ORIGINAL RESEARCH

Evaluation of the Hypertensive Phase after Ahmed Glaucoma Valve Implantation in Neovascular Glaucoma

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Abstract

Purpose: To compare Ahmed glaucoma valve (AGV) outcomes in neovascular glaucoma (NVG) eyes with and without a postoperative (PO) hypertensive (HTN) phase.

Design: Retrospective study at a single tertiary care center of patients who underwent AGV implantation for NVG treatment with ≥6-month follow-up.

Methods: Main outcome measures included intraocular pressure (IOP), number of glaucoma medications (GM), and failure at month 6 or at the most recent visit. Failure was defined as decline to no light perception (NLP) vision, IOP >21 mm Hg, or need for glaucoma reoperations (all with GM).

Results: A total of 76 eyes of 74 patients (37 without HTN phase and 39 with HTN phase) with a mean follow-up duration of 28.9 ± 25.7 months ($p = 0.602$) were included. Both groups had similar demographics, visual acuity (VA), number of GM, etiology of NVG, and retina treatment perioperatively. Baseline IOP was significantly higher in the HTN phase group ($p = 0.001$). Compared to eyes without an HTN phase, HTN phase eyes more commonly met failure criteria at month 6 (33.3 vs 9.1%; $p = 0.01$), but both groups had a comparable cumulative failure for the entire follow-up period ($p = 0.180$). At the most recent visit, the number of GM was higher in the HTN phase group ($p = 0.019$), but IOP was similar in both groups. PO complications were comparable and uncommon in both groups.

Conclusion: Hypertensive (HTN) phase following AGV implantation for NVG is associated with higher preoperative IOP and greater failure by PO month (POM) 6. However, eyes with and without the HTN phase had similar needs for GM and failure rates over the long term.

Keywords: Ahmed glaucoma valve, Hypertensive phase, Intraocular pressure, Neovascular glaucoma.

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Introduction

Neovascular glaucoma (NVG) is a disease known to lead to significant vision loss.[1] Central retinal vein occlusion and diabetic retinopathy are common causes of NVG, as it is often caused by underlying retinal ischemia.[1] The pathogenesis of NVG is thus thought to be related to high intraocular vascular endothelial growth factor (VEGF) levels, giving rise to vascular proliferation that ultimately contributes to secondary angle closure[2]; other molecular underpinnings have also been implicated.[2] In the United States of America, the prevalence of NVG is estimated to be about 3.9% of all glaucomas.[2] As the elderly population increases and the incidence of diabetes continue to rise, that of NVG will likely rise as well.[3]

Treatment of NVG is dually directed at both suppressing the underlying ischemic process (e.g., diabetes) and controlling intraocular pressure (IOP).[2] The former includes measures such as pan-retinal photocoagulation (PRP) or intravitreal injection of VEGF inhibitors.[2] The latter takes the form of medical or surgical management of glaucoma. IOP management is challenging as a medical treatment has been correlated with poor response,[2] and surgery can be complicated by high failure rates.[4] Glaucoma drainage implants (GDI) are typically the preferred surgical treatment, as conventional trabeculectomy has minimal success in the context of active neovascularization, and cyclophotocoagulation (CPC) can lead to a decline in vision.[2]

The Ahmed glaucoma valve (AGV) tends to be the glaucoma drainage implant of choice for NVG, as its unidirectional valve has demonstrated immediate and predictable IOP lowering.[5] A known complication of AGV placement is a hypertensive (HTN) phase, which has previously been defined as an IOP of >21 mm Hg within 3 months after its implantation.[6] Perioperative methods (e.g., early initiation of aqueous suppressants,[5] subconjunctival injections of mitomycin C,[7] digital ocular massages,[8] and intraoperative sub-Tenon's triamcinolone acetonide[9]) have been attempted to decrease HTN phase frequency.[4,10–14] Although the characteristics

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of the HTN phase have been described,[4,15–19] this study aims to understand surgical outcomes in NVG eyes with and without an HTN phase following AGV surgery.

