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# Can trainees perform Ahmed glaucoma valve surgery as effectively as attendings?

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## Abstract:

**OBJECTIVE:** To compare the surgical outcomes and early postoperative complications of Ahmed glaucoma valve (AGV) implantation performed by residents with those performed by attending physicians.

**METHODS:** This is a retrospective, case-control study. Data were gathered from chart reviews of consecutive cases of AGV model FP7 implantation between January 2014 and July 2017. Postoperative 1-year results of patients who had at least 3 months follow-up were evaluated.

**RESULTS:** One hundred and forty-four eyes of 144 patients were included in this study: 72 patients in the resident group, and 72 age- and sex-matched patients in the attending group. Hyphema and shallow anterior chamber were significantly more common in the resident group vs. attending group (25% vs. 2.8% and 19.4% vs. 7.0%;  $P = 0.001$  and  $P = 0.04$ , respectively). Neovascular glaucoma (NVG) was more common in resident vs. attending group (30.6% vs. 1.4%;  $P < 0.001$ ). No significant difference in mean intraocular pressure (IOP) was found at any postoperative follow-up visits between the surgery groups ( $P > 0.05$ , for all). The number of postoperative visits within 3 months was similar between the groups ( $P = 0.84$ ).

**CONCLUSION:** Resident-performed AGV surgery lowered IOP, similar to attending-performed surgery. More frequent complications were observed in the resident group, which might be due to the predominance of NVG in this group.

## Keywords:

Complications, glaucoma drainage device, glaucoma, resident, trainee

## Introduction

Ahmed glaucoma valve (AGV; New World Medical, Rancho Cucamonga, CA) implantation is an effective procedure that has been widely used in the surgical treatment of glaucoma, particularly in refractory cases requiring immediate intraocular pressure (IOP) lowering.<sup>[1,2]</sup> The implantation of AGV requires multiple complex maneuvers by the primary surgeon, and surgeons early in their training may face a steep learning curve when performing this surgery.

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Resident surgical training in the United States primarily focuses on cataract surgery, with less emphasis on glaucoma tube shunts and filtering procedures. Mean phacoemulsification surgeries performed by residents in the Accreditation Council for Graduate Medical Education accredited centers in 2014–2015 were 173.6 cases, while mean glaucoma procedures performed by residents were 4.5 for filtering procedures and 6.7 for tube shunt surgeries.<sup>[3]</sup> The lack of emphasis on glaucoma surgery may be due to the expected complexity of tube shunt implantation and variability in the postoperative course. However, unlike Baerveldt implant surgery, AGV surgery

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does not require placement of the plate under the rectus muscles, insertion of a ripcord suture, occlusion with a ligating suture, and thus may require fewer surgical maneuvers. For these reasons, along with its proven efficacy, the AGV may be the ideal tube surgery for resident teaching.<sup>[4,5]</sup>

Given the rising numbers of glaucoma worldwide,<sup>[6]</sup> it is crucial that current ophthalmology residents become well-versed in performing glaucoma surgery and managing patients postoperatively. Prior studies have evaluated resident-performed AGV surgeries,<sup>[7-9]</sup> but have not compared outcomes of resident-performed AGV surgeries with those performed by attending physicians. The purpose of this study was to compare the short-term success and early postoperative complication rates of AGV surgery performed by residents and attending physicians.

## Methods

This retrospective case-control study was approved by the Institutional Review Board of Wills Eye Hospital (#19-857E). Chart review was performed on consecutive cases of standalone AGV model FP7 implantation between January 2014 and July 2017. Informed consent was waived because of the retrospective nature of the study.

All patients underwent classic fornix-based conjunctival peritomy AGV implantation with anterior chamber tube placement as described by Coleman *et al.*<sup>[10]</sup> Topical antibiotics were used four times a day for 1 week and topical steroids were used four times a day for 1 week, followed by a taper. Patients were classified into two groups based on primary surgeon: the resident group and the attending physician group. All resident cases performed by second or 3<sup>rd</sup>-year ophthalmology residents and all surgeries were assisted by the fellowship-trained attending physicians. Inclusion criteria included at least 3 months of postoperative follow-up and complete documentation (including attending attestation at all visits). A randomly selected equal number of surgeries performed by fellowship-trained attending physicians during the same period were included. If both eyes of the patients were eligible, only one eye was randomly included in the study.

Demographic, preoperative, and postoperative clinical information was collected from the electronic medical record. Postoperative visit data were gathered from day 1, week 1, and months 1, 3, 6, and 12 after surgery. The following information was recorded at each visit: visual acuity (VA), IOP, and complications. VA was expressed in logarithm of the minimum angle of resolution units. Glaucoma medications were recorded at postoperative

months 3, 6, and 12. Additionally, the number of visits within 3 months after surgery were recorded.

