Original Article

Effect of immediate shallow anterior chamber after Ahmed glaucoma valve implantation on intermediate-term intraocular pressure control

Trupti Sudhir Patil, Baskaran Mani, Shantha Balekudaru, Ronnie J George, Vijaya Lingam

Purpose: To evaluate the incidence of shallow anterior chamber in the early postoperative period following Ahmed glaucoma valve (AGV) implantation and its effect on the hypertensive phase (HP), intermediate-term intraocular pressure (IOP) control, and success rate. **Methods:** A retrospective analysis of 369 eyes of 360 patients who underwent AGV implantation between January 2005 and January 2020 with a minimum follow-up of 2 months was performed. Twenty-six patients developed shallow anterior chamber (AC) within 8 weeks following surgery (cases). They were compared with 39 randomly selected controls (no shallow AC post AGV). HP (IOP spike >21 mmHg), use of ocular hypotensive medications, and other associations were compared. **Results:** Incidence of shallow AC post AGV was 7% (95% confidence interval [CI] 4, 9). The onset of shallow AC was 3 ± 2.1 days and resolved within 6 ± 4.7 days. Hypotony (12 [47%] vs. 1 [2.5%], *P* 0.0001) and choroidal detachment (CD; 7 [27%] vs. 3 [8%], *P* 0.03) were more common in cases compared to controls. The HP occurred in 11 (43%) cases versus 13 (34%) controls (*P* 0.4). Cases required more ocular hypotensive medications than controls at the end of 8 weeks (1.1 ± 1 vs. 0.5 ± 0.5, *P* 0.01). There was no significant difference in the qualified success between the groups at 1 year. **Conclusion:** The development of postoperative shallow AC post AGV implantation was not detrimental to IOP control at 1 year. However, there is a need to monitor the occurrence of HP in these eyes.

Key words: Ahmed Glaucoma Implantation, choroidal detachment, glaucoma, hypertension phase, hypotony, shallow anterior chamber

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Intraocular pressure (IOP) control is crucial in reducing the risk of glaucomatous optic nerve damage. Surgical treatment is resorted to when medical treatment is no longer effective. Complications following glaucoma surgery occur because of its effect on the integrity of the globe.[1] Formerly, implant surgery was restricted to the management of refractory glaucoma following the failure of trabeculectomy despite the use of adjunctive antimetabolites. A recent trend is a shift toward the primary implantation of a glaucoma valve implant.[2,3]

Glaucoma drainage implants currently in use include valved and non-valved versions. While the non-valved implants are more effective in terms of IOP reduction, they are at an increased risk of hypotony-related severe complications because of a sudden drop in IOP after absorption of the ligating suture. Valved implants such as Ahmed glaucoma valve (AGV) have the advantage of reduced risk of hypotony with an early postoperative reduction in IOP.[4,5] A layer of thin silicone elastomer membrane acts as a valve. The valve is designed in such a way that it opens when the IOP is > 8 mmHg. However, a meta-analysis comparing AGV versus Baerveldt implant has shown a lower frequency of adverse events with AGV.[6]

The incidence of shallow anterior chamber (AC) during the early postoperative period was noted to be 27 (19%) post AGV implantation and 26 (20%) post Baerveldt implantation by Budenz *et al*.[7] in their series, and AVB study reported that it was found in 18 (15%) eyes post AGV implantation.[8] A meta-analysis of four studies reported an incidence of 15/135 (11%) for AGV and 17/144 (12%) for trabeculectomy eyes.[3] Shallow AC can be associated with adverse events such as tube-cornea touch and a subsequent detrimental effect on the control of IOP.[9-11]

The hypertensive phase (HP) was reported to be as high as 56%[12] and was noted to persist after AGV implantation. Use of aqueous suppressants contributed to better IOP control post HP compared to prostaglandin analogs or other interventions.[13] Those eyes with no hypotony and no HP seem to do better with long-term IOP control.[12] However, the relationship between early shallow AC and HP has not been understood. Hypotony was reported as one of the risk factors for failure of tube shunt revision.[14] Failure rate secondary to shallow AC post AGV implant has not been analyzed separately in the literature so far.

This study reports the incidence and associations for developing shallow AC following AGV and its effect on short-term IOP control and success at 1 year and beyond.

