Original Article

Outcomes and Complications of Ahmed Glaucoma Valve Implantation in Neovascular versus Other Secondary Glaucoma: A One-Year Follow-up Study

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ABSTRACT

Purpose: To compare the visual outcomes and intraocular pressure between patients with neovascular glaucoma (NVG) and other secondary glaucoma (OSG) one year after Ahmed glaucoma valve (AGV) implantation.

Study Design: Retrospective study.

Place and Duration of Study: Islamic International Medical College/Railway Hospital Westridge Rawalpindi, from January 2015 to January 2022.

Methods: Ahmed glaucoma valve (model FP7) was implanted in 54 patients with NVG and OSG. The preoperative and post-operative vision and IOP was compared between the two groups with one year follow-up. Success was defined as IOP of 5-21 mmHg without topical therapy (complete success) or with topical therapy (qualified success), no loss of light perception and not requiring subsequent glaucoma surgery or tube removal.

Results: After one year, the mean postoperative vision improved to 0.9385 from 1.25 LogMAR in NVG group and to 0.8143 from 0.8500 LogMAR in OSG group. The mean IOP reduced from 41.69 to 16.27mmHg in NVG group. While in OSG group it reduced from 33.39 to 12.857 mmHg one year postoperatively (p-value 0.0001). Hyphema was the commonest complication in NVG and hypertensive phase in the OSG. NVG group showed complete success in 2, qualified success in 18 and failure in 6 cases. In the second group, complete success was seen in 8, qualified success in 18 and failure in 2 cases.

Conclusion: Ahmed glaucoma valve implantation is effective in saving useful vision and controlling IOP in the majority of refractory glaucoma and the results are comparable between neovascular and other secondary glaucoma.

Key Words: Neovascular glaucoma, Ahmed Glaucoma Valve, Intraocular pressure.

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INTRODUCTION

The Ahmed Glaucoma Valve (AGV), introduced in 1993, has since gained widespread use, particularly in managing complex glaucoma cases, with notable success in treating the neovascular variety.[1] Due to recent increase in diabetes and other vascular diseases, the incidence of NVG has increased to more than 30% of the refractory glaucomas.[2] NVG is considered a greater risk for surgical failure which is attributed to progression of the underlying disease.[3] Among refractory glaucoma, secondary glaucoma resulting from retinal vein occlusion is associated with a poorer prognosis, even after Ahmed Glaucoma Valve (AGV) implantation.[4] However, when comparing the outcomes of tube surgery for managing neovascular

glaucoma (NVG) with cyclodestruction or trabeculectomy combined with antimetabolites, the latter two approaches demonstrate a lower success rate than tube surgery.[5,6] AGV has shown decreased dependence on medications as compared to cyclophotocoagulation.[7] In NVG, trabeculectomy fistula is blocked by the proliferation of neovascular tissue. There is inconclusive evidence regarding the use of anti-VEGF in controlling NVG.[8]

Two common tube devices used world-wide for complicated glaucoma are Ahmed glaucoma valve and Baerveldt tube and both depict comparable results.[9] AGV has the disadvantage of having some resistance to outflow due to the valve mechanism and a small surface area leading to a hypertensive phase.[10] Eyes with a hypertensive phase are usually those which had a higher preoperative IOP.[11] The other serious problem is corneal endothelial loss.[12] On the other hand, Baerveldt tube is more commonly associated with prolonged postoperative hypotony and may require tube lumen occlusion with non-absorbable suture.[13]

The outcomes of tube surgery in neovascular glaucoma (NVG) are generally considered less favorable compared to OSG, largely due to the aggressive nature of the underlying disease. Nevertheless, among the available treatment options for NVG, tube surgery provides better IOP control and a higher likelihood of preserving vision compared to other modalities. This study aimed to compare the results of AGV implantation in neovascular versus OSG over a one-year follow-up period in the Pakistani population of the Pothohar region.

METHODS

The study was approved by the Institutional Review Committee of the institution and Declaration Helsinki was followed for the research. There were 54 patients who underwent AGV (FP 7) implantation. All the surgeries were performed by a single surgeon in a teaching hospital from January 2015 to January 2022. It was a retrospective study and included 26 cases of NVG and 28 patients with OSG. Inclusion criteria comprised of cases above 40 years of age with neovascular or other secondary causes of glaucoma, having uncontrolled IOP on maximum topical antiglaucoma therapy. Patients younger than 40 years of age and those with primary uncontrolled glaucoma on maximum topical therapy were excluded. The sample size was calculated using the Raosoft formula[14] with a confidence interval of 95% and margin of error at 5%. For a target population of 20,000, the estimated sample size was 45. This study comprised of 54 cases.

The criteria taken for comparison were visual acuity, IOP, complications and number of medications. Data were recorded and analyzed using SPSS 21. P value of less than 0.005 was taken as significant.