Patients and Methods

Study Design

This was a retrospective study from a tertiary care center reviewed by the Wills Eye Hospital Institutional Review Board and found to be in line with Health Insurance Portability and Accountability Act regulations. Notably, as this was a retrospective study without identifiable data, informed consent was waived. The medical records of patients at our hospital who were diagnosed in the 12-year range between 2007 and 2019 with NVG and implanted with the AGV were reviewed. NVG diagnosis was defined as the presence of both neovascularization of the iris (and/or anterior chamber (AC)) and IOP of >21 mm Hg. HTN phase was defined as IOP of >21 mm Hg at any visit in the first 3 months following surgery. No external funding was obtained for this study. Of note, these study designs and methods were previously described in our prior study (Shalaby et al., 2020). In addition, this retrospective cohort study adheres to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist for observational studies.[20]

Inclusion and Exclusion Criteria

Patients aged over 18 with NVG resistant to medical treatment and preoperative IOP of >21 mm Hg were included in the study. Exclusion criteria included: no light perception (NLP) vision at baseline, history of glaucoma drainage device implantation or CPC, follow-up duration of <6 months, and concomitant phacoemulsification with glaucoma drainage device placement. Patients were not excluded from prior trabeculectomy or other nonglaucoma surgeries, including vitreoretinal and cataract surgeries.

Patient Visits

Electronic medical records from seven total visits (baseline preoperative visit in addition to postoperative (PO) day 1, week 1, months 1, 3, 6, and the most recent visit) were reviewed. Demographic data were collected, including gender, age, and race; medical and surgical history were also recorded. Preoperative clinical data included visual acuity (VA), IOP, systemic acetazolamide use, and the number of glaucoma medications (GM). Baseline neovascular disease data (prior to AGV implantation) were identified, including etiology and laterality of NVG, retinal treatment with PRP or anti-VEGF intravitreal injection (within 2 weeks of surgery), and prior vitrectomy. PO data included VA, IOP, number of GM, PO complications, and additional glaucoma surgery.

Surgical Procedure

A total of 12 surgeons participated in this study. In each procedure, the sclera was exposed at 8–10 mm posterior to the limbus. The AGV was primed with a sterile, intraocular irrigating solution, and the plate was inserted. After the tube was trimmed, it was placed through a scleral tunnel covered with a patch graft (typically irradiated cornea, sclera, or pericardium). At this point, the conjunctiva was secured with absorbable suture after being reapproximated to the limbus. Finally, a paracentesis was created; depending on surgeon preference, a viscoelastic was sometimes left in the AC.

Outcome Measures

Surgical failure (defined as one of five outcomes: IOP of >21 mm Hg with GM, <5 mm Hg at two successive visits, need for AGV removal, need for glaucoma reoperation or new finding of NLP vision) was the primary outcome measure in the HTN and non-HTN groups at two time points [PO month (POM) 6 and at the most recent visit]. Secondary outcome measures were VA, IOP, and GM (at POM 6 and at the most recent visit). We censored eyes from the analysis of subsequent visits if they, at any time point, reached failure criteria of either glaucoma reoperation or removal of the AGV implant.

Statistical Analysis

Statistical Package for the Social Sciences software version 27.0 (IBM Analytics, Chicago, Illinois, United States of America) was the primary tool used. Treatment groups were compared using two-sided student *t*-tests and Chi-squared tests, respectively. Same-group variables were compared using paired sample *t*-tests and McNemar tests. The cumulative surgical failure rates in HTN and non-HTN phase eyes were calculated using Kaplan-Meier survival analysis with log-rank tests. Significance was denoted for *p*-values <0.05. Patients and encounters with incomplete data were excluded from the analysis.

