Repositioning a glaucoma drainage device (GDD) tube from the anterior chamber to the ciliary sulcus or pars plana can be a challenging procedure owing to the difficulty in obtaining tight closure of the original limbal fistula. Failure to achieve watertight and airtight closure of the fistula can result in substantial difficulty in completing other key portions of the surgery and may lead to postoperative hypotony and associated complications. A novel technique using a Tutoplast scleral plug, polyglactin sutures, and, in certain cases, fibrin tissue sealant to close a limbal fistula at the time of glaucoma drainage device tube repositioning is described. This technique can be replicated with ease and provides a tight seal so that other concurrent surgical procedures can safely be completed and postoperative hypotony is avoided.

**METHODS**

**TECHNIQUE**

A conjunctival peritomy is made in the area of the tube insertion and patch graft, creating a fornix-based conjunctival flap. The previous patch

Repositioning a glaucoma drainage device (GDD) tube from the anterior chamber to the ciliary sulcus or pars plana is an uncommon but challenging procedure. There are several indications for tube repositioning. Often, patients in need of this procedure have undergone multiple prior surgical procedures and may be in need of additional concurrent surgery. Extensive subconjunctival scarring and scleral ectasia may further complicate the surgical manipulations involved in tube repositioning. Secure closure of the original limbal fistula is often one of the most critical and challenging steps in the procedure. Failure to achieve watertight and airtight closure of the fistula can result in substantial difficulty in completing other portions of the surgery and may lead to postoperative hypotony and associated complications such as serous or hemorrhagic choroidal detachment, flat anterior chamber, and hypotony maculopathy.

The 23-gauge, limbal needle track through which a GDD tube is inserted develops into a fistula lined by fibrous tissue with a diameter that approximates the external dimension of the tube. These openings can be difficult to close following removal of the tube. Direct suture closure is often difficult owing to the tension required to appose the edges of the opening and achieve a tight seal. When the surrounding sclera is ectatic from prior surgery and scarring, this difficulty is further increased and “cheesewiring” of the sutures under tension can result in suture track leaks and poor wound stability. Additionally, when direct suture closure is achieved, a significant amount of irregular astigmatism is often induced, especially when a nonabsorbable suture is used.

We describe herein 4 patients for whom we used a novel technique with a Tutoplast scleral plug, polyglactin sutures, and, in some cases, fibrin tissue sealant to close a limbal fistula at the time of GDD tube repositioning.
graft is undermined with blunt and sharp dissection, exposing the underlying tube. When the fibrous capsule surrounding the tube is incised, the tube is ready to be removed from the eye. An infusion cannula is used to prevent shallowing of the anterior chamber and intraoperative hypotony. Immediately after pulling the tube, a dry, wedge-shaped piece of Tutoplast sclera (Figure 1) is inserted into the fistula, narrow end first. The scleral plug is advanced into the fistula to a point at which its width exceeds the diameter of the fistula. As the plug is inserted, the infusion is temporarily discontinued to allow for easier advancement of the plug into the fistula. The plug rapidly hydrates and expands, occluding the sclera opening. An X-shaped 8-0 polyglactin suture that incorporates the scleral plug is then tightened, closing the fistula and securing the plug to the surrounding sclera (Figure 2). The plug is then trimmed until flush with the scleral surface. If there is a minimal amount of leakage from the fistula even after a wide X-shaped suture is placed or the surgeon wishes to further reinforce the fistula closure, several drops of each component of fibrin adhesive are placed over the plug. The fistula site is then checked to confirm that it is watertight. If the tube is to be repositioned, a more posterior entry into the anterior chamber/sulcus/pars plana is then made at a new site adjacent to the patch graft. The new insertion site and tube are covered with standard patch graft material and secured with absorbable (polyglactin) suture either alone or combined with fibrin adhesive. The conjunctiva is then reapproximated and secured at the limbus.

REPORT OF CASES

Case 1

A 38-year-old man with a history of congenital cataracts and aphakic glaucoma required the insertion of 3 GDD tubes for control of intraocular pressure. The patient subsequently developed corneal edema with decreased visual acuity in his remaining eye. Two of the tubes had been placed deep with the anterior chamber along the anterior iris plane. However, the third tube was anteriorly positioned and was thought to be likely to interfere with the placement of an endothelial keratoplasty graft.

