Original Article

Ahmed glaucoma valve in eyes with preexisting episcleral encircling element

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Background: To describe the use of Ahmed glaucoma valve (AGV) in the management of intractable glaucoma in eyes with a preexisting episcleral encircling element. **Materials and Methods:** This is a retrospective, consecutive, noncomparative study. The study included 12 eyes of 12 patients with a preexisting episcleral encircling element that underwent implantation of silicone AGV to treat intractable glaucoma during January 2009 to September 2010. **Results:** The mean patient age was 25.6 (standard deviation 17.1) years. Five (41.6%) patients were monocular. The indications for AGV were varied. The mean duration between placement of episcleral encircling element and implantation of AGV was 30.5 (33.8) months. The mean follow-up was 37.4 (22.9) weeks. Preoperatively, the mean intraocular pressure (IOP) was 31.4 (7.9) mmHg and the mean antiglaucoma medications were 2.8. At the final postoperative follow-up, the mean IOP was 12.5 (3.5) mmHg and the mean number of antiglaucoma medications was 0.8 ($P < 0.001$). The complications observed over the follow-up period did include corneal graft failure in three eyes, tube erosion in two eyes and rhegmatogenous retinal detachment in one eye. **Conclusion:** AGV is an effective option in the management of intractable glaucoma in eyes with a preexisting episcleral encircling element keeping in mind the possibility of significant postoperative complications.

Key words: Ahmed glaucoma valve, episcleral band, episcleral encircling element, scleral buckle

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Medically uncontrolled glaucoma in eyes with an episcleral encircling element is a difficult management challenge. Conjunctival scarring and recession caused by previous retinal surgery may decrease the likelihood of a successful trabeculectomy, despite the use of adjunctive antimetabolite.[1] A cyclodestructive procedure is a less-than-ideal management option due to its unpredictable and irreversible effect. While implantation of glaucoma drainage device is technically more difficult due to the presence of a retinal implant, it provides more predictable outcomes.

Various types of glaucoma drainage devices have been implanted in eyes with a preexisting episcleral encircling element. A tube placed through an incision in the fibrous capsule over an encircling band with the anterior end inserted into the anterior chamber has been tried.[2-4] Tube obstruction due to fibrous capping of the distal tube ostium caused several failures.[2,4] The Baerveldt[5] and trimmed Baerveldt[4] and Ahmed glaucoma valve (AGV)[6] implants were placed in a restricted conjunctival space. However, reduction in the surface area of the trimmed implant is of concern for adequate filtration of the aqueous.

The base plate of the silicone AGV is thinner, more flexible and has the same surface area compared with the earlier polypropylene model.[7] The silicone base plate, additionally, has a tapered profile for easy insertion.[7] These features make it possible to insert an AGV over the retinal implant. This, to the best of our knowledge, is the first series on implantation of an intact AGV in the management of intractable glaucoma in eyes with a preexisting episcleral encircling element.

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Materials and Methods

Study design

This was a retrospective, consecutive, noncomparative study. Patients with a preexisting episcleral encircling element who underwent implantation of a silicone AGV to treat intractable glaucoma during January 2009 to September 2010 at a large, tertiary care ophthalmic hospital were identified by means of operative records. Postsurgical follow-up of less than 6 weeks and inability to measure intraocular pressure (IOP) were the exclusion criteria.

Surgical procedure

The surgeries were performed by one of the four surgeons using a similar technique. The surgical procedure was performed under general anesthesia or a peribulbar block. The conjunctival incision was made at the corneal limbus or at 4-5 mm behind and parallel to the limbus, at the operating surgeon's discretion, for approximately 100° in the supero-temporal quadrant. A careful dissection was done antero-posteriorly in the sub-conjunctival plane. The AGV (model FP7, New World Medical, Rancho Cucamonga, LA, USA) was primed by injecting 1-2 ml balanced salt solution. The plate of AGV was placed over the episcleral encircling element; either encircling band or scleral buckle [Figure 1]. The plate was secured to the underlying sclera with 8-0 nylon suture material (M/S GN Corporation Ltd., Yamanashi, Japan) such that its anterior edge lied 8 mm behind the corneal limbus. This was followed by placement of the silicone tube into anterior chamber or pars plana

