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Outcome of valved versus non-valved glaucoma drainage implant surgeries in eyes with refractory glaucoma

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Abstract
Purpose: The aim of this work was to compare the surgical outcomes of valved glaucoma drainage implants versus non-valved glaucoma drainage implants in the management of patients with refractory glaucoma.
Methods: A retrospective comparative investigation was conducted involving 50 eyes diagnosed with refractory glaucoma. 25 eyes received Ahmed glaucoma valve (AGV), and 25 eyes received non-valved GDI (Aurolab) at the Ophthalmology Department in Tanta University Hospital (2020-2023). The primary outcome measure was intraocular pressure (IOP) reduction. The secondary outcome measures encompassed antiglaucoma medications (AGMs), LogMAR best-corrected visual acuity (BCVA), as well as intraoperative and postoperative complications, eyes exhibiting no light perception vision at baseline and those subjected to a follow-up period of less than three months and < 18 years were excluded.
Results: Baseline data, patients' characteristics, and glaucoma diagnosis were similar between groups. The mean preoperative intraocular pressure (IOP) recorded in mmHg was 44.9± 6.3 for the Ahmed Glaucoma Valve (AGV) group and 44.0± 6.1 for the Aurolab Aqueous Drainage Implant (AADI) group. The mean duration of follow-up was 17.6±10.1 months for the AGV group and 16.5±9.98 months for the AADI group, respectively. The success rate was observed to be superior in the AADI group (88%) compared to the AGV group (72%) ($p = 0.16$). At the final follow-up assessment, the mean IOP was determined to be 19.3±8.3 in the AGV group and 12.3 ± 3.7 in the AADI group. The mean IOP and the requirement for AGMs were significantly lower in the AADI group at the last follow-up ($p<0.001$), while the rates of postoperative complications (AADI 20% vs. AGV 36%) exhibited comparability ($p = 0.21$).
Conclusion: Both Glaucoma Drainage Implants (GDIs) demonstrated efficacy in lowering IOP and diminishing the necessity for AGMs. Nonetheless, the overall success rate was markedly higher within the AADI group, characterized by significant IOP reduction and a reduced number of AGMs utilized.

Keywords: Intra-ocular pressure, aurolab aqueous drainage, Ahmed glaucoma valve, glaucoma drainage implant, refractory glaucoma

Introduction

Refractory glaucoma is characterized by the presence of uncontrolled intraocular pressure (IOP) accompanied by demonstrable deterioration of the optic nerve and/or visual fields, despite the administration of maximally tolerated anti-glaucoma pharmacotherapy (both topical and/or systemic), previous surgical interventions having failed, or a significant likelihood of failure associated with conventional filtering surgeries [1]. The classification of refractory glaucoma encompasses various types, including childhood, neovascular, uveitis, and traumatic glaucoma's, characterized by extensive conjunctival scarring, as well as conditions such as post-vitrectomy, Post-keratoplasty complications, ciliary block, recurrent glaucoma, and glaucoma manifesting in both aphakic and pseudophakia eyes were noted [2].
Glaucoma drainage implants (GDIs), which were originally designated for individuals with unsuccessful trabeculectomy, are increasingly becoming the preferred surgical intervention for a variety of refractory glaucoma cases. Generally, GDIs establish alternative drainage pathways by facilitating the diversion of aqueous humor from the anterior chamber to an equatorial plate via an elongated tube, concurrently promoting the formation of a bleb in the posterior region [3, 4]. Ahmed glaucoma valve (AGV) is recognized as the most widely utilized valved GDI globally. Composed of silicone, it features a reduced surface area of 184 mm² and is designed with a tapered profile to facilitate straightforward insertion.

Its distinctive, non-obstructive valve mechanism effectively mitigates excessive drainage and prevents anterior chamber collapse while ensuring immediate reduction of IOP [5, 6].

The Aurolab Aqueous Drainage Implant (AADI), manufactured by Aurolab, a subsidiary of the Aravind Eye Institute in India, is a type of Glaucoma Drainage Implant that lacks a valve mechanism. Crafted from silicone, it is designed based on the principles of the Baerveldt glaucoma implant, notable for its large surface area of 350 mm². The implant's end plate extends significantly along the sclera, covering more than two clock hours of circumference.