Results

Baseline Characteristics

Of the 76 eyes of 74 patients who met inclusion criteria, 39 eyes developed an HTN phase, and 37 eyes did not. Table 1 includes baseline patient characteristics. Both groups had comparable baseline demographics (including mean age, sex, and race) as well as underlying NVG etiology, bilaterality of the ischemic retinal pathology, baseline logMAR VA, glaucoma medication number, retinal treatment within 2 weeks of surgery, and prior or concomitant pars plana vitrectomy. HTN phase eyes had higher baseline IOP compared with the non-HTN phase eyes (46.2 ± 12.5 vs 36.9 ± 10.1 mm Hg; $p = 0.001$). The predominant causes of NVG in both groups were proliferative diabetic retinopathy (59.2%), retinal vein occlusion (27.6%) ($p = 0.390$), and retinal artery occlusion (3.9%).

Outcome Measures

Clinical outcomes at POM 6 and the most recent visit are displayed in Table 2.

Surgical Failure

At month 6, a total of 16 (21.1%) eyes met the failure criteria. The rate of failure was significantly higher in HTN phase eyes compared with non-HTN phase eyes (33.3 vs 8.1%; $p = 0.010$). Additionally, time to failure was significantly shorter in HTN phase eyes (2.3 ± 1.9 vs 6.0 ± 0.0 months; $p < 0.001$). Both groups failed for similar reasons ($p = 0.474$) and included elevated IOP of >21 mm Hg (nine eyes, 56.3%) followed by reoperation for glaucoma (four eyes, 24.9%) and progression to NLP vision (three eyes, 18.8%).

At the most recent visit (mean 28.9 ± 25.7 months), surgical failure increased to 44.7% (34 eyes) and remained higher in HTN phase eyes compared with the non-HTN phase eyes (53.8 vs 35.1%); however, this difference was not statistically significant ($p = 0.113$). Likewise, time for failure was similar between groups (24.8 ± 18.5 vs 27.6 ± 29.6 months; $p = 0.731$), and reasons for failure remained similar in both groups ($p = 0.237$). Those included elevated IOP of >21 mm Hg (nine eyes, 26.5%), reoperation for glaucoma (14 eyes, 41.2%), new finding of NLP vision (10 eyes, 29.4%), and tube removal (one eye 2.9%). Kaplan-Meier survival analysis comparing the cumulative surgical failure rate between HTN phase eyes and non-HTN phase eyes throughout the follow-up period showed no difference between the groups ($p = 0.180$) (Fig. 1).

Table 1: Baseline patient characteristics of the AGV eyes with and without hypertensive phase

	Non-HTN phase	*HTN phase*	*Total*	*p-value*
Number of eyes	37	39	76	
Number of patients	37	38	74*	
Age, years: M ± SD	65.5 ± 14.2	63.6 ± 13.8	64.6 ± 14.0	0.575$^{\otimes}$
Sex, females: *N* (%)	12 (32.4)	18 (48.6)	30 (40.5)	0.236$^{\chi}$
Surgical eye, right: *N* (%)	14 (37.8)	23 (59)	37 (48.7)	0.072$^{\chi}$
VA: LogMAR	1.8 ± 0.8	1.9 ± 0.7	1.8 ± 0.8	0.943$^{\otimes}$
IOP: mm Hg	36.9 ± 10.1	46.2 ± 12.5	41.7 ± 1.8	0.001$^{\otimes}$
Medication number	3.5 ± 0.9	3.3 ± 0.9	3.3 ± 0.9	0.923$^{\otimes}$
Follow-up duration: months	27.4 ± 22.3	30.5 ± 28.8	28.9 ± 25.7	0.602$^{\otimes}$
Race: *N* (%)				
				0.329$^{\chi}$
White	14 (37.8)	17 (45.9)	31 (41.9)	
Black	11 (29.7)	13 (35.1)	24 (32.4)	
Asian	4 (10.8)	0 (0.0)	4 (5.4)	
Hispanic	3 (8.1)	2 (5.4)	5 (6.8)	
Indian	1 (2.7)	0 (0.0)	1 (1.4)	
Unknown	4 (10.8)	5 (13.5)	9 (12.2)	
NVG etiology: *N* (%)				
				0.390$^{\chi}$
PDR	19 (51.4)	26 (66.7)	45 (59.2)	
CRVO	11 (29.7)	10 (25.6)	21 (27.6)	
CRAO	1 (2.7)	2 (5.1)	3 (3.9)	
OIS	1 (2.7)	0 (0.0)	1 (1.3)	
ROP	1 (2.7)	0 (0.0)	1 (1.3)	
Combined	4 (10.8)	1 (2.6)	5 (6.6)	
Vitrectomy: *N* (%)				
				0.699$^{\chi}$
None	32 (86.5)	36 (92.3)	68 (89.5)	
Prior vitrectomy	3 (8.1)	2 (5.1)	5 (6.6)	
Combined vitrectomy and Ahmed	2 (5.4)	1 (2.6)	3 (3.9)	
Other ocular histories: *N* (%)				
Bilateral retinal pathology: *N* (%)	18 (48.6)	26 (66.7)	34 (57.9)	0.163$^{\chi}$
Intravitreal injection: *N* (%)	28 (75.7)	30 (76.9)	58 (76.3)	1.000$^{\chi}$
Panretinal photocoagulation: *N* (%)	31 (83.8)	29 (74.4)	60 (78.9)	0.403$^{\chi}$

