Effect of Ahmed Glaucoma Valve Implantation on Cataract Development in Phakic Eyes with Refractory Glaucoma

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ABSTRACT

Purpose: To evaluate the rates of surgical outcomes and cataract development and the time interval after Ahmed glaucoma valve (AGV) implantation surgery in phakic eyes.

Materials and Methods: A case series including 83 phakic eyes without cataracts that underwent AGV implantation for refractory glaucoma was analyzed retrospectively. The Kaplan-Meier analysis was applied according to the time interval between AGV implantation and phacoemulsification (PE), as well as surgical failure time. Surgical failure was defined as an intraocular pressure (IOP) of >21 mmHg at two consecutive visits or the requirement of additional IOP-reducing surgery, the presence of light perception loss, AGV explantation, or the diagnosis of phthisis bulbi.

Results: The mean age was 52.9±20.8 years. The mean follow-up time was 28.7±22.2 months. The mean preoperative IOP was 39.5±11 mmHg, which was reduced to 16.1±8 mmHg at the postoperative last visit. At the last visit, 55 eyes (66.2%) met the surgical success criteria. Twenty-one patients (25.3%) developed cataracts during the follow-up period, and the mean time interval from AGV implantation to PE was 11.57±8.29 months. The cumulative probability of clear lens continuation according to the time interval from AGV implantation to PE showed a survival time estimate of 66.8 months and a success probability of 64% at three years. The Kaplan-Meier analysis according to the surgical success criteria showed 67.6% success at three years.

Conclusions: AGV implantation in phakic eyes successfully reduced the IOP values and resulted in 64% cumulative probability of lens survival without cataract development at three years.

Keywords: Ahmed glaucoma valve, Cataract, Intraocular pressure, Phacoemulsification.

INTRODUCTION

Glaucoma drainage devices (GDDs) provide an effective reduction in intraocular pressure (IOP) and are widely used in eyes with refractory glaucoma.[1] They are usually preferred treatment options for eyes in which other filtrating procedures have failed or those that have a poor prognosis in the case of classical filtrating surgery.[2] The Ahmed glaucoma valve (AGV) is one of the most used GDDs worldwide.[3] It has a silicon tube, a silicon or polypropylene plate, and a valve mechanism.[4] With the aid of the valve mechanism, it provides an IOP of above 8 mmHg.[5] The plate is fixated to the sclera, mostly the superotemporal quadrant of the eye. After securing the plate, the anterior or posterior chamber tube positioning of the tube tip provides aqueous drainage to the subconjunctival space, as well as systemic circulation via the episcleral venous channels.

Although AGV is successful in reducing the IOP, it also presents with some complications, including early hypotony and choroidal detachment, hyphema, corneal decompensation, tube and plate exposure, plate encapsulation, and cataract formation.[6-9] Although the valve mechanism prevents over-filtration, the drainage around the tube entrance site may still lead to early postoperative hypotony. In phakic eyes, cataract development is one of the considerations when deciding on AGV implantation.

In the current study, we analyzed phakic eyes that underwent AGV implantation to determine surgical outcomes, the incidence of cataract formation, and the time interval from surgery to cataract development.

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MATERIALS AND METHODS

This study was approved by the local ethics committee and adhered to the rules of the Declaration of Helsinki. This retrospective cohort study investigated phakic eyes that underwent AGV implantation for refractory glaucoma of any etiologies. The files of patients who presented to the ophthalmology clinic of a tertiary center from January 2015 to December 2021 were reviewed retrospectively. Only patients with phakic eyes who had glaucoma of any etiology, were of any age, and had available files were included in the study. Patients who were followed up for less than six months and those with missing files or data were excluded.

Patient age, sex, type of glaucoma, number of previous ocular operations (including vitrectomy, intravitreal injections, keratoplasty, and transscleral cyclophotocoagulation), and ophthalmological examination notes, including best-corrected visual acuity (BCVA), IOP, and glaucoma medications, were recorded. The primary outcome measures were cataract development and cataract surgery time. The secondary outcome measures were IOP, glaucoma medication, BCVA, and surgical success, which was defined as an IOP of ≤21 mmHg and at least a 20% decrease in IOP without light perception loss, additional glaucoma surgery, or AGV explantation.

All the surgical procedures were performed by a single glaucoma surgeon (S.I.). Under subtenon or general anesthesia, a fornix-based approach was used, and the double-long scleral tunnel technique described by Kugu et al. was applied.[10] The AGV FP 7 (New World Medical, Rancho Cucamonga, CA, USA) model was used during surgery. Prior to implantation, all the AGV tubes were primed using a balanced salt solution. Before entering the anterior chamber, viscoelastic material was injected to prevent acute hypotonia, and the tube was implanted in the anterior chamber. The proximal side of the scleral tunnel was secured with two 10/0 nylon sutures to prevent postoperative hypotonia. Postoperative topical moxifloxacin eye drops were prescribed for two weeks, and topical prednisolone eye drops were prescribed for eight weeks.

