Comparison of Ab Externo and Ab Interno 360-degree Suture Trabeculotomy in Adult Open-angle Glaucoma

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Precis: Ab interno (gonioscopy-assisted transluminal trabeculotomy) and ab externo 360-degree suture trabeculotomy (ST) achieved similar success rates for reducing intraocular pressure (IOP) without serious complications threatening visual acuity.

Purpose: We aimed to compare the efficacy of ab externo and ab interno 360-degree ST in reducing IOP, decreasing the number of antiglaucoma medications required, and decreasing the rates of intraoperative/postoperative complications in adults with open-angle glaucoma (OAG).

Patients and Methods: This retrospective study included 33 eyes of 33 patients who underwent ab externo 360-degree ST (group 1) and 23 eyes of 23 patients who underwent ab interno 360-degree ST for OAG (group 2). We analyzed demographics as well as preoperative and postoperative (1, 3, 6, and 12 mo) data related to IOP, the number of antiglaucoma medications, complications, and surgical success rates.

Results: In group 1, the mean IOP was 26.2 ± 10.4 mm Hg, and the mean number of antiglaucoma medications was 3.2 ± 1.0 preoperatively, decreasing to 11.2 ± 3.0 mm Hg and 0.1 ± 0.4 at 12 months, respectively (P < 0.001, <0.001). In group 2, the mean IOP was 28.3 ± 10.4 mm Hg, and the mean number of antiglaucoma medications was 3.5 ± 0.9 preoperatively, decreasing to 13.3 ± 6.5 mm Hg and 0.8 ± 1.0 at 12 months, respectively (P < 0.001, <0.001). Decreases in IOP at 6 and 12 months were similar in groups 1 and 2 (50% vs. 47%, P = 0.6; and 51% vs. 49%, P = 0.7, respectively). At 12 months, complete and qualified success rates were 88% and 97% for group 1 and 57% and 87% for group 2, respectively. The most common complications in both groups were hyphema and transient IOP spikes.

Conclusion: Ab interno 360-degree ST is similar to ab externo 360-degree ST in terms of safety and efficacy in patients with OAG.

Key Words: circumferential suture trabeculotomy, ab externo, ab interno, gonioscopy-assisted transluminal trabeculotomy, open angle glaucoma

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Glaucoma is among the most common causes of irreversible blindness worldwide.1 Given that increased intraocular pressure (IOP) represents the main risk factor for glaucoma progression, pharmacological and surgical treatment strategies primarily aim to lower IOP.2 IOP is regulated by aqueous humor production and outflow, the latter of which is mainly controlled by Schlemm’s canal (SC) and the juxta-canalicular region.3 Standard filtering glaucoma surgery, which is known as trabeculectomy, can effectively lower IOP in patients with glaucoma. However, this surgical method is associated with severe intraoperative and postoperative complications, most of which are bleb related.4 SC surgeries including trabeculotomy, viscoanalostomy, and canaloplasty are important alternatives to glaucoma filtration surgeries such as trabeculotomy. These surgeries enhance aqueous outflow through the trabeculum, SC, and collector channels without bleb formation.5 Recent advancements in trabeculotomy surgery include the use of circumferential suture techniques and flexible microcatheters for SC cannulation. Among these techniques, 360-degree suture trabeculotomy (ST) involves creating a circumferential incision in the inner wall of SC and the juxta-canalicular trabeculum, thereby decreasing resistance between the anterior chamber and SC and increasing aqueous outflow. The 360-degree ST can decrease IOP to a level nearly equal to the episcleral venous pressure (8 to 10 mm Hg).5 In 1995, Beck and Lynch reported high success rates following ab externo 360-degree trabeculotomy using a 6-0 polypropylene suture in patients with congenital glaucoma. 6 Chin and colleagues were the first to evaluate the efficacy of 360-degree ST in adults with primary open-angle glaucoma (POAG) and secondary open-angle glaucoma (SOAG). In their study, ab externo 360-degree ST was significantly more effective than metal trabeculotomy.8 Grover et al9 described a novel ab interno approach to circumferential 360-degree trabeculotomy, reporting that gonioscopy-assisted transluminal trabeculotomy (GATT) achieved success rates of 68% to 80% in patients with POAG and SOAG in different clinical settings.9 Subsequently, their 24-month follow-up data indicated that GATT is relatively safe and effective in patients with different forms of open-angle glaucoma.10

To the best of our knowledge, no previous studies have compared the safety and efficacy of ab externo and ab interno 360-degree ST. Therefore, in the present study, we aimed to evaluate and compare the success rates of ab externo and ab interno 360-degree ST in lowering IOP, decreasing the number of antiglaucoma medications, and reducing intraoperative/postoperative complications in patients with adult OAG.