CRVO, central retinal vein occlusion; CRAO, central retinal artery occlusion; M, mean; NVG, neovascular glaucoma; OIS, ocular ischemic syndrome; PDR, proliferative diabetic retinopathy, ROP, retinopathy of prematurity; SD, standard deviation; *p*-values with a "⊗" were calculated with a student t-test; those with a "χ" were calculated with a Chi-squared test; bolded values denote statistical significance; *one patient had one hypertensive phase eye and one nonhypertensive phase eye

Intraocular Pressure (IOP)

Both study groups maintained a noticeable reduction of IOP at POM 6 and at the most recent visit. In HTN phase eyes, mean IOP decreased from 46.2 ± 12.5 mm Hg at baseline to 18.7 ± 6.6 mm Hg at 6 months ($p < 0.001$) and 16.8 ± 9.5 mm Hg at the most recent visit ($p < 0.001$). In non-HTN phase eyes, mean IOP decreased from 36.9 ± 10.1 mm Hg at baseline to 14.8 ± 4.9 mm Hg at 6 months ($p < 0.001$) and 14.9 ± 6.7 mm Hg at the most recent visit ($p < 0.001$). Between-group comparison (Fig. 2) demonstrated that the IOP was significantly higher in HTN phase eyes compared with non-HTN phase eyes at all PO visits in the first 6 months ($P < 0.05$ for all) except the PO day 1 visit. However, both groups achieved comparable IOP at the most recent visit (16.8 ± 9.5 vs 14.9 ± 6.7 mm Hg; $p = 0.198$).

Medical Therapy

In HTN phase eyes, the average number of GM decreased from 3.3 ± 0.9 at baseline to 2.5 ± 1.2 at 6 months ($p = 0.001$) and 2.9 ± 1.3 at the most recent visit ($p = 0.181$). In the non-HTN phase eyes, the average number of GM decreased from 3.5 ± 0.9 at baseline to 2.1 ± 1.2 at 6 months ($p < 0.001$) and 2.1 ± 1.5 at the most recent visit