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Methods

Retrospective screening of records of those who underwent AGV (FP7 with 184 mm^2 area made of silicone plate and S2 with 184 mm^2 area made of polypropylene; New World Medical Inc., Rancho Cucamonga, CA, USA) between January 2005 and January 2020 with a minimum follow-up of 2 months was performed. Institutional review board approval was obtained before data collection. Those who developed a shallow AC with at least peripheral iris–corneal contact on the slit-lamp biomicroscopic examination within the first 8 weeks were included as cases. Shallow AC was graded as follows: grade 1: peripheral iridocorneal contact, grade II: iridocorneal touch at the pupillary border, and grade III: flat AC with lenticular–corneal touch.[15] Out of 369 eyes of 360 patients who underwent AGV during the study period, 26 eyes of 26 patients developed a shallow AC within 8 weeks following surgery and were included as cases. Thirty-nine eyes of 39 patients who had AGV in the same period but had a well-formed AC in the postoperative period were randomly selected as controls. The controls were matched for age, gender, and operating surgeon. We excluded three patients who had a follow-up period of less than 2 months and those less than 18 years of age. Surgeries were performed by three senior surgeons (LV, BS, and RG) with a minimum working experience of 15 years.

Surgical technique

A superior rectus bridle suture was taken for adequate conjunctival exposure. A limbus-based conjunctival flap was made 4–5 mm from the limbus. Posterior subconjunctival dissection was done to facilitate glaucoma valve implantation. The tube was primed using a 27-gauge cannula with a balanced salt solution. The plate was anchored to the sclera using a 9-0 monofilament nylon suture (Ethicon Johnson and Johnson, Aurangabad, India), 8 mm away from the limbus. The tube was trimmed bevel up to allow easier insertion. A needle track was created using a 23-gauge needle 2 mm away from the cornea–scleral junction parallel to the iris for placement in the AC. The tube was secured to the sclera using a 9-0 monofilament nylon suture and covered with either a corneal partial-thickness graft or scleral patch graft. The patch graft was secured to the globe over the tube with fibrin glue or interrupted 9-0 monofilament nylon suture. Conjunctival and Tenon's capsule was sutured in separate layers using 8-0 polyglactin sutures (Vicryl; Ethicon, Johnson and Johnson, Aurangabad, India).

All patients received 1% prednisolone acetate (Allergan, Bangalore, India) in a tapering dose for 8 weeks. Antibiotics were used in monocular patients only. Topical cycloplegics were used as per surgeons' discretion. Topical cycloplegic (Atropine 1% eye drops; Jawa Pharmaceuticals, Jaipur, India) was used in patients who developed shallow AC postoperatively for 2 weeks. Systemic steroids (Tab. Wysolone; Pfizer Limited, Goa, India) were administered in tapering doses in cases with choroidal detachment (CD). Additional laser was done for patients who developed pupillary block or malignant glaucoma. Patients with central iridocorneal touch were managed surgically. Topical aqueous suppressants (timolol maleate 0.5%, FDC Ltd, Aurangabad, India; dorzolamide 2%, Cipla, Ahmedabad, India; brimonidine *P* 0.15%, Allergan India Private Limited, Pithampur, India; and combinations) were used, once the postoperative IOP measured >10 mmHg, as a routine in order to reduce the risk of entering the ocular HP.[16] A standard postoperative regimen was followed by all surgeons.

Hypotony was defined as IOP less than 6 mmHg. The HP was defined as IOP more than 21 mmHg on two consecutive visits within the first 3 months following surgery.[12] All details regarding intraoperative and postoperative complications were noted.

Complete success was defined as IOP ≥6 and ≤15 mmHg without medications. Qualified success was defined as IOP ≤21 mmHg with medications. Criteria for failure included IOP less than 6 mmHg or more than 21 mmHg with maximum medications (maximal medical therapy was defined as per the World Glaucoma Association (WGA) guidelines, wherein three or more topical medications were given, including oral Carbonic Anhydrase Inhibitors (CAI), if tolerated) or the need for additional surgical or laser intervention for glaucoma, absence of light perception, or removal of the implant. AC reformation in the postoperative period was not considered as a failure. Surgical or diode cyclophotocoagulation as an intervention for IOP control (more than 8 weeks) was considered a failure.

