURE 4. Bar chart representing the number of complete (360 degrees) and not-complete trabeculotomy (<360 degrees) divided into 6 groups of consecutive procedures. The interpolation line represents the progressive improvement of the learning curve.
the trabecular meshwork and Schlemm’s canal inner layer, where the majority of the pathologic outflow resistance takes place. Supposedly, with this technique, the postoperative IOP should approximate the episcleral venous pressure, known to be approximately 12 mm Hg;27, however, malfunctioning collectors channels, with increased outflow resistance, as seen in glaucomatous patients, and scarring of the trabeculotomy opening may play a role explaining the greater than expected IOP observed with this procedure.

What the correct extent of the trabeculotomy to achieve an adequate IOP-lowering effect is still unclear. Theoretically, a more extensive trabeculotomy should promote the maximal recruitment of all available collector channels, thus favoring aqueous outflow. This hypothesis is questioned by a study reporting no correlation between the size of the trabeculotomy and the IOP reduction obtained.28 Accordingly, in our study, we observed a similar IOP-lowering effect in patients in whom a 360-degree GATT was accomplished, compared with the ones in whom a less extensive trabeculotomy was achieved. Interestingly, in all our cases, GATT was performed starting from the nasal toward the inferior angle quadrant, and in this way, we assured that an incomplete trabeculotomy always involved these quadrants where the higher number of collector channels is present.29

Being a less invasive procedure, GATT may be more easily combined with CE than TRAB in glaucoma patients with visually significant cataracts. With GATT, the surgeon may take advantage of the same temporal incision for performing standard phacoemulsification before or after trabeculotomy. Grover et al30 reported that the pseudophakic PAOG showed a higher cumulative proportion of failure and a higher cumulative proportion for reoperation after 24 months.22 In contrast, our results indicated a greater IOP-lowering effect of GATT when coupled with CE. Combined procedures were associated with ~2 mm Hg lower IOP than GATT performed in isolation in phakic and pseudophakic patients. An explanation for this may come from the observation that phacoemulsification alone is capable of reducing the IOP of POAG patients and so the number of their medications.30 Although a minority of patients in this study underwent the 2 procedures combined, the additive pressure-lowering effect of CE may have somehow positively influenced the IOP result of GATT. In our study, TRAB was not associated with CE due to the known limited additional pressure-lowering effect and to the higher rate of postoperative complications.31,32

Since GATT belongs to the MIGS scenario, it could be of interest to compare our results of IOP control and medication burden with data from other types of MIGS reported in the literature. After MIGS (Trabectome,33 iStent,34,35 Hydrus,36 and Cypass37) the mean IOP lowering ranges from 4.57 to 11.80 mm Hg with a reduction in the number of medications varying from mean 0.10 to 1.64.38 Our results show that GATT is capable of lowering the IOP equally or more than other types of MIGS.

Although TRAB still represents the gold standard for glaucoma surgery, conjunctiva sparing, less invasive techniques may be preferable as the first surgical approach, preserving to a second time the choice for a filtering procedure or glaucoma drainage device implantation in case of failure. GATT, like other types of MIGS, may act as a midpoint between medical or laser treatment and conventional glaucoma surgery, augmenting the armamentarium of therapeutic options for the patient and surgeon. The ab interno surgical approach, sparing the conjunctiva and sclera, offers the advantage of performing a filtering procedure in more optimal conditions, possibly increasing the probability of success.

Moreover, it is well known that TRAB is associated with early postoperative and long-term complications, including hypotony, bleb leakage, anterior chamber shallowing, choroidal detachment, and bleb infection.39–42 Predictably, after TRAB, hypotony was the most frequent complication encountered in our study, whereas intraocular bleeding with hyphema was commonly seen after GATT. Previous studies with this technique described hyphema as an inevitable event occurring from tearing of the vascularized angle structures.13,43 Seldomly, blood clot aspiration from the anterior chamber may be required in case of long-standing hyphema disturbing the visual acuity.

The surge in less invasive ways to treat glaucoma has increased the surgeons need to acquire novel techniques, but few data are available on the learning curve required to learn these new procedures. Dang and colleagues44 published the results on the learning process in mastering an ab interno trabeculotomy with the trabectome using an animal model, suggesting that about 30 procedures are necessary to be autonomous. Our results showed that GATT seems to be a reasonably easy-to-learn technique. We observed a consistent reduction of the surgical time and a steady percentage of complete 360 degrees trabeculotomies after the first 20 procedures. We believe that this information may be useful for those glaucoma specialists willing to undertake this technique. Although several authors42,45–48 support the use of a prolene suture because of its limited cost, the use of an illuminated microcatheter allows less experienced surgeons to be sure of the position and progression of the probe along the Schlemm’s canal, facilitating this procedure.

There are several inherent limitations in this study, including its retrospective design, lack of power calculation, and limited follow-up, all reflecting the process of acquisition of any new surgical procedure.

In conclusion, in open-angle glaucoma patients, at 18 months after surgery, GATT is as effective as TRAB on
reducing the IOP ≥ 30% from baseline and ≥ 18 mm Hg and the number of glaucoma medications. However, TRAB determines a greater IOP reduction than GATT and is capable of lowering the IOP to the low teens level. Complications and reintervention occurred equally after both procedures but differed in type. Ab interno trabeculotomy carries the advantage of a less invasive technique that may be effectively combined with cataract surgery and spares the conjunctiva and sclera for a potential future filtration surgery.

Further research is warranted to understand better who are the appropriate patients for GATT as well as to learn more about the long-term efficacy of this procedure.

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