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Highlighting the limited efficacy of gonioscopy-assisted transluminal trabeculectomy in Fuchs uveitis syndrome: a case series

Cansu Yuksel Elgin[1*] and Mustafa Hepokur[1]

Abstract

Background This study aimed to investigate the outcomes of gonioscopy-assisted transluminal trabeculectomy (GATT) surgery in patients with Fuchs' uveitis syndrome (FUS) related glaucoma.

Case presentation The clinical and surgical records of 4 FUS patients who underwent GATT surgery between 2021 and 2023 were retrospectively reviewed. The preoperative process, clinical course under medical treatment, postoperative clinical course, intraocular pressures (IOP), glaucoma medication requirements, need for additional surgeries, visual outcomes, and surgical success results were evaluated for each patient GATT surgery was performed as the first intervention for glaucoma control in FUS patients under 50 years of age with IOP above 20 mm Hg despite multiple different medications. The average follow-up period after GATT surgery was 12 months. Despite reaching the maximum level of antiglaucomatous treatment in any of the patients, the target IOP was not achieved. On average, 6 months later, mitomycin-C trabeculectomy (MMC-trab) was performed as a conventional surgical option in three of the patients, and diode laser cyclophotocoagulation was applied to one patient with poor visual prognosis.

Conclusions In FUS, which causes low-grade inflammation, has a low likelihood of synechial formation, and relatively affects a younger age group, GATT surgery, a minimally invasive glaucoma surgery (MIGS) method, was considered a good alternative as an initial surgical option. However, it was observed that the surgical success was limited.

Keywords Fuchs uveitis syndrome, Gonioscopy-assisted transluminal trabeculectomy, Glaucoma, Microinvasive glaucoma surgery, Uveitic glaucoma

*Correspondence:
Cansu Yuksel Elgin
cansu.elgin@iuc.edu.tr
[1]Istanbul University-Cerrahpasa Department of Ophthalmology, Kocamustafapasa Cad. No 53, Fatih Istanbul 34098, Türkiye

Background

Fuchs Uveitis Syndrome (FUS) presents as a mild inflammatory condition causing chronic, unilateral anterior uveitis, predominantly affecting young to middle-aged individuals without gender preference. Patients are often asymptomatic, and diagnosis is usually made during routine eye examinations. However, atypical vision complaints such as decreased vision from cataracts or noticing floaters and opacities in the vitreous can also occur [1, 2]. Characteristic findings observed during examination include heterochromia, pan-corneal small satellite-shaped fine keratic precipitates, low-grade anterior chamber inflammation, a typically flattened iris appearance due to iris stromal loss, posterior subcapsular cataract (PSCC), and high intraocular pressure (IOP). There are no signs of inflammation such as pain, redness, or photophobia [1, 2].

Unlike other conditions that cause pigment dispersion from the iris, gonioscopy does not show an increase in pigmentation of the trabecular meshwork (TM). Gonioscopy frequently shows fine vessels crossing the TM and these vessels are not associated with peripheral anterior synechiae (PAS) or fibrosis, but they may progress and bleed spontaneously, leading to hyphema [3]. While the visibility of the angle greatly facilitates the applicability of GATT surgery, it is necessary to be cautious in the early and late postoperative periods regarding complications such as hyphema and PAS that may be caused by abnormal angle vasculature.