The AGV operates as a Venturi-based flow restrictor, engineered to diminish the incidence of postoperative hypotony and its associated complications. Notwithstanding, it has been linked to elevated rates of encapsulation and inadequate IOP reduction, often necessitating the administration of postoperative glaucoma medications. In contrast to valved devices, the BGI (which lacks a valve) requires the surgeon to temporarily restrict fluid flow during surgery. This restriction allows adequate time for a bleb, or fluid-filled sac, to form at the drainage site. However, this method has been associated with significant fluctuations in eye pressure in the early postoperative period, leading to both elevated intraocular pressure (ocular hypertension) and complications arising from low eye pressure (hypotony). However, once the end plate attains functionality, the BGI has demonstrated superior IOP regulation, reduced reliance on glaucoma medications, and diminished encapsulation over an extended period. This phenomenon may be attributed to its larger end plate (350 vs. 184 mm²) and the absence of resistance induced by a valve [11].

The aim in this study was to compare the surgical outcomes of AGV versus AADI in the management of eyes with refractory glaucoma in terms of IOP reduction, fewer antiglaucoma medications, preservation of visual status, and safety (intra-operative and postoperative complications, postoperative surgical interventions).

Methods

Study Design

This retrospective comparative was carried out on 50 eyes of 50 patients with refractory glaucoma; 25 had Ahmed valve (AGV group) and 25 had Aurolab implant (AADI group) at the Ophthalmology Department in Tanta University Hospital during the period (2020-2023).

This study focuses on individuals experiencing treatment-resistant glaucoma. These patients have intraocular pressure (IOP) exceeding 21 mmHg despite receiving the highest tolerable dose of medication. This patient cohort includes individuals who have previously undergone unsuccessful glaucoma surgery on one or more occasions and are now candidates for a glaucoma drainage implant (GDI). Additionally, it encompasses patients diagnosed with secondary glaucomas, such as neovascular glaucoma. silicon-induced, and uveitic who are considered high-risk of failure of glaucoma filtering surgery and had GDI as the primary surgical intervention.

Exclusion criteria included patients <18 years of age, less than 3 months of follow-up visits, patients with no light perception (NLP) vision at baseline, and combined surgery with the implant, such as cataract surgery or keratoplasty.

Ethical considerations

The research was conducted following the approval granted by the Ethical Committee of Tanta University Hospitals in Tanta, Egypt. Given that this study was retrospective and employed deidentified data, the acquisition of informed consent was deemed unnecessary.

Surgical Procedure

Surgical technique of Ahmed glaucoma valve

Before surgically implanting the device, its functionality was verified and prepared by injecting one cubic centimeter of Balanced Salt Solution or sterile water through a drainage tube using a 26-gauge cannula. A conjunctival flap based on the fornix was carefully created to expose two rectus muscles in the superotemporal quadrant. During the surgical procedure, the Tenon's capsule was carefully dissected from the episclera. Any blood vessels encountered in the episclera were sealed using cauterization. The implant plate was then placed 10 millimeters behind the limbus and affixed to the sclera with a 5/0 Ethicon suture. Lastly, the drainage tube was shortened to facilitate an insertion depth of 2-3 millimeters into the anterior chamber. The orientation of the bevel was adjusted upwards in eyes with natural lenses (phakic) or downwards in eyes that had undergone cataract surgery (pseudophakic) if the tube was placed in the ciliary sulcus.

The anterior chamber (AC) was subsequently accessed 2 mm posterior to the corneoscleral limbus utilizing a 23G needle. The trajectory of the needle was positioned anteriorly and in alignment with the plane of the iris, deliberately distanced from the corneal endothelium, and thereafter, the tube was introduced into the AC via the established needle tract; in instances of a shallow AC, a viscoelastic agent was administered prior to the insertion of the tube. The tube was securely affixed to the scleral tissue employing a 10/0 nylon suture and subsequently enveloped with either a scleral or pericardial graft, which was likewise secured with a 10/0 nylon suture. Closure of conjunctiva by 7/0 vicryl. Subconjunctival injection of antibiotic and dexamethasone.

