

Clinical efficacy of Ahmed glaucoma valve implantation combined with 23-gauge vitrectomy for medically uncontrolled neovascular glaucoma with proliferative diabetic retinopathy

Zhong–Jing Lin¹, Zheng–Hua Chen², Shou–Yue Huang¹, Jun Sun¹, Xi Shen¹, Yi–Sheng Zhong¹

¹Department of Ophthalmology, Ruijin Hospital Affiliated Medical School, Shanghai Jiao Tong University, Shanghai 200025, China

²Department of Ophthalmology, Suzhou Eye and ENT Hospital, Suzhou 215006, Jiangsu Province, China

Co-first authors: Zheng-Hua Chen and Zhong-Jing Lin

Correspondence to: Yi-Sheng Zhong and Xi Shen. Department of Ophthalmology, Ruijin Hospital Affiliated Medical School, Shanghai Jiao Tong University, 197 Ruijin Er Road, Shanghai 200025, China. yszhong68@126.com; carl_shen2005@126.com

Received: 2019-03-09 Accepted: 2019-11-12

Abstract

• **AIM:** To describe the clinical results of combined Ahmed valve implantation and 23-gauge vitrectomy for medically uncontrolled neovascular glaucoma (NVG) secondary to proliferative diabetic retinopathy (PDR).

• **METHODS:** The medical records of medically uncontrolled NVG patients with PDR who underwent Ahmed valve implantation and 23-gauge vitrectomy between March 2016 and December 2018 were reviewed. Enrolled patients had at least 6-month follow-up. Panretinal photocoagulation (PRP), anti-vascular endothelial growth factor, surgery and medication history were documented.

• **RESULTS:** Eleven eyes of 11 patients were included in our study. The visual acuity improved in 8 eyes and remained unchanged in 3 eyes. The preoperative intraocular pressure (IOP) was significantly decreased at the last follow-up (48.8 ± 4.3 to 17.0 ± 1.5 mm Hg, $P < 0.001$). All eyes needed three topical anti-glaucomatous medications before surgery, but the number was significantly reduced to 0.72 ± 0.19 at the last visit ($P < 0.001$). Four eyes had choroidal detachment and 3 eyes had minor hyphemia, all of which gradually resolved without treatments in one week.

• **CONCLUSION:** Ahmed glaucoma valve implantation combined with 23-gauge vitrectomy might be a safe and alternative treatment for NVG with PDR.

• **KEYWORDS:** Ahmed glaucoma valve; vitrectomy; neovascular glaucoma; diabetic retinopathy

DOI: 10.18240/ijo.2020.05.20

Citation: Lin ZJ, Chen ZH, Huang SY, Sun J, Shen X, Zhong YS. Clinical efficacy of Ahmed glaucoma valve implantation combined with 23-gauge vitrectomy for medically uncontrolled neovascular glaucoma with proliferative diabetic retinopathy. *Int J Ophthalmol* 2020;13(5):832-836

INTRODUCTION

Neovascular glaucoma (NVG) is a devastating form of secondary glaucoma with poor visual prognosis. It is characterized by elevated intraocular pressure (IOP), with the presence of iris and/or iridocorneal angle neovascularization^[1]. Extensive ischemic retinal disorders may be the major causes, including proliferative diabetic retinopathy (PDR)^[2]. With the increasing morbidities of diabetes mellitus, the prevalence of NVG secondary to PDR shows a growing tendency. A retrospective study from India demonstrated that 22% NVG patients were associated with PDR in 2005^[3], a five-year study from Thailand attributed 42% NVG eyes to PDR^[4], while the portion was as high as 90.8% in a four-year study in Mexico^[5]. However, 39.7% NVG were caused by PDR over a ten-year period in a tertiary Chinese hospital^[6].

The treatments for NVG remain challenging, but there may be a chance to preserve the visual function. It is essential to treat the elevated IOP as well as the underlying causes. As for IOP, medical treatment is the first step to relieve pain and prevent visual loss, but it usually does not present satisfactory results, thus necessitating surgical interventions. The most common surgical management is Ahmed glaucoma valve (AGV)^[7]. As for the underlying causes, the most fundamental way is to reduce retinal ischemia and maintain the homeostatic balance between pro-angiogenic and anti-angiogenic factors. Panretinal photocoagulation (PRP) is the standard treatment when the retinal ischemia and neovascularization occur. Anti-vascular endothelial growth factor (anti-VEGF) agents provide

adjunctive treatments in the regression of neovascularization. In NVG cases with PDR, pars plana vitrectomy (PPV) may also be required to address the disorders of posterior segments, such as vitreous hemorrhage^[8]. Therefore, an optimal individualized treatment is recommended for NVG patients.