On the day of endothelial keratoplasty, the patient underwent repositioning of the supronasal tube from its original insertion site to a new site, which allowed it to rest deeper within the anterior chamber just above the iris plane. Using the technique described here, the original tube site was filled with a Tutoplast graft plug and covered with fibrin adhesive. Using a standard tube insertion technique, the tube was reinserted and covered with a corneal patch graft. Descemet membrane automated endothelial keratoplasty was then performed without difficulty. During the procedure, a full anterior chamber air fill was achieved and elevated intraocular pressure (IOP) was maintained for 10 minutes without leakage of air around the tube's insertion site or the closed corneoscleral fistula. Postoperatively, the patient's IOP has been maintained with the 3 functioning GDD tubes. The cornea has cleared without detachment of the graft or further intervention.

Case 2

A 28-year-old woman with chronic, bilateral iridocyclitis underwent anterior chamber GDD tube placement in 1 eye 4 years prior to cataract extraction. Postoperatively, IOPs were noted to be between 6 and 10 mm Hg without choroidal detachment or maculopathy. A cataract extraction was performed, and vision improved until corneal edema developed 6 months postoperatively. On examination, the anterior chamber tube...
was felt to be anteriorly positioned. Using the technique described earlier, the patient underwent tube repositioning to the sulcus and Descemet membrane automated endothelial keratoplasty. Intraoperatively, elevated IOP was achieved for several minutes, which allowed for graft attachment. Postoperatively, the IOP returned to its preoperative range. Visual acuity of 20/25 was achieved 1 month after surgery.

Case 3

A 62-year-old patient had a history of advanced glaucoma necessitating a GDD tube and complex retinal detachment requiring silicone oil placement. The patient developed a recurrent conjunctival erosion with exposure of the inferotemporal plate of the GDD tube and anterior aspect of the scleral patch graft (Figure 3). Of note, silicone oil was also present around the proximal tube tip in the anterior chamber. The patient underwent removal of the entire GDD tube with closure of the inferotemporal corneoscleral fistula site via the technique previously described without use of fibrin adhesive. A superotemporal GDD tube was placed at the same time for IOP control. Postoperative photographs illustrate adequate conjunctival closure with no evidence of erosion or dehiscence. The Tutoplast scleral plug can be seen entering the anterior chamber at the 5-o’clock position. The patient’s eye remained quiet despite slight protrusion of the plug into the anterior chamber (Figure 4).

Case 4

A 1-year-old boy with a history of congenital glaucoma had required prior placement of 2 GDD tubes (superotemporal and inferonasal) for IOP control. Both tubes were directed toward the cornea, and intermittent contact caused early corneal decompensation. The patient had also developed a dense pupillary membrane obscuring the visual axis. The patient underwent repositioning of both tubes as well as membranectomy. The technique described was used to first close both fistula sites without the use of fibrin adhesive. Once a watertight seal was achieved, subsequent vitrectomy and membranectomy were performed, followed by placement of both tubes in the pars plana. The patient had normal IOP throughout the postoperative course and eventually was noted to have a marked decrease in corneal edema.

Repositioning or removal of the GDD is often necessary and presents a surgical challenge. When the position of the tube in the anterior chamber compromises the cornea, it is often necessary to reposition the tube further posterior in the anterior chamber or even place it in the ciliary sulcus or pars plana to prevent further damage to the corneal endothelium. If done early enough, the need for additional surgical procedures to clear a decompensated cornea can potentially be avoided. However, in many cases, patients have an edematous cornea and a tube that is positioned poorly. In these cases, either a penetrating keratoplasty or endothelial keratoplasty needs to be performed for visual rehabilitation. Prior to or concurrent with the corneal surgery, it is often necessary to reposition the tube to avoid damage to the endothelium of the corneal graft. In patients undergoing penetrating keratoplasty and tube repositioning, it is imperative that the original fistula site be closed tightly so that the eye remains stable with an adequate pressure while the donor cornea is...
sutured in place. Leakage from the fistula site will result in difficulty maintaining the anterior chamber, leading to potential endothelial damage from repeated collapse of the chamber. One of the most critical steps during the endothelial keratoplasty procedure is the placement of an air bubble to support the donor lenticle and brief elevation of IOP to assist graft attachment. All wounds need to be watertight during this part of the procedure as air will escape from any potential site of leakage. Air leakage can result in partial or complete donor detachment. Hence, when tube repositioning is combined with either a penetrating keratoplasty or endothelial keratoplasty, adequate closure of the fistula site is critical to maximize the chances of an optimal outcome.

