World Journal of Surgery and Surgical Research

Research Article
Published: 09 Aug, 2021

A Comparison of Two Treatments for Neovascular Glaucoma: Anterior Chamber Ahmed Valve with Panretinal Photocoagulation *vs.* Pars Plana Ahmed Valve with Vitrectomy and Endolaser

Bailey M Harrison[1#], Mohammad Yazdanie[2#], Sai Nimmagadda[1], Hamza Sadhra[1], Donald Harrington[3], Brent Johnson[3], Sana Idrees[2] and David A DiLoreto Jr[2,4*]

[1]University of Rochester School of Medicine and Dentistry, USA

[2]Department of Ophthalmology, Flaum Eye Institute, University of Rochester Medical Center, USA

[3]Department of Biostatistics, University of Rochester, USA

[4]Center for Visual Sciences, University of Rochester, USA

[#]Co-first authors Contributed

Abstract

Purpose: To compare the effect of two types of treatment for Neovascular Glaucoma (NVG): Anteriorly placed Ahmed Glaucoma Valve (aAGV) and Panretinal Photocoagulation (PRP) performed in the clinic to posteriorly placed Ahmed Glaucoma Valve (pAGV) with pars plana vitrectomy and panretinal photocoagulation performed *via* Endolaser (PPV/EL).

Methods: A retrospective chart review was performed for the diagnosis of neovascular glaucoma. Treatment types were reviewed and divided into two groups: Group 1 (aAGV/PRP) and group 2 (pAGV/PPV/EL). The outcome measures evaluated were Visual Acuity (VA, LogMAR) and intraocular pressure (IOP, mmHg) at 6 month and 1 year intervals post-treatment using the analysis of variance. Secondary outcomes included complications and number of procedures required post-operatively.

Results: Both groups consisted of 15 eyes in 15 patients. The adjusted change in VA between groups 1 and 2 was not statistically significant at 6 months (-0.28 ± 0.66 *vs.* -0.04 ± 0.60 logMAR, p=0.32) nor at 1 year (-0.40 + 0.72 *vs.* 0.12 + 0.68 *vs.* logMAR, p=0.10). The mean baseline IOP (43.0 ± 8.9 *vs.* 38.6 ± 6.6 mmHg) and VA (1.3 ± 0.8 *vs.* 1.4 ± 0.7 logMAR) were similar between groups 1 and 2. The adjusted change in IOP between groups 1 and 2 was not statistically significant at 6 months (-25.6 ± 9.5 *vs.* -20.5 ± 6.1 mmHg, p=0.11) nor at1 year (-27.9 ± 11.0 *vs.* -23.8 ± 10.3 mmHg, p=0.38). Complications and post-operative procedures were minimal and similar between the two groups except for the number of post-operative anti-VEGF injections required: 31 injections were required in group 1 post-operatively, and 16 injections were required in group 2 post-operatively (p=0.001).

Conclusion: aAGV/PRP and pAGV/PPV/EL were both effective in preserving vision and lowering IOP with no significant difference detected in VA or IOP outcomes between the two groups at the 6 months and 1 year follow-up intervals. There were no increased risks attributed to one treatment type *vs.* another. However, those undergoing aAGV/PRP required more post-operative anti-VEGF injections. While this is a small study, it does not support one treatment modality over another. Decision for neovascular glaucoma treatment type should continue to be based on the patient's condition, access to care, and type of subspecialty care available.

OPEN ACCESS

****Correspondence:***
David A DiLoreto Jr, Department of Ophthalmology, Flaum Eye Institute, University of Rochester Medical Center, 601 Elmwood Avenue, Box 659, Rochester NY 14642; USA, Tel: 5852751126; Fax: 5852731153; E-mail: david_diloreto@urmc.rochester.edu

Received Date: *13 Jul 2021*
Accepted Date: *04 Aug 2021*
Published Date: *09 Aug 2021*

Citation:
Harrison BM, Yazdanie M, Nimmagadda S, Sadhra H, Harrington D, Johnson B, et al. A Comparison of Two Treatments for Neovascular Glaucoma: Anterior Chamber Ahmed Valve with Panretinal Photocoagulation vs. Pars Plana Ahmed Valve with Vitrectomy and Endolaser. World J Surg Surgical Res. 2021; 4: 1323.