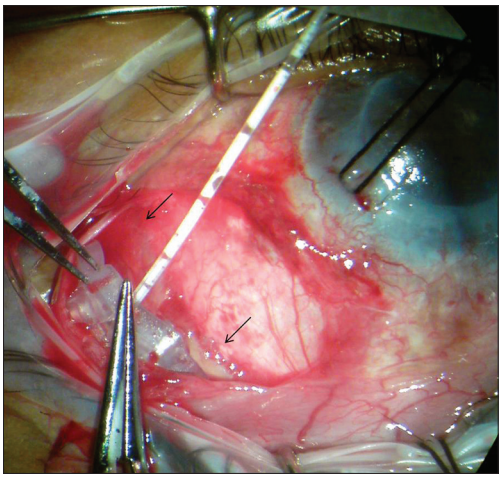

Figure 1: The base plate of Ahmed glaucoma valve being placed over the episcleral encircling element that is indicated by arrows

region through a 23-gauge needle track. The silicone tube was shortened to the desired length prior to insertion. The anterior part of the tube was covered with previously prepared human donor scleral patch graft. Fibrin sealant (Tisseel kit, Baxter AG, Vienna, Austria) or 8-0 nylon suture material was used to secure the scleral patch graft. The overlying conjunctiva was sutured with 8-0 polyglactin suture material (Ethicon Inc., Aurangabad, India). If there was limited mobility of the conjunctiva due to prior surgeries, relaxing incisions were given in the conjunctiva and/or amniotic membrane transplantation was considered. The eye was inspected for any leaks after the anterior chamber was inflated using balanced salt solution.

Preparation of donor scleral graft

The donor scleral tissue preserved in absolute alcohol was used in every case. The tissue was cleaned of all the uveal tissue attachments, washed thoroughly with balanced salt solution and cut into the desired size (4-5 × 4-5 mm).

Data collection and analysis

The data collection included information on patient demography, diagnosis of glaucoma, prior ocular surgeries, measurement of visual acuity, IOP, number of antiglaucoma medications at pre-AGV and every post-AGV follow-up visit, duration between placement of episcleral encircling element and AGV, and complications, if any. Visual acuity was measured using Snellen visual acuity chart. We measured IOP either by applanation tonometer, namely, Goldmann tonometer (Haag-Streit, Switzerland), a hand-held Perkin's tonometer (Haag-Streit, Essex, UK), or by Tonopen XL (Reichert ophthalmic instruments, Walden ave. Depew, NY, USA). The cause (s) for low vision and postoperative reduction in visual acuity, if any, were also recorded. Surgical success was defined as a final IOP between 5 and 22 mmHg without (complete success) or with topical antiglaucoma medication (s) (qualified success) and without any vision threatening complication. Descriptive statistics were calculated. Paired *t*-test was used to compare measurements of IOP and number of antiglaucoma medications at the preoperative and the final visits. Data analysis was done using SPSS software version 15.0 for Windows (SPSS Inc., Chicago, IL, USA).

Results

Fourteen patients underwent implantation of AGV in eyes with a preexisting episcleral encircling element during the study period. Two patients were excluded as their IOP could not be measured. Table 1 shows the patients data. Table 2 shows the demographic and preoperative data. Five (41.6%) patients were monocular. Ten eyes (83.3%) had number 240 episcleral encircling band. Two eyes (16.6%) had undergone placement of a circumferential scleral buckle in the supero-temporal quadrant. In one of these eyes with scleral buckle, we gave two relaxing incisions in the conjunctiva for adequate wound closure. The shunt plate was additionally covered with two layers of cryo-preserved human amniotic membrane to reduce the chances of exposure of this implant in the postoperative period. Table 3 shows the postoperative data. The mean (standard deviation) duration between placement of episcleral encircling element and implantation of AGV was 30.5 (33.8) months; median, 11.5 months. The mean follow-up was 37.4 (22.9) weeks; median, 33.5 weeks. The mean preoperative IOP was 31.4 (7.9) mmHg; median, 32mmHg with an average of 2.8; median, 3 medications. At last postoperative follow-up, the mean IOP decreased to 12.5 (3.5) mmHg; median, 14 mmHg with 0.8; median, 0.5 medications. The postoperative reduction in IOP and in number of antiglaucoma medications was statistically significant ($P < 0.001$, paired *t*-test).

