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Ab externo complete glaucoma drainage device occlusion with bulbed polypropylene suture

Daniel L. Liebman MD MBA[1], Cormac H. Nolan AB[1,2], Michael M. Lin MD[1*]
[1] Massachusetts Eye and Ear, Harvard Medical School Department of Ophthalmology, Boston, MA, USA
[2] Washington University in St. Louis School of Medicine, Saint Louis, MO, USA

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*Corresponding Author
Michael M. Lin MD
800 Huntington Ave
Boston, MA, USA 02115
E-mail: michael_lin@meei.harvard.edu

Introduction

Hypotony, both immediate and delayed, can arise after glaucoma shunt surgery and can lead to vision loss due to refractive shift, maculopathy, and choroidal detachment, among other reasons.[1–3] Despite careful surgical technique, postoperative hypotony can result in approximately 4.1% of eyes within 5 years of glaucoma drainage device (GDD) implantation, while hypotony maculopathy occurs in <1% of cases.[4,5] While many cases are uncomplicated or transient and can be managed medically with topical steroids and cessation of glaucoma medications, surgical revision is indicated when medical intervention fails to raise IOP sufficiently to reverse symptomatic hypotony.[6] When hypotony presents in patients postoperatively, several methods have been previously described to address the presumed overfiltration through the GDD, including occlusion of the tube by ab interno tube stenting or ligation[7–11], tube occlusion with cauterized suture[12], and transient ab externo stent ligature placement.[13] The following report describes a novel ab externo method of tube occlusion that achieved successful IOP restoration while requiring less internal manipulation and technical complexity than previously described techniques.

Case Report

A 66-year-old male with severe-stage primary open-angle glaucoma presented to the Massachusetts Eye and Ear glaucoma clinic with hypotony of the left eye, complicated by hypotony maculopathy, macular edema, and decreased vision. His ophthalmic history was notable for a trabeculectomy 12 years prior, which had scarred, followed by placement of a 250 mm^2 non-valved GDD (Ahmed ClearPath, New World Medical, Rancho

Cucamonga, CA, USA) with concurrent cataract extraction 2 years prior, subsequently followed by G-Probe cyclophotocoagulation (CPC) for refractory elevated intraocular pressure (IOP) 11 months prior. Following CPC, while postoperative day 1 IOP was 9 mmHg with pinhole visual acuity of 20/40, the patient developed persistent hypotony starting at postoperative week 1, with IOP consistently in the low-to-mid single digits, despite cessation of antihypertensive drops and intensive topical steroids. Visual acuity decreased from 20/40 to 20/1000 due to symptomatic hypotony maculopathy, with choroidal folds and macular edema. Treatment of his left eye hypotony was delayed for eleven months due to right eye IOP elevation necessitating urgent surgical intervention and subsequent follow-up care. Following stabilization of the right eye, the patient was consented for revision of the glaucoma drainage device of the left eye to address persistent hypotony. The aim of the procedure was complete occlusion of the tube, with the option for future reversibility in the event of subsequent IOP elevation.

Procedure

Paracentesis incisions in the nasal and superior cornea were made with a 15-degree blade. The anterior chamber was filled with cohesive viscoelastic to achieve physiologic IOP. A short (approximately 2 mm) fragment of 3-0 polypropylene suture was cut, and a bulbed tip was created with a low-temperature cautery device, which shortened the suture fragment to approximately 1.5 mm. This fragment was inserted into the anterior chamber, and two intraocular forceps were introduced into the anterior chamber, one to hold the tube and one to hold the bulbed suture fragment. There was difficulty fitting the large bulbed end of the suture into the tube. Therefore, the bulbed suture fragment was removed from the eye, and intraocular forceps were used to grasp and externalize the tip of the glaucoma tube via the superior paracentesis. Using tying forceps that were more robust than the intraocular forceps, the bulbed polypropylene suture fragment was easily inserted into the externalized tube lumen, bulbed end first, to achieve complete occlusion of the tube lumen. A short portion of the polypropylene fragment was left protruding from the tube lumen to facilitate removal in the future, if needed. The occluded tube was then reposited into the anterior chamber. Viscoelastic was irrigated out of the eye, and the paracentesis incisions were closed with interrupted 10-0 nylon sutures. Intracameral moxifloxacin was instilled, and the eye was patched and shielded.

