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ORIGINAL ARTICLE

Novel Method of Conjunctival Revision for Encapsulated Blebs after Ahmed Valve Implantation

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Background: Encapsulation after Ahmed glaucoma valve (AGV) is difficult to manage and sometimes results in treatment failure. We proposed a novel conjunctival revision method to improve intraocular pressure (IOP) control due to encapsulation after AGV implantation. The efficacy and safety of this method in refractory glaucoma patients were evaluated. **Methods:** The present study was done in a clinical trial design. Patients of encapsulation after AGV implantation for at least 6 months were enrolled and divided into three groups (control group, single revision group, and repeated revision group). Characteristics such as visual acuity, glaucoma type, IOP change, underlying diabetes mellitus, and complications were assessed. **Results:** In total, 120 patients were enrolled in this study, and they were randomly divided into three groups on a 1:1:1 base. At the study end, there were 28 patients in the control group, 32 patients in single revision group and 37 patients in repeated revision group. The results showed that the conjunctival revision method significantly reduced the mean IOP of the encapsulated eyes on day 1 after the procedure (24.5 ± 6.3 to 11.8 ± 3.4 mmHg in single revision group and 25.1 ± 4.7 to 10.2 ± 2.3 mmHg in repeated revision group, respectively). The eye pressure was remained relatively low during follow-up visits for 4.17 ± 4.2 months in single revision group, whereas stable IOP could be maintained in repeated revision group for 10.43 ± 3.7 months in average. Changes in preoperative and postoperative visual acuities and the refraction errors were insignificant. Only mild complications occurred and most resolved without treatment. **Conclusions:** The conjunctival revision could relieve entrapped subconjunctival aqueous and therefore reduced IOP temporarily with single procedure, and IOP could be maintained with repeated procedures. This method is suggested to be a safe and simple alternative for refractory glaucoma patients developed encapsulation after AGV implantation.

Key words: Ahmed valve implant, conjunctival revision, encapsulation

INTRODUCTION

Glaucoma drainage device (GDD) is one of the solutions to manage complicated and refractory glaucoma, especially in patients with prior failed trabeculectomy history. It is implanted into sub-Tenon's space to drain aqueous drainage through a tube inserted into either anterior or posterior chamber with scleral suturing.[1] Ahmed glaucoma valve (AGV), a valved GDD, possesses a Venturi-type unidirectional valve, in which a folded silicone elastomer membrane is used. The valve is set to be passively opened at an intraocular pressure (IOP) of 8 mmHg.[2] AGV has been reported to reduce the rate of postoperative hypotony,[3,4] whereas nonvalved GDDs exhibit better reduction in IOPs.[5]

Asians receiving GDDs implantation have been reported to have more severe tissue reactions than the other races,[4,6] although the success rate of AGV implantation still ranged from 74% to 87% at 12 months.[2,7] A previous study has shown that 23% of AGV implantation resulted in encapsulation cysts, and 84% of the cysts needed to undergo surgical excision in

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the long term.[8] Currently, there are some effective treatments in these situations such as needling revision and surgical excision. However, needling revisions with antifibrotic adjuvant may only provide temporarily pressure relief and surgical excision may induce further extensive scarring. There is a great need for effective treatment of dilemma. In the present study, a novel conjunctival revision was proposed and evaluated for its efficacy and safety both at single and repeated procedures. It was hypothesized to effectively reduce the IOP without extensive scarring due to its minimally invasive procedure. Differences in preoperative and postoperative IOP and surgical complications during the follow-up period after this procedure were determined.

METHODS

In this study, we evaluated the participants from January 2011 to December 2016. The protocol was approved by the Institutional Review Board of the Tri-Service General Hospital and conducted in accordance with the tenets set out in the Declaration of Helsinki.

The inclusion criteria were as follows: (1) failure of AGV implantation and (2) failure of AGV implantation was defined as IOP elevation >21 mmHg with encapsulation formation despite the use of maximal antiglaucoma therapy (≥3 medications), ocular massage, and oral IOP-lowering agents at least 6 months after the AGV implantation operation. The exclusion criteria were as follows: (1) other ocular surgeries except laser peripheral iridotomy, trabeculectomy, and AGV implantation within the study period, (2) poor adherence to eye drops, (3) failure due to other causes except encapsulation, such as tube kinking, tube obstruction, corneal touch, tube migration out of anterior chamber, retinal or choroidal detachment, (4) inability to undergo ophthalmic examinations by slit lamp, and (5) follow-up visits <12 months.

