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Research Article

Short-Term Clinical Outcomes Following Baerveldt Glaucoma Implantation with Mitomycin C for Neovascular Glaucoma After Vitrectomy for Proliferative Diabetic Retinopathy

Masashi Sakamoto*, Izumi Yoshida, Ryuya Hashimoto, Asao Sakai, Hidetaka Masahara and Takatoshi Maeno

Department of Ophthalmology, Toho University Sakura Medical Center, Sakura-shi, Japan

***Corresponding Author:** Masashi Sakamoto, Department of Ophthalmology, Toho University Sakura Medical Center, Sakura-shi, Chiba, Japan.

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Abstract

The aim of this retrospective, comparative study was to examine the short-term clinical outcomes following Baerveldt glaucoma implantation (BGI) with mitomycin C (MMC) for neovascular glaucoma (NVG) after vitrectomy for proliferative diabetic retinopathy (PDR). All patients were followed up for longer than 12 months postoperatively. Intraocular pressure (IOP) was measured before and after surgery. Seven eyes in 7 subjects (5 men, 2 women; mean age 59.3 ± 15.0 years) were enrolled and followed up for a mean of 17.0 ± 2.6 months. The mean IOP was significantly lower at the 1-month, 6-month, and final follow-up visits (10.0 ± 3.3, 16.6 ± 1.2, and 16.3 ± 2.5 mmHg, respectively) than at the preoperative visit (29.4 ± 6.3 mmHg, $P < 0.05$). These results support the conclusion that BGI with MMC can effectively reduce IOP in eyes with NVG after vitrectomy for PDR in the short term.

Keywords: *Glaucoma Implantation; Mitomycin C; Neovascular Glaucoma; Baerveldt Glaucoma Implantation; Proliferative Diabetic Retinopathy*

Abbreviations

BGI: Baerveldt Glaucoma Implantation; GGD: Glaucoma Drainage Device; IOP: Intraocular Pressure; MMC: Mitomycin C; NVG: Neovascular Glaucoma; PDR: Proliferative Diabetic Retinopathy; SD: Standard Deviation

Introduction

Postoperative neovascular glaucoma (NVG) is a complication of vitrectomy in eyes with proliferative diabetic retinopathy (PDR) and occurs in 2% - 18% of cases [1-6]. Trabeculectomy for NVG has a poor outcome and it has been reported that the main prognostic factor for failure of trabeculectomy is previous vitrectomy [7]. A glaucoma drainage device (GDD) is a valuable tool in the management of patients in whom filtering surgery has failed or as the first surgical option in patients at high risk of failure [8].

Tube shunt surgery with implantation of a GDD reduces intraocular pressure (IOP) by increasing aqueous outflow. The aqueous liquid flows from the anterior chamber via the inserted tube and oozes out around to the plate sutured onto the posterior sclera.

Complications, including a shallow anterior chamber and corneal endothelial decompensation, have been reported following insertion of a GDD tube into the anterior chamber [9-13]. The pars plana GDD is designed to avoid these complications [12], but requires thorough resection of the vitreous by vitrectomy to avoid occlusion of the tube by vitreous. Therefore, if the patient has already undergone a vitrectomy for PDR, pars plana GDD is considered a good device for NVG after vitrectomy. Unfortunately, previous studies of GDD implants in eyes with NVG has reported bad outcomes [14,15]. However, use of mitomycin C (MMC) when implanting an Ahmed glaucoma valve increases the success rate when performed for refractory glaucoma [16,17].

Baerveldt glaucoma implantation (BGI) surgery with MMC for NVG after vitrectomy has not been reported previously. This study examines the surgical outcomes and complication rates of BGI with MMC performed for NVG after vitrectomy for PDR.

Materials and Methods

The protocol for this retrospective study was approved by the ethics committee at Toho University Sakura Medical Center (approval number S16047). All study conduct adhered to the tenets of the Declaration of Helsinki. In accordance with the clinical research guidelines of the Japanese Ministry of Health, Labour, and Welfare, the study design was explained to subjects using the hospital's website. We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during this research.

Study subjects

The medical records of consecutive patients who underwent BGI surgery with MMC for NVG after vitrectomy for PDR were retrospectively reviewed. All patients underwent surgery at Toho University Sakura Medical Center between June 2017 and June 2017 and were followed up for at least 12 months after surgery.