In FUS, glaucoma is the second most common complication after cataract, with an incidence reported between 15 and 30% in many studies [4–8], though this can rise to 50% depending on the definition of glaucoma used and the duration of follow-up [8, 9]. In this study, glaucoma is defined based on the presence of persistently elevated intraocular pressure (IOP > 21 mmHg) despite maximal tolerated medical therapy, in association with progressive optic nerve damage (as evidenced by structural and/or functional loss, such as retinal nerve fiber layer thinning on OCT and/or visual field defects). This definition aligns with the consensus criteria for FUS-related glaucoma used in recent literature, allowing for more accurate comparison of outcomes across studies. Despite FUS being an uveitic condition with an excellent visual prognosis, glaucoma remains its only serious complication and the leading cause of severe visual loss. Therefore, effective glaucoma management is crucial [8, 10, 11]. In the development of glaucoma secondary to FUS, multiple factors are noted, including abnormal angle vascularization, PAS formation, excessive steroid use, blockage of the angle with inflammatory debris, and an inflammation-related scarring process [4–6]. Medical treatment of glaucoma in FUS is generally inadequate, often necessitating surgical intervention [8]. The literature suggests that if medical management fails, procedures like trabeculectomy or tube implants may be required [8, 11, 12].

GATT is an innovative MIGS method that has demonstrated a high safety profile and effectiveness in reducing IOP in cases of open-angle glaucoma. A key benefit of this approach is that it preserves the conjunctiva, allowing for future trabeculectomy or tube shunt surgery if required. In FUS, both tube shunts and MMC-Trab were found to be moderately effective [12], but their efficacy diminishes over the years [11], which is concerning for a group with a long life expectancy.

Table 1 Demographic and clinical charactheristics of patients

	Case 1	Case 2	Case 3	Case 4
Age at FUS diagnosis	33	32	30	31
Age at GATT surgery	37	36	46	39
Sex	M	F	M	M
Time between diagnose to GATT	4 years	4 years	16 years	8 years
Time between GATT to 2nd intervention	8months	6 months	3 months	4 months
Preop number of medication	4	4	3	4
BCVA (decimal)	20/20	20/20	2 mt. CF	20/20
CCT (µm)	580	556	495	612
RNFL (µm)	97	63	45 (floor effect)	85

Case presentation

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Human Subjects Review Board (HSRB-20240805). Informed consent was obtained from all individual participants included in the study.

All cases showed a unilateral, chronic, low-grade anterior chamber reactions, widespread small or medium keratic precipitates on the corneal endothelium, diffuse iris atrophy, and/or heterochromia, but without acute exacerbations, posterior synechiae, or cystoid macular edema. These patients were clinically diagnosed with FUS. One single physician conducted all diagnoses and follow-up visits in the uveitis clinic. Table 1 provides an overview of the patients' initial demographic and clinical information.

Three of the patients had undergone combined phacoemulsification and pars plana vitrectomy (phaco-PPV) due to cataracts and significant vitreous opacities some time after being diagnosed with FUS. This allowed for a more accurate assessment of glaucoma's structural and functional tests, namely OCT-RNFL and computerized visual field tests. They required glaucoma surgery at least three years after the mentioned procedures.

GATT was selected as the initial surgical option for FUS-related glaucoma based on several factors. All patients were under 50 years of age, physically active, and

trabeculectomy-associated complications were deemed undesirable. Three patients had previously undergone lens extraction and core vitrectomy without intra- or postoperative complications such as angle hemorrhage, hyphema, or PAS. All exhibited asymptomatic courses without pain, photophobia, or ciliary injection, and gonioscopy revealed widely open angles with occasional fine neovascularizations in a pigment-free trabecular meshwork. These favorable clinical features supported the feasibility of GATT, although caution was exercised regarding potential bleeding and inflammatory complications associated with circumferential trabeculotomy. Accordingly, a strict postoperative monitoring protocol was implemented to promptly address hyphema, PAS formation, and IOP elevation.

All GATT procedures were performed by the experienced surgeons (CYE, MH) without any perioperative complications. The GATT procedure was in line with Grover et al. [13] To briefly summarize, using a direct goniolens, a nasal goniotomy with a temporal approach was performed. A 5 – 0 Prolene suture was circumferentially advanced along the path corresponding to the Schlemm's canal through the goniotomy incision with the help of micro forceps. When the suture tip, having completed 360° in the canal, reached the opposite side of the incision line, it was grasped and pulled through with micro forceps. Thus, a 360-degree trabeculotomy was achieved successfully.