The following information of each participant were collected and analyzed: age, gender, visual acuity (VA), glaucoma diagnosis, prior ocular surgery, glaucoma medications, and IOP within 12 months from enrolled into the study [Table 1]. Visual acuities were measured by logMAR VA testing (Chart 2210, Precision Vision, LaSalle, IL, USA). IOP measurements were performed by the same physician using applanation tonometry.

All patients underwent AGV (model S3 or FFP8) implantation by one physician (DW Lu, MD, PhD) through the standard technique. Briefly, after priming the AGV, it was implanted under the superotemporal or superonasal fornix-based conjunctival flap and fixed by 8-0 prolene sutures. Then, the tube was trimmed to an appropriate length with a bevel-up tip and then inserted into the anterior chamber through the corneoscleral incision under a triangular scleral flap. Finally, a scleral graft was covered on the tube and the conjunctival flap was closed by 8-0 Vicryl sutures. After the surgery, all patients received topical antibiotics and corticosteroids for 4–8 weeks.

Table 1: Baseline characters of patients with encapsulation after Ahmed valve implantation

	Group I (*n*=28), *n* (%)	Group II (*n*=32), *n* (%)	Group III (*n*=37), *n* (%)
Gender			
Male	13 (43)	18 (56)	21 (57)
Female	15 (50)	14 (44)	16 (43)
Diagnosis of glaucoma			
POAG	4 (14)	4 (13)	7 (19)
Chronic angle closure	6 (21)	7 (22)	5 (14)
Cornea transplant	1 (4)	4 (13)	4 (11)
Neovascular glaucoma	12 (43)	10 (31)	10 (27)
Uveitis	3 (11)	3 (9)	6 (16)
Trauma	2 (7)	3 (9)	4 (11)
Aniridia	0 (0)	1 (3)	1 (3)
Baseline IOP-lowering agents			
≥3	24 (86)	24 (77)	29 (78)
2	4 (14)	8 (25)	8 (22)
1	0 (0)	0 (0)	0 (0)
Mean	3.36	2.59	3.16

IOP=Intraocular pressure; POAG=Primary open-angle glaucoma

The patients enrolled in this study were then randomly divided into the following three groups: Group I was the control group, patients in this group can only receive anti-glaucomatous agents; Group II was the single conjunctival revision group, patients in this group can only undergo single conjunctival revision and then only anti-glaucomatous agents were allowed; and Group III was the multiple conjunctival revision group, patients in this group can receive more than one conjunctival revision procedures and anti-glaucomatous agents depend on physician's evaluation.

The conjunctival revision was performed by the same physician. The patient sat in front of the slit lamp with their lesion eye premedicated with Vigamox (Moxifloxacin 0.5%, Alcon Laboratories, Inc.) and Alcaine (0.5% Proparacaine Hydrochloride, Alcon Laboratories, Inc). During the procedure, the patient was requested to look down constantly. Two horizontal superficial incisions of the conjunctiva by 25-G needle were made over the fibrous encapsulation around the body of AGV [Figure 1]. The depth of incisions was as deep as possible, with penetration

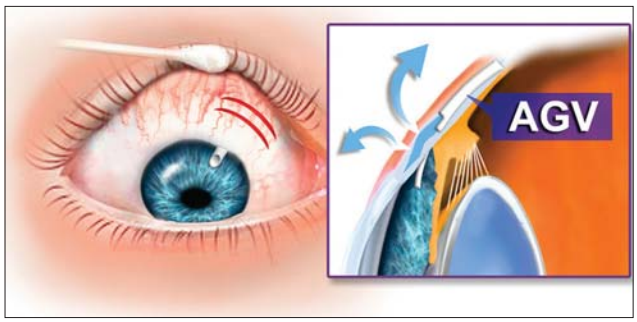

Figure 1: Two horizontal superficial incisions of the conjunctiva by 25G needle were made over the fibrous encapsulation around the body of Ahmed glaucoma valve

into encapsulation bleb. Copious flow of aqueous was or was not noted. Then, 0.1 ml of 0.02 mg/ml mitomycin-C was injected into the bleb. After the procedure, the patient was prescribed with regular topical corticosteroids and antibiotics. IOP was measured on preoperative day (before the procedure), day 0 (immediately after the procedure), and day 1 and at 1 week, 2 weeks, and every month. Complications were recorded with each visit.