Surgical technique of Aurolab aqueous drainage implant

A fornix-based conjunctival flap was meticulously crafted to reveal two rectus muscles located within the superotemporal quadrant. To the greatest extent feasible, Tenon’s capsule was separated from the episclera, and the underlying episcleral vessels were cautiously cauterized. Flow restriction at the tube junction in proximity to the tube plate was achieved through external ligation employing a 7/0 vicryl suture, while internal ligation was conducted using a 4/0 silk or prolene ripcord suture. The absence of fluid flow through the tube was corroborated by the infusion of a balanced salt solution into the tube. Two to three venting slits were created anterior to the external ligature utilizing a 7/0 vicryl needle. The plate was strategically situated 10 mm posterior to the limbus and secured to the sclera employing a 5/0 Ethicon suture. The drainage tube was appropriately adjusted to permit a 2–3 mm insertion into the anterior chamber (AC) with the bevel directed upwards in phakic eyes (or downwards in pseudophakia eyes if the tube was inserted within the ciliary sulcus). The anterior chamber was then accessed 2 mm posterior to the corneoscleral limbus with a 23G needle. The needle pathway remained anterior and parallel to the iris plane, distanced from the corneal endothelium, and the tube was subsequently positioned into the AC through this needle pathway; in scenarios of shallow AC, a viscoelastic substance was introduced prior to the tube's insertion. The tube was affixed to the sclera utilizing a 10/0 nylon suture and was enveloped with either a scleral or pericardial graft, which was also secured with a 10/0 nylon suture. Closure of conjunctiva by 7/0 vicryl. Subconjunctival injection of antibiotic and

dexamethasone.

The primary outcome measures were surgical failure defined by any of the following criteria

1. Intraocular pressure (IOP) exceeding 22 mm Hg despite maximal tolerated medical therapy on two consecutive assessments.
2. IOP <6 mmHg with hypotony-related complications on two consecutive visits.
3. Reoperation necessitated for the management of glaucoma.
4. Removal of implant.
5. Advancement to no light perception vision.

Eyes with controlled IOP (6-21 mmHg with at least 20% reduction of IOP from baseline) without glaucoma medications or additional intervention at the relevant follow-up visits were considered a complete success.
Eyes with controlled IOP with glaucoma medications were considered a qualified success.

The secondary outcomes included in-group and between-group comparisons of the following parameters

1. IOP.
2. Quantification of glaucoma medications utilized.
3. Best-corrected visual acuity assessment.
4. Intraoperative and postoperative complications.
5. Additional surgical interventions.

Statistical Analysis

Data analysis was performed using IBM SPSS Statistics software (version 26). Quantitative data are presented as means and standard deviations, and were compared between the two groups using an unpaired Student's t-test. Qualitative data are represented as frequencies and percentages, and were analyzed using Chi-square or Fisher's exact tests, as appropriate. Statistical significance was defined as a p-value of 0.05 or less. The Kaplan-Meier method was employed to compare the cumulative probability of failure between the two groups over time.

