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iSTAT (Intraluminal Suture Transfixed and Titratable) technique for ligature-free Reversal of long-term drainage implant hypotony

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ABSTRACT

Purpose: To describe the iSTAT (Intraluminal Suture Transfixed and Titratable) technique, an improvement on prior tube occlusion methods, allowing for variable flow.

Observations: A 76-year-old woman who underwent an uncomplicated glaucoma drainage device (GDD) placement for uncontrolled mixed mechanism glaucoma presented with hypotony 4 years post-operatively. The iSTAT technique was performed to adjust the flow in the GDD tube: a 4–0 polypropylene suture tip was blunted with a low-temperature cautery, creating a bulbed end that would occlude the tube. The suture was introduced into the tube bulb-first intracamerally, extending to the plate. If partial occlusion of the tube is desired, the suture can be secured in place by piercing the side wall of the tube tip with the distal end of the suture. After complete occlusion of the GDD tube with a large bulb, the patient had intraocular pressures (IOPs) > 40 mmHg on post-operative day 1, which remained in the 25–30 mmHg range 2–3 weeks post-operatively on maximally tolerated medications. Patient underwent a second revision with a smaller-bulbed stent (with a 3–0 polypropylene suture), which stabilized her IOP at 8 mmHg.

Conclusion and Importance: The iSTAT technique allows for an ab interno revision, titration of flow, and stabilization of the stent in the wall of the tube. The ab interno approach precludes the need for conjunctival incisions, thus maintaining bleb integrity and permitting surgery under topical anesthesia. The intracameral stabilization of the stent in the tube allows for smaller bulbs to titrate the flow without external ligatures.

1. Introduction

Post-operative hypotony after glaucoma drainage device (GDD) placement is a complication that can be challenging to manage, with the risk of vision-threatening outcomes such as choroidal effusion or hemorrhages, hypotony maculopathy, flat anterior chambers, and endothelial injury.[1] Numerous flow-control mechanisms targeting the tube lumen have been utilized since the first GDD was introduced in the 1960s,[2] including ligating sutures,[3] occluding stents,[4] unidirectional valves,[5] and a magnetic compression system.[6]

The intraluminal stents used for restricted flow range from nylon[7,8] or polypropylene sutures,[9] to Xen Gel Stent (Allergan Inc, New Jersey, USA).[10] For complete tube occlusion, surgeons have used large-diameter sutures,[7] multiple smaller-diameter sutures[8] or suture cauterization to create a bulbed end.[11] Using these methods, intraluminal flow could be adjusted by partially or fully retracting the sutures, but the concern for suture migration within the tube remained, especially in cases of partial occlusion.

In this report, we describe a modified approach to ab interno intraluminal stenting using polypropylene sutures with variable bulb sizes, stabilized within the tube by embedding the intracameral end of the suture in the tube wall.

2. Case report

A 76-year-old woman with an ocular history of cataract extraction with intraocular lens implantation, penetrating keratoplasty (PK), and selective laser trabeculoplasty in the right eye presented in 2014 with uncontrolled intraocular pressures (IOPs) despite maximally-tolerated medical therapy including timolol, latanoprost and brimonidine in the right eye. On initial presentation, she had a visual acuity (VA) of 20/50 in the right eye (OD), 20/25 in the left eye (OS), IOPs 23 OD and 18 OS. She also had a clear PK graft, and cup-disc ratio of 0.75 OD and 0.2 OS. She underwent an uncomplicated superior-temporal placement of a

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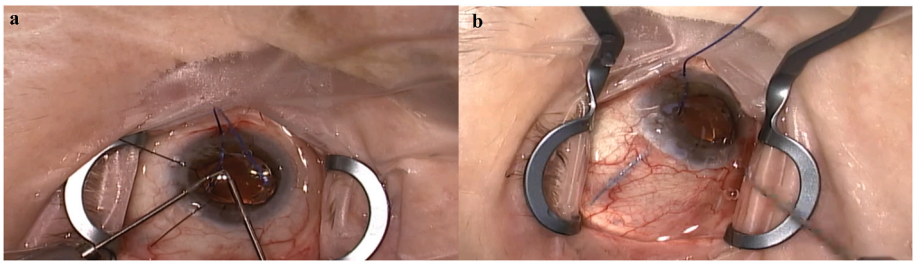