Corneal graft failure occurred in three eyes in late postoperative period following implantation of AGV (cases 4, 7, 9). In one of these eyes, the AGV tube was placed in the pars plana region. In the remaining two eyes, the AGV tube was placed in the anterior segment, however, there was no tube-cornea touch. The mean duration between placement of AGV and corneal graft failure was 7.3 (5.3) months; median, 8.5 months. Tube erosion occurred in another two eyes in late postoperative period (cases 10, 11). Case 12 reported reduced vision at sixth postoperative week and was found to have a rhegmatogenous retinal detachment.

Discussion

In this series, we describe implantation of the silicone plate AGV in eyes with a preexisting episcleral encircling element. This novel use of Ahmed valve can be helpful in the management of intractable glaucoma after the encircling procedure.

Sidoti *et al.*[2] described the use of a silicone tube to shunt aqueous from the anterior segment to the fibrous capsule surrounding a previously placed episcleral encircling element. Using the existent fibrous capsule around the encircling element as an aqueous reservoir obviated the need for temporary restriction of the aqueous flow to allow encapsulation. They also avoided introduction of additional hardware into the orbit. Qualified control of IOP was achieved in 11 (85%) of 13 patients. Early postoperative complications attributable to hypotony were few and self-limiting. However, eight instances of fibrous obstruction of the distal tube opening occurred within 4 months of the initial procedure. Each instance necessitated surgical revision. Suh *et al.*[3] also reported high overall success rate with the same technique, but they studied only seven eyes. Smith *et al.*[4] modified the technique by using a valved (plate less) Krupin-Denver tube. No case of early postoperative hypotony occurred, although

Table 1: Patient data

No./ eye	Age/ sex	Preoperative diagnosis	Prior surgery	Preoperative			Postoperative			FU	Comments, complications
				VA	IOP	Rx	VA	IOP	Rx		
1/R	33/M	Neovascular glaucoma	L+V+BB, Trab+MMC	6/60	24	3+1	6/60	8	0	27	Delayed postoperative hyphema, tube in pars plana
2/L	36/M	SiO glaucoma	L+V+BB+PFCL+EL+SOI, SOR+ECPC, TSCPC, PK	HM	40	2+1	PL	14	0	21	Postoperative traumatic wound dehiscence, re-suturing done
3/R	11/F	Aphakic glaucoma	Cataract, Squint Sx, V+BB+FGE+C_3F_8, Trab+MMC	6/36	26	0	6/36	11	0	20	AGV was done 4 weeks after trab as bleb was failing and could not be rescued
4/R	7/M	Posttraumatic glaucoma	Corneal tear repair, Memb+AV, Memb+V+BB+EL+TSC+SOI, SOR+EL+ECPC+ERM Removal, PK	HM	29	2+1	PL	11	2	40	Post-AGV corneal graft failure, decided not to further intervene
5/L	13/M	SiO glaucoma	Cataract, V+BB+EL+SOI	6/60	44	2+1	6/36	14	1	18	AGV combined with SOR, uniocular diplopia due to large PI
6/L	5/F	Congenital glaucoma	Trab+MMC, L+V+BB+PFCL+EL+SOI	FF	32#	1	FF	30	0	12	Prescribed topical combination Rx, no subsequent follow up
7/R	56/M	Secondary glaucoma	PK+ECCE+IOL, Limbal tear repair+IOL Explant[n], V+BB+FGE+TSC+C_3F_8	HM	32	2	CF@ 2mt	14	2	74	Post-AGV corneal graft failure, underwent repeat PK
8/L	35/M	Uveitic glaucoma	SB	6/18	38	2+1	6/18	15	3	52	Post-AGV cataract Sx with IOL
9/R	39/F	Secondary ACG	TPK×2, PKE+IOL, Corneal wound repair, V+BB+EL+SOI; SOR, PK	6/36	32	3+1	CF@ 2mt	16	1	64	Posttraumatic IOL extrusion, corneal graft failure at last follow up
10/R	18/M	Secondary ACG	Cataract extract[n], V+BB+IOL removal+EL+SOI+ILO, SOR, Vit lavage+ECPC	6/36	36	3+1	6/60	13	0	60	Tube erosion 52 weeks post-AGV, underwent tube repositioning and sclera patch grafting
11/R	46/M	SiO glaucoma	Cataract extract[n], V+BB+EL+SOI, SOR+ECPC, TSCPC	6/36	14	3+1	6/24	16	1	55	High myope, tube erosion 36 weeks post-AGV, underwent conjunctival and scleral patch grafting
12/L	9/M	Posttraumatic glaucoma	L+V+BB+EL+ECPC+SOI, SOR	6/60	30	3	CF@ 0.2mt	4	0	6	RD at last follow up