Table 2A: Month 6

	Non-HTN phase	*HTN phase*	*Total*	*p-value*
VA: LogMAR	1.7 ± 0.9	1.9 ± 1.0	1.8 ± 1.0	0.415⊗
IOP: mm Hg	14.8 ± 4.9	18.7 ± 6.6	16.5 ± 6.	0.004⊗
Medication number	2.1 ± 1.2	2.5 ± 1.2	2.3 ± 1.2	0.201⊗
Surgical failure: *N* (%)	3 (8.1)	13 (33.3)	16 (21.1)	0.010χ
Reasons for failure: *N* (%)				
IOP of >21 mm Hg	1 (33.3)	8 (61.5)	9 (56.3)	0.474χ
Progression to NLP	1 (33.3)	2 (15.4)	3 (18.8)	
Glaucoma reoperation	1 (33.3)	3 (23.1)	4 (24.9)	
Time to failure: months	6.0 ± 0.0	2.3 ± 1.9	3.0 ± 2.3	<0.001⊗
Complications: *N* (%)				
Suprachoroidal hemorrhage	0 (0.0)	0 (0.0)	0 (0.0)	--
Tube erosions	0 (0.0)	4 (10.3)	4 (5.3)	0.116χ
Endophthalmitis	0 (0.0)	0 (0.0)	0 (0.0)	--
Glaucoma reoperation: *N* (%)	1 (2.7)	3 (7.7)	4 (5.3)	0.615χ

IOP, intraocular pressure; NLP, no light perception; *p*-values with a "⊗" were calculated with a student *t*-test; those with a "χ" were calculated with a Chi-squared test; bolded values denote statistical significance

Table 2B: Final visit

	Non-HTN phase	*HTN phase*	*Total*	*p-value*
VA: LogMAR	2.0 ± 1.0	2.2 ± 1.0	2.1 ± 1.0	0.457⊗
IOP: mm Hg	14.9 ± 6.7	16.8 ± 9.5	15.6 ± 8.1	0.198⊗
Medication number	2.1 ± 1.5	2.9 ± 1.3	2.6 ± 1.5	0.019⊗
Surgical failure: *N* (%)	13 (35.1)	21 (53.8)	34 (44.7)	0.113χ
Time to failure: months	27.6 ± 29.6	24.8 ± 18.5	25.9 ± 23.0	0.731⊗
Reasons for failure: *N* (%)				
IOP of >21 mm Hg	3 (23.1)	6 (28.6)	9 (26.5)	0.237χ
Progression to NLP	2 (15.4)	8 (38.1)	10 (29.4)	
Glaucoma reoperation	8 (61.5)	6 (28.6)	14 (41.2)	
Tube removal	0 (0.0)	1 (4.8)	1 (2.9)	
Glaucoma reoperation: *N* (%)				
CPC	7 (18.9)	2 (5.1)	9 (11.8)	0.128χ
Second tube	1 (2.7)	4 (10.3)	5 (6.6)	
Tube removal	0 (0.0)	1 (2.6)	1 (1.3)	

CPC, cyclophotocoagulation; IOP, intraocular pressure; NLP, no light perception; *p*-values with a "⊗" were calculated with a student *t*-test; those with a "χ" were calculated with a Chi-squares test; bolded values denote statistical significance

($p < 0.001$). Between-group comparison (Fig. 3) showed a comparable mean number of GM between the two groups in the first 6 months. However, HTN phase eyes required a higher number of GM to control IOP at the most recent visit compared with the non-HTN phase eyes (2.9 ± 1.3 vs 2.1 ± 1.5 mm Hg; $p = 0.019$).

Postoperative (PO) Complications

Both groups had comparable major PO complications at POM 6. Tube erosions occurred in 4 (10.3%) HTN phase eyes versus no eyes in the non-HTN phase group ($p = 0.116$). No eyes experienced PO endophthalmitis, suprachoroidal hemorrhage, or hypotony with maculopathy in either group through POM 6.

Reoperation for Glaucoma

At the most recent visit, a total of 15 (19.7%) eyes required additional glaucoma surgery with no difference between groups ($p = 0.128$). In the HTN phase group, four (10.3%) eyes required a second glaucoma drainage device, two (5.1%) eyes underwent CPC, and one (2.6%) eye required tube removal. In the non-HTN phase group, seven (18.9) eyes underwent CPC, while only one (2.7%) eye required a second glaucoma drainage device.