Hypotony was defined as IOP <6 mmHg detected 3 months or later after the surgery. Shallow anterior chamber was defined as grade 1 (peripheral iridocorneal touch) grade 2 (iris pupillary border corneal touch), and grade 3 (lens or vitreous touch with the cornea).

## Statistical analysis

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) for Windows version 24.0 (SPSS, Inc., Chicago, IL, USA). For continuous variables with a normal distribution, the independent sample *t*-tests were used, and the Mann-Whitney test was used for nonparametric variables. Chi-square and Fisher's exact tests were used for categorical variables.  $P < 0.05$  was considered statistically significant.

## Results

One hundred and forty-four eyes of 144 patients were included in this study: 72 patients in the resident group, and 72 age- and sex-matched patients in the attending group. The mean follow-up was  $8.33 \pm 3.64$  (range = 3–12) months in the resident group and  $8.04 \pm 3.73$  (range = 3–12) months in attending group. There were no statistically significant differences in baseline demographics and characteristics between the groups except for race and glaucoma type [Table 1]. African-American descent was more common in the resident than the attending group (59.7% vs. 19.4%, respectively;  $P < 0.001$ ). Neovascular glaucoma (NVG) and primary open-angle glaucoma (POAG) were the most common glaucoma types in the resident group (30.6% for both), while 50% of patients had POAG in the attending group and only 1.4% had NVG ( $P < 0.001$ ).

Baseline and postoperative VA, IOP, and the number of glaucoma medications are shown in Table 2. While the mean baseline VA was lower in the resident than the attending group ( $P = 0.03$ ), this difference was not present at any postoperative follow-up visit ( $P \geq 0.05$  for all). Baseline mean IOP was higher in the resident than the attending group ( $31.2 \pm 12.4$  mmHg vs.  $25.4 \pm 8.9$  mmHg;  $P = 0.002$ ), but this difference was not observed at any postoperative follow-up visit ( $P > 0.05$  for all). The mean baseline number of glaucoma medications was higher in the resident group than the attending group ( $3.3 \pm 1.1$  vs.  $2.9 \pm 1.2$ , respectively;  $P = 0.02$ ). There was no significant difference between the groups for the number of glaucoma medications at all postoperative follow-up visits. Trends of VA and IOP over time are demonstrated in Figure 1a and b, respectively.

**Table 1: Demographic factors and type of glaucoma in resident- and attending-performed surgery groups**

	Resident group (n=72 patients), n (%)	Attending group (n=72 patients), n (%)	P
Age (years)*	64.4±16.5	71.1±15.6	0.01
Sex†			
Male	39 (54.2)	38 (52.8)	0.88
Female	33 (45.8)	34 (47.2)	
Race†			
White	10 (13.9)	36 (50.0)	<0.001
African American	43 (59.7)	14 (19.4)	
Hispanic	4 (5.6)	1 (1.4)	
Asian	2 (2.8)	2 (2.8)	
Others/not reported	13 (18.0)	19 (26.4)	
Missing data	0	5 (6.9)	
Glaucoma type†			
Primary open-angle	22 (30.6)	40 (55.6)	<0.001
Chronic angle-closure	12 (16.6)	15 (20.8)	
Pseudoexfoliative	0	2 (2.8)	
Pigmentary	0	1 (1.4)	
Neovascular	22 (30.6)	1 (1.4)	
Uveitic	10 (13.9)	5 (6.9)	
Others	6 (8.3)	8 (11.1)	
Lens status†			
Phakic	29 (40.2)	19 (26.4)	0.21
Pseudophakic	40 (55.6)	49 (68.0)	
Aphakic	3 (4.2)	2 (2.8)	
Missing data	0	2 (2.8)	

\*The values are presented in mean±SD, †The values reported in parentheses are percentages. SD: Standard deviation

**Table 2: Visual acuity, intraocular pressure, and the number of glaucoma medications following Ahmed glaucoma valve implantation in resident- and attending-performed surgery groups**