PATIENTS AND METHODS

Study Population

This retrospective, comparative study was conducted in the Department of Ophthalmology at Gaziantep University Medical School in Turkey. The Ethics Committee approved the study design and procedures (approval number: 172).
which were developed in accordance with the principles outlined in the Declaration of Helsinki and ethical standards for human experimentation. Written informed consent was obtained from all participants. Inclusion criteria were as follows: OAG with IOP > 21 mm Hg, glaucomatous optic nerve changes and visual field loss despite exhaustive medical treatment, need for glaucoma surgery due to intolerance of antiglaucoma medications, and age 18 years and above. Patients with narrow-angle glaucoma, uveitic glaucoma, neovascular glaucoma, bleeding disorders, conditions that affect viewing angle structures such as corneal opacities, an inability to discontinue treatment with systemic anti-coagulants, and a previous history of laser therapy (argon laser trabecuoplasty, selective laser trabecuoplasty) for trabeculotomy or glaucoma surgery were excluded.

**Surgical Procedure**

**Ab Externo 360-degree ST**

We utilized a standard nonpenetrating incision technique previously described for patients undergoing visco-canalostomy and canaloplasty. A parabolic 5×5-mm superficial flap (1/3 scleral thickness) and a 4×4 mm deep scleral flap were prepared. The roof of the SC was removed, following which its ostia were dissected. A small amount of viscoelastic material was injected to identify the SC ostia and allow for easy passage of the sutures. The SC was cannulated circumferentially using a 5-0 or 6-0 polypropylene suture rounded at the tip via cautery as described by Chin et al. On the opposite side of the scleral flap, a clear corneal side-port incision was made, and viscoelastic material was injected into the anterior chamber. The sutures used during SC cannulation were inserted into the anterior chamber through 30-G holes created using a needle at the flap corners. Both ends of the sutures were then removed from the eye through the same side-port incision using microsurgical forces, and the 360-degree circumferential SC incision was completed. The deep scleral flap was excised, and the superficial flap was sutured watertight to prevent bleb formation. When resistance prevented further cannulation, the suture was removed and inserted from the other side of the scleral flap. During surgery, some sodium hyaluronate was left in the anterior chamber to limit hyphema. ST was combined with phacoemulsification and intraocular lens implantation from a separate clear corneal side-port incision was made, and viscoelastic material was injected into the anterior chamber. The suture tip was visualized at the goniotomy incision, it was clutched with the microsurgical forceps and externalized via the temporal incision. The suture was advanced circumferentially 360 degrees into the canal. When the suture tip was visualized at the goniotomy incision, it was clutched with the microsurgical forceps and externalized via the temporal incision. The suture was advanced circumferentially 360 degrees into the canal. When the suture tip was visualized at the goniotomy incision, it was clutched with the microsurgical forceps and externalized via the temporal incision. This constituted the first 180-degree trabeculotomy. The 360-degree ST was completed by holding the proximal end of the suture and removing the viscoelastic material from the anterior chamber using a bimanual irrigation-aspiration system. At the end of the procedure, almost 25% of the anterior chamber was filled with viscoelastic material to tamponade postoperative bleeding from the canal. ST was combined with phacoemulsification and intraocular lens implantation in patients with cataracts. After surgery, patients were instructed to maintain their heads in an elevated position to reduce episcleral vascular pressure. Postoperative antibiotic eye drops were administered 4 times daily for 1 week, while steroid eye drops were administered 4 times daily and tapered over a period of 4 weeks.