Cases of NVG were given intravitreal anti-VEGF, 5-7 days before surgery. Postoperatively, pan-retinal photocoagulation (PRP) was performed once the media clarity permitted. The valve plate was implanted 8-10 mm behind the limbus in superotemporal quadrant, in all the cases, with 10/0 nylon suture. The preoperative vision and IOP was compared with the one-year postoperative vision and IOP. Complications (if any) were recorded in all the cases. Success criteria was defined as IOP of 5- 21 mmHg without topical therapy (complete success), IOP of 5- 21 mm Hg with topical therapy (qualified success), no loss of light perception and not requiring subsequent glaucoma surgery or tube removal.

RESULTS

The mean age in NVG group was 61.08±6.118 years. There were 20 males and 6 females in NVG group. In OSG group, the mean age was 49.57±17.20 and there were 17 males and 11 females. In NVG group, the mean preoperative vision was 1.25±0.344 LogMAR which improved to 0.9385±0.5419 after one year (p-value 0.013). The vision was stable in 7 (27%), reduced in 7 (27%) and improved in 12 (46%) cases. Mean preoperative IOP was 41.692±11.74996) and after one year was 16.269±5.984 (p-value 0.0001).

In the other OSG group, mean preoperative vision

Table 1: *Type and causes of Secondary glaucoma and number of cases.*

Type of glaucoma	Underlying Disease	Number of cases
NVG	Diabetes Mellitus	18
	Central retinal vein occlusion	4
	Diabetes and ischemic heart Disease	4
	Total	26
Other secondary glaucoma	Uveitic glaucoma	3
	Postsurgical glaucoma	19
	Pigment dispersion glaucoma	3
	Steroid induced glaucoma	2
	Post-traumatic glaucoma	1
	Total	28

Table 2: *Early and late complications in neovascular and other secondary glaucoma.*

Complications	Neovascular glaucoma		Other secondary glaucoma	
Early	Hyphema	15	Hypertensive crises	6
	Shallow anterior chamber	3	Diplopia	2
	Hypertensive crises	2	Large Reservoir Syndrome	1
			Filamentary keratopathy	1
			Tube cornea touch	1
Late	Bleb encapsulation	3	Diplopia	1
	Tube exposure due to scleral melting	2	Hypertensive crises	1
	Corneal edema	1	Tube exposure due to scleral melting	1
			Filamentary keratopathy	1
			Endophthalmitis	1
			Aponeurotic ptosis	1

was 0.85±0.46865, which improved to 0.8143±0.576 LogMAR after one year (p-value 0.77). The vision was stable in 8 (28.5%), reduced in 8 (28.5%) and improved in 12 (43%) cases. Mean preoperative IOP was 33.39±12.22 and after one year was 12.857±5.867 (p-value 0.0001).

The main underlying cause in NVG was diabetes mellitus and in other secondary glaucoma group, postsurgical glaucoma (Table 1).

The commonest complications in NVG cases were hyphema and bleb encapsulation while in the second group, hypertensive crisis and diplopia (Table 2).

The mean reduction in antiglaucoma eye drops was similar between the two groups. In NVG group, mean preoperative eye drops were 2.5±0.64 which reduced to 1.23±0.81 after one year. In OSG group, the mean preoperative eye drops were 2.82±0.47 and after one year were 1.21±1.03.

NVG group showed complete success in 2, qualified success in 18 and failure in 6 eyes. In the OSG group, complete success was seen in 8, qualified success in 18 and failure in 2 eyes. Overall results were slightly better in other secondary glaucoma group, but qualified success was achieved in equal number of cases in both the groups.

DISCUSSION

NVG is considered to be one of the difficult fields in glaucoma and its management poses many challenges. The literature shows variable results in NVG management with tube surgery. Success criteria is defined, according to WGA guidelines, as an IOP between 5 and 21mmHg or a 20% or more reduction from baseline IOP, no increase in the number of antiglaucoma eye drops and no visual loss.[15]

Our study included 26 cases of neovascular glaucoma (NVG) and 28 cases of other secondary glaucoma (OSG) that underwent Ahmed Glaucoma Valve (AGV) implantation. The findings revealed striking similarities in visual outcomes and intraocular pressure (IOP) control between the NVG and OSG groups managed with AGV. In the NVG group, visual improvement was primarily attributed to the resolution of vitreous hemorrhage and cataract surgery, when deemed necessary. Statistically significant reduction in IOP was seen in both the groups even after one year (p-value 0.005). The success rate was 76.92% in NVG group, and 92.85% in other secondary glaucoma, at one year. The reduction in mean number of antiglaucoma eye drops was also similar between the two groups i.e. from 2.5 to 1.23 in NVG and from 2.82 to 1.21 in other secondary glaucoma. The commonest postoperative complications were hyphema in NVG and hypertensive crises in other secondary glaucoma.

