Original Article

The Relationship between Serous Choroidal Detachment and the Ahmed Glaucoma Valve Failure

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Abstract

Purpose: To investigate the effect of serous choroidal detachment (SCD) on the success of Ahmed glaucoma valve (AGV) implantation.

Methods: Patients who underwent AGV implantation and developed SCD were included in the case group. The control group was matched based on age, sex, baseline intraocular pressure (IOP), glaucoma type, and the number of glaucoma medications. The patient data were retrospectively extracted from available records. The primary outcome measure was an AGV success rate based on 5 < IOP <18 and a 20% reduction from baseline.

Results: Seventeen patients were enrolled in the case group and 38 in the control group. Preoperative visual acuity of patients was 1.17 ± 0.43 and 1.16 ± 0.37 logMAR in the case and control groups, respectively. The patients in the case group showed higher mean IOP at all time intervals compared to controls. However, the mean IOP only reached a statistically significant difference at 3 months (17.94 ± 6.78 mmHg vs. 13.39 ± 3.09 mmHg, $P = 0.003$). The mean survival duration was significantly shorter in patients with SCD (10.4 ± 0.7 months vs. 11.7 ± 0.2 months for controls log-rank = 4.1, $P = 0.04$). The cumulative probability of success was 76.5% in patients with SCD and 94.7% in the control group after 12 months.

Conclusions: SCD after AGV implantation could be a risk factor for failure. A larger prospective study with a longer follow-up duration is required to confirm the present study results.

Keywords: Ahmed glaucoma valve, Serous choroidal detachment, Success rate, Surgery

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Introduction

Glaucoma drainage devices are used in glaucoma surgery, when conventional filtering surgery fails or is not considered.[1] Several types of aqueous shunts, such as Molteno, Krupin, Baerveldt, and Ahmed glaucoma valve (AGV), have been devised. The first use of Molteno glaucoma device was in 1976. Still, due to a lack of resistance to aqueous humor by this device, there were complications including hypotony, shallow anterior chamber (AC), and serous choroidal detachment (SCD). The Food and Drug Administration approved AGV in 1993. Its difference from Molteno or Baerveldt is in the resistance to the aqueous humor created by a valve.[2]

The success rate for AGV is reported to be between 63% and 100% at postoperative year 1 and 49% at 5 years.[3] Several factors affect the surgical success of AGV: age, encapsulated cyst formation, biomaterial and endplate size of implant, preoperative intraocular pressure (IOP), active uveitis at the time of surgery, type of glaucoma, the surgeon's experience, and history of previous glaucoma surgery.[1,4,5]

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AGV surgery may cause several intra- or postoperative complications, including hypotony, rise in IOP, encapsulated bleb, corneal decompensation, tube exposure, infection, SCD, and hemorrhage.[6,7] SCD remains a common complication after filtering surgeries and is reported in 2.8%–33.9% of cases undergoing trabeculectomy.[8,9] In AGV surgery, SCD has been reported with a prevalence of up to 57.8%.[10] Patients with a history of ophthalmic surgery, shorter axial length, pseudoexfoliation, neovascular glaucoma, presence of pseudophakic lens, and systemic hypertension (HTN) are at a higher risk of detachment.[10-12]

SCD management includes discontinuation of all aqueous suppressant medications. Topical and systemic steroids are also used to suppress inflammation as an important factor in SCD pathology. For surgical intervention, decisions should be made based on the cause of SCD; for example, if there is a high aqueous outflow transtube shunt, tucking the tube under conjunctiva or tube ligation is recommended.[13,14] Drainage is performed if a large SCD affects visual acuity or causes flat AC, cataract formation, and corneal edema.[13,14]

Although a common complication, the data on the effect of SCD on the success rate of AGV are scarce. In this study, we intended to investigate the impact of SCD on the success of AGV.