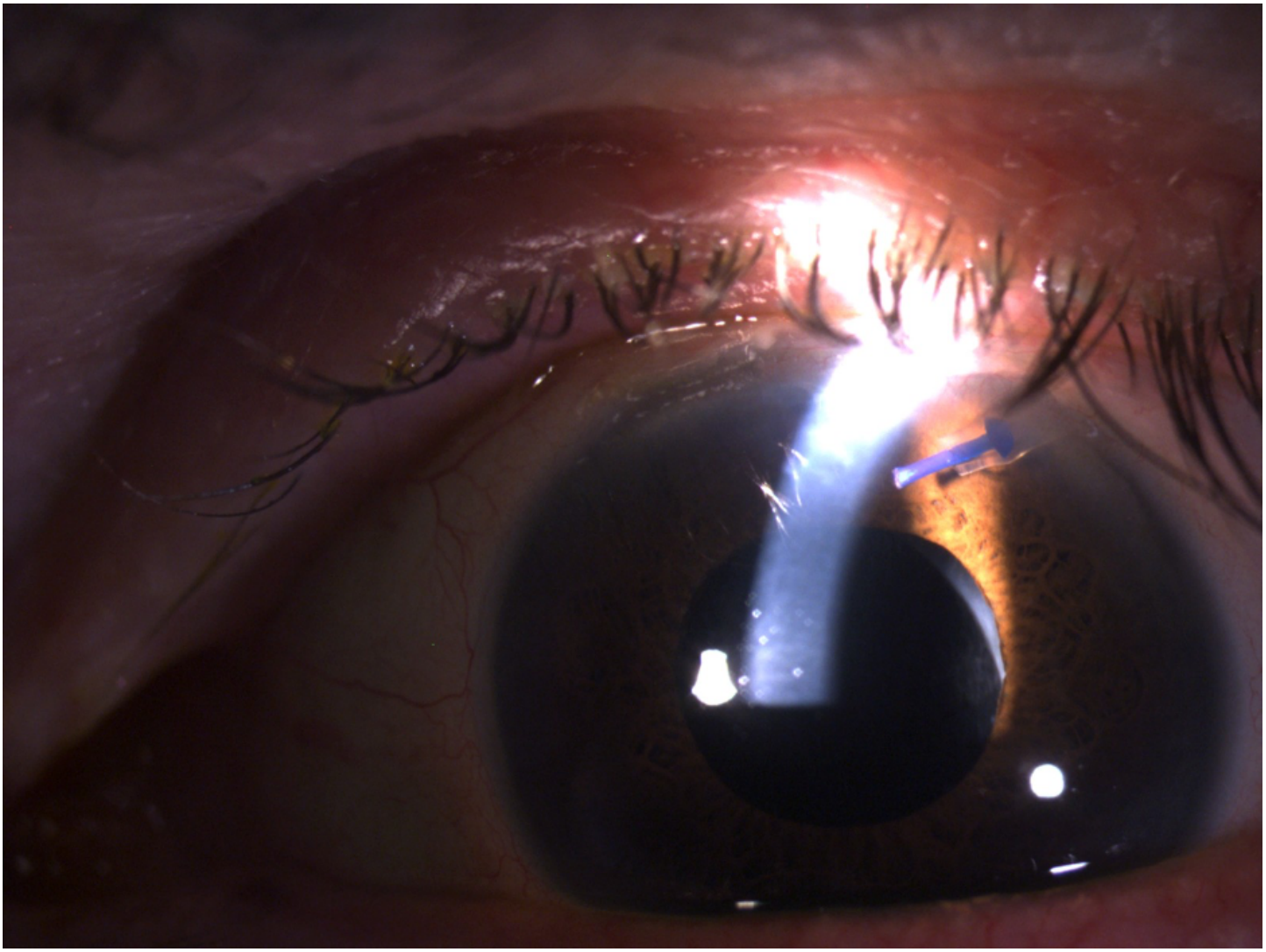

Figure 1. Slit lamp photo of occluded glaucoma drainage device in the left eye at postoperative month one.