During the following visits, antiglaucoma agents were prescribed as an adjuvant to reduce IOP elevation and medications if any would be included in the analysis. Criteria for successful outcome were IOP <21 mmHg with or without medication, whereas an IOP >21 mmHg was considered as a failure. Patients with IOP >21 mmHg were reexamined and treated with additional procedures such as modified conjunctival revision or surgical excision. Complications were recorded at follow-up visits.

All the data were collected and analyzed using the SPSS (SPSS for Windows, version 16.0, SPSS Inc., Chicago, IL, USA). Differences between the preoperative IOPs and the IOPs that were measured at each follow-up examination were analyzed using the Wilcoxon signed-rank tests. A Kaplan–Meier life table analysis was applied to access the survival times of the procedure. All statistical assessments were evaluated at the $P \leq 0.05$ level for statistically significant differences.

RESULTS

A total of 120 patients were enrolled in this study. The mean age was 58 (standard deviation [SD] = 14.2) years. All patients received prior antiglaucomatous surgical procedures before their AGV implantation. The mean number of surgical procedures before AGV implantation in whole group was 1.8 ± 0.3. The mean preoperative (baseline) IOP of all patients was 24.5 mmHg (SD 6.3). There were 40 patients in each group at the beginning of the study. At the end visit of the study (12th month), numbers of patients dropped from the study were 12 in Group I, 8 in Group II, and 3 in Group III, respectively. As a result, there were 28 patients in Group I, 32 patients in Group II, and 37 patients in Group III into further analysis. The mean time between AGV implantation and first conjunctival revision was 10.3 ± 2.9 months (Group II and Group III).

During the follow-up visits, VA, IOP, and IOP-lowering agents were analyzed. Immediately after the procedure, the mean IOP was decreased from 24.5 ± 6.3 to 13.8 ± 2.6 mm Hg (the only one procedure in Group II and first procedure in Group III). (Data not shown). Only 9 patients (4 in Group II and 5 in Group III) exhibited IOP elevations early in their 1st month (IOP more than 21 mmHg in <4 weeks), who were neovascular glaucoma (3 in Group II and 4 in Group III), uveitis (1, Group II), and postpenetrating keratoplasty (1, Group III). Following IOP curve monthly in each group, IOP dropped significantly in Group II and Group III in the first 4 months, and IOP in Group II elevated significantly from Group III after the 5th month (14.2 ± 4.7 mmHg in Group II and 10.8 ± 3.7 mmHg in Group III, $P < 0.05$) [Figure 2]. IOP in Group II elevated progressively after the procedure and was to the insignificantly level with IOP in Group I after the 9th month (25.6 ± 4.2 mmHg in Group I and 21.5 ± 4.8 mmHg in Group III, $P = 0.17$). Definition of success after either one or multiple procedures was IOP more than 21 mmHg regardless of antiglaucomatous agent usage. At the first 3-month time point, success rate was 57.14% (16/28) in Group I, 69.23% (18/26) in Group II, and 94.74% (36/38) in Group III [Figure 3]. The mean period of success was 4.17 months (SD = 4.2) in Group II and 10.43 months (SD = 3.7) in Group III.

The mean number of IOP lowering medication was decreased from 3.3 ± 0.84 to 1.2 ± 0.44 at the first 3-month time point (Group two and Group three). VA varied without significant changes perioperatively except for those with hyphema temporally. The patients developing mild-grade hyphema after the procedure regained their visual acuities after hyphema resolution to the level before the procedures.

The majority of complications were conjunctival hemorrhage (57.7%) and conjunctival hematoma (19.2%) [Table 2]. All of these appeared to spontaneously resolve by observation only, and there were no cases of infectious endophthalmitis or blebitis in this study.