Results

Baseline data, demographics of the patients, and preoperative characteristics of the study eyes are demonstrated in Table 1. 25 patients in each group were followed up for 17.56±10.08 months in group AGV and 16.52±9.98 months in group AADI; both groups were comparable (p > 0.05).
Table 2 presents the type and underlying causes of refractory glaucoma in the study. There were 25 eyes in the AGV group; 16 eyes had neovascular glaucoma, 8 eyes had silicone oil-induced glaucoma, and 1 eye had PACG with previously failed trabeculectomy, while 25 eyes in the AADI group; 12 eyes had neovascular glaucoma, 7 eyes had silicone oil-induced glaucoma, 4 eyes had PACG with previously failed trabeculectomy, and 2 underwent previous corneal graft surgery.
In the AADI group, mean IOP decreased from 44.04 ± 6.11 mmHg at baseline to 12.33 ± 3.66 mmHg at the final follow-up assessment (p<0.001), the percentage reduction in intraocular pressure (IOP) was determined to be 71.5%. Within the Ahmed Glaucoma Valve (AGV) cohort, the mean IOP demonstrated a decrement from 44.88±6.30 mmHg at baseline to 19.29±8.29 mmHg at the last follow-up (p<0.001), yielding a percentage reduction of 56.8%. The AGV cohort exhibited a markedly lower mean IOP in comparison to the AADI cohort at the one-month postoperative follow-up (p<0.04). Conversely, the mean IOP recorded in the AADI cohort was significantly lower than that of the AGV cohort at all subsequent postoperative evaluations (p<0.001). (table 3)
A substantial reduction in the necessity for medical therapy was observed in both treatment cohorts (p<0.001), with the AADI cohort demonstrating a significantly diminished requirement for antiglaucoma medication (AGM), starting from the 3rd month visit (p<0.001) and thereafter till the last follow-up. (table 3)
There was no significant improvement in early and last follow-up BCVA (log MAR) compared to preoperative BCVA in group AGV (P = 0.711, 0.702, respectively), while in group AADI there was a statistically significant improvement in early and last follow-up BCVA compared to preoperative BCVA (P = 0.022*, 0.032*, respectively). However, the difference in early and late postoperative visual acuity between the two groups was not statistically significant (p = 0.64, 0.98, respectively). (table 3)
In the AGV group, we started a fixed combination of topical AGMs in the form of carbonic anhydrase inhibitors and β blockers by the 2nd week postoperatively to guard against hypertensive phase (HP). Seven (28%) of 25 patients in this group demonstrated an HP, with a mean IOP of 30.29±3.20 mmHg at 4±1.14 weeks postoperatively and required a mean of 2.57±0.53 AGMs. The mean IOP after resolution of HP in the AGV group was 16.86± 3.34 mmHg and required a mean of 2.08±0.71 AGMs.
In the AADI group, the mean IOP before stent removal was 25.58±7.75 mmHg with (2.4±0.42) AGMs. Stent removal was done after 5.58±0.65 weeks. Mean IOP after stent removal was 11.79±3.82 mmHg with 1.38± 0.64 AGMs (Figure 1).
None of the study eyes had intraoperative complications; early (<3 months) postoperative complications were encountered in 3 patients in group AGV (12%); tube obstruction, vitreous hemorrhage, and choroidal detachment vs. 2 patients in group AADI (8%); vitreous hemorrhage and suprachoroidal hemorrhage. Late (>3 months) postoperative complications were encountered in 6 patients in group AGV (24%), including hypotony, vitreous hemorrhage, strabismus, and 3 bleb encapsulations, vs. 3 patients in group AADI (12%), including tube erosion, aqueous misdirection, and hypotony (p = 0.267).
In the AADI cohort, three eyes (12%) and in the AGV cohort, six eyes (24%) necessitated interventions due to complications; however, this discrepancy did not reach statistical significance (p = 0.27) (table 4).
In the AGV group, none of the eyes achieved complete success, while 18 eyes (72%) achieved qualified success, and 7 eyes (28%) were considered surgical failure. While in group AADI, 2 eyes (8%) achieved complete success, 20 eyes (80%) achieved qualified success, and 3 eyes (12%) were considered surgical failure (table 5).
Censored Kaplan-Meier survival analysis comparing the cumulative probability of failure between the two groups (Figure 2).

Table 1: Baseline data and preoperative characteristics of the study eyes.

Preoperative parameters	Group AGV	Group AADI	*P*- value
Age (in years)			
Mean ±SD	54.52±12.99	53.72±9.00	0.8
Range	(20-71)	(36-68)	
Gender: number (%)			
Male	15(60%)	18(72%)	0.4
Female	10(40%)	7(28%)	
Medical history: number (%)			
Diabetes mellitus	17(68%)	14(56%)	0.4
Hypertension	13(52%)	15(60%)	0.6
Studied Eyes: number (%)			
Right	13(52%)	14(56%)	0.8
Left	12(48%)	11(44%)	
Preoperative visual acuity (LogMAR)			
Mean ±SD:	1.50 ± 0.51	1.57 ± 0.74	0.7
Range:	(0.6-2.48)	(0.3-2.48)	
Preoperative IOP (mmHg)			
Mean ±SD:	44.88 ± 6.30	44.04 ±6.11	0.6
Range:	(36-62)	(35-56)	
Preoperative AGM			
Mean ±SD:	2.4±0.5	2.16±0.37	0.06
Range:	(2-3)	(2-3)	
Number of previous surgeries:			
Mean ±SD:	1.20±0.40	1.4±0.50	0.8
Range:	(1-2)	(1-2)	
Lens status: number (%)			
phakic	14 (56%)	9(36%)	0.6
pseudophakic	1(44%)	16(64%)	
Follow-up duration (in months)			
Mean ±SD:	17.56±10.08	16.52±9.98	0.7
Range:	(0.07-36)	(0.07-40)	

AGV: Ahmed glaucoma valve, AADI: Aurolab aqueous drainage implant, Data are presented as mean ± SD.