Postoperative course

Intraocular pressure improved to 13 mmHg on postoperative day one, at which time the patient was started on prednisolone and moxifloxacin drops 4 times daily. At postoperative month one (Figure 1), IOP was 10 mmHg. IOP rose to 18 mmHg at postoperative month 4, at which time the patient resumed topical dorzolamide 3 times per day. At postoperative month 27, IOP was 11 mmHg on dorzolamide, with stable appearance of the occluded glaucoma tube. Visual acuity improved to 20/300. Figure 2 shows improvement of choroidal folds and macular edema on the optical coherence tomography scans of the macula from preoperatively to postoperative month 27.

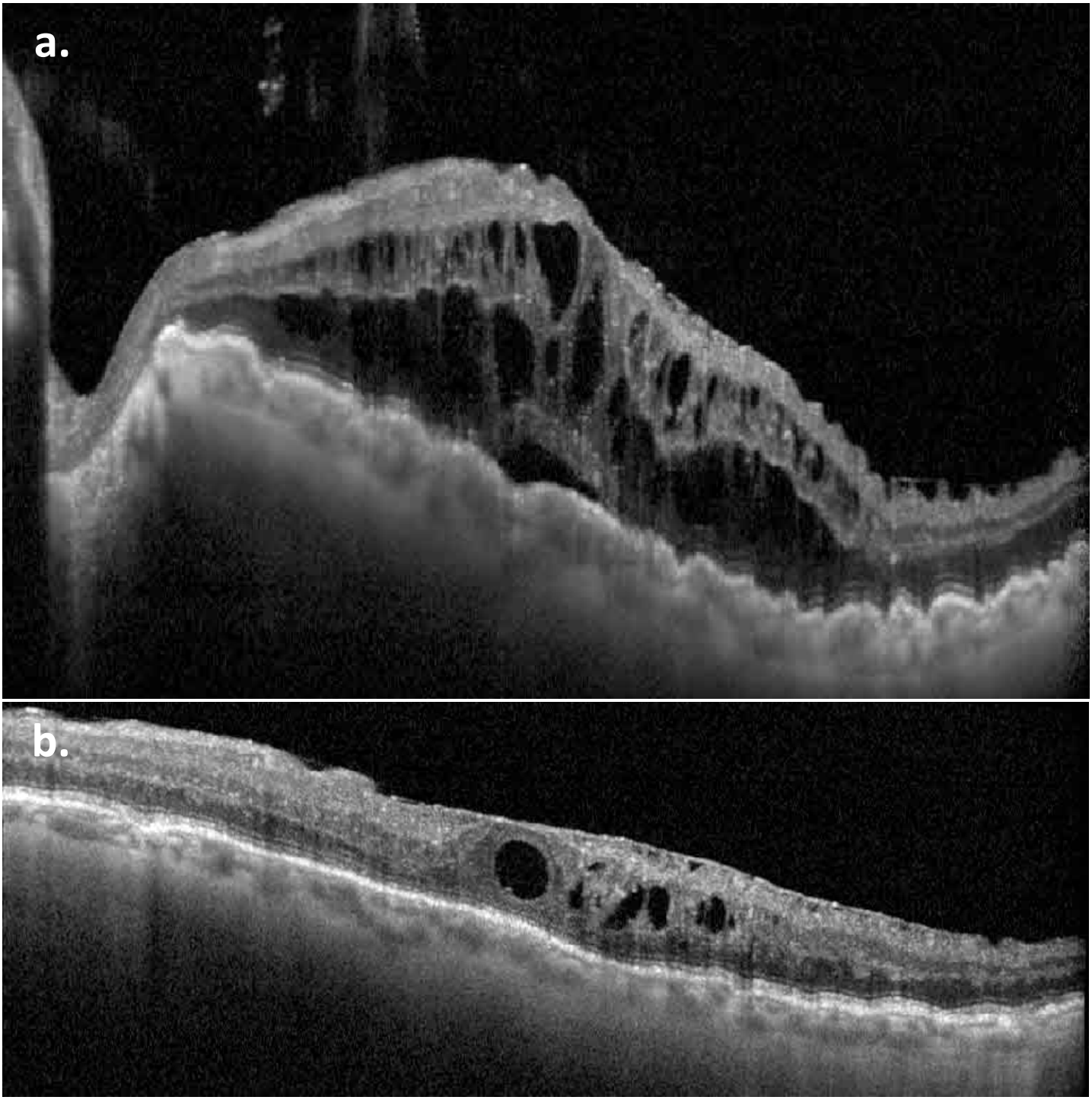

Figure 2. Optical coherence tomography macular scans (a) preoperatively and (b) 27 months postoperatively demonstrate improvement in choroidal folds and macular edema.