Introduction

Neovascular Glaucoma (NVG) is an aggressive form of glaucoma in which elevated Intraocular Pressure (IOP) develops secondary to neovascularization and fibrovascular tissue that blocks the trabecular meshwork due to posterior retinal hypoxia [1]. This can be caused by any disease process leading to retinal ischemia and hypoxia, including, but not limited to, diabetic retinopathy, Central Retinal Vein Occlusion (CRVO), Central Retinal Artery Occlusion (CRAO), and Ocular Ischemic Syndrome (OIS). The treatment of NVG involves treating the underlying cause of ischemia and controlling the IOP, as well as disruption of neovascularization [2]. Control of IOP can be achieved either with medical therapy or with surgical procedures that increase the outflow of aqueous humor. Treating the underlying condition involves laser ablation of the ischemic retinal tissue producing Vascular Endothelial Growth Factor (VEGF) or decreasing the concentration of VEGF with anti-VEGF intravitreal injections [1].

Surgery for lowering intraocular pressure in generally indicated if medications have failed or are likely to fail [3]. For open angle glaucoma that fails medical management, surgeons perform trabeculectomy (filtering surgery) before considering a tube shunt [3]. Trabeculectomies have a better chance of maintaining lower intraocular pressures but can take time to stabilize. However, in cases of neovascular glaucoma, trabeculectomy has poor outcomes due to surrounding neovascularization and inflammation leading to closure of the trabeculectomy site [4]. Tube shunts are used to decrease intraocular pressure by draining aqueous humor out of the eye into an external reservoir. These procedures have a more immediate effect than trabeculectomies and are less likely to fail from inflammation [5]. Ahmed Glaucoma Valve (AGV), a type of tube shunt, can be placed either in the anterior chamber or in the pars plana, with the latter necessitating a vitrectomy to prevent vitreous from occluding the tube of the AGV.

AGV placement in conjunction with PRP in the clinic (+/- anti-VEGF injections) is frequently used in the management of NVG. In these cases, the tube of the AGV is placed in the anterior chamber (aAGV). By using anti-VEGF injections to temporize the growth of neovascularization, Panretinal Photocoagulation (PRP) can then be performed before or after the placement of the AGV to permanently prevent further neovascularization.

AGV tubes may be placed posteriorly through the pars plana (pAGV) and are indicated in several settings over aAGV. In NVG, pars plana shunts are appropriate for patients who require a vitrectomy in addition to glaucoma surgery (e.g., limited view due to non-clearing vitreous hemorrhage) [6,7] or other reasons such as a limited view due to a small pupil, inability to return for frequent anti-VEGF injections or multiple laser sessions, previous corneal transplantation, or for avoiding the need to create an ostomy through neovascular/fibrovascular tissue in the angle. In these cases, PPV with endolaser and pars plana shunt may be performed.

aAGV and pAGV have been evaluated previously and both have been shown to effectively reduce IOP in a small retrospective analysis of glaucoma patients [8-11]. To our knowledge, comparison of the two IOP lowering procedures in management of NVG specifically has not been studied previously. Currently, the treatment choice for NVG is dictated by the patient's condition, access to care, and type of subspecialty care available at the time. We wondered if pAGV/PPV/EL might be a more effective treatment option since it treats the NVG in one session and there is the ability to provide a more comprehensive laser fill in the Operating Room (OR) than in the clinic. We were also interested to know if VA or IOP control was affected by the anterior of posterior placement of the tube of the AGV. This study retrospectively compared aAGV/PRP to pAGV/PPV/EL using two main outcome measures: VA and reduction in IOP. Secondary outcomes such as procedural complications and number of post-operative procedures required were also evaluated.

Methods

This study consisted of a retrospective review of clinical charts and surgical reports from one institution (Department of Ophthalmology, Flaum Eye Institute, and University of Rochester Medical Center). Data was collected between January 01st, 2010 and December 31st, 2020. ICD-9 and ICD-10 diagnosis codes were used to identify all patients with neovascular glaucoma in both paper charts and the electronic medical record. CPT codes were used to identify all patients (all ages and sexes) with neovascular glaucoma who underwent surgeries/procedures, including PRP, PPV, and AGV placement.