Fig. 1. Intraoperative photographs demonstrating (a) cannulation of the tube via an ab interno approach to titrate flow through the tube, (b) the iSTAT technique with adjustable suture bulb size for graduated aqueous flow.

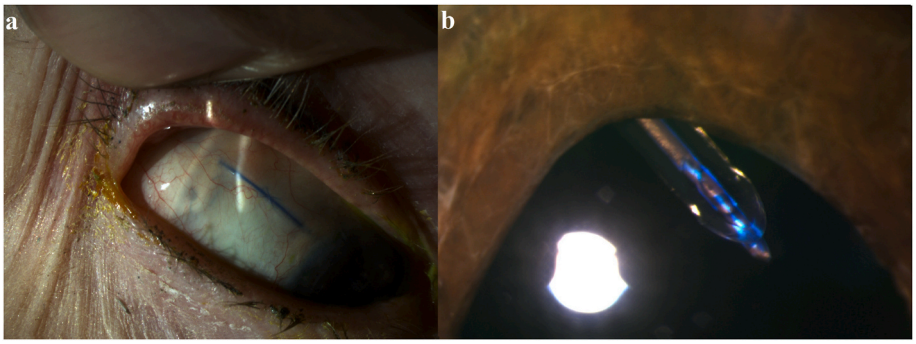

Fig. 2. (a) Slit lamp photographs showing (a) the blunted tip of the suture abutting the plate. (b) the tip of the suture in the anterior chamber, embedded in the side wall of the tube, thus preventing migration.

Baerveldt 350 GDD with tube placement in the sulcus in the right eye. At the 5-month post-operative visit, she had stable VA of 20/60 and improved IOP of 11 mmHg OD on timolol daily and prednisolone acetate thrice a day (TID), and was followed locally for further post-operative care. In 2016, the patient returned with VA 20/200 OD, 20/70 with pinhole, trace corneal edema in her graft, and IOP 10 mmHg on prednisolone acetate BID without any glaucoma medications. Her steroids were increased to four times a day but she was then lost to follow up for 2 years due to the death of her spouse.

In 2018, the patient returned with VA 20/80 OD, IOP 5 mmHg on prednisolone acetate TID alone, and a clear PK graft, but now with new vitreomacular traction and mild macular edema. Flow was apparent to the plate area at the slit lamp and it was surmised the patient was now making less aqueous. After a trial of steroids and cycloplegics failed to reverse the hypotony, the patient underwent a complete tube occlusion with a large-bulbed 4–0 polypropylene suture stent placed via an ab interno approach. Her IOPs increased to >40 mmHg on post-operative day 1, and remained elevated in the 25–30 mmHg range 2–3 weeks after the stent placement on maximally-tolerated medications. The patient therefore underwent a second revision using the iSTAT technique, detailed below. A Baerveldt 350 glaucoma drainage device (GDD; Johnson and Johnson Vision, Santa, CA, USA) was used in this case report, but the technique can be utilized with any non-valved or valved implant for the treatment of chronic hypotony.