Discussion

While numerous methods for hypotony reversal via tube occlusion have been previously reported, the currently reported ab externo method improves on previously described methods in several ways, including better ease of

technique instead of operating within the confines of the anterior chamber, being less invasive than prior ab externo techniques that require conjunctival manipulation, and ensuring complete tube occlusion using a bulbed suture instead of non-bulbed suture that may still permit aqueous outflow through the tube lumen.

The reported ab externo approach can be easier from a technical standpoint than ab interno tube occlusion while working inside the anterior chamber. Feinstein et al. and Pollmann et al. have described ab interno intraluminal stenting with a 4-0 polypropylene suture, suggesting the potential to occlude outflow by 24-43%.[7,9] Other analytical models, however, suggest that significant increases in IOP only occur with suture diameters >0.27mm, equivalent to a 2-0 or 3-0 suture[14]; case reports have been published describing ab interno stenting with such larger caliber sutures.[8,11] However, manipulating larger sutures within the anterior chamber to achieve occlusion is technically challenging, can encounter resistance while cannulating the tube lumen, and carries the risk of inadvertent damage to intraocular structures, such as the corneal endothelium, lens, and iris. The currently reported technique involves externalizing the tube through a corneal incision, facilitating stenting of the tube while outside the eye, which allows easier manipulation of the stent and tube, without as much risk of corneal endothelial damage or contact with intraocular structures. It can also be more feasible than in situ tube stenting in the anterior chamber if corneal opacity limits visualization. However, care must be taken not to cause excessive corneal endothelial trauma near the paracentesis incision while the tube is being externalized or reposited. In addition, it requires that the intraocular portion of the tube in the anterior chamber is long enough to be grasped and externalized through a corneal paracentesis incision. In situations where the tube is short, ab interno *in situ* occlusion while in the anterior chamber or open conjunctival ab externo tube ligation may be better suited.

In situations such as concern about low corneal endothelial cell count and risk of worsening corneal edema by working ab interno, ab externo ligation techniques such as described by Al Houssien and colleagues using sutures placed around the external portion of the GDD tubing may be safer.[13] However, this approach is more surgically invasive, requiring conjunctival manipulation and incisions which can be challenging to close and which may increase the risk of subsequent tube exposure.

The use of low-temperature cautery to create a bulb additionally facilitates more complete occlusion of the tube lumen than non-bulbed approaches. Canut et al. similarly used 5-0 polypropylene suture and cautery to create a bulbed occlusive stent[12]; however, the presently described method is more easily reversible, as the remnant tail of the suture is readily accessible from the anterior chamber and could be removed ab interno with greater relative ease if indicated. In contrast, the Canut et al. approach requires dislodging the snugly fitting bulb from the tube lumen, without the ease of a smaller handle on non-bulbed suture end that the currently described method provides. In addition, they perform the suture fragment insertion completely in the anterior chamber, which can be technically challenging due to the snug fit of the bulb in the tube lumen. The presently described

technique differs because of the direction of bulbed end insertion and because a corneal paracentesis is used to externalize the tube out of the eye to facilitate easier insertion of the suture fragment into the tube.

Conclusion

In summary, we present a relatively safe, simple, effective, and reversible method for the surgical treatment of hypotony secondary to GDD overfiltration. The presented method is comparatively easier to perform than previously described approaches and represents a minimally-invasive option for treatment of GDD-mediated hypotony.

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Statement of Ethics

The patient gave written consent to publish the data. The report does not include personal information that could identify the patient directly or indirectly. All medical interventions have been carried out according to the latest protocols of therapy. Reporting and writing are all in compliance with the Declaration of Helsinki.

Conflict of Interest Statement

The authors declare no conflicts of interest related to this topic.

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