Due to the risk of hyphema and secondary PAS, a follow-up program was established: twice a week for the first 3 weeks and once a week for the next 5 weeks. Topical moxifloxacin and dexamethasone were administered six times a day in the postoperative period. Moxifloxacin was stopped two weeks postoperatively. Dexamethasone was tapered gradually after the first week and discontinued based on the inflammation level up to 6 weeks. At each visit, IOP was carefully measured, and in cases where IOP > 20 mm Hg, timolol, dorzolamide, brimonidine and latanoprost treatments were sequentially added to monitor IOP. Table 2illustrates the preoperative and postoperative intraocular pressure profiles, and the number of medications used.

Table 2 The course of Postop IOP and Number of Medication

	Case 1	Case 2	Case 3	Case 4
Preop IOP (mmHg)/ number of medication	28/4	24/4	18/3	40/4
Postop IOP 1 week (mm Hg)/number of med.	22/0	19/0	23/0	22/0
Postop IOP 2nd week (mm Hg)/number of med.	27/0	26/1	28/1	25/1
Postop IOP 1 month (mm Hg)/number of med.	27/1	26/2	32/2	34/3
Postop IOP 2 month (mm Hg)/number of med.	19/2	30/4	28/3	36/4
Postop IOP 3 month(mm Hg)/number of med.	24/2	25/4	27/3	40/4

Case 1

A 37-year-old male patient diagnosed with FUS has been followed up in the uveitis clinic for 4 years. He underwent phaco-PPV surgery one year after diagnosis. He was also taken under follow-up in the glaucoma unit a year ago due to an IOP of 47 mmHg, and despite increasing the number of topical glaucoma medications used to 4 within a year, the average RNFL value decreased from 114 µm to 97 µm, and localized glaucomatous loss was observed in the inferotemporal area. Subsequently, the patient underwent 360° GATT surgery. In the early postoperative period, a clot spreading around the angle region transformed into a total hyphema following the resorption of the limited viscoelastic material left in the anterior chamber on the 3rd postoperative day. Due to the very slow resorption of the hyphema within a week, an anterior chamber washout was performed. Rapid recovery was observed after this intervention, and no PAS developed (Fig. 1)**.** Following the washout, the IOP was measured at 22 mmHg in the first postoperative week and 27 mmHg in the second week, and topical glaucoma medications were started. By the 4th postoperative month, the number of molecules had increased to four, and since the IOP values could not be reduced below 25 mmHg, MMC-Trab was performed in the 8th month after GATT. The patient has been followed up in the glaucoma unit with an IOP ranging between 16 and 18 mmHg with a single anti-glaucoma molecule.

Case 2

A 36-year-old phakic female patient had been followed up for 4 years with a diagnosis of FUS. Two years after the diagnosis, timolol was started due to elevated IOP, and due to progressive IOP increase during the follow-up period, GATT was planned under 4-molecule anti-glaucomatous topical treatment. A 360° GATT was performed without any issues on the left eye. On the first postoperative day, a limited clot was observed in the anterior chamber. and IOP was measured at 19 mmHg. On the 10th postoperative day, the hyphema completely resolved and no anterior or posterior synechiae development was observed. (Fig. 2) At the 2-week follow-up, IOP was measured at 26 mmHg, and timolol was started. During weekly visits, as IOP ranged between 25 and 30 mmHg, additional anti-glaucomatous treatment was added, reaching 4 molecules by the third month. Despite being under 4 molecules of treatment, the patient's IOP was monitored in the range of 20–25 mmHg for 3 months. Six months after GATT, an MMC-Trab surgery was performed. Follow-ups after MMC-Trab surgery