There were 48 AGV implants performed during this ten-year period in the setting of neovascular glaucoma. Those 48 cases were reviewed and divided into those that underwent aAGV/PRP (Group 1, n=17), those that underwent pAGV/PPV/EL (Group 2, n=20), and those that were treated in other ways (n=11). Those in groups 1 and 2 with documented visual acuities, intraocular pressures, as well as follow up intervals of at least at 6 ± 1 month were used in this study 11, leaving 15 patients in each group.

As part of the subject's medical history the following were obtained: Gender, age at time of surgery, and eye that surgery was performed. Pre-operative data that was collected included: Intraocular Pressure (IOP), number of glaucoma medications used, visual acuity (VA in Snellen and LogMAR), lens status (phakic, pseudophakic), etiology of neovascular glaucoma (diabetes, vein occlusion, ocular ischemic syndrome), and previous treatments (e.g. anti-VEGF injections, PRP, previous glaucoma surgery, previous vitrectomy).

Operative data that was collected included: Date(s) of surgery/procedures, surgeon specialty, position of the AGV tube (anterior or posterior), type of laser (PRP in clinic *vs.* endolaser in the OR), and PPV *vs.* no PPV. Post-operative outcomes included: VA (Snellen, LogMAR) and IOP. Other secondary measures included number of glaucoma drops used, number of anti-VEGF injections required, and number of laser sessions required. Postoperative complication data included: hypotony, hyphema, choroidal detachment, macular edema, vitreous hemorrhage, retinal tear, retinal detachment, endophthalmitis, and exposure of tube.

Results

Demographic and pre-operative data among Groups 1 and 2 were recorded (Table 1). Both groups consisted of 15 eyes of 15 patients. Only patients who had at least 6 months follow-up after surgery were included in the analysis. Eleven of 15 patients in group 1 and 11 of 15 patients in group 2 had documented 1 year follow-up. Three of 15 eyes were pseudophakic in group 1 and 11 of 15 eyes were pseudophakic in group 2. The mean baseline IOP (43.0 + 8.9 mmHg *vs.* 38.6 + 6.6)

Table 1: Demographic and preoperative data for both study groups.

	Group 1: aAGV/PRP	Group 2: pAGV/PPV/EL
Age (yrs, mean ± SD)	52.4 ± 11.2	67.0 ± 10.6
Sex (female, male)	9, 6	5, 10
Eye (right, left)	10, 5	7, 8
IOP (mmHg, mean ± SD)	43.0 ± 8.9	38.6 ± 6.6
Snellen VA (logMAR, mean ± SD)	1.3 ± 0.8	1.4± 0.7
Previous PRP	10	3
Previous Vitrectomy	3	2
Lens Status (phakic, IOL)	12, 3	4, 11
Etiology of NVG (PDR, CRVO, CRAO, OIS)	11, 1, 2, 1, 0	9, 5, 0, 0, 1

