SCIENTIFIC REPORT

Baerveldt glaucoma implant insertion in the posterior chamber sulcus

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Aim: To report the clinical outcome of a surgical technique for insertion of the silicone tube of a Baerveldt glaucoma implant (BGI) in the posterior chamber sulcus.

Methods: Non-comparative, interventional case series. Eight eyes of eight patients, with a follow-up of at least 18 months, who underwent insertion of a BGI with the silicone tube placed in the posterior chamber sulcus between 1998 and 2005 were included. Control of intraocular pressure (IOP), number of pressure-lowering medications, visual acuity and surgical complications were recorded.

Results: Eight eyes of eight patients (mean (range) age 76.4 (62–94) years) were included in the study. The IOP was reduced from a preoperative mean (SD) of 28.2 (14.4) to 12.6 (5.8) mm Hg at 18 months. The mean (SD) number of preoperative medications for IOP control was reduced from 2.8 (1.5) to 1.3 (1.5) medications in the same period. No complications were observed during surgery or follow-up.

Conclusion: Placement of the silicone tube in the posterior chamber sulcus is a safe and effective alternative technique for IOP control in patients with pseudophakia. Sulcus placement may reduce the likelihood of corneal endothelial loss and avoid the need for pars-plana vitrectomy and posterior segment tube insertion in complicated eyes.

In eyes with shallow anterior segments, compromised corneal endothelial function, or previous corneal grafts, tubes in the anterior chamber may increase the risk of corneal endothelial injury and lead to corneal oedema or graft failure.^{1–6} Although the mechanisms are unknown, progressive endothelial damage in patients with tubes in the anterior chamber may occur from mechanical endothelial damage from tube–endothelium contact during eye rubbing, eye movements or blinking.^{7,8}

An approach to maximising the distance between the tube and the corneal endothelium is the insertion of the glaucoma device into the anterior vitreous cavity after pars-plana vitrectomy. This procedure has become a common practice in patients with concurrent or previous corneal transplantation, corneal endothelial pathology or shallow anterior chambers.^{7–12} Although pars-plana vitrectomy is relatively safe in experienced hands, vitrectomy and insertion of the tube into the posterior segment carries significant risks,^{7,8} including retinal detachment, greater postoperative inflammation, endophthalmitis, vitreous haemorrhage or vitreous incarceration in the tube lumen.

The posterior chamber sulcus is a potential anatomic space for tube placement in patients with posterior chamber intraocular lens implants. This space is bounded anteriorly by the iris pigment epithelium, posteriorly by the ciliary processes, and more centrally by the anterior zonular fibres and the lens capsule. The sulcus is an option for haptic support of a posterior chamber lens when the lens capsule is disrupted or when the capsule–zonular diaphragm lacks sufficient strength. An

advantage of this anatomic space is the increase in its anterior–posterior length after cataract extraction due to the smaller thickness of the intraocular implant compared with the crystalline lens. Previously, Rumelt and Rehany¹³ reported a small series of three patients who underwent implantation of the tube, either a Molteno implant or Ahmed valve, in the posterior chamber sulcus.

In this manuscript, we report a technique for implantation of the silicone tube of the Baerveldt glaucoma implant (BGI) into the posterior chamber sulcus in patients with pseudophakia as an alternative to either anterior chamber or pars-plana insertion.

PATIENTS AND METHODS

This retrospective study was conducted in accordance with the tenets of the Declaration of Helsinki of 1975 and the New York Eye and Ear Infirmary institutional review guidelines. Each patient gave written informed consent after the nature, risks and possible adverse consequences of the procedure had been explained. One surgeon (CT) performed the procedure at one centre (New York Eye and Ear Infirmary, New York, New York, USA).

The charts of all patients undergoing BGI insertion through the posterior chamber sulcus and having at least 18 months of follow-up were reviewed. All patients were either with pseudophakia, with a posterior chamber intraocular lens placed in the capsular bag, or underwent cataract extraction and intraocular lens placement at the time of the BGI implantation. Patients were selected for BGI surgery on the basis of uncontrolled intraocular pressure (IOP) after maximally tolerated medical treatment, prior laser trabeculoplasty, and at least one failed trabeculectomy (six eyes). In two patients, BGI was the initial surgical intervention because of extensive conjunctival scarring after retinal detachment repair.