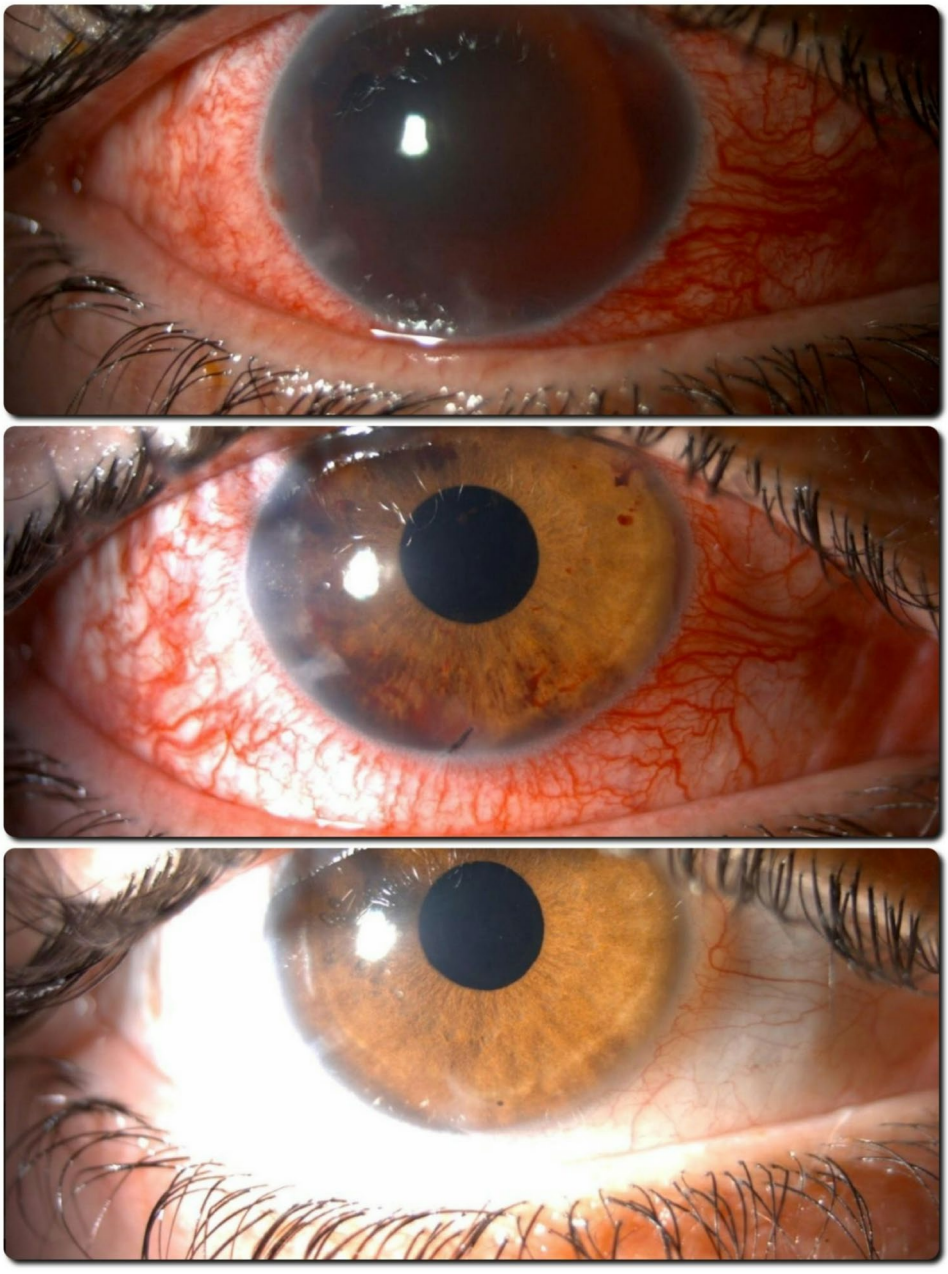

Fig. 1 The resorption of the annular coagulum observed in the anterior chamber

have been ongoing for 2 years. The IOP ranges between 12 and 17 mmHg without medication, BCVA is 20/20, the average RNFL thickness is 60 μm, and the inferior nasal step visual field defect remains stable.