DISCUSSION

In the present study, we proposed that a modified conjunctival revision method represents a solution for IOP elevations due to encapsulation around AGV in refractory glaucoma patients. We reported a temporary relief of

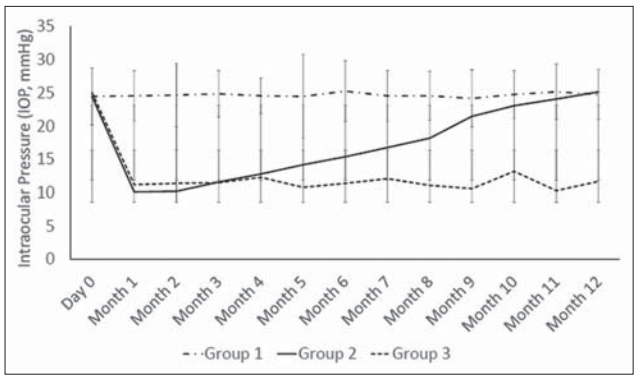

Figure 2: Intraocular pressure measured in three groups from day 0 to month 12

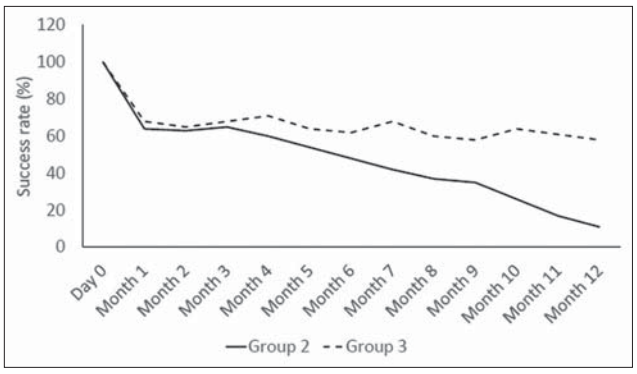

Figure 3: Success rate measured in three groups from day 0 to month 12

Table 2: Complications after conjunctival revision procedures

	Group II (*n*=32), *n* (%)	Group III (*n*=37), *n* (%)
Conjunctival hemorrhage	15 (46.9)	21 (56.8)
Conjunctival hematoma	5 (15.6)	7 (19)
Hyphema	2 (6.3)	4 (10.8)
Shallow anterior chamber	3 (9.4)	5 (13.5)
Hypotony	2 (6.2)	1 (2.7)

encapsulation after AGV implantation. The modified conjunctival revision procedure resulted in a decrease in mean IOP by 10.7 mmHg. The mean effective period to control elevated IOP despite antiglaucoma agents was approximately 5.17 months (SD = 4.2). The success rates of needling or bleb revision in previous reports have been reported to range from 77% to 96% based on different definitions of success and inclusion/exclusion criteria.[9-11] However, these studies mainly are focused on bleb formation after trabeculectomy. Eibschitz-Tsimhoni *et al*. reported that 11 out of 57 patients developed encapsulation after AGV implantation and failed to respond to initial medical therapy. The patients underwent surgical revision of capsulation with a success rate of 84% at 12 months.[8] Compared with Eibschitz-Tsimhoni study, in which 44% of patients (25/62) received no ocular surgery preoperatively, all patients enrolled in this study received other previous antiglaucomatous surgeries. In addition, most of participants in this study had diffuse and moderate-to-severe scar tissue in the conjunctiva due to prior surgeries or underlying ocular pathologies. In our study, high portion of participants were diagnosed with neovascular glaucoma with failure of trabeculectomy. Our results showed a noninferior relative success rate of 65.4% (17/26) in the first 3 months with the minimally invasive method. Nonetheless, this effect seemed to last for 6 months [Figure 2]. The vigorous scarring and neovascularization probably are postulated to contributing factors. We have organized another trial to evaluate the efficacy of repeated modified conjunctival revision method to control IOP in this situation.