All demographic details were collected, including age, gender, systemic and ocular medical history, number of IOP-lowering medications used, best-corrected visual acuity (BCVA), details of the slit-lamp biomicroscopic examination, and fundus evaluation. Follow-up data were collected at intervals of up to 8 weeks, 6 months, 1 year, and the last follow-up visit. Complications within the first 3 months were labeled as early postoperative complications, and those that occurred after 3 months were labeled as late postoperative complications.

Statistical analysis was performed with Statistical Package for the Social Sciences (SPSS) version 23.0 (SPSS Inc., Chicago, IL, USA). The Kolmogorov–Smirnov test was applied to check the distribution of the data. Both groups were compared for age, gender, type of glaucoma, angle status, preoperative IOP, preoperative IOP-lowering medications, previous intraocular surgery, and postoperative IOP control (medications, laser, or surgical interventions) by using unpaired *t*-test, Chi-square test, and Fisher exact test for categorical data. Mann–Whitney test was used for nonparametric data comparison. The eye was the unit of analysis. Snellen visual acuity was converted into logarithm of the minimum angle of resolution (LogMAR) units for analysis. Logistic regression analysis was used to assess the associations for the development of shallow AC. Kaplan–Meier survival analysis was performed to analyze the qualified success at 1 year and at the last follow-up. Statistical significance was set at $P < 0.05$.

Results

Baseline demographics were similar between the two groups. All patients had severe glaucoma (based on mean deviation [MD]); however, the controls had higher MD values than cases (−23.6 dB [interquartile range {IQR} −28- −19.7] vs. −29.1 dB [IQR − 30- 27.3], $P = 0.004$) [Table 1]. All patients in both groups had undergone at least one intraocular surgery before AGV implantation. The most commonly used AGV implant was FP7 (85% cases and 90% controls). The most frequent site for tube implantation was in the superotemporal quadrant. The tube was placed in the AC in 53 patients, while six cases and six controls had the tube implanted in the ciliary

Table 1: Baseline demographics between cases and controls

Preoperative data	Cases (26)	Controls (39)	*P*
Mean age (years)	52±13.8	44±18	0.07
Range	(26-72)	(18-72)	
Gender	14:12	28:11	
Male: female			0.1
Median follow-up duration (months)	9	17	
Interquartile range	(3, 50)	(10, 40)	0.9
Mean preoperative IOP (mmHg)	31±9	31±8	0.7
Range	(18-49)	(20-54)	
No. of IOP-lowering medications (mean)	4±0.8	4±0.9	
Range	(2-5)	(1-5)	0.2
Number of non-glaucoma surgeries performed			
Mean	1±0.5	1.5±0.7	
Range	(0-3)	(0-3)	0.09
Post cataract surgery	12	28	0.2
Post cataract+trabeculectomy with mitomycin C	7	0	
Post vitreoretinal surgery	0	12	
Post penetrating keratoplasty	2	0	
Post trabeculectomy with mitomycin C	21	26	
Preoperative diode cyclophotocoagulation	2	1	
LogMAR visual acuity mean	0.8±0.8	0.7±0.7	0.7
Median	0.5	0.5	
Range	(0-2.4)	(0-2.7)	
Lens status number (percentage)			0.2
Phakic	7 (27)	7 (18)	
Pseudophakia	18 (70)	24 (62)	
Aphakia	1 (3)	8 (20)	
Gonioscopy findings	8 (30)	15 (39)	0.2
Open angle	15 (48)	23 (59)	
Synechial angle closure	1 (4)	1 (2)	
Appositional angle closure	2 (8)	0	
Diagnosis of glaucoma			0.1
Primary open-angle glaucoma	4 (15)	9 (23)	
Primary angle-closure glaucoma	9 (35)	4 (11)	
Secondary angle-closure glaucoma	6 (23)	18 (46)	
Uveitic glaucoma	1 (4)	1 (2)	
Others	6 (23)	7 (18)	
Median deviation median dB[a]	−23.6 (−28- −19.7)	−29.1 (−30- −27.3)	0.004

IOP=intraocular pressure, LogMAR=logarithm of the minimum angle of resolution. [a]HVF data not available for 14 cases and five controls, HVF= Humphery visual field

sulcus [Supplementary Table 1]. Postoperative aqueous suppressants were given in 16 (62%) cases versus 20 (52%) controls ($P = 0.4$). The median follow-up period was 9 months in cases versus 17 months in controls ($P = 0.6$).