Case 3

A 46-year-old pseudophakic, vitrectomized male patient had been followed up with a diagnosis of FUS for 16 years. Following the diagnosis, he underwent phaco-PPV surgery 16 years ago due to cataract and vitreous opacities. His follow-up has been irregular for the last 10 years, and his adherence to topical antiglaucomatous treatments, which were started 10 years ago was very poor. At his last examination before GATT, his IOP was 18 mmHg under 3-molecule antiglaucomatous treatment, his BCVA was at the level of counting fingers from 2 m, and the optic disc appearance showed total glaucomatous excavation. During the last 10 years of follow-up, the patient's IOP regulation was stable under topical treatment, but due to long periods of non-attendance and poor adherence to follow-up, total glaucomatous excavation developed. GATT was planned with the recommendation to reduce or discontinue medication, and it was successfully performed over 360° in his left eye. (Fig. 3)

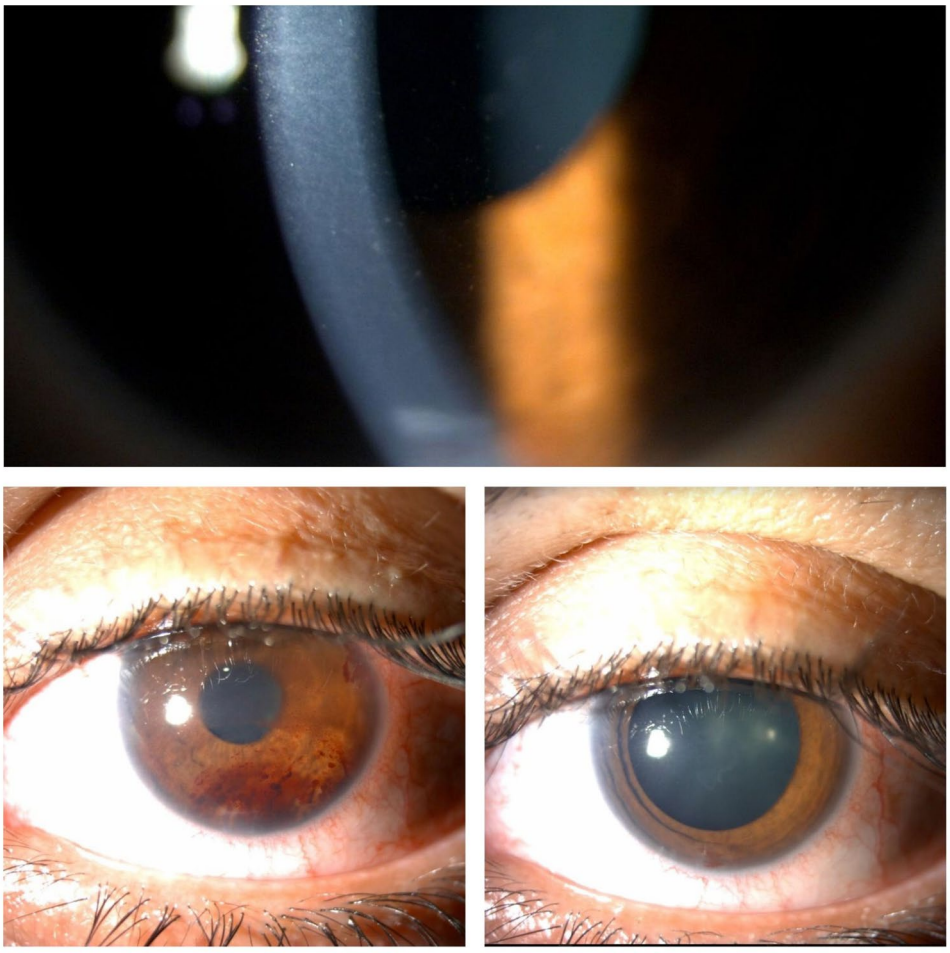

Fig. 2 Small satellite-shaped fine keratic precipitates and resorption of the hemorrhage in the anterior chamber of the phakic patient