Methods

This was a retrospective study performed in an academic tertiary ophthalmology center. The subjects included 112 patients who underwent AGV implantation between April 2018 and September 2021. Those who developed SCD and were followed for at least 12 months were selected as the study cases (17 patients). The diagnosis of SCD was established based on clinical findings obtained through fundoscopic examination and confirmed by ultrasound B-scan. Among the patients who had not developed SCD, the nearest match was selected as the control group (n = 38). The control group was matched in terms of age, sex, systemic disease, lens status, baseline IOP, glaucoma type, and the number of previous glaucoma surgeries. The study protocol was approved by the review board at Shahid Beheshti University of Medical Sciences, and the registration code is IR.SBMU.MSP.REC.1401.359. The study adhered to the tenets of the Declaration of Helsinki. The indication for surgery was determined by a glaucoma specialist.

All surgeries conducted by glaucoma specialists (MY and MH) adhered to the steps outlined in the following description. After preparing and draping, a 7-0 polyglactin traction suture was placed in the peripheral cornea. The limbal-based conjunctival flap was dissected posteriorly between the rectus muscles in the supratemporal quadrant. The endplate was inserted between the muscles, and the anterior edge of the endplate was sutured to the sclera 8 mm posterior to the limbus using nylon 8-0. The tube was trimmed with a bevel into the AC, and the limbal portion of the tube was covered with a scleral patch graft. Finally, the conjunctiva was reapproximated. Sufficient Healon gel was retained in the AC to ensure that the tactile IOP remained approximately 20–25 mmHg at the end of the surgery. Surgery was performed without steroid injection, mitomycin-C, or tube ligation for all patients.

In the postoperative treatment plan, chloramphenicol eye drops (Chlobiotic, Sinadarou, Tehran, Iran) were administered four times daily for the 1st week to prevent bacterial infection due to its broad-spectrum antibacterial coverage. Additionally, betamethasone eye drops (Betasonate, Sinadarou, Tehran, Iran) were applied four times daily for 1–2 months, leveraging its anti-inflammatory properties to minimize postoperative inflammation. The dosing of betamethasone was then tapered monthly, guided by the clinical evaluation of IOP and conjunctival hyperemia, to mitigate steroid-related complications. For patients diagnosed with SCD, we moderated the topical steroid regimen to reduce the risk of exacerbating fluid accumulation and initiated systemic steroid to control intraocular inflammation. Concurrently, we commenced treatment with atropine eye drops for their cycloplegic effect, which helps to stabilize the blood–aqueous barrier and minimize discomfort from ciliary spasm. They also act to deepen the AC by the posterior rotation of the ciliary body. Surgical interventions were reserved for cases presenting with appositional SCD or persistently flat ACs, where the risk of anatomical and functional sequelae warranted more aggressive management.

The data, including glaucoma type, the IOP at the baseline and at each visit, preoperative and postoperative medications, and surgical history were recorded and reviewed by glaucoma specialists during the follow-up. Intraoperative and postoperative complications were documented. Complete success was defined as achieving 5< IOP <18 mmHg and a 20% reduction from the baseline IOP without glaucoma medication. Qualified success was defined the similarly to complete success, but with the use of glaucoma medications to achieve the target IOP. Reoperation or loss of light perception was considered a surgical failure. IOP and glaucoma medications were considered secondary outcomes. The hypertensive phase (HP) was defined as an IOP increase to more than 21 mmHg in the first 3 months after surgery.

The best match for each case was found by exact matching based on age, glaucoma type, baseline IOP, and number of glaucoma medications, and the closest match was selected for each case. To analyze the data, we used Mann–Whitney and Wilcoxon tests to compare IOP medication between and within the groups, respectively. For comparison of the success rate, Chi-square test was used. Furthermore, the Kaplan–Meier survival curve was used to perform survival analysis. The survival duration was compared using the log-rank test between the study groups. We conducted a linear regression model with multiple stepwise methods with the final IOP at 12 months as the dependent variable to test the effect of baseline IOP, age, and sex on the surgical failure. The collected data were analyzed using SPSS version 25 (IBM Corp., Armonk, NY, USA).