Postoperative outcomes

Shallow AC and its management

The incidence of shallow AC post AGV implantation was 7% (26/369) (95% confidence interval [CI]: 4%, 9%). The average time of onset of the shallow AC was 3 ± 2.1 days (median 3 days, range 1–9 days) following surgery, and the resolution was 7.5 ± 5.61 days (median 3.5 days, range 1–18 days).

Grade III shallow AC occurred in 9/26 (35%), grade II shallow AC in 6/26 (23%), and grade I shallow AC in 11/26 (42%) eyes. Nine (35%) eyes were managed with hourly topical steroids and cycloplegics, and nine (35%) eyes needed systemic steroids along with topical therapy for associated CD. Of those requiring systemic steroids, four required Neodymium Yttrium Aluminium Garnet laser (Nd:YAG) laser treatment (tube block due to exudative membrane – 1, pupillary block – 1, and aqueous misdirection – 2). Two patients with wound leak responded to bandage contact lens application with improved AC depth.

Surgical intervention was required in eight (30%) patients with grade III shallow AC (tube ligation ± choroidal drainage in three, pars plana vitrectomy in one, tube repositioning in one, AC reformation with Healon in one, wound leak repair in one, and iris tuck removal in one) [Supplementary Table 2].

Visual acuity

Last visit BCVA was comparable in both the groups (0.6 [IQR 0.3- 1.5] vs. 0.5 [IQR 0.2-1], $P = 0.2$) [Table 2].

One patient with neovascular glaucoma in the control group lost perception of light at the end of 1 year following diode cyclophotocoagulation. Five (20%) patients among cases and eight (21%) patients among controls experienced a drop in vision of more than two lines at the last follow-up visit. Among the cases, the reasons were glaucomatous optic atrophy, uncontrolled IOP post diode cyclophotocoagulation, endophthalmitis that developed 6 months post conjunctival patch graft for plate exposure, corneal decompensation with Iridocorneal Endothelial Syndrome (ICE) syndrome, central retinal vein occlusion secondary to systemic hypertension with ischemic cardiac disease, and glaucoma progression post retinal detachment surgery after diode cyclophotocoagulation in one eye each. Causes of drop in vision among controls were proliferative diabetic retinopathy (PDR) with neovascular glaucoma, corneal decompensation- three (two patients with ICE syndrome and a third patient post blunt trauma after multiple vitreoretinal surgeries for retinal detachment), thinned out macula- two (a patient with PDR with clinically significant macular edema and a second patient with posttraumatic glaucoma post scleral buckle), and ischemic optic neuropathy- two (one patient underwent multiple surgical interventions for retinal detachment and glaucoma and a second patient with high myopia post corneal tear repair after multiple vitreoretinal surgical interventions for retinal detachment).

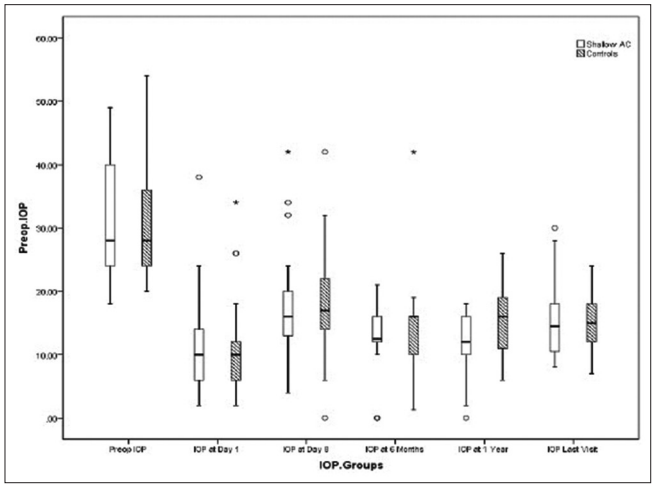

Figure 1: Comparison of intraocular pressure control before and after Ahmed glaucoma valve implantation between cases with shallow anterior chamber (cases = 26) and controls without shallow anterior chamber (controls = 39) till the last visit. Significant drop in intraocular pressure was noted in the postoperative period. Intraocular pressure control was similar between both groups during all follow-up visits

Two (8%) patients among cases and three (8%) patients among controls had preexisting endothelial dysfunction (iridocorneal endothelial syndrome).