On the first post-operative day, limited coagulum at the anterior chamber was observed and IOP was measured at 22 mmHg. Following the resorption of the limited viscoelastic material left in the anterior chamber after surgery, a hyphema at the level of 1/3 developed on the 3rd postoperative day. Anti-glaucomatous treatment was not started to avoid increasing the hyphema due to hypotony, and the hyphema completely resolved within 2 weeks. During the 2-week follow-up, IOP ranged between 20 and 30 mmHg. Despite starting anti-glaucomatous treatment afterwards, IOP values could not be reduced below 20 mmHg. Considering the postoperative IOP was higher than preoperative values, the possibility of steroid sensitivity was considered, and steroids were stopped in the 4th week without any flare-up in inflammation. During the 2-month follow-up after discontinuing steroids, IOP ranged between 25 and 32 mmHg under maximum antiglaucomatous treatment, and at the 3rd postoperative month, it was treated with diode laser cyclophotocoagulation. In the follow-up after cyclophotocoagulation, IOP values ranged between 10 and 15 mmHg. Vision was maintained at the level of counting fingers from 2 m, and the patient was able to maintain without medication as desired.

Case 4

A 39-year-old male patient has been under control for 8 years with a diagnosis of FUS. Two years after the diagnosis, he underwent phaco-PPV surgery to clear the media opacities and was followed up without medication for 4 years. 2 years ago, due to elevated IOP, he was started on dorzolamide-timolol fixed combination therapy. 6 months ago, at his last routine check-up, he reported no complaints, biomicroscopic examination revealed no signs of inflammation, but IOP was measured at 46 mmHg. Despite quickly increasing his treatment to 4 molecules, IOP could not be reduced below 35 mmHg. A successful 360° GATT surgery was performed. The coagulum that had adhered to the angle region postoperatively had completely resolved by the 10th day. (Fig. 4) Postoperative IOP ranged between 20 and 25 mmHg for the first two weeks, but even with the addition of medication within three months, IOP could not be controlled and increased up to 40's. In the 4th month after GATT,