The following data were collected for each eye preoperatively and during postoperative visits: visual acuity, IOP, number of pressure-lowering medications, and intraoperative and postoperative complications. Ultrasound biomicroscopy was performed in a majority of patients to evaluate the position of the tube in the sulcus. Successful IOP control was defined by Goldmann tonometry readings between 5 and 20 mm Hg.

Surgical technique

A 350 mm² BGI (Advanced Medical Optics, Santa Ana, California, USA) was used in all cases. The surgery was performed under local anaesthesia with sub-Tenon's injection of lidocaine 1% in a preservative-free solution. A superotemporal 4–5 clock-hour conjunctival peritomy was created and the space between Tenon's capsule and sclera carefully dissected. After priming the implant with balanced salt solution, a 7-0 polyglactin suture was used to ligate the silicon

Abbreviations: BGI, Baerveldt glaucoma implant; IOP, intraocular pressure

Figure 1 Technique of implantation in the posterior chamber sulcus. (A) After the plate has been fixed to the sclera, the tube end is cut bevel-up making sure that the tip will be within the pupil. (B) A temporal paracentesis is performed with a 75° blade. (C) Viscoelastic is injected into the sulcus. (D) A track is created for tube insertion with a 23 G needle. (E) The tube is inserted to the posterior chamber and located in the sulcus, making sure that the tip is located within the pupillary axis. (F) The tube is secured to the sclera with a 9-0 nylon suture.

tube approximately 2 mm proximal to the plate. Once the lateral and superior rectus muscles were isolated with muscle hooks, the wings of the plate were placed under the muscles and the central part of the plate sutured to the underlying sclera with a 9-0 nylon suture. The tube was trimmed in a bevel-up fashion to have an intraocular segment of approximately 4–5 mm (fig 1A). A temporal paracentesis was created with a 75° blade (fig 1B) and preservative-free lidocaine 1% solution injected into the anterior chamber. Sodium hyaluronate (Healon, Advanced Medical Optics, Santa Ana, California, USA) was injected into the posterior chamber sulcus to enlarge

it using a 27-gauge cannula (fig 1C) so as to facilitate the entry of the 23-gauge needle and avoid trauma to the iris and ciliary-zonular-capsule diaphragm. The tube was then carefully introduced through the track of a 23-gauge needle located 2.5 mm posterior to the limbus and directed toward the centre of the pupil (fig 1D) and placed parallel to the posterior iris and the intraocular implant, making sure that half of the bevel-up sector was within the pupil (fig 1E). The tube was then secured to the underlying sclera with a 9-0 nylon suture (fig 1F) and covered with a lyophilised pericardial patch graft and conjunctiva. Subconjunctival steroids and antibiotics were injected at the end of the procedure. Postoperatively, patients received topical antibiotics for 7 days and prednisolone acetate 1% that was tapered according to the degree of intraocular inflammation. All patients had an orphan trabeculectomy without anti-fibrotic agents for temporary IOP control.

RESULTS

Eight eyes of eight patients (mean (SD) age 76.4 (9.6) years; range, 62–94 years) met the entry criteria and were included. Mean (SD) follow-up was 23.2 (7.2) months (range, 18–36 months). Four patients had primary open-angle glaucoma, two had exfoliative glaucoma, one had neovascular glaucoma and one developed glaucoma after penetrating keratoplasty. Four patients had undergone previous laser trabeculectomy and trabeculectomy with mitomycin C, two patients had undergone only trabeculectomy with mitomycin C and two patients had BGI placement as the primary procedure for IOP control (table 1). Seven patients were pseudophakic before device implantation. One patient underwent simultaneous cataract extraction and tube placement. Three patients had a previous corneal transplant in the eye where the tube was inserted.

The IOP was reduced from a preoperative mean (SD) of 28.2 (14.4) mm Hg to a postoperative mean (SD) at 18 months of 12.5 (5.9) mm Hg ($p = 0.016$). The mean (SD) number of preoperative medications for IOP control was reduced from 2.8 (1.5) to 1.3 (1.5) at the end of the follow-up period. There were no intraoperative or postoperative complications and additional glaucoma surgery was not required for any patient. Ultrasound biomicroscopy evaluation did not show any angle recession, cleft, iridodialysis, ciliary body detachment or tube rubbing against the posterior surface of the iris.

DISCUSSION

Implantation of a glaucoma tube shunt into the posterior chamber sulcus may minimise the deleterious effects of anterior chamber placement and avoid the complications associated with surgical vitrectomy during pars-plana insertion.