Discussion

Our study revealed preoperative IOP and surgical outcomes differ between NVG eyes that do and do not develop an HTN phase following AGV implantation. We found that HTN phase eyes were more likely to have higher preoperative IOP, develop surgical failure within the first 6 POMs, and require more GM in the longer term. Notably, in the longer term (entire follow-up duration, mean 28.9 ± 25.7 months), both the HTN phase eyes and the non-HTN phase eyes had similar IOP reduction and similar proportions of surgical failure. Our findings suggest that transient IOP rise in the early PO period after AGV surgery for NVG is not necessarily associated with

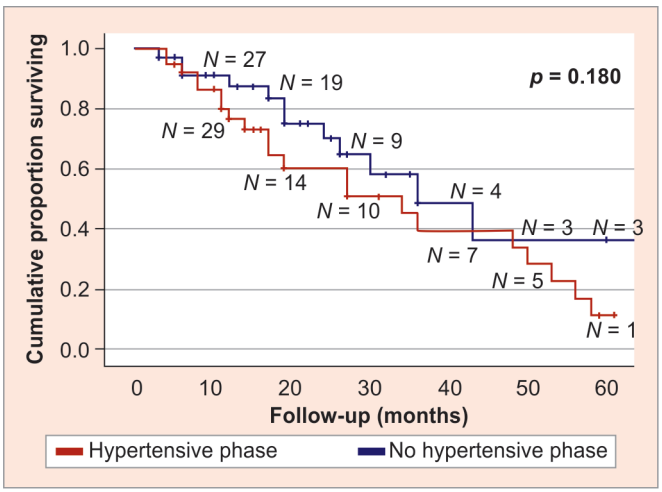

Fig. 1: Kaplan-Meier survival analysis comparing the cumulative rate of surgical failure between HTN and non-HTN phase eyes

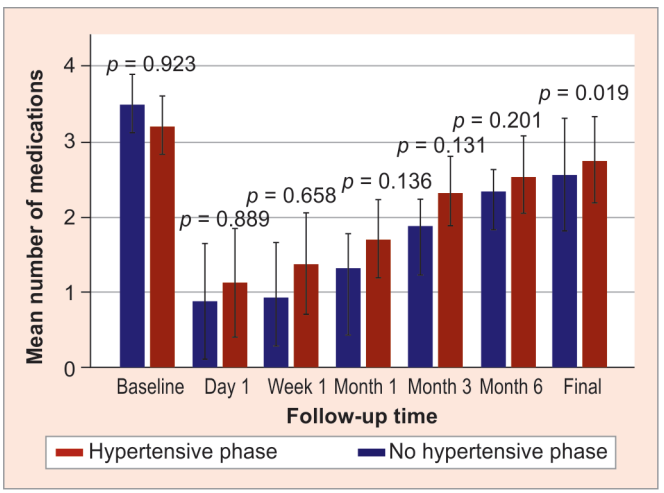

Fig. 3: Mean number of GMs in the PO period

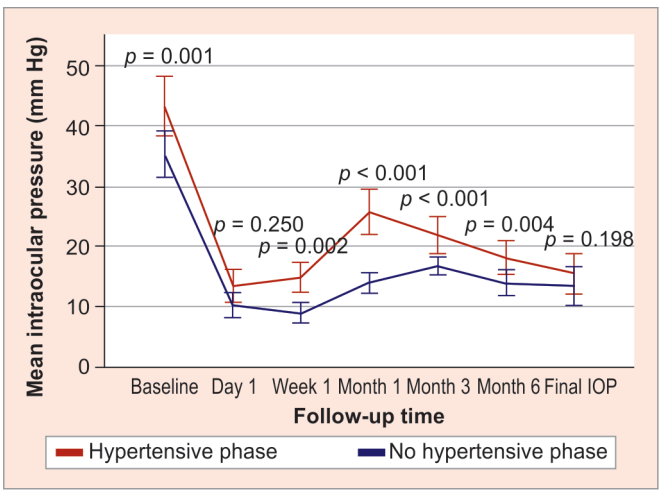

Fig. 2: Mean IOP in the PO period

worse outcomes in the long term. While the features of the HTN phase following AGV implantation have been described in the literature,[5,15,16] our study is novel in its report on a relatively sizeable cohort of eyes, specifically with NVG.