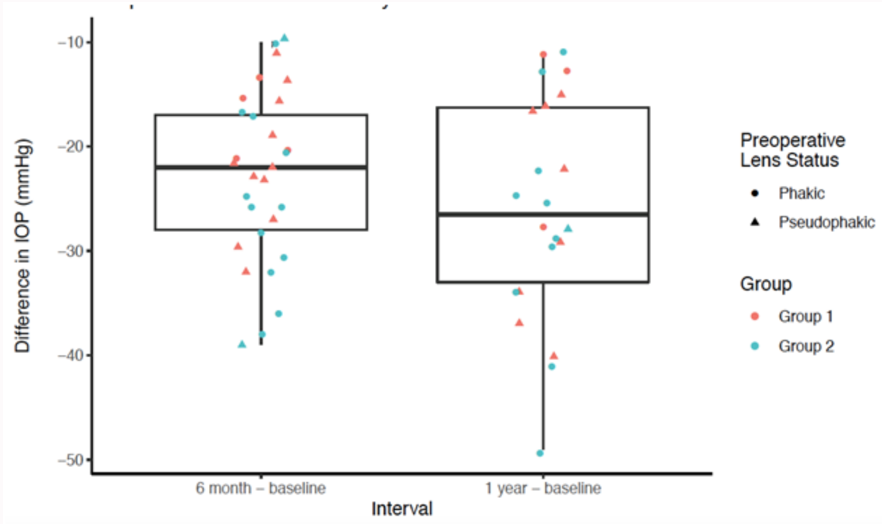

Figure 1: Intraocular pressure differences at follow-up compared to pre-operative baseline.

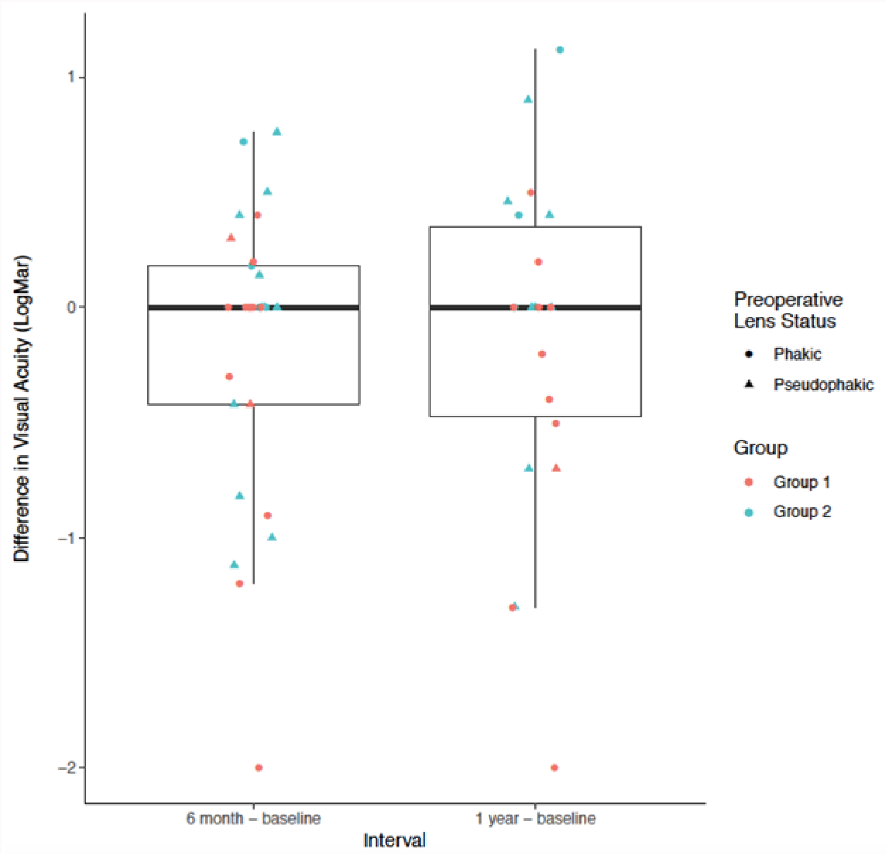

Figure 2: Differences in Visual Acuity at follow-up compared to pre-operative baseline.

and VA (1.3 + 0.8 *vs.* 1.4 + 0.7 LogMar) were similar between groups 1 and 2.

Operative data included type of tube shunt placed. All but one patient (who had an M4) in group 1 had FP7 AGVs placed and all patients in group 2 had FP7 AGVs placed.

The adjusted change in VA between groups 1 and 2 (Figure 1) was not statistically significant at 6 months (-0.04 + 0.60 *vs.* -0.28 + 0.66 LogMar, p=0.32) nor at 1 year (0.12 + 0.68 *vs.* -0.40 + 0.72 LogMar, p=0.10). The adjusted change in IOP between groups 1 and 2 (Figure 2) was not statistically significant at 6 months (-20.5 + 6.1 *vs.* -25.6 + 9.5 mmHg, p=0.11) nor at 1 year (-23.8 + 10.3 *vs.* -27.9 + 11.0 mmHg, p=0.38).