Table 1 Follow-up, previous surgical procedures and changes in intraocular pressure and pressure-lowering medications before and after insertion of the glaucoma implant

Patient	Age (years)	Diagnosis	Follow-up (months)	Previous IOP-lowering operations	Other surgical procedures	IOP before surgery	IOP 1 week after surgery	IOP 6 weeks after surgery	IOP change at latest follow-up	Medicines change
1	83	POAG	20	LTP, Trabec MMC	Phaco	56	33	8	-47	-2
2	62	POAG	33	LTP, Trabec MMC	Phaco	12	23	19	1	1
3	81	XFG	24	Trabec MMC	Phaco, PKP	31	16	14	-20	0
4	68	POAG	18	LTP, Trabec MMC		19	12	9	-10	0
5	73	POAG	18	None	Scleral Buckle, phaco	28	22	16	-2	-2
6	75	XFG	36	Trabec MMC	Scleral Buckle, Phaco, PKP	15	11	9	-5	-5
7	94	NVG	18	LTP, Trabec MMC	Phaco	25	26	16	-9	0
8	74	Post-PKP	19	None	Phaco, PKP	40	10	10	-31	-4

IOP, intraocular pressure; LTP, laser trabeculectomy; NVG, neovascular glaucoma; PKP, penetrating keratoplasty; POAG, primary open-angle glaucoma; Trabec MMC, trabeculectomy with mitomycin C; XFG, exfoliative glaucoma.

Figure 2 Slit-lamp examination showing postoperative outcome in different patients. (A) External examination shows a quiet conjunctiva covering the plate and the scleral patch covering the tube entrance behind the limbus. (B) A quiet anterior chamber at 19-, (C) 24- and (D) 33-months of follow-up.

Sulcus implantation is at least comparable to the standard insertion into the anterior chamber or the more time consuming and complicated pars-plana tube insertion.

In the present small series, there was an absence of postoperative inflammation or posterior synechiae. One might have expected that inserting the tube in a limited space and in close proximity to the iris would create substantial inflammation, particularly considering that the tube could rub against the posterior iris surface. However, the absence of pigment release or anterior uveitis suggests that minimal or no contact between the silicone tube and the iris exists. Placement of the bevelled tube tip within the pupillary space avoids contact between the iris border and silicone tube and could minimise inflammation. Interestingly, patients are not aware of the presence of the tube near the visual axis.

The technique is easily performed once experience with the surgical steps is attained. We believe the most important technical points to be the injection of viscoelastic between the posterior chamber implant and the iris before inserting the tube, and the placement of the silicone tube bevel-up, with the pupillary margin covering part of the tube bevel. However, more cases and a longer follow-up are needed to determine the frequency of complications, if any.

It is noteworthy to discuss cases 3, 6 and 8, where the tube was inserted into the posterior chamber sulcus in the presence of a previous corneal graft. A standard approach to these cases would be to perform a pars-plana vitrectomy and place the tube in the vitreous cavity to preserve the graft endothelial integrity. However, during close follow-up for 24, 36 and 19 months, no change in visual acuity or sign of corneal graft rejection has been observed and the IOP remains controlled without uveitis or pigment release in all eyes.

Limitations of the present study are its retrospective design, small number of samples, limited follow-up and lack of corneal endothelial counts before the procedure. This technique is amenable for use with other glaucoma drainage devices as most of them have a silicone tube of identical dimensions to the Baerveldt implant. The effectiveness of this implantation technique in cases of uveitic glaucoma or glaucoma with concurrent episodes of intraocular inflammation is unknown and the implantation of the silicone tip in the posterior chamber sulcus could be hypothetically detrimental, considering that microscopic and continuous touch between

Figure 3 Postoperative outcome after 24-months' follow-up of tube insertion in the sulcus in a patient with penetrating keratoplasty. (A) A clear corneal graft without signs of intraocular inflammation is observed with a superonasally located tube. (B) Ultrasound biomicroscopy images confirming the location of the tube in the posterior chamber sulcus parallel to the iris and lens. (C) Bevelled tip seen within the pupillary axis.

the tube and the iris may occur with resultant intraocular inflammation. There were no patients with uveitic glaucoma in our series.

In conclusion, implantation of the silicone tube into the posterior chamber sulcus is a safe alternative technique for IOP control in patients with pseudophakia. The procedure could potentially limit long-term damage to the corneal endothelium and avoid the need for pars-plana vitrectomy and tube insertion in the posterior segment in individuals who are at a high risk for corneal decompensation or with shallow anterior segments. Further study is required to validate the long-term safety and efficacy of this technique.

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