The features of the HTN phase following AGV implantation have been described in the literature in studies that have included all glaucoma types.[5,15,16] Nouri-Mahdavi et al.'s retrospective review of 156 consecutive eyes after AGV placement reported an incidence of HTN phase in 56% of eyes.[15] Similarly, a retrospective review by Won et al. on 325 eyes found an HTN phase incidence of 31.1%; other studies have described an incidence of up to 80%.[21,22,16] Our study's HTN phase incidence of 51% in NVG is in keeping with these prior studies on all-comers of glaucoma. Of note, in our study, mean age, sex, race, underlying NVG etiology, bilaterality of the ischemic retinal pathology, baseline logMAR VA, medication number, retinal treatment within 2 weeks of surgery, and history of pars plana vitrectomy were not associated with the development of an HTN phase. This is also consistent with previous literature aiming to determine underlying predictors of the HTN phase after AGV placement.

Won et al. reported that the mean preoperative IOP was considerably higher in the HTN group.[16] Our study found a similar pattern in which baseline IOP was significantly higher in HTN phase eyes compared to non-HTN phase eyes (46.2 ± 12.5 vs 36.9 ± 10.1 mm Hg; $p = 0.001$); thus, this relationship between preoperative IOP and the subsequent development of HTN phase is also present in NVG. Won et al. also report that IOP remained elevated in the HTN phase group as compared to the non-HTN phase group through the first 6 POMs; this relationship subsided by 1-year follow-up visit.[16] In a study of 61 eyes, Dubey et al. found that the HTN phase resolved by 6 months in 92.9% of patients.[23] Our study in NVG eyes corroborates this pattern, in which the IOP was significantly higher in the HTN phase eyes compared with non-HTN phase eyes at all PO visits in the first 6 months ($p < 0.05$ for all) with the exception of the PO 1-day visit. However, both non-HTN phase and HTN phase eyes experienced significant IOP reduction at POM 6 and the most recent visit. In the HTN phase eyes, mean IOP was reduced from 46.2 ± 12.5 mm Hg at baseline to 18.7 ± 6.6 mm Hg at 6 months ($p < 0.001$) and 16.8 ± 9.5 mm Hg at the most recent visit ($p < 0.001$). In the non-HTN phase eyes, mean IOP was reduced from 36.9 ± 10.1 mm Hg at baseline to 14.8 ± 4.9 mm Hg at 6 months ($p < 0.001$) and 14.9 ± 6.7 mm Hg at the most recent visit ($p < 0.001$). As with Won et al.'s 2016 study,[16] both of our groups ultimately achieved comparable IOP at the most recent visit (16.8 ± 9.5 vs 14.9 ± 6.7 mm Hg; $p = 0.198$). This implies that the pattern of a transient IOP increase with eventual resolution after AGV implantation is preserved among patients with NVG.

The present study defined surgical failure as IOP of >21 mm Hg, progression to NLP vision, or glaucoma reoperations at either the 6-month or most recent follow-up visits. At POM 6, a total of 16 (21.1%) eyes met the failure criteria; the failure rate was significantly higher in the HTN phase eyes as compared with the non-HTN phase eyes (33.3 vs 8.1%; $p = 0.010$). Reasons for failure were comparable in both groups ($p = 0.474$), including elevated IOP of >21 mm Hg (nine eyes, 56.3%), reoperation for glaucoma (four eyes, 24.9%), and progression to NLP vision (three eyes, 18.8%). However, Kaplan-Meier survival analysis comparing the cumulative surgical failure rates between HTN phase eyes and non-HTN phase eyes for the entire follow-up duration showed no significant difference between both groups ($p = 0.180$). Nouri-Mahdavi et al. reported glaucoma reoperation (including removal or replacement of GDI and penetrating keratoplasty) in nine eyes (5.7%) and progression to NLP vision in three eyes (1.9%).[15] Other studies

describing the HTN phase after AGV also report lower rates of surgical failure than in the present study.[24] This difference can perhaps be accounted for by the aggressive nature of NVG versus other causes of glaucoma.