Baerveldt glaucoma implant surgery

Sub-Tenon's anesthesia was administered, and a conjunctival incision was made along the corneal limbus to expose the superior and lateral rectus muscles. Cotton-tipped applicators soaked in 0.05% MMC were placed under the conjunctiva and Tenon in the operation area for 4 minutes followed by copious irrigation with balanced salt solution. A 6 × 6-mm fornix-based lamellar scleral flap was created, and a 25-gauge infusion line was placed in the inferotemporal quadrant. The other two ports were created under the scleral flap on the scleral flap side and on the conjunctiva on the other side. Endophotocoagulation was performed in all cases. The Baerveldt implant tube was knotted using 8-0 polyglactin suture thread because aqueous flow through the device must be restricted until plate encapsulation and insertion beneath the lateral and superior rectus muscles in the superotemporal quadrant is completed. The anterior edge of the plate was then anchored to the sclera using 5-0 polyester suture thread. Next, a sclerotomy was made 3.5 mm to the limbus under the scleral flap using a 20-gauge V-lance. The Hoffmann elbow was inserted through the sclerotomy and fixed in place with 8-0 nylon thread. The Hoffmann elbow was then covered by the scleral flap, which was sutured closed using 10-0 nylon thread. A Sherwood slit was made using a microblade to avoid early postoperative elevation of IOP. Finally, the infusion cannula was removed, and a continuous suture was used to close the conjunctival incision.

Study parameters

IOP (measured using a Goldmann applanation tonometer), visual acuity, and number of hypotensive medications being taken at the 1-month, 6-month, and final visits were compared with the values recorded at the preoperative visit. A previous study had shown that the effect of a combination of topical IOP-lowering agents is equivalent to that of an oral hypotensive agent [14,15]. Therefore, we counted the number of hypotensive medications as follows: single medication drops = 1 medication; combination medication drops = 2 medications; and an oral hypotensive agent = 2 medications. BGI surgery was considered successful if the IOP was normal (6 - 22 mmHg) without use of oral hypotensive medication, visual acuity at the final visit was light perception or better, and further glaucoma surgery was not needed.

Statistical analysis

Paired t-tests were used to compare the IOP values and number of hypotensive medications used before and after surgery. All statistical analyses were performed using Statcel software (OMS, Saitama, Japan). A P-value < 0.05 was considered statistically significant.

Results

Seven eyes of 7 subjects (5 male, 2 female; mean age 59.3 ± 15.0 years) were followed up for 17.0 ± 2.6 months postoperatively. All eyes had previously undergone combined lensectomy, vitrectomy, and implantation of an intraocular lens.

The mean IOP was 29.4 ± 6.3 mmHg at the preoperative visit and 10.0 ± 3.3, 16.6 ± 1.2, and 16.3 ± 2.5 mmHg at the 1-month (P = 0.0001), 6-month (P = 0.0011), and final follow-up (P = 0.0011) visits, respectively (all comparisons with the preoperative value were performed using the paired t-test; Table 2). There was a significant reduction in the number of hypotensive medications used from 5.4 ± 0.9 before surgery to 1.0 ± 1.1 after surgery (final visit, P = 0.0004, paired t-test; Table 3). Visual acuity was stable or improved in 5 (71.4%) of 7 eyes, and all eyes had a visual acuity better than light perception at the final follow-up visit. Therefore, we rated BGI surgery as successful in all cases.

						Preoperative visit			Final postoperative visit			
Case	Sex	Age (years)	Glaucoma type	Vitreous status	Prior intraocular surgeries	LogMAR VA	IOP (mmHg)	Number of hypotensive drugs	LogMAR VA	IOP (mmHg)	Number of hypotensive drugs	Follow-up (months)
1	M	42	NVG	—	1	0.70	27	4	0.70	16	3	20
2	M	75	NVG	—	1	1.70	29	5	1.40	16	0	20
3	F	67	NVG	—	1	0.70	42	7	0.82	15	0	18
4	M	36	NVG	—	1	0.70	35	6	1.00	21	1	18
5	M	51	NVG	—	1	0.30	25	5	0.30	18	0	16
6	M	76	NVG	—	1	0.82	23	6	0.30	16	1	14
7	F	68	NVG	—	1	1.40	25	5	1.05	12	2	13
Mean	----	59.3	----	----	----	0.90	29.4	5.4	0.80	16.3	1.0	17.0
SD	----	15.0	----	----	----	0.44	6.3	0.9	0.37	2.5	1.1	2.6

Table 1: *Demographic and ophthalmic characteristics of patients who underwent Baerveldt glaucoma implant surgery for neovascular glaucoma.*

F: Female; IOP: Intraocular Pressure; logMAR: Logarithm of the Minimum Angle of Resolution; M: Male; NVG: Neovascular Glaucoma; SD: Standard Deviation; VA: Visual Acuity

	Intraocular pressure (mmHg)			
Case	Before surgery	1 month	6 months	Final visit
1	27	7	16	16
2	29	10	16	16
3	42	9	16	15
4	35	17	19	21
5	25	7	17	18
6	23	12	17	16
7	25	8	15	12
Mean	29.4	10.0	16.6	16.3
SD	6.3	3.3	1.2	2.5
P-value*	----	0.0001	0.0011	0.0011

Table 2: *Intraocular pressure before and after Baerveldt glaucoma implant surgery.*

**Comparison with the preoperative value, paired t-test. SD, standard deviation.*

	Hypotensive drugs, n	
Case	Preoperative visit	Final postoperative visit
1	4	3
2	5	0
3	7	0
4	6	1
5	5	0
6	6	1
7	5	2
Mean	5.4	1.0
SD	0.9	1.1

Table 3: *Number of hypotensive drugs used before and after Baerveldt glaucoma implant surgery.*

SD: Standard Deviation.