Data were evaluated using the statistical package program of IBM SPSS Statistics Standard Concurrent User, v 26 (IBM Corp., Armonk, New York, USA). The two-way analysis of variance test was used in repeated measures to compare the changes in the IOP, BCVA, and glaucoma medication from the first to the last visit. The Kaplan-Meier survival analysis was applied according to failure time and the time interval from AGV implantation to phacoemulsification (PE) for the evaluation of surgical success and cataract development, respectively. Hazard ratios for glaucoma type and age were analyzed using the Cox proportional hazard model. A p-value of <0.05 was considered statistically significant.

RESULTS

Eighty-three phakic eyes of 83 patients with refractory glaucoma met the inclusion criteria. The mean age of the patients was 52.99±20.86 (1-86) years. The mean follow-up time was 28.7±22.2 months. Fifty-nine patients (71%) were male. Thirty-seven patients (44.5%) had diabetes mellitus, and 41 (49%) had systemic hypertension. Of the operated eyes, 33 (39.7%) were the right eyes of the patients. The type of glaucoma was neovascular glaucoma (NVG) in 44 (53%) patients, pseudoexfoliative glaucoma (PEXG) in 12 (14.4%), secondary glaucoma, including traumatic, post vitrectomy, and uveitic glaucoma in 12 (14.4%), primary open-angle glaucoma (POAG) in nine (10.8%), and congenital glaucoma (CG) in six (7.3%). The mean preoperative BCVA was 1.81±1.03 logMAR. Four eyes (4.8%) had no previous intraocular surgery, while the number of previous intraocular operations was one for 61 eyes (73.4%), two for 14 eyes (16.8%), and three for four eyes (4.8%) (Table 1).

The mean preoperative IOP was 39.5±11.2 mmHg, and the mean number of preoperative glaucoma medications used was 3.5±0.7. The IOP change curve according to the evaluation times is shown in Figure 1. The mean IOP at the last visit was 16.1±8.2 mmHg. At all control visits, there was a significant reduction in IOP (p=0.0001). The mean number of glaucoma medication at the last visit was 2.2±1.09, and there was a significant difference when compared to the preoperative value (p=0.001). The mean BCVA at the last visit was 2.05±1 logMAR, which was significantly different compared to the first visit (p=0.001).

During the follow-up, PE surgery was performed on 21 patients (25.3%), of whom 19 underwent PE alone, one underwent PE combined with penetrating keratoplasty, and one underwent PE combined with pars plana vitrectomy. The PE surgery was completed without any complications in 95.2% of the eyes that underwent this surgery. In one case, a posterior capsule rupture was noted, and the operation was completed without intraocular lens (IOL) implantation. Among the postoperative complications were corneal edema in four eyes and a fibrinous reaction in three eyes, which all recovered with medical treatment. IOL subluxation occurred in one eye. The mean time interval from AGV implantation to PE was 11.57±8.29 months. Figure 2 presents the Kaplan-Meier analysis

Table 1: *Demographic characteristics of the study population*	
Age (years)	52.99±20.86
DM, n (%)	37 (4.58)
HT, n (%)	41 (49.4)
Sex	
Male, n (%)	59 (71.08)
Female, n (%)	24 (28.92)
Laterality	
Right, n (%)	33 (39.76)
Left, n (%)	50 (60.24)
Glaucoma type	
CG, n (%)	6 (7.23)
NVG, n (%)	44 (53.01)
POAG, n (%)	9 (10.84)
PEXG, n (%)	12 (14.46)
Secondary glaucoma, n (%)	12 (14.46)
Preop intraocular surgery number	
0, n (%)	4 (4.82)
1, n (%)	61 (73.49)
2, n (%)	14 (16.87)
3, n (%)	4 (4.82)
Abbreviations: DM: diabetes mellitus, HT: hypertension, CG: congenital glaucoma, NVG: neovascular glaucoma, POAG: primary open-angle glaucoma, PEXG: pseudoexfoliative glaucoma, preop: preoperative	