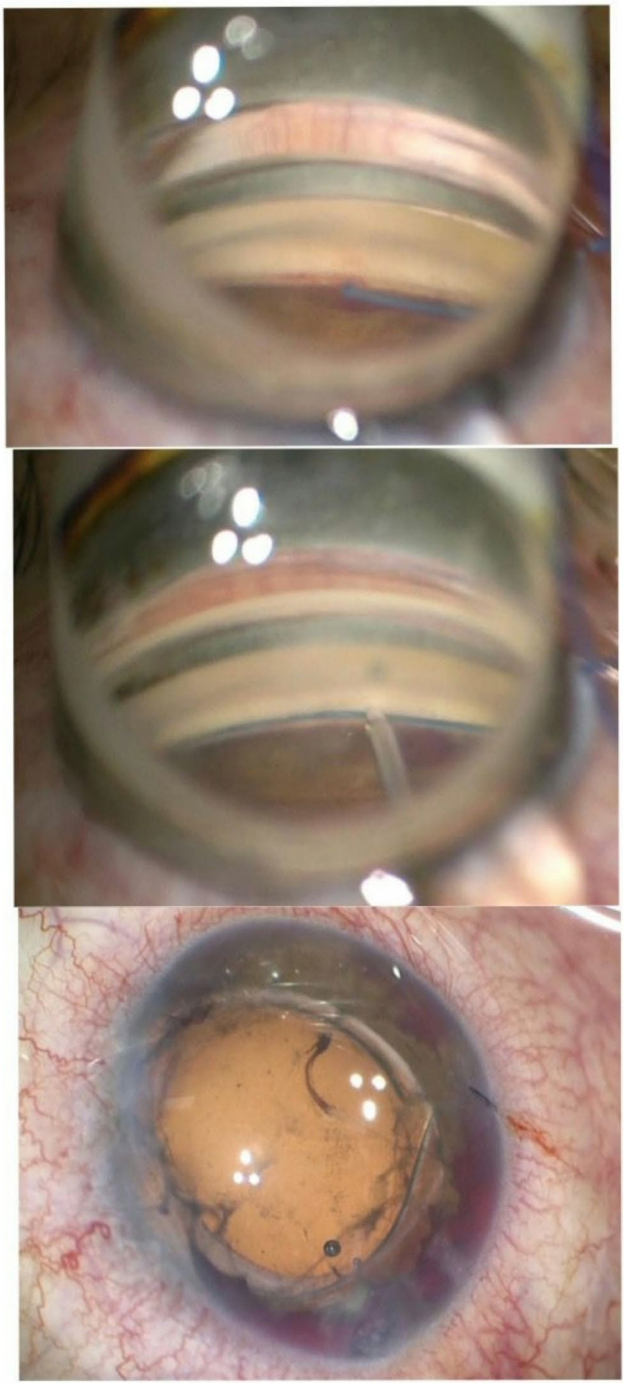

Fig. 3 GATT procedure with a 5.0 prolene suture

MMC-Trab surgery was performed succesfully. For approximately 6 months, the patient has been followed up without medication, with IOP ranging between 16 and 19 mmHg, BCVA at 20/20, an average RNFL thickness of 85 µm, and no visual field loss.

Discussion and conclusion

FUS presents the most benign course among uveitis types, with minimal disruption of the blood-aqueous barrier, limited anterior chamber reaction, and only slight increases in laser flare meter readings [4, 14], without significant impact on visual function. As there is no definitive cure, corticosteroids are generally not indicated except for short-term use during acute attacks, given their potential to induce glaucoma and cataract. Management focuses on balancing minimal steroid use with effective control of glaucoma and cataract, addressing their interactions as needed.

There is no consensus on the etiology of this type of secondary glaucoma. Possible causes include abnormal angle vascularization, angle hemorrhages following interventional anterior chamber procedures leading to PAS formation, excessive use of steroids, aqueous outflow obstruction due to inflammatory debris, trabecular meshwork scarring as a result of chronic inflammation [4–6, 10]. There is a widespread consensus regarding the triggering role of cataract surgery in glaucoma. Most researchers associate this with cataract surgery increasing angle hemorrhages and subsequently leading to the development of PAS. However, this is not very common, and in cases where PAS does not develop, the reason for the increase in IOP after cataract surgery might be fibrosis due to the increase in inflammation triggered by the surgery, which is seen in every uveitic condition. In this study, 3 patients had combined phaco-PPV at least 3 years before the glaucoma surgery. One patient didn't have significant cataract at the time of the GATT and no patient had PAS or fibrotic membranes in the angle region. During their follow-up, the use of steroids in the uveitis unit was maintained at an appropriate dose and potency without excess. Given that the effects of cataract surgery, peripheral anterior synechiae (PAS) formation, and steroid exposure were excluded, the etiology of glaucoma in these patients is presumed to involve trabecular meshwork (TM) obstruction caused by inflammatory debris. The success of GATT in conditions where the TM is obstructed by debris, such as pigment dispersion syndrome, bilateral acute iris transillumination (BAİT) syndrome, pseudoexfoliation glaucoma, is at an impressive level [15–18]. This raised the hypothesis that it might offer a potential solution in managing glaucoma, which is a morbidity factor of the disease. However, the results did not progress as expected, and all the patients' surgeries ended in failure. This suggests that FUS glaucoma should not be approached differently from classical uveitic glaucomas, both in terms of etiopathogenesis and surgical options. This outcome could be due to permanent scarring of the outflow structures rather than the trabecular meshwork being obstructed by inflammatory debris. The progressive increase in IOP observed in patients after

Fig. 4 Fine Angle Vessels of the Heterochromic patient

GATT surgery suggested that the existing scarring process was exacerbated by inflammation.