There were no surgery-related complications, such as exposure of the tube and plate or endophthalmitis. In all cases, the Hoffmann elbow was successfully covered with the lamellar scleral flap.

Discussion

GDDs inserted via the pars plana route are used to manage IOP in eyes with refractory glaucoma, particularly when there is conjunctival scarring from previous intraocular surgery. A GDD implanted via the pars plana route reduces IOP as effectively as a GDD inserted into the anterior chamber and is not associated with a shallow anterior chamber or endothelial disorders.

Postoperative NVG is associated with vitrectomy in eyes with PDR and occurs at a rate of 2% - 18% [1-6]. Previous studies of GDD implants in eyes with NVG reported success rates of a 56% - 67% [14,15]. Encapsulated cyst formation is one of the main reasons for failure [18]. Proliferation of fibrous tissue around the implant plates blocks the diffusion of aqueous humor and elevates IOP [19]. Adjunctive use of antimetabolites can greatly inhibit fibrosis, and MMC has been used extensively with GDDs. Use of MMC for Ahmed glaucoma valve implant surgery increases the success rate in eyes with refractory glaucoma [16,17]. Therefore, we used MMC for BGI when performed for NVG. A surgical success rate of 100% was observed in this study.

Use of MMC with trabeculectomy has been reported to have side effects, including development of thin-walled blebs leading to overfiltration, hypotony, and serious complications such as hypotonic maculopathy, late-onset bleb leak, bleb infections, and endophthalmitis. On the other hand, GDD surgery is associated with an increased risk of infection following tube shunt surgery when the Hoffmann elbow, tube, or plate is exposed [20]. Therefore, a lamellar scleral flap or preserved sclera (in eyes with a scarred or thinned sclera) is used to cover the Hoffmann elbow, and the tube and plate must also be covered by conjunctiva. There has been concern about thinning of the sclera and conjunctiva when MMC is used in this procedure, but there were no instances of exposure of plate, tube or Hoffman elbow during the follow-up period in our present study.

It has been reported that the concentration of vascular endothelial growth factor in intravitreal fluid is decreased after vitrectomy for PDR if endophotocoagulation is also performed [21,22]. Conversely, it has been thought that the residual retinal detachment and nonperfusion area without photocoagulation leads to an increase in the inflammatory cytokine concentration. The high concentration of inflammatory cytokines is thought to induce bleb encapsulation [7]. It has been reported that combined vitrectomy and trabeculectomy has a poor outcome because of bleb encapsulation induced by inflammation [23]; however, because the Baerveldt implant tube is knotted using 8-0 polyglactin suture thread, the intraocular fluid flows to the plate for a few months after BGI surgery. We consider that the inflammation caused by vitrectomy including endophotocoagulation during BGI surgery is not related to the proliferation of fibrous tissue around the implant plates because the inflammation decreases until a few months that 8-0 polyglactin absorb. Endophotocoagulation can be performed easily during surgery using a pars plana GDD. We performed endophotocoagulation in the gaps between photocoagulation scars in all our cases.

Our study had several limitations. First is its retrospective design, small sample size, and lack of uniformity in the data. Second, the patients were only followed up for 1 year. It has been reported that use of MMC with an Ahmed valve does not increase the long-term success rate [24], so studies with longer follow-up are needed to assess the long-term risks of plate exposure and elevated IOP following BGI with MMC. Third, because the effect of use of MMC is not unclear, further randomized studies with and without MMC are needed. A magnetic resonance imaging study found that the volume of the filtration bleb was significantly larger in successful cases than in unsuccessful cases [25]. Therefore, bleb evaluation by magnetic resonance imaging will be needed in further studies with and without MMC.

Conclusion

In this study, there was a significant decrease in IOP from preoperative levels following BGI with MMC for postoperative NVG. However, further investigation of the long-term outcomes of this operative strategy is needed.

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Conflicts of Interest

There are no conflicts of interest to declare.

Author Contributions

M.S. and I.Y. conceived the study design and conduct; M.S., R.H., A.S., and T.M. collected the data; M.S., I.Y., R.H., A.S., and T.M. participated in data management, analysis, and interpretation; M.S., I.Y., R.H., A.S., and T.M. prepared, reviewed, and approved the manuscript.

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