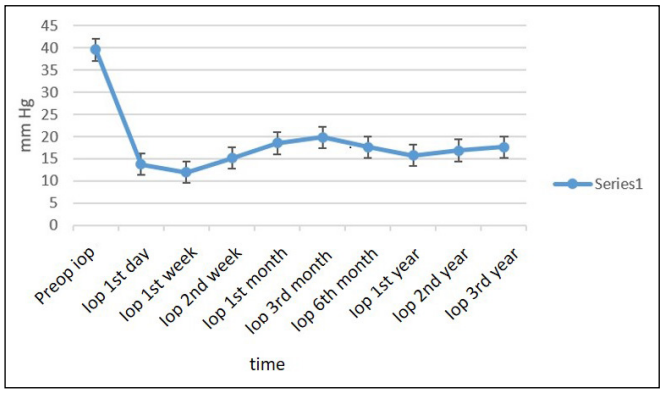

Figure 1: *Intraocular pressure change curve according to time*

according to the time interval from AGV implantation to PE. The cumulative probability of lens survival was found to be 91.3% at six months, 82.9% at one year, 69.4% at two years, and 64% at three years. The estimated mean survival time without cataract formation was 66.8 months. According to the Cox proportional hazard model, patient age and glaucoma type were non-significant for cataract development ($p > 0.05$).

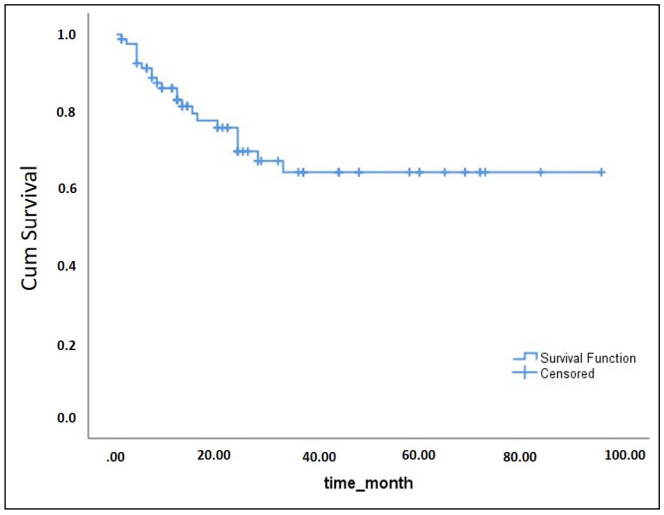

Figure 2: *Kaplan-Meier survival plot according to the time interval from Ahmed glaucoma valve implantation to phacoemulsification*

Fifty-five eyes (66.2%) met the success criteria at the last visit, whereas 28 did not (33%). Failures were due to a lack of IOP control in 11 eyes (39%), surgical explantation of AGV in two eyes (7%), visual loss in seven eyes (25%), and both a lack of IOP control and visual loss in eight eyes (28.5%). The surgical success rates according to glaucoma type were 56.8% for NVG,100% for PEXG, 58.3% for secondary glaucoma, 77.7% for POAG, and 66.6% for CG.

The Kaplan-Meier survival plot according to our surgical success criteria is shown in Figure 3. The cumulative probability of success was found to be 92.5% at six months, 81.1% at one year, 75.2% at two years, and 67.6% at three years. The mean estimated survival time was determined to be 47.9 months.

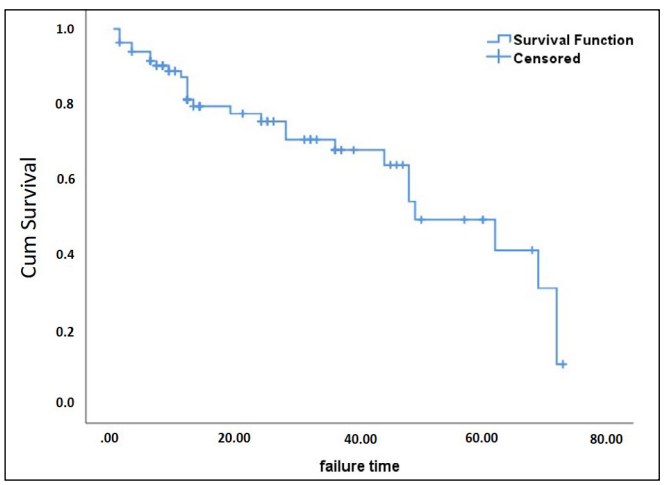

Figure 3: *Kaplan-Meier survival plot according to surgical failure time*

Among the early complications related to AGV implantation were hyphema observed in 27 patients (32.5%), choroidal detachment in seven (8.4%), and a narrow anterior chamber lasting more than a week in three (3.6%). The late complications included bullous keratopathy in three patients (3.6%) and tube exposure in three patients (3.6%). In the latter group, AGV explantation was performed on two patients and donor scleral patch graft repair on one. In addition, one patient developed phthisis bulbi during the follow-up.