Transconjunctival tube erosion is an uncommon but difficult to manage complication following placement of a GDD. Reported estimates of the prevalence of this complication range between 2% and 7%. Management includes various methods to cover the segment of exposed tube with a new patch graft and conjunctiva. Repositioning the tube through a pars plana scleral fistula in this setting generally facilitates conjunctival closure as the new insertion site and the external portion of the tube are moved 3 to 4 mm posterior to the limbus. The aforementioned technique can be used in this setting to aid in the repositioning of the GDD tube from the anterior segment to the pars plana. The more posterior tube insertion site may also reduce the risk of recurrent exposure by allowing more complete coverage of the anterior portion of the tube and patch graft by the eyelid.

One of the most commonly used methods to close corneoscleral fistula sites is direct suture closure, in either an interrupted or figure-of-8 configuration. However, these sutures can be difficult to place and can cause additional problems postoperatively. To obtain adequate closure of the fistula site, the sutures need to be cinched down tightly and, as a result, can often lead to significant amounts of induced irregular astigmatism. For patients with good preoperative vision, this can become a persistent problem as it is not easily corrected with simple resection. Thin, ectatic sclera, which is often present in such patients as a result of prior surgery and underlying disease, frequently makes simple suture closure difficult without residual aqueous leakage. Overlay patch grafting in this situation is generally suboptimal as it is difficult to achieve a watertight seal, and fluid leakage beneath the patch graft results in intraoperative instability and postoperative hypotony. Sibayan and Latina first described a similar surgical technique using processed pericardium. Since then, there has been 1 additional published article describing a pericardium plug to repair a corneoscleral fistula. Though similar, there are numerous differences with our technique. We used dry Tutoplast sclera and secured it in place with absorbable sutures. The use of a dry, wedge-shaped fragment of Tutoplast sclera allows for easy insertion into the scleral fistula. Subsequent hydration of the plug by aqueous causes tissue expansion to fill the fistula. The fistula and plug are then oversewn with 8-0 polyglactin suture, further compressing the walls of the fistula against the plug and securing the plug in place, thereby preventing migration into the eye or out of the fistula and ensuring watertight closure without undue tension and accompanying distortion of the globe or cheesewiring of the sutures. In addition, fibrin glue may be used when necessary to seal any residual leak.

Although this technique was immediately successful in closing the fistula in all 4 cases described, the long-term viability of the graft in the fistula is not known. We have not observed any negative effects from the insertion of the scleral plug into the anterior chamber. We also have not seen the plug dislodge. However, with long-term follow-up, displacement of the plug and/or inflammation could theoretically occur. We have successfully used this technique in all attempted cases where we explanted a GDD tube except in 1 case in which a corneoscleral melt resulted in a 2-mm hole. In this case, we elected to patch the rupture with a partial-thickness corneoscleral lamellar graft.

**CONCLUSIONS**

The Tutoplast scleral inlay graft oversewn with an absorbable suture and possibly supplemented with fibrin sealant provides an effective method for closing a corneoscleral fistula at the time of GDD tube repositioning. The technique is easy to replicate and provides a tight seal so that other concurrent surgical procedures can safely be completed and postoperative hypotony is avoided.

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Correspondence: Michael R. Banitt, MD, MHA, Bascom Palmer Eye Institute, 900 17th St NW, Miami, FL 33136 (mbanit@med.miami.edu).

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**Ophthalmic Images**

**Ten Years With Detached Descemet Membrane**

George D. Kymionis, MD, PhD

Georgios A. Kontadakis, MD, MSc

**Figure 1.** A 75-year-old man with corneal edema for 10 years after phacoemulsification was diagnosed as having Descemet membrane detachment. An air bubble was inserted in the anterior chamber.

**Figure 2.** Edema retreated 3 months postoperatively, indicating that endothelium survived 10 years in the aqueous.