Therapeutically, GDD is considered one of the managements for refractory glaucoma patients who have previous surgery failure and ineffective medications. AGV is one of the GDDs used to drain aqueous to the subconjunctival space through its baseplate. It has advantages over other GDDs, including immediate IOP reduction, reduced risk of hypotony, and relative ease of implantation.[12] However, the AGV has disadvantages owing to its valved design. Higher rates of bleb encapsulation and lower IOP-reducing efficacy are both concerns of postoperative care.[12] AGV implantation has been shown effective in some difficult conditions, such as neovascular glaucoma, corneal grafts, and uveitic glaucoma.[6,13-15] However, we have reported that neovasuclar glaucoma was the major risk factor of AGV implantation failure, and the overall success rate was 43% at 2 years within 24.2% neovascular glaucoma participants.[2] In the present study, 39.3% (10/26) of patients were neovascular glaucoma patients, and they showed a trend toward early failure of AGV. It is suggested that most encapsulation cases after AGV implantation could be benefit from this procedure.

Shin *et al*. have stated that high IOP before and immediate after the needling and lack of mitomycin-C use during the filtration surgery are risk factors leading to the failure of needling revision with 5-fluorouracil for failed conjunctival filtration blebs.[16] We previously reported that neovascular glaucoma was among the factors with increasing likelihood for failure.[2] In this study, we found that neovascular glaucoma or uveitis patients with recurrent high IOP after the procedure have high early failure rate. In general, the AGV has a good prognosis in neovascular glaucoma patients. We observed that neovascular glaucoma and uveitis patients undergoing this procedure of modified conjunctival revision are likely

exhibited hyphema and postoperative inflammation, which might contribute to early IOP elevation and even the failure of the procedure.

Fibrous encapsulation around the baseplate of GDDs forms an aqueous pool initially and then drains out aqueous through diffusion of this encapsulation and overlying conjunctiva. The major controlling factor of aqueous drainage is the resistance through the baseplate and the encapsulation.[17] From a histopathological report of Molteno implants, components of encapsulation around the baseplate vary depending on whether aqueous is drained or not.[18] If the aqueous initially is drained to the conjunctival space and the postoperative IOP is below 12 mmHg, use of Molteno implant leads to a progressive fibrosis encapsulation with limited permeability.[18] In our study, the proposed procedure of the modified conjunctival revision involved two incisions made by a 25-G needle tip over the conjunctiva and the encapsulation around the baseplate. It is implied that these two conjunctival incisions not only expand the diffusion area of the conjunctival surface but also reduce the resistance for aqueous drainage.

The most common postoperative complications in our study were conjunctival hemorrhage, conjunctival hematoma, and shallow anterior chamber. Some complications related to needling are well-known, such as prolonged hypotony,[19,20] delayed bleb leaks,[21] suprachoroidal hemorrhage, blebitis[21] or intraocular infection, and endothelium decompensation if 5-fluorouracil as adjuvant leaks into the anterior chamber. The recurrence of encapsulation in a relatively short period has been reported.[8] The modified conjunctival revision method led to a relatively high rate of conjunctival hemorrhage which was transient and healed without treatment. The modified conjunctival revision method is suggested to be inexpensive and relatively safe for controlling IOP as compared with the needling method.

There were some limitations to our study. First of all, the sample size used in this study was relatively small. However, as AGV is indicated only for the most refractory glaucoma patients, few patients were confronted with device failure and or fail to achieve IOP control postoperative using antiglaucoma agents. Second, although the Ahmed model S2 is widely used in adult glaucoma patients, the pediatric model S3 was used in this study. As tight space for surgery and insufficient conjunctiva to cover a usual adult-sized Ahmed valve (S2) are commonly encountered, we used the S3 model instead of S2 model with modifications as described by Law and Latina.[22,23] It is known that the Ahmed valve has a smaller diffusion area in the S3 model (96 mm^2) as compared with the S2 model (184 mm^2). We have demonstrated that effective IOP control using S3 is achievable. [2] Third, we provide a simple method which can proceed in silt lamp for temporally relief of IOP elevation due to encapsulation in AGV implantation patients. Therefore, we expect that it can be reproduced by other physicians with a similar outcome. However, a further prospective long-term study which will enroll patients with different ages, more than one physician may be needed to clarify these issues.

CONCLUSION

The modified conjunctival revision seemed to be a safe and simple alternative option for temporary relief of IOP elevation due to encapsulation in AGV implantation patients. In this study, no serious adverse events were observed. This procedure may be indicated to exert IOP-lowering effect except the traditional needling method.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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