Currently, numerous surgical treatments have been reported for NVG. However, there is no consensus about the optimal surgical approach to treat medically uncontrolled NVG patients with PDR. Little is known about the efficacy of earlier vitrectomy combined with AGV implantation in such cases. The purpose of this study was to report the clinical results of AGV implantation combined with 23-gauge PPV in NVG patients with PDR.

SUBJECTS AND METHODS

Ethical Approval The study was approved by the local Ethics Committee and was conducted according to the Declaration of Helsinki. Written informed consent was obtained at the time of admission.

Study Population This retrospective study recruited subjects from the ophthalmic clinic of Ruijin Hospital, affiliated to Shanghai Jiao Tong University School of Medicine, between March 2016 and December 2018.

Enrolled NVG patients should meet these criteria: neovascularization of the iris and/or anterior chamber angle, and elevated IOP (>22 mm Hg) that was not medically controlled. NVG developed in PDR (including vitreous hemorrhage, dense vitreous opacity due to previous hemorrhage and fibrovascular proliferation) was included. Those with tractional and/or rhegmatogenous retinal detachment were excluded. NVG due to other ischemic retinal changes was also excluded. We also excluded totally blind eyes and patients with previous surgeries. Patients with corneal decompensation was not taken into consideration either.

Each participant underwent a thorough ophthalmic examination, including best-corrected visual acuity (BCVA), refraction, IOP measurement using Goldmann applanation tonometry, slit lamp examination, fundus examination, gonioscopy, A-scan and B-scan ultrasounds, visual field examination, non-contact specular microscopy of the corneal endothelium. A detailed medical history (such as PRP history, anti-VEGF history, surgery history and medication history) was documented.

Surgical Procedures One glaucoma specialist (Zhong YS) performed AGV implantation and one vitreoretinal specialist (Shen X) performed vitrectomy for all patients. After topical and retrobulbar anesthesia, an incision of the superotemporal conjunctiva was made to create a fornix-based flap between the rectus muscles. A piece of cotton soaked with 25 mg/mL 5-FU was placed for 5min, followed by a thorough rinse. After checking the patency of the tube, the plate of AGV (FP7; New World Medical, Inc., Rancho Cucamonga, CA,

USA) was fixed onto the sclera with 5-0 nylon sutures, with the anterior edge approximately 8-9 mm posterior to the limbus. Then, a 5×5-mm² limbal-based scleral flap with half thickness was prepared. Subsequently, 23-gauge PPV was performed. Endolaser photocoagulation was applied if necessary. Afterwards, the drainage tube was inserted into the anterior chamber, leaving 2-3 mm tube in the anterior chamber with the bevel upwards. The sclera flap was sutured with 10-0 nylon sutures. The conjunctiva was sutured using 8-0 vicryl sutures. Topical antibiotics and glucocorticoids were used postoperatively. Cycloplegics were administered if necessary. Anti-glaucomatous medications and eyeball massage were administered as required according to the postoperative IOP changes. All patients had at least 6-month follow-up.

Statistical Analysis The Statistical Package for Social Sciences software version 20.0 (SPSS Inc, Chicago, IL, USA) was used for the statistical analysis. Quantitative data were expressed as mean±standard deviation (SD). Paired *t*-test was used to compare the IOP values and Fisher exact test was performed to evaluate the number of anti-glaucomatous medications before and after the surgery.

RESULTS

Eleven eyes of 11 patients were finally included. The detailed characteristics are summarized in Table 1. The mean age at surgery was 50.4±10.9y. Eight eyes received PRP and 7 eyes received anti-VEGF therapy preoperatively. Based on their clinical situations, 7 patients with coexisting cataract underwent phacoemulsification at the surgery, including 5 eyes with the implantation of posterior chamber intraocular lens (IOL), and two without implantation.