VA: Visual acuity, IOP: Intraocular pressure, Rx: Number of antiglaucoma medications, FU: (duration of postoperative) Follow-up (in weeks), R: Right eye, L: Left eye, M: Male, F: Female, SiO: Silicone oil, ACG: Angle closure glaucoma, L: Lensectomy, V:Vitrectomy, BB: Belt buckle (episcleral encircling band), Trab: Trabeculectomy, MMC: Mitomycin C, SB: Scleral buckle, PFCL: Perfluorocarbon liquid, EL: Endoscopic laser, SOI: Silicone oil implantation, SOR: Silicone oil removal, ECPC: Endoscopic cyclophotocoagulation, TSCPC: Trans-scleral (diode) laser cyclophotocoagulation, PK: Penetrating keratoplasty, FGE: Fluid gas exchange, C_3F_8: Octafluoropropane (gas), Memb: Membranectomy, AV: Anterior vitrectomy, TSC: Transsclera cryo, ERM: Epiretinal membrane, ECCE: Extra-capsular cataract extraction, IOL: Intraocular lens, TPK: Therapeutic penetrating keratoplasty, PKE: Phacoemulsification, ILO: Indirect laser ophthalmoscopy, AMT: Amniotic membrane transplantation, PL: Light perception, FF: Fixates and follows light, HM: Hand movements, CF: Counting fingers, mt: Meters, FT: Finger tension, AGV: Ahmed glaucoma valve, RD: Retinal detachment. Underlined serial number indicates monocular status. IOP with #sign indicates the recorded IOP is an average of three measurements with Tonopen XL at 5% standard deviation

two (29%) of seven eyes experienced distal tube occlusion necessitating surgical revision.

Scott *et al*.[5] described an alternative approach to manage refractory glaucoma in eyes with a preexisting encircling band. They inserted 250- (7 eyes [44%]) or 350-mm^2 (9 eyes [56%]) Baerveldt drainage devices behind or over a preexisting encircling band and over the adjacent recti muscles. The fibrous capsule overlying the encircling band was excised in the quadrant of surgical implantation. The implant was sutured to the sclera or the encircling band using fixation holes. Nine patients (56%) achieved complete success and seven patients (44%) achieved qualified success at 1 year postoperatively. Implant migration or exposure and diplopia did not develop in any patient over the median follow-up of 22.9 months. However, it might be unsafe to insert a large sized implant in the presence of an encircling band in all four quadrants due to the effects of crowding. It may be that this study with limited number of patients does not reflect the true outcome.[5] The incidence of postoperative diplopia has been shown to be significantly higher with the Baerveldt than any other implant.[8] This is the reason Smith *et al*.[4] trimmed the wings of Baerveldt implants to debulk them before insertion in eyes with a preexisting episcleral encircling element.