**Study Outcomes**

Thirty-three eyes of 33 patients who underwent ab externo 360-degree ST (group 1) and 23 eyes of 23 patients who underwent ab interno 360-degree ST (GATT) (group 2) were enrolled in this study. Before surgery, all patients underwent a complete baseline ophthalmic examination, including IOP measurement (Goldman applanation tonometry), an assessment of best-corrected visual acuity (BCVA), a visual field examination (24-2, Humphrey field analyzer; Humphrey Instruments, Munich, Germany), gonioscopy, slit-lamp biomicroscopy, and fundus examination. Postoperative examinations were performed 1 day; 1 week; and 1, 3, 6, 9, and 12 months after surgery. Demographic characteristics (age, sex, family history, glaucoma type), preoperative and postoperative IOP, number of antiglaucoma medications, complications, further surgeries, follow-up time, lens status, and surgical success rates were evaluated in each group. Complete surgical success was defined as an IOP ≤ 21 mm Hg and a 30% reduction relative to preoperative measurements without the need for medication, while qualified surgical success was defined as an IOP ≤ 21 mm Hg and a 30% reduction relative to preoperative measurements with medication at the 12-month follow-up.

**Statistical Analyses**

All statistical analyses were performed using Statistical Package for the Social Sciences version 20 (IBM Corp., Armonk, NY). Distributions were assessed for normality using the Kolmogorov-Smirnov test. The homogeneity of variables was determined using 1-way analysis of variance homogeneity of variance tests. In the text and tables, symmetrically distributed variables are presented as the mean ± SD, while categorical variables are presented as numbers (n) and percentages (%). The Student t tests or Mann-Whitney U tests were used to compare continuous variables based on the data distribution. $\chi^2$ tests were used to compare categorical variables. Kaplan-Meier survival curves and the associated 95% confidence intervals were used to analyze success rates. The level of statistical significance was set to $P < 0.05$. 

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RESULTS

Demographic Characteristics

Patient characteristics are summarized in Table 1. No significant differences in sex, glaucoma type, cup/disc ratio, visual field mean deviation, lens status, preoperative IOP, number of antiglaucoma medications, or follow-up time were observed between the groups. The mean age of the total study population was 62.7 ± 12.8 years. The mean age at the time of surgery was 66.1 ± 11.1 years in group 1 and 58.2 ± 14.5 years in group 2. Although the mean age was significantly lower in group 2 than group 1 (P = 0.03), the age distribution was similar between the 2 groups (P = 0.1) (Table 1). The mean follow-up time was 14 ± 1.3 months in group 1 and 13.6 ± 1.04 months in group 2, and there was no significant difference between the 2 groups (P = 0.1). The mean preoperative BCVA (logMAR) was significantly higher in group 1 than in group 2 (0.34 ± 0.21 vs. 0.26 ± 0.18, P = 0.04). No significant differences in BCVAs were observed between the groups at the 12-month follow-up (P = 0.8).

Seventeen (51%) eyes in group 1 and 4 eyes (17%) in group 2 underwent combined cataract surgery and ST. In group 1, the mean IOP at 6 months was 10.1 ± 2.8 mm Hg in the combined group and 13.0 ± 3.1 mm Hg in the noncombined group, while the mean IOP at 12 months was 11.1 ± 3.1 mm Hg in the combined group and 11.3 ± 2.9 mm Hg in the noncombined group. The mean IOP was lower in eyes with combined surgery at 6 months, although there was no significant difference at 12 months (P = 0.01 and 0.8, respectively). In group 2, there was no significant difference in IOP between the combined and noncombined groups at either 6 or 12 months (P = 0.3 and 0.5, respectively).

Table 2 shows the mean preoperative and postoperative IOP and the number of antiglaucoma medications in both groups at 1, 3, 6, and 12 months. In group 1, the mean IOP was 26.2 ± 10.4 before surgery, decreasing significantly to 11.5 ± 3.3 mm Hg at 6 months and 11.2 ± 3.0 mm Hg at 12 months (P < 0.001 and < 0.001, respectively). Similarly, in group 2, the mean IOP was 28.3 ± 10.4 mm Hg before surgery, decreasing significantly to 13.8 ± 6.6 mm Hg at 6 months and 13.3 ± 6.5 mm Hg at 12 months (P < 0.001 and < 0.001, respectively). Although the mean IOP was significantly lower in group 1 than in group 2 at 3 and 6 months after surgery (P = 0.02 and 0.04, respectively), the magnitude of IOP reductions was similar between the groups at 3, 6, and 12 months (51% vs. 46%, P = 0.5; 50% vs. 47%, P = 0.6; and 51% vs. 49%, P = 0.7, respectively) (Figs. 1, 2). In group 1, the mean number of antiglaucoma medications was 3.2 ± 1.0 before surgery and decreased to 0.1 ± 0.4 at 6 months and 0.1 ± 0.4 at 12 months (P < 0.001 and < 0.001, respectively). In group 2, the mean number of antiglaucoma medications was 3.5 ± 0.9 before surgery and decreased to 0.8 ± 1.2 at 6 months and 0.8 ± 1.0 at 12 months (P < 0.001 and < 0.001, respectively).