Complications following surgery were recorded in both groups (Table 2). Overall, there were no significant differences between the groups and the complications were minimal.

Of note, 9 of 15 patients in group 1 required anti-VEGF injections

Table 2: Postoperative complications in both groups.

Post-operative Complications	Group 1: aAGV/PRP	Group 2: pAGV/PPV/EL
Foveal macular edema	0	2
Retinal detachment	0	1
Cataract surgery within 1 yr	2	1
Hyphema after tube placement	1	0
Transscleral diode for IOP control	1	0
Tube revision	1	0
Anti-VEGF injection (patients, total # of injections)	9, 29	5, 16
Endophthalmitis	0	0

after completion of the aAGV/PRP and a total of 31 injections were given to those patients. In group 2, only 4 patients required anti-VEGF injections after the pAGV/PPV/EL and a total of 16 injections were given to those patients. There was a significant difference in the number of injections required post-operatively (p=0.001) but there was no significant difference in number of patients requiring post-operative injections (p=0.14).

Two patients in group 1 had cataract surgery within the post-operative period. One patient underwent cataract surgery at one month following tube placement and the other at two months.

Discussion

This was a retrospective analysis comparing outcomes of pars plana Ahmed glaucoma valve with Pars Plana Vitrectomy/Endolaser (pAGV/PPV/EL) and anterior chamber Ahmed Glaucoma Valve with Panretinal Photocoagulation (aAGV/PRP). Primary outcomes studied included IOP (mmHg) and BCVA (Snellen/LogMar). Results showed that both procedures were effective in lowering IOP with no significant between groups. This has previously been demonstrated in comparative studies of both types of procedures, though has not yet been demonstrated to our knowledge in NVG patients specifically.

There was no significant difference in visual acuity when comparing pre-operative BCVA to post-operative BCVA. However, there was a non-statistically significant trend toward better visual acuity in group 2 at one-year follow-up. When analyzing visual acuity across the two groups, it should be noted that overall, visual acuity was worse pre-operatively in patients in group 2 than patients in group 1, which may account for the trend towards greater improvement in group 2 at one year. A larger sample size in future studies may be useful in determining if this trend correlates to surgical approach *vs.* pre-operative sampling error in severity of cases.

Secondary outcomes following surgery for each group included number of anti-VEGF injections by one year of follow-up. Differences in number of injections between the two groups were statistically significant, with more patients requiring injections in group 2 than in group 1. This may be explained by vitrectomy allowing for more thorough laser application and control of neovascularization and edema, though further analysis of the differences in procedures is needed to establish this.

Most patients in this study had Proliferative Diabetic Retinopathy (PDR) as the primary disease and etiology of NVG. Other etiologies included Central Retinal Vein Occlusion (CRVO) and Central Retinal Artery Occlusion (CRAO). A larger sample size in future studies would allow for stratification of data to determine whether etiology of NVG affects the outcomes of surgery. Determination of whether outcomes are different across these different etiologies may guide treatment decision making in a more patient-specific manner.

There were differences in groups that may have contributed to significance of results. Most of the patients in group 1 were pseudophakic, compared to most of group 2 patients being phakic. Lens status was controlled for in analysis of post-operative outcomes. Pre-operative IOP was overall higher in group 2 than in group 1, reflecting again those patients in group 2 may have had increased baseline severity of disease than those in group 1. Further studies using prospective analysis and selection of cases that are more closely matched may improve this and allow for more accurate and precise determination of IOP changes.

Both groups had cases in which complications were seen in follow-up. In group 1, there were two cases of foveal macular edema, one case of retinal detachment, and one case of rapid progressive cataract. These are all known complications of vitreoretinal surgery and photocoagulation procedures, though it is unclear whether underlying disease contributed to these complications in these patients. Further analysis of severity of disease in relation to risk of operative complications may be helpful. In group 2, complications included tube revision, further transscleral laser therapy, development of retinal arteritis, and two patients that subsequently underwent cataract surgery. As with group one, these post-operative events are not uncommon in anterior chamber Ahmed valve surgery, though analysis of a larger cohort to determine the comparative number of complications in the two groups would assist in determining risk differences across surgical approaches. Complications may have had effects on visual acuity measurements during follow-up period. Vision worsened from 20/70 to 20/400 from six months to one year after surgery in one particular group 1 patient with subsequent Foveal Macular Edema (FME), though another patient with FME in group 1 did not have worsening vision. Another patient in group 1 with retinal detachment had worsening vision of CF at 3’ to HM from six months to one year. Vision worsened to HM from six months to one year in the patient with subsequent retinal arteritis in group 2.