	Mean±SD		P
	Resident group	Attending group	
Visual acuity LogMAR			
Preoperative (n=72/72)	0.98±0.83	0.71±0.77	0.03
Day-1 (n=70/71)	1.10±0.78	0.88±0.80	0.09
Week-1 (n=72/71)	1.06±0.77	0.80±0.80	0.05
Month-1 (n=71/72)	0.93±0.76	0.78±0.75	0.24
Month-3 (n=72/72)	0.91±0.81	0.71±0.78	0.13
Month-6 (n=61/59)	0.90±0.84	0.65±0.72	0.09
Month-12 (n=40/36)	0.82±0.83	0.86±0.82	0.85
Intraocular pressure (mmHg)			
Preoperative (n=72/72)	31.2±12.4	25.4±8.9	0.002
Day-1 (n=70/71)	10.5±5.5	9.2±5.4	0.16
Week-1 (n=72/71)	11.7±7.3	12.4±5.7	0.43
Month-1 (n=71/72)	15.7±4.6	15.5±4.5	0.82
Month-3 (n=72/72)	14.8±4.3	14.1±3.6	0.25
Month-6 (n=61/59)	14.2±4.3	14.5±4.9	0.74
Month-12 (n=40/36)	15.9±7.9	15.6±5.0	0.80
Glaucoma medication			
Preoperative (n=72/72)	3.3±1.1	2.9±1.2	0.02
Month-3 (n=72/72)	2.1±1.2	2.4±1.3	0.09
Month-6 (n=61/59)	2.2±1.3	2.5±1.2	0.20
Month-12 (n=40/36)	2.5±1.4	2.5±1.2	0.91

LogMAR: Logarithm of the minimum angle of resolution, SD: Standard deviation

Complications of the AGV implantation are shown in Table 3. Hyphema (25%) and shallow anterior chamber (19.4%) were significantly more common in the resident group than the attending group. The rates of these complications were lower in the attending group (hyphema 2.8%,  $P = 0.001$  and shallow anterior chamber 7.0%,  $P = 0.04$ ). Five patients in the attending group had grade 1 or 2 shallow anterior chamber and all resolved with medical therapy. Two of 14 shallow chambers in the resident group (2.7% of all patients in the resident group) were grade 3 and underwent anterior chamber reformation with viscoelastic agent. Corneal transplantation was not required in either group due to tube-cornea touch during the follow-up period. Three eyes in the resident group with persistent corneal edema and tube-cornea touch underwent tube revision with good visual outcomes requiring no further intervention. Four eyes in the resident group and one in the attending group with tube-cornea touch were managed conservatively as their vision remained stable, and patients were asymptomatic. One patient with choroidal effusion underwent choroidal effusion drainage surgery, and the other patient improved with medical therapy. None of the patients who experienced diplopia needed surgical intervention.

The mean number of postoperative visits was 6.1 in the resident versus 6.2 in the attending group ( $P = 0.84$ ) in the first 3 months after surgery.

## Discussion

This case-control study demonstrated that IOP, VA, and the number of glaucoma medications in resident-performed AGV surgery was similar to that of attending-performed surgery. However, a higher rate of postoperative complications including hyphema and shallow anterior chamber was significantly more common in the resident surgery group. Similar to previous studies, proportions of African American patients<sup>[11,12]</sup> and NVG<sup>[9]</sup> were higher in the resident surgery group.

Resident cases had higher preoperative IOP than attending cases, yet had similar postoperative outcomes, highlighting the ability of residents to successfully carry out this procedure despite challenging baseline circumstances. In resident cases, mean IOP decreased

from  $31.2 \pm 12.4$  mmHg to  $10.5 \pm 5.5$  mmHg on postoperative day 1 and remained below 16 mmHg at all visits through postoperative month 12. Similar results were also observed in the attending group in our study; the mean IOP was  $9.2 \pm 5.43$  mmHg at day 1 visit and remained below 16 mmHg at all visits through postoperative month 12. These findings agree with that of Desai *et al.*, in which resident-performed AGV surgery led to a decrease in mean IOP from  $30.8 \pm 11.3$  mmHg to  $15.3 \pm 11.6$  mmHg over a mean follow-up period of  $34.7 \pm 30.5$  months ( $P < 0.001$ ).<sup>[7]</sup> Another study reported an IOP decrease from  $28.8 \pm 9.4$  mmHg to  $15.5 \pm 7.6$  mmHg following resident-performed AGV surgery at the 3 month postoperative follow-up time point.<sup>[8]</sup> Our results and those of the cited studies demonstrate that desired IOP reduction can be achieved following resident-performed AGV surgeries.

Resident-performed AGV surgery resulted in significantly higher hyphema and shallow anterior chamber rates in our study. The literature describes shallowing of the anterior chamber angle configuration as a prominent feature of NVG<sup>[13,14]</sup> and higher rates of hyphema are seen following the tube shunt surgery of NVG cases, as decompression of the eye can lead to bleeding.<sup>[15-17]</sup> The higher frequency of hyphema and shallow anterior chamber was likely linked to the predominance of complex glaucoma as evidenced by high proportion of NVG and higher preoperative IOP in the resident group as compared to attending group. The literature describes variable complication rates were reported following resident-performed AGV surgery.<sup>[8,9]</sup> Hsia *et al.* reported that the most common complications following resident-performed AGV surgery were choroidal effusion (41%), hypotony (18%), and flat anterior chamber requiring reformation (6.6%), all of which were higher than rates in the present study.<sup>[8]</sup> The rate of hyphema was lower than our study at 4.9%,<sup>[8]</sup> which may be related to the lower proportion of NVG cases (8% in Hsia *et al.* vs. 30.6% in the present study).<sup>[8]</sup> In another study, Sharpe *et al.* reported that 55% of patients had hyphema within the first postoperative week, and 26% of patients had choroidal effusion between months