The mean follow-up was 15.1±3.5mo (range, 8-19mo). Resolution of the iris neovascularization and vitreous hemorrhage was observed in all patients during the follow-up period. Four eyes who only underwent AGV implantation and PPV showed significant improvement of visual acuity. For those with simultaneous phacoemulsification, 4/7 (57%) had visual improvement, while the remaining three cases had the same vision as preoperatively. The mean preoperative IOP was 48.8±4.3 mm Hg, which significantly decreased to 17.0±1.5 mm Hg at the last follow-up ($P<0.001$). All eyes had three anti-glaucomatous medications preoperatively and the number was significantly reduced to 0.72±0.19 at the last follow-up ($P<0.001$). Seven patients received eyeball massage to improve the filtering function after the operations. Overall, 4 patients achieved successful IOP control (<21 mm Hg) without additional anti-glaucomatous medications, whereas 6 eyes were on one medication and one required two medications.

As for complications after the surgery, 4 eyes had choroidal detachment and the symptoms resolved with conservative treatment in one week. Three eyes had minor hyphema that

Table 1 The clinical characteristics before and after surgery in NVG patients with PDR

No.	Age	Gender	Eye	PRP	Anti-VEGF	Pre-operation			Surgical procedure	Complication	Follow-up (mo)	Last follow-up after operation			
						BCVA	IOP	No. of meds				BCVA	IOP	No. of meds	Eyeball massage
1	43	Male	OD	Y	2	0.1	55	3	Ahmed+PPV	Choroid detachment	19	0.5	20	1	Y
2	68	Male	OD	N	0	FC	43	3	Ahmed+PPV+phaco+IOL	Minor hyphema	19	FC	16	0	N
3	34	Male	OS	Y	3	0.1	50	3	Ahmed+PPV	-	18	0.6	16	1	Y
4	54	Female	OD	Y	1	HM	56	3	Ahmed+PPV+phaco+IOL	-	17	0.1	18	0	N
5	43	Male	OS	Y	2	0.1	44	3	Ahmed+PPV	Choroid detachment	17	0.5	17	1	Y
6	50	Female	OD	N	1	LP	47	3	Ahmed+PPV+phaco	-	16	LP	18	1	Y
7	52	Male	OS	Y	0	0.02	45	3	Ahmed+PPV+phaco+IOL	Minor hyphema	15	0.4	15	0	Y
8	48	Female	OD	Y	2	HM	52	3	Ahmed+PPV+phaco+IOL	Choroid detachment	14	0.04	18	1	N
9	57	Male	OD	Y	0	0.2	46	3	Ahmed+PPV+phaco+IOL	-	12	0.6	16	1	Y
10	38	Female	OS	Y	3	HM	49	3	Ahmed+PPV	Minor hyphema	11	0.02	18	2	Y
11	67	Male	OS	N	0	LP	50	3	Ahmed+PPV+phaco	Choroid detachment	8	LP	15	0	N

OD: Right eye; OS: Left eye; PRP: Panretinal photocoagulation; VEGF: Vascular endothelial growth factor; BCVA: Best corrected visual acuity; FC: Finger counting; HM: Hand motions; LP: Light perception; IOP: Intraocular pressure; Meds: Glaucoma medications; PPV: Vitrectomy; phaco: Phacoemulsification; IOL: Intraocular lens.

spontaneously absorbed in one week. There were no other sight threatening complications, such as expulsive hemorrhage, hypotony (IOP<5 mm Hg), bleb leak or endophthalmitis. During the follow-up period, all patients maintained good control of blood glucose levels, and no patient developed recurrent vitreous hemorrhage postoperatively.

DISCUSSION

NVG combined with PDR, one of the devastating ocular disorders, is continuingly an urgent unsolved problem. When the affected eye becomes completely blind and the patient complains of unbearable pain, it may end up with eyeball enucleation. Early in its course, PRP and anti-VEGF therapies could effectively induce the regression of neovascularization, thus preventing a spectrum of secondary complications. Although the majority of NVG patients are effectively managed, many still necessitate additional surgical interventions to control their ischemia or elevated IOP. In this study, we provided an alternative surgical approach in the management of medically uncontrolled NVG patients combined with PDR.