Results

A total of 55 eyes from 55 patients were included in the present study. Seventeen patients were considered as the case groups, and 38 matched individuals were included as controls.

The mean age of patients with SCD and the control group was 51.7 ± 15.1 years and 53.8 ± 13.8 years, respectively. The mean preoperative visual acuity was 1.17 ± 0.43 and 1.16 ± 0.37 logMAR in patients with SCD and the control group, respectively. Two study groups were comparable in baseline IOP and number of glaucoma medications. Among the case group, 8 eyes were phakic and 9 eyes were pseudophakic; in the control group, 26 eyes were phakic and 11 eyes were pseudophakic; there were no significant difference between groups ($P = 0.09$). Glaucoma types were primary open-angle glaucoma in 21 patients, chronic angle-closure glaucoma in 6 patients, pseudoexfoliation syndrome in 4 patients, postvitrectomy in 3 patients, neovascular glaucoma in 14, and complicated cataract surgery in 2 patients and other types in 1 patient. Systemic diseases were matched between groups consisting of diabetes mellitus (DM) in 8 patients, HTN in 7 patients, and HTN and DM in 4 patients [Table 1].

Previous surgeries included trabeculectomy in 17 patients, complicated cataract surgery in 2 patients, deep vitrectomy in 3 patients, and corneoscleral laceration repair in 3 patients.

The HP occurred in 32 patients [Figure 1]. The mean time for developing SCD was 2.12 ± 0.95 days after the surgery. The mean time for resolution of SCD was 13.8 ± 2.6 days.

The mean duration of survival (±standard error [SE]) was 11.3 ± 0.3 months among all patients. The cumulative probability of success for all patients was 98.2%, 89.1%, and 89.1% at months 3, 6, and 12, respectively. The mean duration of survival (±SE) was 10.4 ± 0.7 months in patients with SCD and 11.7 ± 0.2 months in the control group (log-rank = 4.1, $P = 0.04$). The cumulative probability of success was 76.5% and 94.7% at 12 months for patients with SCD and the control group, respectively [Table 2 and Figure 2].

The average baseline IOP was 28.4 ± 7.85 mmHg in patients with SCD, which significantly reduced to 15.29 ± 7.18 mmHg 12 months after surgery ($P < 0.001$). The corresponding value in the control group was 27.97 ± 8.88 mmHg at baseline and 13.26 ± 2.57 mmHg at month 12 postsurgery.

The patients in the case group showed higher IOP in all time intervals. However, the average IOP reached a statistically significant difference only at month 3 (17.94 ± 6.78 mmHg vs. 13.39 ± 3.09 mmHg, $P = 0.003$) [Table 3 and Figure 3a].

The average number of glaucoma medications (3.58 ± 1.003) among patients with SCD was significantly reduced to 2.05 ± 1.59 after 12 months ($P = 0.021$). The corresponding value in the control group was 3.86 ± 0.52 at baseline and 2.39 ± 1.3 at 12 months postoperatively. In all time intervals, the two groups were comparable in terms of the number of glaucoma medications [Table 4 and Figure 3b].

In analyzing the impact of baseline IOP, age, and sex on surgical failure, the regression analysis at 12 months postsurgery revealed that baseline IOP and age had significant coefficients, indicating a notable influence on surgical outcomes. However, sex did not demonstrate a significant effect on the likelihood of surgical failure [Table 5].