IOP control

IOP control was similar between both groups during all follow-up visits. At the end of 1 year follow-up and at the last visit, the IOP was 12.4 ± 4.7 among cases versus 16 ± 6 among controls (P 0.09) at 1 year and 15.1 ± 5.4 versus 15.4 ± 4.7 ($P = 0.9$) at the last follow-up [Table 2 and Fig. 1]. Cases required more IOP-lowering medications compared to controls; the difference was statistically significant (1.1 ± 1 vs. 0.5 ± 0.5, $P = 0.01$) at 8 weeks only, and subsequently, no difference was noted until the last visit (1.6 ± 1.2 vs. 1.5 ± 1.1, $P = 0.7$) [Table 2]. In our study, patients used 3 ± 1.1 medications in the failure group.

An HP was observed in 11 patients (43%) among cases and in 13 (34%) among controls ($P = 0.4$) [Table 3]. The highest mean IOP spike (32 ± 11 vs. 28 ± 6.4, $P = 0.3$) and the onset of the HP did not differ between the two groups (median 5.5 weeks IQR 1-6 weeks vs. 6 weeks IQR 5.5-6 weeks).

Higher incidence of hypotony (12 [47%] vs. 1 [2.5%], $P < 0.0001$) and CD (7 [27%] vs. 3 [8%], $P = 0.03$) was noted more often among cases compared to controls [Table 4]. A similar incidence of hyphema was noted between both the groups (cases 5 [20%] vs. controls 3 [8%], $P = 0.1$). Hemorrhagic CD, aqueous misdirection, and tube blockage were noted in two (8%) cases and retinal detachment in one patient (4%) among cases. The incidence of plate exposure and corneal decompensation was similar between both groups. Two eyes (8%) among cases and six (15%) among controls achieved complete success, while 19 (73%) among the former group and 25 (64%) among the latter group achieved qualified success. Failure was noted for five cases (19%) versus eight controls (21%). Among cases, two (8%) eyes had uncontrolled IOP, while in the control group, one (3%) eye had persistent hypotony and five (14%) eyes had uncontrolled IOP despite the use of IOP-lowering medications.

Seven cases (27%) with serous CD associated with hypotony resolved with hypotony management with the use of topical and systemic steroids. Hypotony secondary to wound leak responded to Bandage contact lens (BCL) and wound leak

Table 2: Comparison of pre- and postoperative visual acuity, intraocular pressure, and number of IOP-lowering medications between cases and controls

Postoperative duration	No. of patients		LogMAR visual acuity (median and IQR)			IOP mmHg (mean±SD)			No. of IOP-lowering medications (mean±SD)		
	Cases	Controls	Cases	Controls	*P*	Cases	Controls	*P*	Cases	Controls	*P*
1 day	26	39	-	-		11.3±8.2	10.3±5.9	0.5	0.1±0.4	0.1±0.3	0.5
8 weeks	26	39	0.5 (0.3-0.9)	0.5 (0.2-0.8)	0.6	17.6±8.4	17.6±7.6	0.9	1.1±1	0.5±0.5	0.01
6 months	17	21	0.6 (0.5-1.25	0.5 (0.2-1.1)	0.3	14.3±3.2	14.5±7.8	0.6	1.5±0.8	0.9±0.9	0.05
1 year	10	18	0.5 (0.4-1)	0.5 (0.2-1.5)	0.8	12.4±4.7	16±6	0.09	1.7±1	1.1±0.7	0.1
Last visit	26	39	0.6 (0.3-1.5)	0.5 (0.2-1)	0.2	15.1±5.4	15±4.7	0.9	1.6±1.2	1.5±1.1	0.7

IOP=intraocular pressure, IQR=interquartile range, LogMAR=logarithm of the minimum angle of resolution, SD=standard deviation

repair. Hemorrhagic CD required choroidal drainage with AC formation under systemic steroid cover in one patient (4%) and was managed conservatively in the second patient (4%).

Kaplan–Meier survival analysis of cumulative probability of survival for cases versus controls for qualified success at 1 year was similar in both groups (94% in cases vs. 91% in controls, $P = 0.735$). The success rate was 73% versus 61% at the last follow-up ($P = -0.4$).