Table 2: Refractory Glaucoma diagnosis of patients in each group.

Diagnosis	Group AGV	Group AADI
Neovascular glaucoma	16(64%)	12(48%)
CRVO	1(6.25%)	1(8.33%)
PDR	15(93.75%)	11(91.66%)
Silicone oil induced glaucoma	8(32%)	7(28%)
Previously failed trabeculectomy for PACG	1 (4%)	4(16%)
Previous corneal graft surgery	0	2(8%)
Total	25	25

Table 3: Comparison of preoperative and postoperative IOP, number of preoperative, early, late postoperative antiglaucoma medications and BCVA (LogMAR) values between the two groups.

		Group AGV (n=25)	Group AADI (n=25)	Test	P
IOP (mmHg)	Preoperative	44.88±6.30	44.04±6.11	0.48	0.64
	Post Day 1	13.92±7.42	15.20±9.82	-0.52	0.61
	Post Day 7	14.58±5.45	17.08±7.67	-1.30	0.2
	Post 1 Month	21.25±6.51	25.58±7.75	-2.1	0.041*
	Post 3 Months	22.13±6.04	15.42±6.21	3.79	<0.001*
	Last Follow up	19.30±8.29	12.33±3.66		
	Difference#	25.71±9.18	31.88±7.48	3.76	<0.001*
	Paired Test	<0.001*	<0.001*		
AGMs	Preoperative	2.40±0.50	2.16±0.37	1.92	0.06
	Post 1 Month	1.96±0.46	2.13±0.61	-1.06	0.29
	Post 3 Months	2.08±0.72	1.21±0.51	4.87	<0.001*
	Last Follow up	1.92±0.72	1.13±0.61		
	Difference#	0.50±0.89	1.00±0.72	4.11	<0.001*
	Paired Test	0.011*	<0.001*		
BCVA (Log MAR)	Preoperative	1.50±0.51	1.57±0.74	-0.40	0.69
	Post 3 Months	1.46±0.63	1.37±0.71	0.48	0.64
	Last Follow up	1.33±0.59	1.33±0.79		
	Difference#	0.02±0.22	0.02±0.26	-0.03	0.98
	Paired Test	0.7	0.72		

The data is presented as the average value plus or minus the standard deviation. A p-value of less than 0.05 was considered statistically significant. The symbol "#" indicates a difference between measurements taken before surgery and at the final follow-up appointment. AADI refers to the Arcolab aqueous drainage implant, AGV represents the Ahmed glaucoma valve, IOP stands for intraocular pressure, AGMs denotes antiglaucoma medications, and BCVA signifies be corrected visual acuity

Table 4: Postoperative surgical interventions for early and late complications in both AGV and AADI groups.

Reoperation	AGV group	AADI group	*P*-value
Early (<3 months) post-operative reoperations:	2(8%)	1(4%)	0.552
Tube lavage for tube blockage	1(4%)	0(0%)	
Choroidal drainage	1(4%)	1(4%)	
Late (>3 months) post-operative reoperations:	4(16%)	2(8%)	0.383
IZHV for aqueous misdirection	0	1	
Conjunctival autograft for conjunctival dehiscence with tube erosion	0	1	
Valve reposition and Squint surgery	1	0	
Bleb revision with MMC Injection for bleb encapsulation	3	0	
Total	6(24%)	3(12%)	0.269

AGV: Ahmed glaucoma valve, AADI: Aurolab aqueous drainage implant, IZHV: irido-zonulohyaloido-vitrectomy, MMC: mitomycine C.

Table 5: Comparison between success rates in both groups.

		Group						T-Test	
		AGV			AADI			t	P-value
Time follow up (in months)	Range	0.07	-	36	0.07	-	40	0.100	0.715
	Mean ± SD	17.563	±	10.082	16.523	±	9.975		
Chi-Square		N		%	N		%	X^2	P-value
Outcome	Complete	0		0.00	2		8.00	3.705	0.157
	Qualified success	18		72.00	20		80.00		
	Failure	7		28.00	3		12.00		

The data is expressed using the format of mean ± standard deviation, or as frequencies. (%).