The SCD was managed conservatively in 12 patients, while 5 patients underwent choroidal tap. We conducted a subgroup analysis comparing those who underwent choroidal tap with those who did not, considering IOP and glaucoma medications. No significant difference was detected [Table 6]. The success rate for those who underwent choroidal tap was

Table 1: Patient's baseline characteristics

	Group		*P**
	Control group	Case group	
Age (years)	53.8±13.8	51.7±15.1	0.612*
Visual acuity, logMAR	1.16±0.37	1.17±0.43	0.92*
Systemic disease			
DM	5	3	0.225**
HTN	4	3	
DM and HTN	3	1	

DM: Diabetes mellitus, HTN: Hypertension, *Based on independent T tests, **Based on Chi-square tests

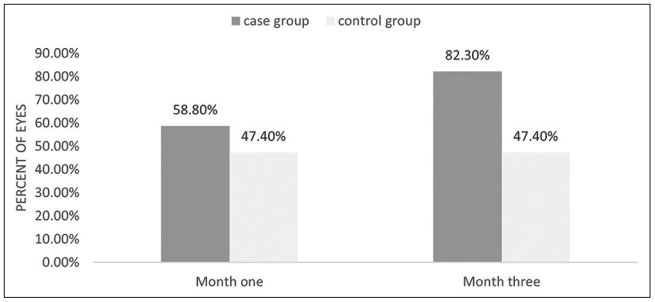

Figure 1: A hypertensive phase bar chart shows the number of patients who experienced hypertensive phase (HP) in 1st and 3rd months in the case and control group. In the 1st month, HP occurred in 58.8% of the eyes in the case group and 47.4% of the eyes in the control group. In the 3rd month, it occurred 82.3% and 47.4%, respectively

Table 2: Comparison of success rate between the case and control groups

Time	Success definition	Group		*P**
		Control group, *n* (%)	Case group, *n* (%)	
12 months	5< IOP <18 and 20% reductions from baseline	36 (94.7)	13 (76.5)	0.045

*Based on Chi-square tests. IOP: Intraocular pressure

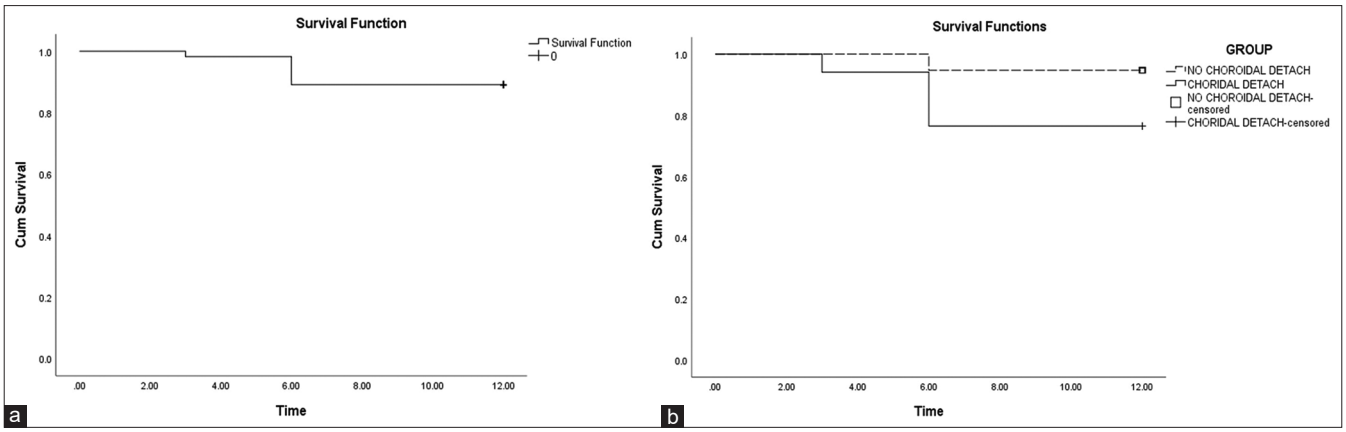

Figure 2: (a) Kaplan–Meier survival plot demonstrates the cumulative probability of success over the study period. The success was defined as 5< intraocular pressure <18 mmHg and a 20% reduction from the baseline. (b) Comparison of survival rates between the study groups. Patients with no serous choroidal detachment had higher survival rates over the study period