Conventional AGV implantation combined with PPV was simultaneously performed for all patients. A dramatic decrease in IOP and anti-glaucomatous medications indicated the success of this surgical procedure. Qualified success (IOP≤21 mm Hg with or without medications) was observed in all eyes (100%), and complete success (IOP≤21 mm Hg without medications) was achieved in 4 eyes (36%). The visual

prognosis was mainly attributed to pre-existing ocular diseases. Phacoemulsification and vitrectomy had a great effect on the visual improvements. Those without prior PRP and anti-VEGF treatments had been under a terrible situation. It was difficult to improve the poor vision, necessitating the early treatment of this disease profile. Moreover, phacoemulsification could also lower postoperative IOP, since the free communication between the anterior chamber and vitreous cavity was established. In the current series, the most frequent postoperative complications were transient hyphemia and choroidal detachment. Therefore, AGV implantation combined with PPV can therefore be regarded as a well-tolerated adjunct to NVG treatment in PDR patients. The results appeared to be similar with previous reports^[9-10]. Moon *et al*^[9] also reviewed 11 eyes underwent vitrectomy combined with AGV implantation, and revealed that the average IOP decreased from 45.27 to 15.81 mm Hg one year after operation. Besides, the average number of anti-glaucomatous medications was 2.27±1.02 before surgery and 0.9±1.37 one year after surgery. In another Korean study conducted by Lee *et al*^[10], only 8 patients underwent combined surgery. They found the qualified success rates were 90%, 80%, 80% and 34% postoperatively at 1, 6mo, 1 and 2y respectively. Moreover, postoperative medications significantly decreased from 2.8 preoperatively to 1.3 at 2-year follow-up. Glaucoma drainage devices are increasingly used for refractory glaucoma, especially NVG eyes. Hernandez-Oteyza *et al*^[11] reviewed the clinical results of 60 NVG patients with PDR

who underwent AGV implantation alone and identified 60% cases as successful. AGV implantation can be done with PPV or phacoemulsification when vitreous or lens opacity may prevent PRP, or vitreous hemorrhage and/or fibrovascular membranes require vitreoretinal surgery. Vitrectomy removes dense vitreous opacity, which might improve inner retina oxygenation, thus promoting the resolution of macular edema and improving postoperative visual acuity. Besides, PRP can be performed completely and easily after PPV. Moreover, the VEGF level may decrease^[12], thus reducing or preventing neovascularization. In addition, phacoemulsification can improve the view so PPV and PRP can be performed more easily. However, in young patients, we tried to leave the clear lenses in the eye, since most retained lenses remained clear or developed slightly opacities postoperatively. Simultaneous combined surgery not only improves the visual clarity of surgical field, but also helps to save medical expense, minimize the surgical injury and promote the recovery.

The current series all received AGV implantation, with the drainage tube in the anterior chamber. The main advantage is that the tube can be visualized directly and tube obstruction can be easily identified. However, pars plana AGV implantation combined with vitrectomy has been reported before. Faghihi *et al*^[13] demonstrated a significant decrease in average IOP from 53.3 to 16.3 mm Hg at the final follow-up, and 72.2% patients had enough IOP control between 5 and 21 mm Hg. Similarly, Jeong *et al*^[14] reported that postoperative IOP between 8 and 18 mm Hg was achieved in all patients, and the anti-glaucomatous medications significantly decreased from 2.9 to 1.2. More recently, Rososinski *et al*^[15] compared pars plana implant with anterior chamber placement of glaucoma drainage device, suggesting that IOP control appeared to be comparable. Pars plana placement was probably due to anterior segment pathology, such as narrow anterior chamber angle, corneal decompensation, or florid rubeosis iridis. Therefore, the choice requires a comprehensive consideration of the patients' specific situation. In our cases, these patients only had diffused corneal edema due to elevated IOP, but without corneal decompensation or narrow anterior chamber angle. Conventional anterior chamber placement may be a better choice. There were several limitations in this study. This was a retrospective study without a control group. The number of recruited patients was relatively small and the follow-up period was fairly short. Although all the enrolled patients received combined surgery, the prior treatments and the surgical procedures were not totally the same after the disease onset. Considering all these factors, the present results should be interpreted with caution. Further explorations are warranted to support and extend our present observations. Even so, our preliminary study revealed that AGV implantation combined

with PPV may be safe and effective for uncontrolled NVG with coexisting PDR. Notably, NVG patients with PDR should be managed by a multi-disciplinary care team that includes a glaucoma specialist to control IOP, a retina specialist to control the diabetic retinopathy and a physician of endocrinology to control the blood glucose levels.

