Neovascular glaucoma (NVG) is often caused by posterior segment disease, primarily diabetic retinopathy, central retinal vein occlusion, or carotid occlusive disease. Surgical options in NVG include trabeculectomy, trabeculectomy with mitomycin-C, cyclodestruction, and tube stent implants. An anterior segment approach to stent placement in patients with NVG may help to control their intraocular pressure (IOP), but the underlying retinal disease often remains untreated or inadequately treated. Combining vitrectomy with pars plana tube implantation ensures that the causative retinal disease can be addressed fully. This article describes surgical pearls for performing combined vitrectomy and pars plana tube implantation in NVG with a ripcord technique.

VITRECTOMY FOR NEOVASCULAR GLAUCOMA

In the setting of NVG, vitrectomy clears the ocular media for laser application, facilitating a more complete laser procedure. In eyes with a cloudy cornea, hyphema, or cataract, better visualization can be achieved with endoillumination and endolaser. Vitrectomy also increases oxygenation, permits treatment out to the ora serrata with scleral depression and wide-angle viewing, and, ultimately, allows the surgeon to address the underlying cause of the NVG. Bevacizumab (Avastin, Genentech) and other anti-vascular endothelial growth factor (VEGF) agents can quiet eyes with NVG, but VEGF inhibition is not usually a long-term cure.

VITRECTOMY WITH PARS PLANA TUBE IMPLANTS

Tube implants are a mainstay of treatment for glaucoma, including NVG. The Ahmed Glaucoma Valve (New World Medical, Inc., Rancho Cucamonga, CA) and the Baerveldt implant (Abbott Medical Optics, Inc., Irvine, CA) are currently the most popular implants in the United States. The Baerveldt BG-102 pars plana implant is designed with a right-angle bend for easy placement during pars plana vitrectomy (Figure 1). In my experience, the right-angle bend reduces the incidence of obstruction compared with placing a straight tube behind the iris. The Baerveldt, which has a large surface area and can be implanted in a single quadrant, has been shown to provide long-term IOP control,\textsuperscript{1,2} and the recent Ahmed vs
Baerveldt implant trial showed better IOP-lowering for the Baerveldt but with a higher risk of complications. As patients with NVG often have impaired outflow and high IOPs, the Baerveldt implant is a natural choice if the complications can be minimized.

When vitrectomy is combined with pars plana tube implantation, patients with NVG undergo only one operation, which reduces the risks associated with anesthesia and provides more rapid treatment. In the combined procedure, the media are cleared to allow evaluation and treatment of the posterior pathology, and placing the tube into the eye 4 mm posterior to the limbus may lower the risk of tube erosion. By avoiding the anterior chamber, hyphema can be avoided, and some studies have reported a reduction in corneal transplant failure with pars plana tube implantation compared with anterior chamber tubes. The posterior approach also carries potential disadvantages; complications can include retinal detachment, vitreous hemorrhage, choroidal detachment, tube obstruction by vitreous, cataract development, and hypotony.

TECHNIQUES TO AVOID HYPOTONY

Several surgical techniques can be used to avoid early postoperative hypotony. In the past, many surgeons used a two-stage procedure, in which a ligation suture is tied around the tube at the time of surgery and then, at a later time, the flap is lifted and the suture is untied. Currently, an absorbable tie—a short-acting dissolvable suture—is used more frequently. Often this technique is combined with fenestrations made in the tube with a fine needle to allow early fluid egress and help control early postoperative IOP until the suture dissolves and opens the tube. Unfortunately, the time it takes for the suture to dissolve can be variable.

Pneumatically stented Baerveldt implants have also been shown to reduce IOP effectively. In this approach, the stent is placed after vitrectomy and air-gas exchange with an expansile gas. The stent may be partially ligated. The procedure allows good early pressure control, but it has been associated with a perceived higher rate of choroidal elevation.

In our practice, we have now adopted a ripcord technique, in which a suture is placed into the lumen of the tube to occlude it, and then it is passed out the conjunctiva at a distant site—to be removed in the office at a later date once the bleb has formed around the implant. One advantage of this technique is that the surgeon can adjust the timing of opening the tube by accelerating or delaying when the ripcord is removed depending upon the postoperative IOP. Fenestrations in the tube can still be used to allow earlier pressure control. Watertight conjunctival closure is not critical as it is for pneumatically stented tubes because one can allow the bleb to form before the tube is opened. This appears to lower the risk of choroidal detachment.

SURGICAL TECHNIQUE

The Baerveldt implant is typically placed before the vitrectomy. After incising the superotemporal conjunctiva at the limbus and making radial relaxing incisions, the superior and lateral rectus muscles are hooked and the Baerveldt implant is slipped under the muscles and sutured to the sclera 12 mm posterior to the limbus. A 4-0 nylon suture is placed into the distal end of the tube where it opens just above the plate. A 7-0 vicryl suture is tied around the outside of the tube that contains the 4-0 nylon ripcord within it. This suture should be tight enough to prevent fluid flow as long as the ripcord is within the lumen. A small-gauge vitrectomy is then performed, and extensive laser is applied.
to reduce ischemia. The superotemporal cannula is removed, and a 20-gauge microvitreoretinal blade is used to enlarge this sclerotomy, which is 4 mm posterior to the limbus. The right-angle Baerveldt tube is then inserted into the sclerotomy and anchored in place using eyelets. A patch graft is then sutured over the tube. The distal end of the 4-0 nylon ripcord is passed inferiorly under the conjunctiva as far away from the implant as possible and then outside the conjunctiva. The tip of the ripcord can be buried into the conjunctivae by taking an additional small bite of conjunctiva and then cutting the needle off. The ripcord is typically removed several weeks later in the office.

**CONCLUSION**

In NVG, anterior chamber placement of a drainage tube can control the patient’s IOP, but this approach does not address the underlying retinal disease. In these cases, therefore, it makes sense to perform a combined pars plana shunt placement and panretinal laser treatment. The ripcord technique allows better control of postoperative IOP and may thereby minimize postoperative complications. This surgical technique is effective in the treatment of glaucoma combined with retinal, vitreal, or corneal disease.

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