The magnitude of IOP reduction

FIGURE 1. Comparison of postoperative decreases in intraocular pressure (IOP) between the ab interno and ab externo techniques. Figure 1 can be viewed in color online at www.glaucomajournal.com.
Surgical Success Rates

Complete and qualified success rates at the 6-month follow-up were 90.6% and 96.9% for group 1 and 65.2% and 87% for group 2, respectively. At 12 months, complete and qualified success rates were 88% and 97% for group 1 and 57% and 87% for group 2, respectively. When we evaluated success rates at 12 months based on age distribution, qualified and complete success rates were similar for patients younger and older than 62.7 years in both groups (P = 0.3 and 0.09 for group 1; P = 0.5 and 0.2 for group 2, respectively) (Table 3). In addition, ab externo and ab interno procedures were associated with similar qualified and complete success rates in terms of age distribution (P = 0.7 and 0.2 for below 62.7 years; P = 0.3 and 0.08, for above 62.7 years, respectively). Complete success rates were significantly higher in group 1 than in group 2 at 6 and 12 months (P = 0.02 and 0.01, respectively). However, there were no significant differences in qualified success rates between the groups at 6 and 12 months (P = 0.1 and 0.3, respectively) (Fig. 3). We performed Kaplan-Meier survival analysis to determine the cumulative probability of complete and qualified surgical success for ab externo and ab interno surgeries. The log-rank test revealed that complete and qualified surgical success rates were similar in both groups (P = 0.2 and 0.5, respectively) (Fig. 4).

Complications

Table 4 shows the intraoperative and postoperative complications for both groups. In group 1, the most common complication was hyphema (n = 22 eyes, 66%), although all but 2 cases resolved spontaneously. One patient was treated via anterior chamber washing at day 10, while the other had...

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**TABLE 3. Success Rates and Magnitude of Intraocular Pressure (IOP) Reduction of Surgical Techniques at 12 Months Visit According to Age Distribution**

| Group 1* | Group 2* |
|----------|----------|
| < 62.7 y (n = 11) | > 62.7 y (n = 22) | P | < 62.7 y (n = 12) | > 62.7 y (n = 11) | P |
| Qualified Success rate, n (%) | 10 (91) | 22 (100) | 0.3 | 10 (83) | 10 (91) | 0.5 |
| Complete success rate, n (%) | 8 (73) | 21 (96) | 0.09 | 5 (42) | 8 (73) | 0.2 |
| The magnitude of IOP reduction (mean percentage ± SD) | 53.9 ± 15 | 50.1 ± 26.8 | 0.6 | 46 ± 25 | 52.3 ± 14 | 0.5 |

*Group 1: Ab externo suture trabeculotomy. Group 2: Ab interno suture trabeculotomy (gonioscopy-assisted transluminal trabeculotomy).*

**FIGURE 2.** Preoperative versus postoperative intraocular pressure at 12 months in each patient.

**FIGURE 3.** Comparison of Ab Externo and Ab Interno 360-degree ST.
undergone treatment with a neodymium-doped yttrium aluminum garnet (Nd:YAG) laser due to the presence of an intracapsular hematoma behind the intraocular lens at the 3-month visit. Three patients exhibited transient elevation of IOP (>30 mm Hg) at 1 month, although medical therapy controlled these increases in all patients. Involuntary bleb formation was observed in 3 eyes postoperatively. In group 2, the most common complication was hyphema (n = 14 eyes, 61%). Anterior chamber washing was performed in 2 eyes within the first 3 weeks after surgery. Two patients in group 2 exhibited transient increases in IOP (>30 mm Hg) during the first month after surgery, which were controlled with medical therapy. No patients in group 2 developed conjunctival blebs. No cases of extreme hypotony, postoperative infection, or wound leakage were observed in any patients during follow-up.