One of the most concerning possibilities when planning GATT surgery in FUS patients was uncontrollable hyphema due to increased vascularization in the angle and PAS development secondary to increased inflammation. However, notably these possibilities did not pose any problems. By ending the surgery with a gentle injection of 1% sodium hyaluronate into the anterior chamber, creating a tamponade effect against bleeding in the anterior chamber, no significant issues related to hyphema are encountered. Although anterior chamber washout was necessary in one patient, a rapid recovery followed the intervention.

Examining studies composed of limited patient groups, one can observe that the initial publications related to goniosurgery in pediatric uveitis began with the desire to preserve the conjunctiva and the long life expectancy of these patients [19, 20]. Ho et al. [19] mentioned in their study that goniosurgery might be effective in juvenile rheumatoid arthritis-associated uveitis, but increased age could be a factor reducing success. They associated this with the establishment of scarring as age increases, which may explain the surgical failures in the adult patients of the present study. When recent studies, sharing surgical outcomes of GATT in uveitic glaucoma, are reviewed, it is very promising to see that the success rates are above 70% [21–24]. However, contrary to the present study, the participants in these studies were heterogeneous, comprising different types of uveitis and lacking homogeneity. Additionally, in the etiology of glaucoma development, these studies identify not only inflammation but also steroid use and mixed mechanisms as contributing factors. Furthermore, the variability in results could be influenced by the course of the uveitis, whether it is acute, recurrent, or chronic.

A recent study by Günay et al. [25, 26], while similar in design to the present case series, reported favorable outcomes of GATT in controlling IOP in FUS-related glaucoma, in contrast to the surgical failures observed in all cases of the current study, which ultimately required secondary interventions. Notably, Günay et al. described prompt control of IOP spikes, whereas in this series, failure was characterized by progressive IOP elevation

without spikes. Several factors may account for these differing results. First, the interval between FUS diagnosis and GATT surgery was shorter in Günay et al.'s cohort, suggesting that prolonged uveitic exposure may contribute to post-trabecular scarring and surgical failure. Second, differences in steroid exposure may have influenced outcomes; while the current cohort consisted of patients followed long-term in a uveitis clinic with careful steroid management, Günay et al.'s patients were referred cases, with unclear prior steroid use. Considering that GATT has demonstrated efficacy in steroid-induced glaucoma [27], prior steroid exposure might partially explain the disparity in surgical success rates.

This study has several limitations. It is a small-scale case series, limiting the possibility for comparative analyses and statistical evaluations and its retrospective nature may introduce bias. However, patient selection was conducted meticulously, minimizing potential etiological factors in glaucoma development such as uveitic adhesions and excessive steroid use.

Even though FUS is considered the most benign type of uveitis, the same cannot be said for FUS-related glaucoma. The development of glaucoma secondary to FUS involves combined mechanisms that clearly complicate treatment. Medical treatments can be insufficient, and the success rates of trabeculectomy and tube surgeries are lower and more limited in duration compared to primary glaucoma [5]. At this stage, GATT is used as the initial surgery for FUS-related glaucoma requiring surgical intervention. However, the follow-ups revealed that the effectiveness of this surgery was also limited. In this regard, this study suggests that the chronic inflammation caused by FUS leads to scarring in the post-trabecular area, rendering both conventional and GATT surgeries ineffective at this point.

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Data availability
All data and materials are available upon request from the corresponding author.

Declarations

Ethics approval and consent to participate
This study was conducted in accordance with the Declaration of Helsinki and was approved by the Human Subjects Review Board (HSRB-20240805) of Istanbul University-Cerrahpasa. Written informed consent for publication of their clinical details and/or clinical images was obtained from the patient/parent/guardian/ relative of the patient. A copy of the consent form is available for review.

Consent for publication
All authors consent for publication of this paper in BMC Ophthalmology. Written informed consent for publication of their clinical details and/or clinical images was obtained from the patient/parent/guardian/ relative of the patient.

Competing interests
The authors declare no competing interests.

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