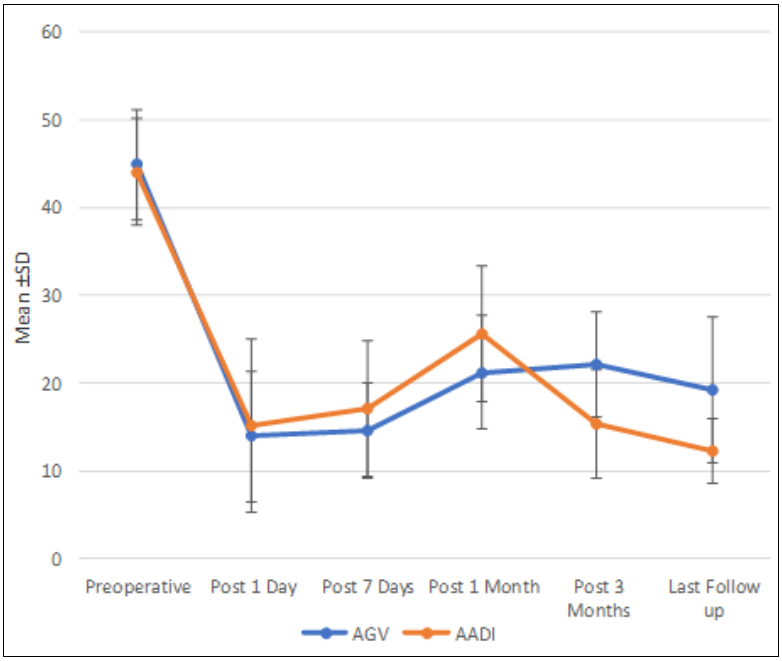

Fig 1: IOP changes over time in both groups.

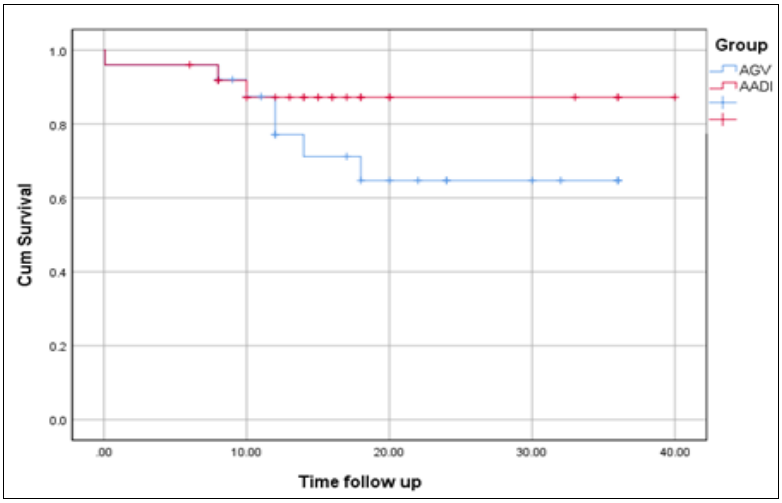

Fig 2: Kaplan-Meier survival analysis for cumulative probability of failure in the two study groups over the follow-up length.

Discussion

This study retrospectively examined the surgical results of two glaucoma drainage implants, AGV and AADI, in patients with refractory glaucoma. The study focused on comparing the effectiveness of these implants in lowering intraocular pressure, maintaining vision, reducing reliance on glaucoma medications, and minimizing surgical complications both during and after the procedure. In this analysis, both groups had a significant IOP reduction from baseline preoperative IOP at all time intervals postoperatively ($P < 0.001$). However, the postoperative mean IOP level at one day and one week was lower but not statistically significant (P = 0.6, 0.2, respectively) in the AGV group compared to the AADI group. After one month, the postoperative mean IOP was significantly higher (P-value = 0.04) in the AADI group (25.6 + 7.7 mmHg) than in the AGV group (21.3 + 6.6 mmHg). After restoration of the flow (removal of the rip cord), Statistical analysis revealed a significant decrease in average intraocular pressure (IOP) within the AADI group when compared to the AGV group ($P < 0.001$). This reduction was observed consistently throughout the entire follow-up period, including assessments at both three months and the final visit. There was a statistically significant difference in mean and percent reduction of IOP (in mmHg) between both groups. In the AGV group, the mean IOP reduction was 25.71±9.18 with a percent reduction of 56.83%, while in the AADI it was 31.88± 7.48 with a percent reduction of 71.48%. (P = 0.014, 0.001, respectively), The greater IOP reduction with a significantly lower mean IOP at the last follow-up end point with significantly fewer antiglaucoma medications in the AADI eyes compared to eyes with AGV suggest that a lower target IOP for eyes with advanced refractory glaucoma can be better achieved with non-valved drainage implants.