**DISCUSSION**

Recent advancements have improved the safety and efficacy of SC surgeries by reducing the risk of bleb-associated complications such as blebitis and endophthalmitis. SC surgeries rely on the patient’s natural outflow pathways and target abnormally high resistance to outflow in the trabecular meshwork. Circumferential trabeculotomy is a type of SC surgery that has proven highly successful in both adult and pediatric patients with glaucoma. Trabeculotomy can be performed via the sclera (ab externo) or through the anterior chamber (ab interno) via a corneal incision. In the current study, we observed similar rates of success in reducing IOP for both ab interno and ab externo 360-degree ST. Moreover, neither procedure was associated with severe complications threatening visual acuity.

**FIGURE 3.** Comparison of complete and qualified success rates for the ab interno and ab externo techniques. Figure 3 can be viewed in color online at www.glaucomajournal.com.

**FIGURE 4.** A, Kaplan-Meier survival plot of complete success rates for ab externo and ab interno trabeculotomy (P = 0.2). B, Kaplan-Meier survival plot of qualified success rates for ab externo and ab interno trabeculotomy (P = 0.5). Figure 4 can be viewed in color online at www.glaucomajournal.com.
Chin and colleagues were the first to evaluate ab externo 360-degree ST in adults with OAG, achieving success rates of 84% and 89% in patients with POAG and SOAG, respectively. Moreover, IOP decreased to 13.1 mm Hg at 12 months, while the number of antiglaucoma medications decreased to 0.5. Importantly, they noted that 360-degree ST was more effective than metal trabeculotomy in adult open-angle glaucoma.\(^5\)

Heşşen et al\(^12\) analyzed 6- and 12-month outcomes of ab externo 360-degree ST among patients with pseudoexfoliation glaucoma, reporting complete and qualified success rates of 77% and 100% at 6 months and 68.4% and 94.7% at 12 months, respectively.\(^13\)

At 12 months, IOP decreased by 58.9% (10.9 mm Hg), while the mean number of antiglaucoma medications decreased to 0.30 at 12 months.\(^13\) In accordance with previous findings, we observed complete and qualified success rates of 88% and 97% following ab externo 360-degree ST, respectively. In our patients, IOP had decreased by 51.3% (11.2 mm Hg) by the 12-month follow-up, while the mean number of antiglaucoma medications had decreased to 0.1. These findings are also similar to those observed in previous studies.

Sato and colleagues investigated outcomes of ab externo 360-degree ST when combined with deep sclerectomy and cataract surgery in patients with POAG, reporting success rates similar to those observed in our study. Postoperative IOP was lower, while survival rates were higher, in the 360-degree ST group than in the 120-degree ST group. This finding may be explained by the width of the incision in the inner wall of SC.\(^14\) Accumulating evidence suggests that ab externo 360-degree ST can achieve complete and qualified success rates similar to those observed for filtering surgeries in patients with OAG.\(^15\)

Grover and colleagues recently demonstrated the efficacy of a novel ab interno 360-degree ST technique known as GATT. In 2014, they reported the preliminary results of their investigation for patients with adult OAG. At 12 months, the mean IOP was 15.7 mm Hg in the POAG group and 12.8 mm Hg in the SOAG group for patients treated via GATT. The authors reported that the procedure was safe and effective in 68% to 90% of eyes in different clinical settings.\(^9\)

At 24 months, IOP had decreased by 37.3% in the POAG group and 49.8% in the SOAG group.\(^10\) Subsequent studies have also confirmed the success rates of GATT.\(^16\) However, Grover and colleagues highlighted the high risk of failure in patients with advanced glaucoma, which they attributed to a dysfunctional collector orifice or a damaged distal collector system.\(^17\) Nonetheless, Aktas et al\(^18\) achieved a success rate of 83.7% in patients with moderate to advanced OAG following GATT. For ab interno 360-degree ST, we achieved complete and qualified success rates of 57% and 87% at 12 months (IOP decrease: 49%). These findings are in accordance with those of the previous studies.

In our study, although the mean IOP was significantly lower in the ab externo group than in the ab interno group at 3 and 6 months, it was similar for both groups at 12 months. The mean number of antiglaucoma medications at 12 months was significantly lower in the ab externo group than in the ab interno group. Our cross-sectional analysis revealed that complete success rates were higher for the ab externo technique than for the ab interno technique at 12 months, while qualified success rates were similar. The lower IOP, lower number of antiglaucoma medications, and higher complete success rates observed in the ab externo group may be due to the use of a standard nonpenetrating incision technique. This incision technique may have also contributed to decreases in IOP following trabeculotomy due to the filtration effect of deep sclerectomy, the creation of an intrascleral lake, and aqueous percolation through the trabeculodendritic membrane window.\(^19\) Leakage from the flap edges may have also helped to reduce IOP. In contrast, Kaplan-Meier survival analysis indicated that both procedures achieved similar complete and qualified success rates during follow-up in patients with OAG.

