A modified technique for intraluminal stenting of glaucoma drainage devices: The guide-wire technique

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Glaucoma drainage tubes have become increasingly popular in the surgical management of uncontrolled glaucoma. Flow restriction is essential to prevent early postoperative hypotony with non-flow restrictive glaucoma drainage devices. Herein, we describe a new way of using a 3–0 Supramid suture as an intraluminal stent. This technique confers no risk of stent exposure, can be removed ab interno without disturbing the conjunctiva, and aids insertion of the tube into the anterior chamber through a scleral tunnel.

Key words: Drainage devices, glaucoma, glaucoma drainage tube, intraluminal stent, stent

Surgical Technique

The surgery begins with a routine glaucoma drainage procedure using either a Baerveldt tube (Advanced Medical Optics, Irvine, CA) or a Molteno-3 tube (Molteno Ophthalmics Limited, Dunedin, New Zealand). After the plate is secured to the sclera, the tube is trimmed in a bevel-up configuration and a 7–0 vicryl ligature is tied near the plate-tube junction. A 3–0 Supramid suture (S. Jackson Inc., Alexandria, VA) is fed into the tip of the tube and advanced towards the plate as far as possible [Fig. 1a]. The suture typically advances 3–5 mm before friction between the suture and the inner surface of the tube prevents further passage. The Supramid suture is then trimmed so that approximately 0.5 mm of suture protrudes beyond the tip of the tube. A scleral tunnel is made into the anterior chamber using a 23 gauge needle. The tube, with intraluminal Supramid stent in situ, is fed down the scleral tunnel into the anterior chamber [Fig. 1b]. Until this point, care is taken to keep the Supramid suture dry so that it remains stiff, as this helps to guide the tube through the scleral tunnel. Tube fenestrations are made between the ligature and scleral tunnel by puncturing the tube with a needle to permit early aqueous drainage before the ligature releases. The donor sclera is fixed and the conjunctiva is readvanced to the limbus and closed with sutures [Video 1]. Written informed consent was obtained from all patients prior to surgery and the study conformed to the Declaration of Helsinki.

Postoperatively, the Supramid stent can be removed ab interno if further intraocular pressure (IOP) lowering is required. Under aseptic conditions and using an operating microscope, a limbal paracentesis incision is made in the quadrant opposite the tube. The anterior chamber is filled

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with ophthalmic viscosurgical device (OVD). Intraocular end gripping micro forceps (23G retinal asymmetric peeling forceps, Bausch and Lomb Inc.) are used to grasp the stent and remove it through the paracentesis. The OVD is removed and the paracentesis sealed with stromal hydration. Although this is intraocular surgery, it is a minor procedure performed under topical anesthesia and takes less than 5 min.

**Results**

This technique was performed by the same surgeon on 11 consecutive eyes undergoing glaucoma drainage device surgery. The glaucoma drainage device was a Baerveldt tube in 10 cases and a Molteno-3 tube in one case. The indications for surgery were primary open-angle glaucoma (2 cases), glaucoma following retinal detachment surgery (1 case), uveitic glaucoma (2 cases), juvenile open-angle glaucoma (2 cases), Sturge-Weber syndrome (1 case), angle recession glaucoma (1 case), Axenfeld-Rieger syndrome (1 case), and primary congenital glaucoma (1 case). The mean preoperative intraocular pressure (IOP) in these 11 eyes was 26.7 ± 9.0 mmHg (median 24 mmHg, range 16–40 mmHg) on a mean of 3.2 ± 1.1 ocular hypotensive medications (median 4 medications). Mean postoperative IOPs were 18.1 ± 8.8 mmHg at day 1 (mean of 0.1 ± 0.3 medications), 22.2 ± 5.5 mmHg at day 7 (mean of 0.7 ± 1.1 medications), and 17.4 ± 7.3 mmHg at 3 months (mean of 1.5 ± 1.4 medications). The mean follow-up was 4.1 ± 1.4 months (range 3–7 months). The Supramid stent was removed in three eyes due to inadequate IOP control at the time points of 5 weeks, 9 weeks, and 3 months postoperatively. Following stent removal intraocular pressure and medication requirement decreased. One of these three cases developed persistent hypotony with choroidal effusions following stent removal. The initial indication for implant insertion was uveitic glaucoma. This was successfully corrected with ab interno reinsertion of Supramid stent into the internal OS of the tube.