Table 3: Intraocular pressure in two study groups over the study period

Time	Group		*P**
	Control group	Case group	
n	38	17	
Before	27.97±8.88	28.41±7.85	0.505
Month 1	12.68±3.69	15.41±7.68	0.244
Change	15.28±8.84	13±7.8	
P value within group	<0.001**	<0.001**	
Month 3	13.39±3.09	17.94±6.78	0.003
Change	14.57±8.61	10.47±7.29	
P value within group	<0.001**	<0.001**	
Month 6	12.68±2.41	15.35±7.4	0.443
Change	15.28±8.73	13.05±7.11	
P value within group	<0.001**	<0.001**	
Month 9	13.05±2.56	15.58±7.77	0.301
Change	14.92±8.31	12.82±7.87	
P value within group	<0.001**	<0.001**	
Month 12	13.26±2.57	15.29±7.18	0.556
Change	14.71±8.35	13.11±7.56	
P value within group	<0.001**	<0.001**	

*Based on Mann–Whitney test, **Based on Wilcoxon test

80%, and for those who did not, it was 75%. Bleb revision was performed in two patients (one patient in the case and one in the control group) due to exposure to the AGV tube. One patient in the case group underwent tube removal in the follow-up period. The bleb status was encapsulated in five patients.

Discussion

The present study suggests that SCD after AGV implantation could be a risk factor for failure. It was found that the patients experiencing SCD had significantly lower survival duration. The average IOP was also significantly higher at 3 months postoperatively using an equal number of glaucoma medications.

The incidence of SCD after AGV implantation is not precisely known. In a study investigating the complications after performing AGV implantation, the prevalence of SCD was reported to be 41%.[15] In a report evaluating the complications of trabeculectomy versus tube, 16% of patients in the tube group experienced early and late SCD.[16]

SCD occurs due to serum leakage from the choriocapillaris into the suprachoroidal space. Various factors lead to the leakage of fluid from the choroidal vascularity. IOP prevents fluid from accumulating in the suprachoroidal space, so a sudden change in IOP alters the hydrostatic pressure between the inner and outer sides of choroidal vessels. The underlying HTN, tachycardia, and systemic unstable hemodynamics predispose the eyes to SCD. The management of SCD ranges from a decreased dosage of corticosteroids and use of cycloplegic drugs in mild detachments to choroidal tap and AC reformation in patients with a flat AC, lens-corneal endothelium touch, and kissing choroidal detachment. Our patients' outcomes were comparable in terms of the management of SCD with the results reported by previous studies.[13,17,18]

Fu *et al*.[10] evaluated the post-AGV occurrence of SCD using anterior segment optical coherence tomography and ultrasound biomicroscopy to detect the lesions. They reported that 57.8% of patients experienced SCD after AGV or AGV combined with phacoemulsification.[10] They found no difference in outcomes after 6 months ($P = 0.86$). However, on the 1st day, the 1st week, and the 1st month, they found that a lower mean IOP in the SCD group was observed. This can be due to high uveoscleral outflow in SCD patients. Although they found no significant difference in IOP after 6 months

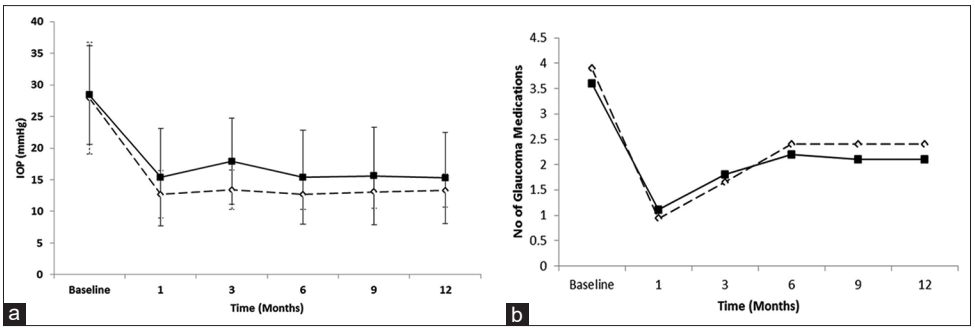

Figure 3: (a) Intraocular pressure over the study period. The full black line demonstrates patients with serous choroidal detachment after Ahmed glaucoma valve (AGV) implantation. The dashed line represents patients with uncomplicated AGV implantation. (b) Number of glaucoma medications in two study groups. IOP: Intraocular pressure