In conclusion, AGV implantation combined with 23-gauge vitrectomy might be a safe and alternative treatment for NVG with PDR.

ACKNOWLEDGEMENTS

Authors' contributions: Conceptualization of the study: Lin ZJ, Shen X and Zhong YS. Data acquisition: Chen ZH, Huang SY and Sun J. Manuscript preparation: Lin ZJ and Chen ZH. Revision of manuscript: Shen X and Zhong YS. All authors have read and approved the final manuscript.

Conflicts of Interest: Lin ZJ, None; Chen ZH, None; Huang SY, None; Sun J, None; Shen X, None; Zhong YS, None.

REFERENCES

- 1 Rodrigues GB, Abe RY, Zangalli C, Sodre SL, Donini FA, Costa DC, Leite A, Felix JP, Torigoe M, Diniz-Filho A, de Almeida HG. Neovascular glaucoma: a review. *Int J Retina Vitreous* 2016;2:26.
- 2 Hayreh SS. Neovascular glaucoma. *Prog Retin Eye Res* 2007;26(5):470-485.
- 3 Gadia R, Sihota R, Dada T, Gupta V. Current profile of secondary glaucomas. *Indian J Ophthalmol* 2008;56(4):285-289.
- 4 Kiddee W, Tantisarasart T, Wangsupadilok B. Neovascular glaucoma: a retrospective review of 5-year experience in Songklanagarind Hospital. *J Med Assoc Thai* 2012;95(Suppl 4):S36-S42.
- 5 Lazcano-Gomez G, R Soohoo J, Lynch A, N Bonell L, Martinez K, Turati M, Gonzalez-Salinas R, Jimenez-Roman J, Y Kahook M. Neovascular glaucoma: a retrospective review from a tertiary eye care center in Mexico. *J Curr Glaucoma Pract* 2017;11(2):48-51.
- 6 Liao N, Li C, Jiang H, Fang A, Zhou S, Wang Q. Neovascular glaucoma: a retrospective review from a tertiary center in China. *BMC Ophthalmol* 2016;16:14.
- 7 Riva I, Roberti G, Katsanos A, Oddone F, Quaranta L. A review of the Ahmed glaucoma valve implant and comparison with other surgical operations. *Adv Ther* 2017;34(4):834-847.
- 8 Havens SJ, Gulati V. Neovascular glaucoma. *Dev Ophthalmol* 2016;55:196-204.
- 9 Moon DRC, Choi KS, Lee SJ, Ha SJ. Vitrectomy and Ahmed valve implantation in neovascular glaucoma patients with vitreous hemorrhage. *J Korean Ophthalmol Soc* 2012;53(6):801.
- 10 Lee CM, Kim EA, Cho YW. Pars plana vitrectomy and Ahmed valve implantation for intractable glaucoma comorbid with retinal disorders. *J Korean Ophthalmol Soc* 2011;52(1):46.
- 11 Hernandez-Oteyza A, Lazcano-Gomez G, Jimenez-Roman J, Hernandez-Garciadiego C. Surgical outcome of Ahmed valve implantation in Mexican patients with neovascular glaucoma. *J Curr Glaucoma Pract* 2014;8(3):86-90.

- 12 Lee SS, Ghosn C, Yu ZL, Zacharias LC, Kao H, Lanni C, Abdelfattah N, Kuppermann B, Csaky KG, D'Argenio DZ, Burke JA, Hughes PM, Robinson MR. Vitreous VEGF clearance is increased after vitrectomy. *Invest Ophthalmol Vis Sci* 2010;51(4):2135-2138.
- 13 Faghihi H, Hajizadeh F, Mohammadi SF, Kadkhoda A, Peyman GA, Riazi-Esfahani M. Pars plana Ahmed valve implant and vitrectomy in the management of neovascular glaucoma. *Ophthalmic Surg Lasers Imaging* 2007;38(4):292-300.
- 14 Jeong HS, Nam DH, Paik HJ, Lee DY. Pars Plana Ahmed implantation combined with 23-gauge vitrectomy for refractory neovascular glaucoma in diabetic retinopathy. *Korean J Ophthalmol* 2012;26(2):92-96.
- 15 Rososinski A, Wechsler D, Grigg J. Retrospective review of pars Plana versus anterior chamber placement of Baerveldt glaucoma drainage device. *J Glaucoma* 2015;24(2):95-99.