Limitations to this study included a small sample size and retrospective chart review study design. Improvements to this study in the future will include prospective data collection on a larger sample size to improve statistical power of results as well as randomization to treatment type. This will also allow for more accurate follow-up of patients involved in the study. Another limitation of this study is the subjective nature of visual acuity measurements amongst different technicians and providers. A more controlled study environment with standardized visual acuity measurement would provide more accurate outcomes in the future. Also, three subjects in group 1 and ten subjects in group 2 that had undergone PRP prior to surgery were included, which may have altered study preoperative data and outcomes. Standardization of timing of procedures using prospective study would ameliorate these differences.

Conclusion

pAGV/PPV/EL and aAGV/PRP were both effective in lowering IOP, and there was no significant difference between the two approaches. There was a trend toward better visual acuity outcomes at 1 year in group 2, but this was not statistically significant. There were also significantly less anti-VEGF injections required in group 2 following surgery. A prospective study and larger sample size will be needed to answer this question and further evaluate the outcomes of both treatment modalities.

Support

Research to Prevent Blindness, Departmental Grant to the Department of Ophthalmology, Flaum Eye Institute, University of Rochester Medical Center.

References

1. Shchomak Z, Cordeiro Sousa D, Leal I, Pinto LA. Surgical treatment of neovascular glaucoma: A systematic review and meta-analysis. Graefes Arch Clin Exp Ophthalmol. 2019;257(6):1079-89.
2. Hayreh SS. Neovascular glaucoma. Prog Retin Eye Res. 2007;26(5):470-85.
3. Sivak-Callcott JA, O'Day DM, Gass JD, Tsai JC. Evidence-based recommendations for the diagnosis and treatment of neovascular glaucoma. Ophthalmology. 2001;108(10):1767-76.
4. Mietz H, Raschka B, Krieglstein GK. Risk factors for failures of trabeculectomies performed without antimetabolites. Br J Ophthalmol. 1999;83(7):814-21.
5. Xie Z, Liu, H, Du M, Zhu M, Tighe S, Chen X, et al. Efficacy of Ahmed glaucoma valve implantation on neovascular glaucoma. Int J Med Sci. 2019;6(10):1371-6.
6. Faghihi H, Hajizadeh F, Mohammadi SF, Kadkhoda A, Peyman GA, Riazi-Esfahani M, et al. Pars plana Ahmed valve implant and vitrectomy in the management of neovascular glaucoma. Ophthalmic Surg Lasers Imaging. 2007;38(4):292-300.
7. Wang MH, Li QM, Dong HT, Dong SQ, Li Y, Zheng CY. Ahmed valves *vs.* trabeculectomy combined with pans plana vitrectomy for neovascular glaucoma with vitreous hemorrhage. Eur J Ophthalmol. 2017;27(6):774-80.
8. Havens SJ, Gulati V. Neovascular Glaucoma. Dev Ophthalmol. 2016;55:196-204.
9. Parihar JK, Jain VK, Kaushik J, Mishra A. Pars plana-modified versus conventional Ahmed glaucoma valve in patients undergoing penetrating keratoplasty: A prospective comparative randomized study. Curr Eye Res. 2017;42(3):436-42.
10. Maris PJG, Tsai JC, Khatib N, Bansal R, Al-Aswad LA. Clinical outcomes of Ahmed Glaucoma valve in posterior segment versus anterior chamber. J Glaucoma. 2013;22(3):183-9.
11. DiLoreto DA, Bressler NM, Bressler SB, Schachat AP. Best and final visual acuity in ophthalmologic research. Arch Ophthalmol. 2003;121(11):1586-90.