Latina *et al*.[6] described implantation of an amputated pediatric Ahmed valve. The valve abutted against the anterior portion of the scleral band and was sutured into position. The valve function of the implant was retained to reduce postoperative hypotony. However, the reduction in the surface area of the trimmed drainage implant is of concern as the extent of IOP reduction with glaucoma drainage implants has been demonstrated to be directly proportional to the surface area of the fibrous capsule.[9,10]

The episcleral encircling element limits the space for placement of a glaucoma drainage implant. Additionally,

Table 2: Demographic/pre-operative data

Age (years)	
Mean±SD	25.6±17.1
Median (range)	25.5 (5-56)
Male:Female	3:1
Aphakia, number (%)	11 (91.6)
Diagnosis, number (%)	
Congenital glaucoma	1 (8.3)
Silicone oil-induced glaucoma	3 (25)
Posttraumatic glaucoma	2 (16.6)
Neovascular glaucoma	1 (8.3)
Secondary angle closure glaucoma	2 (16.6)
Other secondary open angle glaucoma	3 (25)
Visual acuity at the time of AGV implantation, number (%)	
≥6/12	0
6/15-6/60	8 (66.6)
<6/60	4 (33.3)
IOP at the time of AGV implantation in mmHg	
Mean±SD	31.4±7.9
Median (range)	32 (14-44)
No. of antiglaucoma medications	
Mean±SD	2.8±1.2
Median (range)	3 (0-4)
Prior antiglaucoma surgeries, no (%)	
Trabeculectomy with MMC	3 (25)
ECPC	3 (25)
TSCPC and ECPC	2 (16.6)
Duration in months between episcleral encirclage and AGV	
Mean±SD	30.5±33.8
Median (range)	11.5 (2-90)

SD: Standard deviation, IOP: Intraocular pressure, AGV: Ahmed glaucoma valve, MMC: Mitomycin C, ECPC: Endoscopic cyclophotocoagulation, TSCPC: Transscleral (diode) laser cyclophotocoagulation

Table 3: Postoperative data

Follow-up (weeks)	
Mean±SD	37.4±22.9
Median (range)	33.5 (6-74)
Outcome analysis by final IOP,* number (%)	
Complete success	3 (25)
Qualified success	5 (41.6)
Failure	3 (25)
Visual acuity, number (%)	
≥6/12	0
6/15-6/60	6 (50)
<6/60	6 (50)
IOP in mmHg	
Mean±SD	12.5±3.5
Median (range)	14 (4-16)
No. of antiglaucoma medications at last follow-up	
Mean±SD	0.8±1 0.5
Median (range)	(0-3)
Complications at last follow-up, No (%)	
Delayed hyphema	1 (8.3)
Posttraumatic wound dehiscence	1 (8.3)
Uniocular diplopia due to inadvertent large iridotomy	1 (8.3)
Corneal graft failure	3 (25)
Tube erosion	2 (16.6)
Retinal detachment	1 (8.3)
Visual acuity outcome	
Better	1 (8.3)
Same	7 (58.3)
Worse	4 (33.3)

*One patient did not follow-up after antiglaucoma medication was prescribed

it may be difficult to mobilize adequate conjunctiva to cover the implant in eyes with a preexisting episcleral encircling element, especially a scleral buckle. An implant with minimum-sized end-plate that is sufficient to achieve IOP control is preferable in such eyes. Increasing the surface area of the end-plate appears to be beneficial only up to 270 mm^2.[8] A randomized controlled clinical trial showed comparable failure rates at 1-year for both AGV and 350 mm^2 Baerveldt implants.[11] Therefore, AGV should be preferred over Baerveldt implant in eyes with a preexisting episcleral encircling element. Moreover, the base plate of the newer silicone Ahmed valve (model FP7) is thinner (0.9 mm) and has the same surface area (184 mm^2) compared with the earlier polypropylene model S2 (thickness 1.9 mm).[7] The silicone base plate is also flexible and has a tapered profile for easy insertion.[7] These features allowed us to insert a silicone AGV over the episcleral element in our patients. One can also make use of a long, curved surgical scissor for better access to the supero-temporal quadrant, and guide the base plate of the AGV into position over the partly open blades of the scissor.