The iSTAT technique may be performed under monitored topical anesthesia (Video 1). Two corneal paracenteses are created approximately 45° on either side of the tube, and a third about 180° from the tube. Viscoelastic should be injected intracamerally to maintain the anterior chamber. A 3–0 polypropylene suture tip is blunted with low-temperature cautery and inserted ab interno bulb-first into the tube using microsurgical forceps (Fig. 1(a)). For complete occlusion, a large bulb, slightly larger than the inner luminal diameter of the tube, is created with the cautery. The bulbed suture is then fed, ab interno, through the tube and advanced as far back to the plate as possible (Fig. 1 (b)). The suture is trimmed flushed with the tube tip leaving a small amount sticking out of the tube in the event the suture needs to be later removed. For partial occlusion, a smaller bulb and a 3–0 or 4–0 polypropylene suture can be used (depending on the degree of flow restriction desired), and the suture can be passed back to the base of the plate (Fig. 2(a)). Since this is not a tight fit, the suture may potentially migrate back into the anterior chamber. To prevent suture migration, the suture is secured in place by piercing the side of the tube with the intracameral end of the suture, securely embedding the suture tip in the side wall of the tube (Fig. 2(b)).

Supplementary video related to this article can be found at https://doi.org/10.1016/j.ajoc.2022.101569

After the second revision with partial occlusion using the iSTAT technique, the patient has remained well-controlled off all glaucoma medications. Her immediate post-operative IOPs were as below. At her 14-month post-operative visit, the patient's IOP was 8 mmHg on no glaucoma medication. Her vision improved back to her baseline level of 20/50.

IOP on post-operative day 1 = 1 mmHg.
IOP on post-operative week 1 = 5 mmHg.
IOP on post-operative month 1 = 9 mmHg.
IOP on post-operative month 3 = 8 mmHg.
IOP on post-operative month 12 = 10 mmHg.

3. Discussion

Short-term hypotony is one of the most common complications in the first 3–6 months after GDD placement, affecting almost 40% of both pediatric and adult patients.[12,13] The risk of late (>6 months) post-operative hypotony is lower, but still affects approximately 10–15% of GDD patients.[12,14] While immediate post-operative hypotony may be managed with intracameral injection of a viscoelastic, medications, or wound repair, depending on the underlying cause, late or refractory hypotony often requires revision to the GDD tube and/or plate, or GDD removal.[15,16] The problem of long-term drainage device hypotony will likely increase given that patients are living longer; for it is well established that aqueous production decreases with age.[17,18] In addition, the implantation frequency of GDD's is increasing around the

world given their favorable long term safety data and the increased availability of low-cost non-valved glaucoma drainage implants.

As background, the inner lumen of the tube in a GDD is typically 0.30 mm in diameter. The diameter of a 3–0 polypropylene suture has an inner diameter of 0.2mm and the 4–0 polypropylene suture has an inner diameter of 0.15mm. The surgeon should choose the diameter of the suture based on the degree of flow restriction required when attempting a partial occlusion of flow. In this patient, since the suture and the bulb sizes were changed for the second revision, it is unclear how each contributed to the subsequent IOP stabilization.

The iSTAT technique described here evolved from earlier forms of intraluminal sutures, with the advantages of an ab interno approach, titratable occlusion, topical anesthesia, improved instrumentation and suture stabilization. While the ab interno approach obviates the need for conjunctival incisions, thereby avoiding bleb disruption and permitting surgery under topical anesthesia, the ability to stabilize the suture intraluminally allows for graduated flow control without risk of stent migration and consequent risk of intracameral ligature-corneal touch. Although this technique requires a return to the operating room for stent adjustment or removal, it allows for variable IOP control, decreasing the need for ab externo procedures such as tube ligation, or more invasive procedures such as GDD removal.

4. Conclusion

The iSTAT technique allows for titratable flow through glaucoma drainage devices by varying the size of the bulbed tip of the suture, with fixation in the tube to prevent its migration.

Patient Consent

Consent to publish the case report was not obtained. This report does not contain any personal information that could lead to the identification of the patient.

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Authorship

All authors attest that they meet the current ICMJE criteria for Authorship.

Davinder Grover and Ronald Fellman: Conceptualization, Methodology, Resources; **Khin Kilgore:** Writing – Original draft preparation.

Declaration of competing interest

The following authors have no financial disclosures: KPK, RLF, DSG.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.ajoc.2022.101569.

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