Table 4: Comparison of the number of preoperative and postoperative antiglaucoma medications

Time	Group		*P***
	Control group	Case group	
n	38	17	
Before	3.86±0.52	3.58±1.003	0.172
Month 1	0.94±1.038	1.11±1.49	0.29
Change	2.92±1.04	2.47±1.62	
P value within group	<0.001*	<0.001*	
Month 3	1.65±1.02	1.82±1.74	0.71
Change	2.21±1.04	1.76±1.75	
P value within group	<0.001*	0.023	
Month 6	2.28±1.13	2.23±1.52	0.49
Change	1.57±1.08	1.35±1.41	
P value within group	<0.001*	0.009	
Month 9	2.36±1.32	2.05±1.59	0.45
Change	1.5±1.2	1.52±1.5	
P value within group	<0.001*	0.021	
Month 12	2.39±1.3	2.05±1.59	0.41
Change	1.47±1.17	1.52±1.5	
P value within group	<0.001*	0.021	

*Based on Wilcoxon tests, **Based on the Mann–Whitney test

Table 5: Multivariable stepwise linear regression results for the impact of baseline intraocular pressure, age, and sex on surgical failure at 12 months

Independent variable	Regression coefficient	*P*
Constant		0.839
IOP before surgery	0.447	0.001
Age	0.371	0.004
Sex	0.008	0.952

IOP: Intraocular pressure

between SCD and non-SCD groups, IOP was slightly higher than in the non-SCD group. It was suggested that the observed difference would become significant in a longer follow-up with a larger sample size.[10]

Shin *et al*.[11] used fundus photographs (wide field) to evaluate SCD after AGV implantation. In 188 eyes entering their study, 66 patients (35.1%) had SCD in a wide field fundus photo. They identified older age, pseudophakia, pseudoexfoliative glaucoma, and HTN as potential risk factors for SCD. Furthermore, more differences between pre- and postoperative IOP resulted in more severe SCD. Nevertheless, they did not evaluate the IOP changes as an outcome to understand the effect of SCD on AGV failure.[11]

Furthermore, a previous report by our own team indicates that SCD influences the long-term success rate of trabeculectomy.[19]

AGV implantation differs from trabeculectomy in various aspects despite being a filtering surgery. SCD is more prevalent after trabeculectomy, probably due to the sudden hypotony in the postoperative period.[20] After AGV implantation, if the valve works properly, unlike trabeculectomy, it prevents very low IOP. HP is a common phenomenon after AGV not seen in patients undergoing trabeculectomy.[19] However, several theoretical mechanisms could explain the role of SCD in the success rate of filtering surgeries. Previous surgeries are seen as a risk factor for SCD and AGV success. Most patients undergoing AGV have a history of prior surgeries, especially cataract extraction and trabeculectomy.[13] Although our cases and controls were matched for the number of previous surgeries, various factors, including the time between previous surgeries and the surgeon's experience, could not be matched between the groups.