Xie et al, studied the factors leading to surgical success in 66 eyes with NVG.[16] They also recorded IOP, visual acuity, complications, the medications used and overall surgical rates for a period of one year. Their results showed that the postoperative IOP in all the visits was significantly lower than the preoperative IOP and the differences were statistically significant ($p < 0.05$). They reported a success rate of 66.7% after one year and concluded that the efficacy of the Ahmed Glaucoma Valve in managing neovascular glaucoma (NVG) was influenced by factors such as patient age, timely retinal photocoagulation, and the prevention of complications like hyphema. In a retrospective comparative study by Netland et al, which included 38 controls and 38 neovascular glaucoma (NVG) patients, the results in the NVG group were found to be poorer compared to the control group.[17] Success was defined as IOP of 6.0 mmHg and ≤ 21mmHg without loss of

light perception or further glaucoma surgery. Their average follow-up in controls was 18.4 and in NVG 17.4 months. At one year follow-up, mean IOP in control group was 17.9±8.4 and in NVG group 16.5±15.8mmHg (p-0.150). Success in one year was 89.2% and 73.1% in control and neovascular groups respectively. The control of IOP and complications were similar between the two groups. Consistent to our study, the most common complication in NVG was hyphema which was seen in 6 eyes (15.8%). However, 9 patients in neovascular group developed no light perception (23.7%) compared with none in control group. According to their conclusion, NVG posed a greater risk to surgical failure and visual loss was probably due to progression of the underlying disease. The poorer visual outcome in their study as compared to ours was probably due to their longer follow-up.

Siempis et al, studied long-term outcome of AGV in refractory glaucoma.[18] Their results were like our study except that their mean follow-up was 48.5 months. Their mean preoperative IOP was 31.7±11.4, which was reduced to 13.9±4.2 after 5 years. The number of preoperative antiglaucoma eye drops was 3.8±1.4 which reduced to 2.4±1.4. The five-year success rate was 65.2% (based upon consensus of World Glaucoma Association guidelines). Their commonest early complications were hyphema in 12.6% and transient hypotony in 8.1%. The most common late complication was encapsulated bleb in 15.1%. Their long-term results were better since they carried out follow up of all the refractory glaucoma collectively instead of considering NVG separately.

Recent studies over the last 10 years have reported a success rate ranging from 45% to 56% at 5 years. According to Lee et al, a success rate of 56% was observed, which was attributed to a higher proportion of neovascular glaucoma (NVG) cases (39.1%), which lowered the overall success rate.[19] Luzu et al, reported a lower success rate of 45.1% in refractory glaucoma after 5 years in their study.[20]

Mofti et al, studied Ahmed valve in pediatric glaucoma and concluded that short term outcome was good but deteriorated in 10 year-time-period.[21] Younger age and secondary pediatric glaucoma were associated with poorer results.

Shalabi et al, compared AGV and Baerveldt tube in NVG and concluded that outcome was similar except that Baerveldt tube required lesser number of antiglaucoma eye drops.[9] Failure was related to poorer initial vision, neglect in timely retinal treatment and bilateral involvement. In another study comparing AGV with Baerveldt tube for pars plana implantation in NVG, Baerveldt group required lesser postoperative medications.[22] However, 3-year results in both the groups showed effective IOP reduction and lesser complications.

Regarding the timing of surgery, Lee et al, concluded that in cases with NVG occurring after diabetic vitrectomy, early surgery within six days by Ahmed valve implantation may lead to a favorable response.[23]

Limitations of our study include small sample, retrospective nature and short postoperative follow-up of one year. A follow-up of 5 years may provide a better picture of long-term results. An early demise in some of the NVG cases due to ischemic nature of underlying disease barred a 5-year follow-up.

The strengths of this study are the comparative analysis of tube surgery between NVG and OSG, which has not been done in Pakistani patients before. One of the reasons for promising results in NVG is timely treatment of retinal ischemia by intravitreal anti-VEGF preoperatively and PRP postoperatively. All the surgeries were performed by the author himself, and meticulous record keeping was done with the purpose of subsequent analysis. Among the current armamentarium in the management of NVG, tube surgery offers the best outcome. However, in the long run, progression of the underlying ischemic disease can lead to further visual loss and early demise. Timely detection and early surgical management are of utmost importance to improve the results. Further studies should be carried out in a multidisciplinary manner by monitoring and managing the ocular and systemic disease simultaneously in order to improve the outcome in the long run.

CONCLUSION

Refractory glaucoma carries a poorer prognosis. They require aggressive surgical intervention to prevent complete visual loss. The most notorious among them is NVG. Ahmed glaucoma valve implantation is effective in saving useful vision and controlling IOP in the majority of these cases and the results are comparable between neovascular and other secondary glaucoma.

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Patient's Consent: Researchers followed the guidelines set forth in the Declaration of Helsinki.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval: The study was approved by the Institutional review board/Ethical review board **(Riphah/IIMC/IRC/23/3093)**.

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Author's Designation and Contribution

Aneeq Ullah Baig Mirza; *Professor: Concepts, Design, Literature search, Data acquisition, Data analysis, Statistical analysis, Manuscript preparation, Manuscript editing, Manuscript review.*