Two patients in our series had preexisting scleral buckle in the supero-temporal quadrant (cases 8 and 12). The Ahmed valve was implanted over the buckle in these eyes. However, the procedure was difficult in one eye (case 12) due to multiple prior surgeries. We gave a couple of relaxing incisions in the surrounding conjunctiva for adequate wound closure. The shunt plate was additionally covered with two layers of cryo-preserved human amniotic membrane, as described by Amini *et al.*[12] to reduce the chances of exposure of the implant in the postoperative period. Despite these efforts, the anterior edge of the scleral patch graft covering the implant tube did expose in the early postoperative period. However, the exposed surface did epithelise over the next 3 weeks.

Nonimmunological corneal graft failure occurred in three (25%) eyes in this study. One of them had prior corneal graft failure (case 9). In two of these three eyes, the AGV tube was placed in the anterior segment, however, there was no demonstrable tube-cornea touch. Corneal graft failure is not uncommon in eyes with a glaucoma drainage implant. Kwon *et al.*[13] found corneal graft failure in 24 (43.6%) out of 55 eyes that had undergone both penetrating keratoplasty (PK) and either Baerveldt or Ahmed glaucoma implant. Hollander *et al.*[14] also found poor long-term survival of corneal grafts in their study of 77 eyes that underwent PK following AGV implantation. The grafted corneas failed in 46 [59.1%, (95%

confidence interval: 47.5-71.2%)] eyes at 3 years. The majority of graft failures were unassociated with immunologic rejection. Prior PK and stromal vessels, but not tube-cornea touch, did increase the risk of graft failure.[14]

Erosion of drainage tube through the overlying conjunctiva was seen in two eyes despite meticulous conjunctival closure and the use of a scleral patch graft. Both eyes underwent early repair as tube erosion carries with it increased risk of endophthalmitis.[15] One patient (case 12) experienced retinal detachment after implantation of an AGV. He was a high myope, suffered from posttraumatic retinal detachment and developed secondary glaucoma following retinal detachment repair. He presented with recurrent rhegmatogenous retinal detachment 6 weeks after the implantation of AGV. Retinal detachment as a complication of glaucoma drainage device has been reported in as many as 16% cases with varied risk factors.[16,17] Nevertheless, considering the presence of multiple risk factors for retinal detachment, the complication may not necessarily be related to the implantation of AGV in our case.

Conventional filtration surgery such as trabeculectomy was either not possible or carried an unacceptably high risk of failure in these eyes. Known frequent complications such as early postoperative hypotony, shallow anterior chamber, tube obstruction, and conjunctival wound leak were not detected in this series. Even so, the overall postsurgical complications do appear frequent in this series; however, many patients maintained useful vision that they could potentially have lost since all had uncontrolled glaucoma prior to surgery.

The retrospective design and the heterogeneity of the cases are major limitations of this study. The sample size is small and therefore, we did not analyze complete and qualified success separately. One-third (4 out of 12) cases had undergone PK. Three of these cases experienced corneal graft failure following AGV implantation. This suggests that previous PK may be a contraindication for the procedure. Future studies with more sample size may provide additional information in this regard. However, the clinical situations in which the procedures were done were extremely severe and until now none of the proposed treatments have gained general acceptance. This study, for the first time, shows that the silicone, flexi-plate Ahmed valve can be effectively implanted in eyes with a preexisting episcleral encircling element keeping in mind the possibility of significant postoperative complications.

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