Furthermore, it is expected that IOP is lower with the presence of SCD. SCD occurs within the 1st month after the surgery, which is a critical period in the postoperative management of AGV. Hypotony in this period might induce inflammation. Various factors increase the inflammation in the early postoperative period in the presence of SCD. Reducing topical steroids to facilitate early fibrosis formation around the plate aiming to mitigate overfiltration and resolving SCD

Table 6: Subgroup analysis between those who underwent choroidal tap and those who did not in terms of intraocular pressure and glaucoma medications

Time	Group		*P**
	Medical management	Choroidal tap	
n	12	5	
Preoperative			
IOP	27.00±8.66	31.80±4.49	0.234
Number of medications	3.75±0.45	3.20±1.79	1.000
Month 1			
IOP	14.67±5.16	17.20±12.56	0.879
Number of medications	1.42±1.62	0.40±0.89	0.279
Month 3			
IOP	16.50±4.58	21.40±10.26	0.442
Number of medications	2.25±1.60	0.80±1.79	0.104
Month 6			
IOP	14.33±4.58	17.80±12.29	0.959
Number of medications	2.50±1.44	1.60±1.67	0.328
Month 9			
IOP	14.25±3.77	18.80±13.59	0.879
Number of medications	2.42±1.44	1.20±1.79	0.195
Month 12			
IOP	14.08±3.87	18.20±12.25	0.879
Number of medications	2.42±1.44	1.20±1.79	0.195

*Based on the Mann–Whitney test. IOP: Intraocular pressure

may lead to a decrease in the success rate due to the early development of subconjunctival scarring, resulting in elevated IOP. [19,21,22] Simultaneous hypotony is linked to alterations in aqueous flow and its cellular composition, characterized by an increase in inflammatory mediators, consequently contributing to subconjunctival scarring.[23] Surgical procedures such as a choroidal tap, AC reformation, or injection also increase postoperative inflammation. Inflammation may stimulate Tenon's fibroblasts, leading to fibrosis around the AGV plate or tube, which could result in higher IOP.[24] Consequently, the increased inflammation observed in patients with SCD, along with early hypotony and other mentioned factors, may explain the reduced success rate in this group.

In the subgroup analysis regarding IOP, medication, and success rates in patients with SCD, no significant differences were observed concerning medications or IOP. However, the success rate in the subgroup that underwent choroidal tap was higher than in the group treated medically. The increased success in the surgically managed group may be attributed to a more rapid resolution of SCD in this subgroup. However, the reliability of this outcome is limited due to the small number of cases analyzed.

Preventive measures to minimize SCD include reducing high preoperative IOP with systemic intravenous osmotic agents, controlling blood pressure, and using perioperative steroids in patients with inflammatory glaucoma to lower the risk of SCD. Intraoperative care includes tube ligation to avoid overfiltration or two-stage surgery (first placing the tube subconjunctival out of AC, later replacing it into AC) to allow the fibrotic capsules to be formed around the plate and avoid early postoperative overfiltration. For postoperative care, discontinuing topical and systemic aqueous suppressants can be considered.[13,19,25]

In the study by Yalvac *et al*.,[26] it was observed that AGV tends to have higher success rates in older individuals. This finding is not aligning with our study findings, suggesting a reduced probability of success in patients with advanced age. Results of a study by Song *et al*.[27] reveal that higher preoperative IOP was associated with increased postsurgery success. However, our study indicates that elevated baseline IOP is linked to a higher chance of surgical failure, emphasizing the potential efficacy of better preoperative IOP management in enhancing the likelihood of a successful outcome.

The limitations of this study were the retrospective nature of the study and the small sample size. The limited sample size may have implications for the statistical power and generalizability of the findings. In addition to the aforementioned limitations, the study lacked sufficient biometric data, such as AC depth and axial length, which are essential for evaluating the correlation between these parameters and SCD formation, as well as their impact on AGV outcomes. Furthermore, there was no corneal thickness information to assess the association between IOP and corneal thickness. The surgeries performed by different glaucoma surgeons could affect the success rate. However, we believe that looking at SCD as an independent risk factor strengthens our study.

Briefly, SCD after AGV implantation could be a risk factor for failure. A larger prospective study with a longer follow-up duration is required to confirm the present study results.

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Conflicts of interest
There are no conflicts of interest.

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