Univariate logistic regression analysis did not show any statistically significant associations with the occurrence of shallow AC [Table 5].

Table 3: Comparison of hypertensive phase post AGV implantation between cases and controls

Hypertensive phase post AGV implant	Cases number of eyes (26)	Controls number of eyes (39)	*P*
Number of patents having OHT phase	11 (43)	13 (34)	0.4
Highest mean IOP (mmHg) Mean	32±11	28±6.4	0.3
Onset of IOP spike (weeks)	5.5	6	0.3
Median IQR	(1-6)	(5.5-6)	

AGV=Ahmed glaucoma valve, IOP=intraocular pressure, IQR=interquartile range, OHT= Ocular Hypetertension

Discussion

Among glaucoma drainage devices, the valve reduces the risk of hypotony in patients with AGV implantation. Despite the protective mechanism, previous studies have reported complications such as hypotony, shallow AC, and CD with an AGV implant.[7,8,9,17]

Previous studies have reported an incidence of shallow AC varying from two (2.6%)[18] to 27 (19%).[7] The incidence of the shallow AC noted was 7% (26 eyes out of 369 eyes) in our study. The exact definition of shallow AC can vary among the studies, which may be the reason for the varying incidence reported. In our study, shallow AC developed in 3 ± 2.1 days following the surgery and resolved in 6 ± 4.7 days. Park *et al*.[11] retrospectively analyzed records of patients who underwent AGV surgery and had developed a system for definition of

Table 4: Comparison of postoperative adverse events and resurgery between cases (*n*=26) and controls (*n*=39)

Postoperative adverse events and resurgery	Cases	Controls	*P*
	Number of eyes 26 (%)	Number of eyes 39 (%)	
Within 3 months post-surgery			
Hypotony	12 (47)	1 (2.5)	0.0001
Choroidal detachment	7 (27)	3 (8)	0.03
Hemorrhagic choroidal detachment	2 (8)	0	0.1
Hypertensive phase	11 (43)	13 (34)	0.4
Tube blockage	2 (8)	0	0.1
Hyphema	5 (20)	3 (8)	0.1
Aqueous misdirection	2 (8)	0	0.1
Retinal detachment	1 (4)	0	0.4
3 months post-surgery			
Plate exposure[b]	1 (4)	1 (2.5)	1
Corneal decompensation	3 (12)	3 (8)	0.5
Tube exposure	0	1 (2.5)	1
Uncontrolled IOP	2 (8)[a]	5 (13)	0.5
Hypotony	0	1 (2.5)	1
Loss of light perception	0	1 (2.5)	1
Resurgery within 3 months	1 (4)	0	0.1
Intravitreal anti-VEGF injection	1 (4)	0	
Vitrectomy with silicone oil implantation			
Resurgery after 3 months			
AGV removal	2 (8)[b]	1 (2.5)	0.5
Diode cyclophotocoagulation	0	2 (5)	
Conjunctival patch graft	1 (4)[b]	1 (2.5)	
Conjunctival resuturing	0	1 (2.5)	
Penetrating keratoplasty	1 (4)	2 (5)	
Intravitreal injections	1 (4)[b]	2 (5)	

AGV=Ahmed glaucoma valve, IOP=intraocular pressure, VEGF=vascular endothelial growth factor. [a]Two patients from cases were advised diode cyclophotocoagulation. [b]Patient who underwent conjunctival patch graft later developed plate exposure with endophthalmitis patient was managed with intravitreal injection and AGV removal

hypotony with shallowing of the AC in order to assess risk factors. Hypotony was defined as IOP less than 5 mmHg on two consecutive visits. AC depths <4 of the corneal thickness in the center or <1/4 corneal thickness at the periphery were included as shallow AC. They reported the average time to recover normal AC depth as 7.84 days.[11]

Various studies have reported shallow AC with AGV surgery. The reported incidence of the shallow AC in the AVB study was 18 eyes (15%) for AGV group, of which 13 (72%) underwent AC reformation.[8] AC reformation with viscoelastic,[11] surgical peripheral iridectomy for pupillary block,[7] and tube removal for persistent shallow hypotony[18] were reported as interventions for management of shallow AC post AGV implantation. In our series, eight (30%) eyes required surgery for shallow AC. Incidence of adverse events reported in our study is comparable to the literature reports. Fiore *et al*.[19] proposed intraoperative and postoperative shallowing of the AC as one of the reasons for endothelial damage. We had three patients with corneal decompensation, of whom two had preexisting endothelial dystrophy.