DISCUSSION

Although both glaucoma and cataract are diseases that impair visual acuity, glaucoma has a permanent effect and leads to visual field loss through irreversible nerve fiber damage. Cataract development is one of the complications after tube implant surgery.[6] Cataract development after AGV implantation may not be directly related to the surgery itself, and intraoperative surgical damage to the crystalline lens, postoperative inflammation, changed aqueous composition by the increased drainage through the tube, a narrow anterior chamber or the corneal-lenticular touch postoperatively are factors that can contribute to cataract development. Since the crystalline lens does not have a blood supply, the changes in aqueous humor composition after tube surgery due to increased drainage may affect the lens metabolism and lead to cataract development. In the tube versus trabeculectomy study,[11] factors associated with cataract progression were analyzed, and no relationship was found between the presence of any intraoperative complication and cataract progression. In the same report, postoperative anterior chamber shallowing was determined to be the only surgical complication that independently predicted cataract progression according to the multivariate logistic regression model ($p = 0.008$).

In the current study, we focused on phakic eyes that had undergone AGV implantation. In our sample, 21 eyes (23.5%) developed cataracts after AGV implantation within a mean follow-up of 28.7±22.2 months. The mean interval between AGV implantation and PE was 11.57±8.29 months. Glaucoma type and patient age may be contributing factors for cataract development. Since aging is the most important risk factor for cataract development, the cataract rates are probably higher in elderly patients compared to the younger population. Some glaucoma types are also known to be associated more often with cataracts like NVG and PEXG.[12,13] Therefore, we analyzed patient age and glaucoma type using the Cox proportional hazard analysis for cataract development. However, we did not detect any significant hazard ratio for either variable.

In our study, the intraoperative and postoperative complications of PE surgery in AGV-implanted eyes were not different from those of routine PE surgery. We determined PE surgery to be safe for eyes with AGV. We observed posterior capsule rupture and vitreous loss in one eye (4.7%). We also detected corneal edema and fibrinoid reaction, which were both resolved with medical treatment. However, there are some reports concerning the effect of PE surgery on AGV function. Bhattacharyya et al.[14] reported the outcomes of cataract surgery in glaucomatous eyes with various functioning tube shunts followed up for 21 months and found that three eyes (27%) developed irreversible corneal edema and one eye (9%) lost IOP control. In a brief report by Gujral et al.[15], explaining the outcomes of small-incision PE in 23 eyes with functioning AGV, two eyes (9%) developed irreversible corneal edema, the IOP increased in two eyes (9%), and one eye (4%) required repeat glaucoma surgery, although the mean IOP after PE remained unchanged. The authors also noted that the median interval between AGV surgery and PE was 0.7 years over a mean follow-up of 1.6 years. Erie et al.[16] reported the results of PE in nine glaucomatous eyes in which Baerveldt tube shunts were used and concluded that in most cases, PE with a functioning Baerveldt tube shunt improved vision and maintained the control of IOP.

In our study, the rates of surgical success and encountered complications, glaucoma medications, and vision changes were consistent with the literature. At the last visit, our success rate was 66.2%, the mean number of glaucoma medications decreased from 3.5±0.7 to 2.2±1.09, the IOP decreased by 59%, and the mean BCVA changed from 1.81±1.03 to 2.05±1.05 logMAR. In the Ahmed versus Bearveldt (AVB) study, [3] which is a pivotal prospective multicenter study, the AGV success rate was reported to be 51% at five years. The authors determined that the mean IOP reduction was 49%, and the mean number of glaucoma medications decreased from 3.3±1.1 preoperatively to 1.9±1.5 at five years. In the same study, visual acuity worsened from 1.2±1.0 preoperatively to 1.5±1.2 at five years in the AGV group. We found that at the last visit, visual acuity decreased from the baseline. This is not surprising because the eyes in our study already had low vision levels and additionally had ocular pathologies with a progressive nature, such as proliferative diabetic retinopathy.

There are some limitations to our study. The study group comprised heterogeneous subjects in terms of their etiologies and ages. The mean follow-up time was 28.72±22.28 months, and the level of lens sclerosis before AGV implantation was probably not similar among the

patients. We also did not analyze the correlation between complications and cataract development due to the low sample size for each complication. Our study population was composed of different glaucoma types, each with a different prognosis after AGV implantation. We also did not compare the cataract development and surgical success rates according to glaucoma etiologies due to the small and unequal size of different etiology groups. Prospective studies with a larger number of patients investigating quantitative measurements of lens sclerosis are needed to further elucidate the effect of AGV implantation on cataract development.

In conclusion, in this study, we determined the cataract development rate after AGV implantation to be 23.5% at a mean follow-up of 28.7 months. Using the Kaplan-Meier analysis, the estimated cumulative lens survival time was found to be 66.8 months. The three-year lens survival probability was calculated to be 64%. As with other all ocular operations, AGV implantation has a specific efficacy, safety, and risk profile. Before AGV implantation into phakic eyes, patients should be informed about the associated risks and the possibility of further surgery requirements.

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