Multiple studies have investigated the comparative effectiveness of AGV and AADI managing intraocular pressure (IOP).

Early postoperative results from the Ahmed Versus Baerveldt (AVB) Study [12] indicated that AGV implantation led to lower IOP, and reduced medication dependence compared to AADI within the first month. However, beyond this initial period, AADI demonstrated superior IOP control and medication reduction, achieving statistically significant differences by one year.

This trend of AADI superiority was further corroborated by Pandav *et al* [13], who observed significantly reduced IOP in both AGV and AADI groups across all follow-up evaluations. While both implants effectively lowered IOP, the AADI group consistently exhibited a greater percentage reduction compared to the AGV group at three, six, and twelve months.

Similarly, Ray *et al* [14] reported significantly lower median IOP in the AGV group compared to the AADI group during the initial postoperative week. Overall, these studies suggest that while both AGV and AADI effectively reduce IOP, AADI may offer superior long-term IOP control.

In the current study, the IOP at days 1 and 7 was higher yet not significant in the AADI group compared to the AGV group. This may be explained by measures applied to decrease the IOP by venting slits and continuing antiglaucoma medications for the AADI during periods of flow restriction.

Ray *et al.* [14] a statistically significant decrease in the requirement for medical intervention was observed in both therapeutic cohorts ($p<0.001$), with a notably reduced necessity for AGM within the AADI cohort at each postoperative evaluation subsequent to the six-week mark. The Ahmed Baerveldt Comparison (ABC) Study [15] demonstrated a considerable decline in the demand for pharmacological treatment across both intervention groups. A propensity for increased utilization of glaucoma pharmacotherapy at the one-year mark was noted within the AGVcohort in comparison to the AADI cohort. In contrast to our analysis, Tsai *et al*. [16] found a statistically significant reduction in glaucoma medication use among patients who underwent Ahmed valve implantation. This decrease was observed both one week ($P < 0.001$) and one month ($P < 0.001$) following the surgical procedure. A possible explanation is that in our study, patients in the AGV group started a fixed combination of AGMs (CAI + B-blocker) to guard against HP from the second postoperative week.

The 3-month and late postoperative BCVA in both groups was comparable with no statistically significant difference (P = 0.636, 0.976). In the study by Rathi *et al.* [6], There existed no statistically significant disparity in the enhancement of mean BCVA (log MAR) at the six-month follow-up between the two cohorts.

In this study, HP was noted in 7 (28%) of 25 patients in the AGV group; the mean IOP during HP was 30.29±3.20 mmHg, which was detected at 4-6 weeks postoperatively and required a mean of 2.57±0.53 AGMs. The mean IOP after resolution of HP in the AGV group was 16.86± 3.34 mmHg and required a mean of (2.08±0.71) AGMs to maintain the IOP. The prevalence of HP observed in our research was lower compared to the findings reported by Özalp *et al*. [17] Their extensive study identified HP in 31 eyes (51.7%), with an average peak intraocular pressure (IOP) of 27.6 ± 4.5 mmHg. The median IOP was 27 mmHg, ranging from 22 to 40 mmHg, and the average duration was 5.8 ± 2.7 weeks.

Also, in Neaves-Mendez *et al*. [18], a total of 193 eyes of 177 patients were included; HP was present in 58%. This could be explained in our study: patients in the AGV group were on a fixed combination of topical AGMs in the form of CAI and B-blockers by the 2nd week postoperatively to guard against HP.