Various studies have reported an incidence of CD following hypotony ranging from 6% to 23%.[11,20] Park *et al*.[11] noted incidence of CD as 32.3% in the shallow AC group and 18.2% in the control group, compared to 27% and 8% in our study, respectively. Measures recommended for preventing hypotony post AGV implantation are avoiding aggressive priming to prevent damage to the tube glaucoma valve and partial ligation. Kee *et al*.[21] have used 8-0 Vicryl for partial ligature of AGV tube to limit aqueous drainage. They reported that one out of 16 (6.3%) patients with partial ligation had developed hypotony, compared to four out of 16 (25%) patients without ligation. Chaudhari *et al*. suggested that post-production sterilization can affect valve properties. They had shown in their *in vitro* study that resistance used for priming does not affect the opening and closing pressure of AGV implant.[22] Any contact with the valve leaflet areas should be avoided. Peritubal leakage can cause postoperative hypotony. It is recommended to use 22–23 G needle to create a needle track.[20] Unexplained hypotony was reported secondary to ciliary body shutdown in a patient with neovascular glaucoma neovascular glaucoma post glaucoma drinage implant surgery.[23]

Park *et al*.[11] noted myopia, fewer previous intraocular surgeries, and young age as the risk factors and partial ligation of the tube as a protective factor for postoperative shallow AC. A retrospective analysis of flat AC post trabeculectomy found associations of higher IOP of >50 mmHg (odds ratio 0.508, *P* 0.04) before admission and old age (>60 years, odds ratio 1.191, *P* < 0.001).[24] We could not identify any specific associations for shallow AC post AGV, probably due to the smaller sample size as well the study design.

The subconjunctival tissue gets exposed to the inflammatory mediators from aqueous drianage, which results in thick fibrous capsule formation with IOP spike leading to HP after AGV implantation.[25] In our study, the incidence of HP was similar in both cases and controls (43% vs. 34%, *P* 0.4). Cheng *et al*.[26] highlighted the importance of opening pressure of AGV. If the opening pressure was over 18 mmHg, then HP occurred early in the postoperative period, compared to those who had an opening pressure of 18 mmHg or less. Pakravan *et al*.,[16] in their randomized control trial, have shown that the use of aqueous suppressants (dorzolamide–timolol fixed combination) for postoperative IOP higher than 10 mmHg or more blunted the HP. Reduction in HP was noted in the aqueous suppressant group (aqueous suppressant group 23.4% vs. 66.0% in the conventional treatment group) compared to the conventional treatment group. Noor-Mahdavi *et al*.[12] have reported that patients who developed the HP required a more significant number of IOP-lowering medications than those who did not develop the HP at 6–12 months follow-up. Many of our patients have been aggressively treated with aqueous suppressants in the later years of the study, which can explain the similarity between the groups as well as the relatively lesser HP occurrence.

Our study has some limitations. It is a retrospective study with a small sample size, and the follow-up interval is variable with loss of follow-up in both groups. The shallow AC was diagnosed based on slit-lamp findings, as documented by the primary surgeon. The possibility of subjective variation in the grading of shallow AC could not be ruled out because of lack of anterior segment imaging to confirm the same. There is a possibility of subjective variation in the management of the shallow AC; however, patients with central iridocorneal touch were managed surgically as per the protocol. Surgeon skills could affect the surgical outcome; however, uniform surgical steps were followed for all the patients. The small sample size

Table 5: Univariate logistic regression analysis for associations for postoperative shallow AC