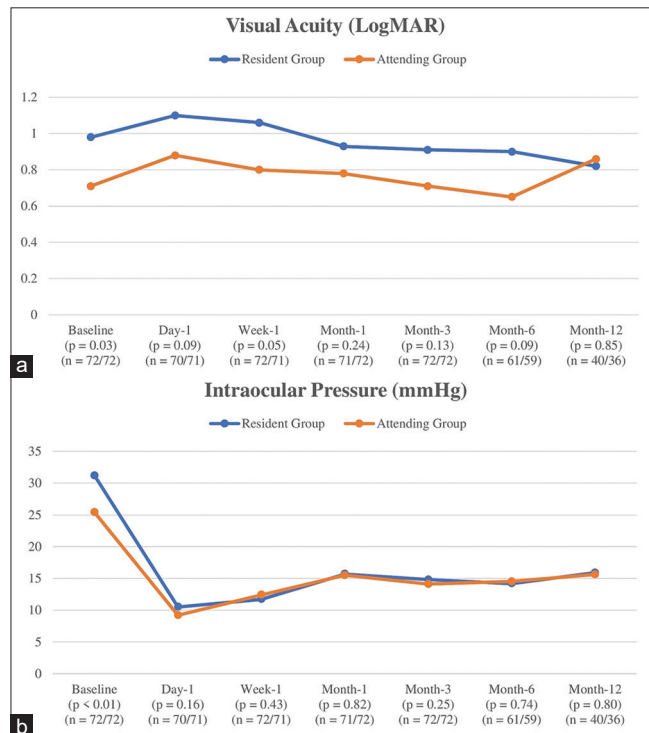


Figure 1: Visual acuity (a) and intraocular pressure (b) profile over time following Ahmed glaucoma valve surgery in the resident and attending groups

Table 3: Postoperative complications of Ahmed glaucoma valve implantation in resident- and attending-performed surgery groups

Complications	Resident group (n=72 patients), n (%)	Attending group (n=72 patients), n (%)	P
Hyphema	18 (25.0)	2 (2.8)	0.001
Shallow anterior chamber	14 (19.4)	5 (7.0)	0.04
Tube-cornea touch	7 (9.7)	1 (1.4)	0.06
Choroidal effusion	2 (2.8)	0	0.49
Diplopia	2 (2.8)	0	0.49
Bleb leak	1 (1.4)	0	1.00
Conjunctival wound dehiscence	1 (1.4)	4 (5.6)	0.36
Encapsulated bleb	2 (2.8)	0	0.49
Hypotony	1 (1.4)	1 (1.4)	1.00

1 and 3, both of which were higher than rates seen in our study.<sup>[9]</sup> Similar to the present study, the proportion of NVG cases was high (41%), which may explain the higher rates of hyphema seen in both studies. Accordingly, we can theorize that differences in baseline characteristics among varying patient populations may account for the variability in types of complications.

Despite the higher rate of complications in the resident group, the number of visits during the first 3 months was similar in both groups. Although visits during the first three postoperative months are included in the surgical cost (during the “global period”), the need for additional visits incurs more costs to patients and the healthcare system. Data on the number of visits has not been reported in prior evaluations of postoperative costs to the academic institutions. Costs related to the operating room, such as hours of operating room utilization, have previously been included in the evaluation of cataract surgery costs in previous studies.<sup>[18,19]</sup> In addition to operating room related costs, we believe that the number of follow-up visits is also a valuable parameter for glaucoma surgery, which requires several more follow-up visits than cataract surgery.<sup>[20]</sup> The relative success of glaucoma surgery also has an impact on the frequency of follow-up visits. A future study including operating room costs, patient costs, postoperative interventions, and diagnostic tests in a cost calculation would provide valuable information.

Limitations of this study include the unequal distributions of glaucoma type and race between groups, which is partially due to its retrospective nature. A prospective study with a similar patient population could give us more accurate results in this regard.

## Conclusion

Although the resident performed cases had worse disease at baseline (evidenced by higher mean IOP, lower VA values, and higher number of medications), 12-month outcomes among resident AGV cases were similar to those of attending cases. Transient complications including hyphema and shallow anterior chamber were significantly higher in the resident group; these may be related to the higher percentage of NVG in this group. Including glaucoma procedures in the resident surgical experience enables the next generation of ophthalmologists to safely manage this complex disease.

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## Conflicts of interest

There are no conflicts of interest.

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