Regarding complications in our study, there were no significant intraoperative complications noted in both groups. Early postoperative complications were seen in 3 (12%) eyes in group AGV, including tube obstruction, vitreous hemorrhage, and choroidal detachment, vs. 2 (8%) eyes in group AADI, including vitreous hemorrhage and suprachoroidal hemorrhage (P = 0.637). Late postoperative complications were seen in 6 eyes in group AGV (24%), including hypotony, vitreous hemorrhage, strabismus, and 3 bleb encapsulations, vs. 3 eyes in group AADI (12%), including tube erosion, aqueous misdirection, and hypotony (P value = 0.267). The study by Rathi *et al.* [6] found no significant differences in complication rates between the two surgical implants. During surgery, no major complications occurred in either group. Early postoperative complications were observed in a similar proportion of patients receiving each implant: 42.11% in the AGV group and 36.84% in the AADI group (P = 0.752). Similarly, there was no significant difference in late postoperative complication rates between the two groups (26.31% in the AGV group vs. 21.05% in the AADI group; P = 0.705).

In this study, bleb encapsulation was observed in 3 eyes (12%) in the AGV group, while none of the eyes in the AADI group experienced bleb encapsulation. In the aggregated analysis conducted by Christakis *et al.* [19], the AGV implant exhibited a heightened incidence of bleb encapsulation (AGV 60%, BGI 27%; $p<0.001$). Iwasaki *et*

al. [20] observed a more pronounced degree of fibrous encapsulation associated with AGV surgery relative to BGI surgery. The initial formation of a capsule around the implant (AGV) is likely due to the device's immediate filtering action on aqueous humor containing inflammatory substances. This triggers a fibrous tissue growth response, resulting in the encapsulation of the AGV's end plate [23].

Our study found no statistically significant difference in the rate of surgical re-interventions due to postoperative complications between the two groups (P value greater than 0.05). This finding aligns with previous research conducted by Hong *et al*. [22], which also observed comparable rates of overall postoperative complications between the AGV and AADI implant types. Similarly, Ray *et al*. [14] reported no statistically significant difference in the need for re-intervention due to complications between the two groups (p = 0.23).

On the contrary, the ABC [12] and the AVB study [15] showed a higher rate of serious complications in the BGD group (p = 0.014) and a higher re-procedure rate in the BGD group (p = 0.009). We hypothesize that meticulous technique of flow restriction of AADI by luminal stent and external ligature and venting slits with continuing postoperative glaucoma medications, delayed stent removal (5.6 weeks), and the fact that all surgeries were done by a single surgeon may have helped to minimize complications in the current study.

This research investigated the effectiveness of two glaucoma drainage implants: AADI and AGV implants. The findings demonstrated a higher success rate with the AADI implant. While no eyes in the AGV group achieved complete success, 72% attained qualified success. Conversely, 8% of eyes in the AADI group experienced complete success, with an additional 80% achieving qualified success. Consistent findings were noted in the AVB study [12]; the Baerveldt cohort demonstrated a superior success rate compared to the Ahmed cohort after a one-year follow-up.

In agreement with our study, Parajuli *et al* [23]. These results align with previous research by Hong *et al*. [22], which also suggested the superiority of AADI implants in terms of both complete and qualified success rates compared to AGV implants. This strengthens the argument that AADI may be a more effective treatment option for managing refractory glaucoma.

In Wang *et al*. [24] The success rate for the AGV cohort was inferior to that of the BGI cohort; specifically, the success rate in the AGV group was 59.2%, while the BGI group achieved a success rate of 68.4%. In contrast to our findings, Das *et al*. [25] reported an approximately 85% success rate at the one-year mark, and Parihar *et al*. [26] documented an 88% success rate in their analysis, which marginally exceeds the success rate of AGV in our investigation (72%). This could be explained by the difference in sample sizes between our study (25 eyes), Das *et al*. (64 eyes), and Parihar *et al*. (52 eyes). In this study, the failure rate in AADI was 12% while in AGV it was 28%; this agreed with Elbaklish *et al*.'s study [27]; the failure rate was 19.64% in the AGV group and (12%) in the BGI group at 12 months.

Conclusion

When juxtaposed with AGV, the economically viable device AADI is capable of achieving significantly lower IOP with a markedly reduced requirement for medications, a benefit that is maintained throughout the follow-up period while ensuring comparable safety. The financial burden associated with the AGV presents a significant barrier to access for large segments of impoverished populations in the developing world, whereas the AADI offers a safe, efficient, and cost-effective alternative for such patients.

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