As observed in previous studies, the most common complications among both groups in the present study were hyphema and transient spikes in IOP.\(^8,9\) Hyphema resolved spontaneously in all but 2 cases across both groups. Grieshaber et al\(^20\) reported that hyphema was a positive indicator of surgical success following canuloplasty. At the end of the procedure, viscoelastic material can be left in the anterior chamber to help tamponade postoperative bleeding from the canal. Transient IOP spikes were controlled with medical therapy. Previous authors have suggested that viscoelastic substances can decrease passage through the trabeculodendritic window and collector channels, which may result in IOP spikes.\(^21\) Although the rates of these complications were similar in our 2 groups, involuntary bleb formation was observed in 3 patients following ab externo surgery.

Since both ab externo and ab interno (GATT) 360-degree ST techniques are bleb-independent, they avoid such bleb-related complications as blebitis, endophthalmitis, and hypotony. Both GATT and ab externo require shorter hospitalization times and fewer postoperative follow-up visits than filtering surgeries. However, GATT is particularly advantageous due to the shorter duration of the procedure, sparing of the conjunctiva, the lack of sutures, and the possibility for future filtration surgery. Target tissues are also better visualized through the goniolens during GATT, decreasing the risk of suture misdirection and increasing success rates following 360-degree cannulation.

In our study, the mean age was significantly lower in the ab interno (GATT) group than in the ab externo group. GATT is a less invasive surgery that requires fewer follow-up visits and can be performed at an earlier stage and age. Tanito et al\(^22\) reported that advanced age was an indicator for good surgical outcomes in patients undergoing combined trabeculotomy and cataract surgery. They speculated that the favorable effects of older age on surgical success were due to removal of more increased lens volume, and weak repair processes at the trabeculotomy area because of impaired healing reaction. At 12 months, the success rates were higher in our ab externo group than in our ab interno group.

### TABLE 4. Complications Related to the Surgical Techniques

| Complications                      | Group 1*, n (%) | Group 2*, n (%) |
|------------------------------------|-----------------|-----------------|
| Hyphema                            | 22 (66)         | 14 (61)         |
| Posterior synechia                 | 2 (6)           | 0 (0)           |
| Peripheral anterior synechia       | 3 (9)           | 2 (8)           |
| Iris prolapse                      | 7 (21)          | 0 (0)           |
| Transient intraocular pressure     | 3 (9)           | 2 (8)           |
| elevation (> 30 mm Hg)             |                 |                 |
| Hypotony (< 6 mm Hg)               | 0 (0)           | 0 (0)           |
| Cycloiridiodalysis                 | 0 (0)           | 1 (4)           |
| Involuntary bleb formation         | 3 (9)           | 0 (0)           |
| Infection                          | 0 (0)           | 0 (0)           |
| Wound leak                         | 0 (0)           | 0 (0)           |

*Group 1: Ab externo suture trabeculotomy. Group 2: Ab interno suture trabeculotomy (gonioscopy-assisted transluminal trabeculotomy).
group (88% vs. 57%), which may again be explained by the relatively higher age of patients in the ab externo group. However, when the groups were evaluated according to the age distribution determined based on the average age of all patients, we observed no significant differences in qualified and complete success rates within groups. Nevertheless, the complete success rate tended to be higher in patients with higher age in the ab externo group. The low number of patients in our study may explain the lack of a significant difference in these results.

The present study possesses several limitations of note, including the small number of patients and single-center design, which may have reduced the statistical power of the study. In addition, we included patients with different glaucoma types and those undergoing either combined or uncombined cataract surgery, which may have influenced the success rates observed in the study. Despite these limitations, our results demonstrate that GATT is a relatively simple, effective, and minimally invasive technique for glaucoma surgeons familiar with angle anatomy. Although the success rates for GATT were similar to those for ab externo ST, further prospective randomized controlled studies with longer follow-up periods are required to verify our findings.

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