**Discussion**

The “ripcord technique”, tunneling an intraluminal stent beneath the conjunctiva to where it can be accessed postoperatively if required,[3] has several drawbacks. The most serious of these is the risk of stent exposure, which can serve as a conduit for infection leading to colonization of the drainage tube and endophthalmitis. This complication was well described by Kwon et al. and we have also had several cases in our center.[3] In addition, suture removal requires a conjunctival incision, which can result in an aqueous leak and typically leaves the patient with a subconjunctival hemorrhage.

In our experience, our “guide-wire” technique is applicable to both Baerveldt and Molteno devices. It is an effective means of flow restriction, confers no risk of stent exposure, and allows stent removal without disturbing the conjunctiva. In addition, the Supramid stent improves the ease of insertion by helping to pass the tube through a scleral tunnel and visualize it entering the anterior chamber. Although our duration of follow-up is relatively short, we have observed no adverse effects from having Supramid suture protrude beyond the tip of the tube into the anterior chamber.

In our experience, this technique is an effective means of flow restriction. In the three eyes that had the stent removed, IOP and hypotensive medication use reduced. In addition, we have previously performed ab-interno retrograde insertion of 3–0 Supramid suture into the internal os of a Baerveldt tube to successfully control hypotony.[4] The initial indication for implant insertion in these cases was uncontrollable uveitic glaucoma and uncontrollable glaucoma in a patient with chronic iridocyclitis.[4] In these cases, a short segment of Supramid suture was passed across the anterior chamber and fed up the tube using micro forceps.[4] We have found this to be an effective way of managing postoperative hypotony with glaucoma tubes. Our favorable experience with this maneuver, and our results from this case series, suggest that stenting the internal os of glaucoma drainage tubes reduces aqueous drainage.

Our technique should be considered in the context of previously published methods for stenting non-flow restrictive glaucoma drainage devices. Stent materials have included 4–0 chromic suture,[5] 3–0 prolene,[5] 4–0 nylon, 5–0 nylon,[6] and 3–0 Supramid.[5,7,8] Several variations of the “ripcord technique” have been described such as introducing a Supramid suture stent for the entire length of the tube, passing the tube through a tight sclera tunnel to further reduce flow and avoid the need for an external ligature, and then checking flow rate on the
operating table by observing the dilution of fluorescein over the plate.\textsuperscript{[7]} Sharkawi \textit{et al.} described accessing subconjunctival Supramid ripcord post-op and partially withdrawing it by an amount titrated to IOP of the patient.\textsuperscript{[8]} In our experience, Supramid is more forgiving than nylon or prolene stents. Supramid swells to occupy the entire lumen but the material is porous, allowing aqueous to seep through it. In contrast, nylon and prolene stents are impermeable, forcing aqueous to flow around them. A short segment of nylon or prolene stent may impart little extra resistance to flow except for where the tube is compressed within the scleral tunnel, at which point the stent can plug the lumen entirely, like a cork in a bottle. For this reason, we believe Supramid is best suited to our technique as it usually does not completely obstruct flow.

Alessandro \textit{et al.} described inserting a XEN-45 \mu m gel stent ab externo into the anterior chamber, and feeding 4 mm of the gel stent into the lumen of an unligated Baerveldt tube.\textsuperscript{[9]} In their initial experience with 19 cases, the authors reported a mean day one postoperative IOP of 9.1 mmHg with no cases of hypotony.\textsuperscript{[9]} The technique has been criticized from a health economics perspective and for not permitting postoperative adjustment of flow,\textsuperscript{[10]} whereas our technique is not limited by these disadvantages. In 1994 Wright and colleagues described using a 3–0 prolene stent as a surgical tool to aid the passage of the tube into the eye through a scleral tunnel. The authors fed the suture down the tube from the plate-end and then removed it as soon the tube was inside the eye.\textsuperscript{[11]} Our guide-wire technique offers the same mechanical advantages but leaves a stent in situ. It also allows the tube to beligated before it is inserted into the eye.

We acknowledge that confidence in this technique would be improved if data were available for a larger number of patients with longer follow-up. This would better allow us to assess for any complications such as stent migration and effect on endothelium cell loss. However, the Supramid stent is most relevant to IOP control in the early postoperative period, whereas late IOP control is more dependent on bleb capsule porosity. Given our favorable experience, we feel that the available follow-up is adequate to showcase the technique. We also acknowledge that the disadvantage of our technique is that stent removal involves an intraocular procedure. However, stent removal is quick, safe, and has the advantage of not disturbing the conjunctiva.

In conclusion, we describe a novel technique of intraluminal stenting of glaucoma drainage devices that confers no risk of stent exposure. Furthermore, the technique has the additional advantage of serving as a surgical tool to help pass the tube into the eye and visualize it entering the anterior chamber. If required, the Supramid stent can be replaced ab interno to counter hypotony.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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