Variables	Odds ratio	95% CI	*P*
Age (years)	1.027	(0.996, 1.058)	0.09
Gender - female	2.182	(0771, 6.171)	0.141
Closed angle	2.75	(0.934, 8.1)	0.06
Appositional angle closure	2.75	(0.233, 49.359)	0.492
Synechial angle closure			
One quadrant	1.071	(0.206, 5.584)	0.935
Two quadrants	1.667	(0.22, 12.617)	0.621
Three quadrants	0.625	(0.057, 6.801)	0.7
Four quadrants	3.333	(0.925, 12.012)	0.06
Number of preoperative IOP-lowering medications	1.422	(0.802, 2.52)	0.228
Total number of surgeries	4	(0.709, 22.556)	0.116
Prior trabeculectomy			
One	1.981	(0.585, 6.705)	0.272
Two	2.6	(0.518, 13.041)	0.245
Prior diode cyclophotocoagulation	1.542	(0.203, 11.693)	0.675
Other non-glaucoma surgeries	1.193	(0.281, 5.058)	0.389
Preoperative visual acuity (LogMAR units)	1.07	(0.55, 2.081)	0.811
Preoperative intraocular pressure (mmHg)	1.009	(0.954, 1.067)	0.758
Phakic status	9	(0.888, 91.255)	0.06
Preoperative mean deviation (dB)	1.034	(0.968, 1.104)	0.321
Preoperative axial length (mm)	0.567	(0.315, 1.021)	0.059

AC=anterior chamber, CI=confidence interval, IOP=intraocular pressure, LogMAR=logarithm of the minimum angle of resolution

might be the reason for the inability to find any significant associations for shallow AC. Topical cycloplegics were used as per surgeons' discretion.

It may be noted that our incidence of shallow AC is similar to or even lesser than that reported in literature.

Conclusion

Our study suggests that the incidence of shallow AC post AGV implant is relatively small and may have favorable IOP control outcomes in the first year. However, the association with HP may need to be evaluated with a large sample size to confirm a true association with early postoperative shallow AC. Long-term control of IOP after AGV implant and its association with shallow AC need follow-up studies.

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Conflicts of interest

There are no conflicts of interest.

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Supplementary Table 1: Intraoperative details regarding AGV implantation

Intraoperative details regarding AGV implant	Cases number of eyes 26 (%)	Controls number of eyes 39 (%)	Significance *P*
Type of AGV used			0.5
FP7	22 (85)	35 (90)	
S2	4 (15)	4 (10)	
Site of tube implantation			0.4
Anterior chamber	20 (77)	33 (85)	
Ciliary sulcus	6 (23)	6 (15)	
Tube position			0.4
Superotemporal quadrant	25 (94)	33 (84)	
Superonasal quadrant	1 (4)	3 (8)	
Inferotemporal quadrant	0	3 (8)	
AGV + additional combined surgery			1
AGV lensectomy	1 (4)	0	
AGV + silicone oil removal	0	2 (5)	
AGV + pars plana vitrectomy +endolaser + fluid gas exchange	1 (1)	0	

AGV=Ahmed glaucoma valve

Supplementary Table 2: Details regarding management of shallow AC among cases post Ahmed glaucoma valve implantation

Management for postoperative shallow AC	Number of patients (26)	Type of intervention	Indication for intervention
Grade 1 shallow AC	9	Topical hourly steroids	To reduce inflammation
Topical hourly steroids+atropine eyedrops		Atropine eyedrops	To pull iris lens diaphragm backward
Grade 2 shallow AC	5	Prednisolone tablet	To reduce inflammation
Topical treatment+systemic steroids[a]			
Additional laser intervention along with systemic steroids	4	1 YAG peripheral iridotomy (1 week postop)	To relieve pupillary block
		2 YAG laser membranectomy (1 week postop)	To break the exudative membrane
		3 YAG laser hyaloidotomy (2 weeks postop)	To break the anterior hyaloid phase
Grade 3	8	1 tube ligation along with choroidal drainage (4 weeks postop)	1 suspected valve dysfunction
Surgical intervention for AC formation		2 pars plana vitrectomy with peripheral iridectomy (2 weeks postop)	2 to create anterior and posterior chamber communication
		3 tube repositioning from the ciliary sulcus into the AC (1 week postop)	3 blockage with anterior capsular tissue
		4 tube ligation (1 week postop)	4 suspected valve dysfunction
		5 hemorrhagic choroidal drainage (2 weeks postop)	5 choroidal drainage
		6 AC formation with Healon (4 week postop)	6 AC formation
		7 wound resuturing (2 weeks postop)	7 wound leak
		8 iris tuck removal (1 week postop)	8 to relive tube blockage

AC=anterior chamber. All postoperative surgical interventions were done within 4 weeks post-surgery. [a]One patient with grade 3 shallow AC with suprachoroidal hemorrhage was managed conservatively