In our study, HTN phase eyes required a higher number of GM to control IOP at the most recent visit compared with the non-HTN phase eyes (2.9 ± 1.3 vs 2.1 ± 1.5 mm Hg; $p = 0.019$). This is consistent with the Nouri-Mahdavi et al. study, in which eyes with an HTN phase required more GM up to a year after surgery than eyes without an HTN phase (1.7 ± 1.2 vs 0.3 ± 0.6 GM; $p < 0.001$).[15] However, Won et al. found a similar mean of GM use (1.21 vs 1.20) between HTN phase and non-HTN phase eyes.[16] These findings imply that regardless of glaucoma etiology, eyes with HTN phase eyes may require more GM. However, we found that this need for GM in the HTN phase group appeared to decrease over time. Of mention, it has been suggested in the literature that the type of glaucoma medication used immediately after AGV implantation (aqueous suppressants vs prostaglandins) could impact surgical outcomes[25,26]; one such study found that aqueous suppressants have demonstrated improved IOP control and higher success rates.[26] Our study did not delineate the type of GM used.

In the present study, major PO complications were similar in both groups at 6 months. Tube erosions occurred in four (10.3%) HTN phase eyes vs no eyes in the non-HTN phase group ($p = 0.116$). These are comparable to other studies in which erosion is a notable complication.[15,16] Nouri-Mahdavi et al. found choroidal detachment to be a major complication (12%),[15] but this was not found to be the case in our study.

Limitations

Our study is limited by its retrospective nature, which may have introduced information bias (data for all time points were not available for all of the patients) and selection bias in the type of tube used for NVG treatment. Still, patients in the HTN phase and non-HTN phase groups had comparable baseline characteristics, including mean age, sex, race, underlying NVG etiology, bilaterality of the ischemic retinal pathology, baseline LogMAR VA, medication number, retinal treatment within two weeks of surgery, and history of pars plana vitrectomy. Baseline IOP was higher in the HTN phase group, which could have confounded our analyses, as eyes with higher preoperative IOP may have had a greater propensity to higher PO IOPs. Furthermore, both eyes were included for only one patient, leading to a minimal anticipated impact on statistical analysis. Additionally, twelve surgeons were involved in this study, which could lead to minor differences in surgical technique; however, the overall surgical procedure used was consistent between the surgeons in the study. Further studies with our data can include a stratified analysis of surgeon outcomes in order to address technique-specific factors. In addition, it is possible that the HTN phase did not resolve within the 6-month period, making the IOP data from the longer-term follow-up period more meaningful. Finally, additional data collection to highlight other factors (such as the number of PRP sittings in the pre/PO period, specifics of anti-VEGF/steroid injections used, and the exact prior surgeries) may highlight further details regarding the HTN phase following AGV implantation in NVG.

Conclusion

In summary, our study demonstrated that HTN phase eyes had significantly higher preoperative IOP than non-HTN phase eyes. At the follow-up period's conclusion, both groups achieved comparable IOP, but the HTN phase eyes required more GM. By POM 6 following AGV implantation, HTN phase eyes with NVG failed more frequently compared to non-HTN phase eyes. Additionally, although causes for failure were similar in both groups, the time for failure was significantly shorter in the HTN phase eyes. Kaplan-Meier survival analysis comparing the cumulative surgical failure rate between HTN phase eyes and non-HTN phase eyes found no difference between the groups by the end of the follow-up duration. At the most recent visit, about 20% of eyes required additional glaucoma surgery, with no difference between both groups. Both groups had similar major PO complications. Overall, we find that while the post-AGV HTN phase in NVG may be more aggressive than the post-AGV HTN phase in other types of glaucoma, these eyes ultimately fare similarly to non-HTN phase eyes. Future studies and randomized control trials on NVG management might be helpful in better delineating these differences.

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