The future of ophthalmology is minimally invasive surgery. Whether for glaucoma, cataract, or retina surgery, smaller incisions reduce rehabilitation time and increase the surgeon’s chance of meeting patient demands and expectations. For multiple reasons, I perform high-frequency deep sclerotomy (HFDS) ab interno for the treatment of primary open-angle glaucoma. This procedure requires only two 1.2-mm clear corneal incisions, located 120° apart. In addition to its minimally invasive approach, HFDS has many advantages, including fast procedure time, high success rate, effective and long-lasting intraocular pressure (IOP)-lowering effect, and low complication rate. Additionally, there is no need for application of antimetabolites or needling. I started performing HFDS more than 10 years ago; at that time, the procedure was called sclerothalamotomy (STT). Despite the name change, the goal of the procedure is still the same—to decrease the resistance of the trabecular meshwork. HFDS triggers an outflow of fluid through the trabecular meshwork and into Schlemm canal. It also avoids bleb formation and fibroblast movement toward the area of the sclerotomy.

THE PROCEDURE
After creating two 1.2-mm clear corneal incisions in an arc of approximately 120°, the surgeon fills the anterior chamber with a cohesive ophthalmic viscosurgical device (OVD). Traditionally, a high-frequency diathermic probe is then fed through the temporal paracentesis using a four-mirror gonioscopic lens, until the probe is properly placed opposite the iridocorneal angle (nasally). Alternatively, using a new diathermic probe design (Abee Glaucoma Tip; Oertli Instrumente AG, Berneck, Switzerland; Figure 1), the procedure can even be performed from a temporal, supertemporal, or superonasal position. Thus, retreatments can now be performed more easily than before.

The Abee tip consists of an inner platinum electrode that is isolated from an outer coaxial electrode. The tip of the probe is bent 15° posteriorly and is 1 mm long, 0.3 mm high, and 0.6 mm wide. The external diameter is 0.9 mm. The advantage of the tip's dimensions is that it is compatible with minimally invasive surgery. This diathermic probe applies bipolar radiofrequency energy 1 mm nasally through the trabecular meshwork, into Schlemm canal, and finally approximately 1 mm into the sclera (Figure 2). The resultant deep sclerotomy pocket is 0.3 mm thick and 0.6 mm wide; it takes approximately 3 seconds to create. This process is repeated until four sclerotomies are placed, corresponding to a resorption surface area of 2.4 mm²; if six sclerotomies are placed, the resorption surface area is 3.6 mm² (Figure 3). For a video demonstration of HFDS, visit http://eyetube.net/?v=mefun.

The learning curve is very brief, and the experienced surgeon can master HFDS in as little as two procedures. The only challenge is that the procedure is performed nasally while looking temporally at the four-mirror gonioscopic lens.

COMBINED WITH CATARACT SURGERY
If I am treating a cataract patient who has been on antiglaucomatous eye drops for several years, I combine
Cataract surgery with HFDS. The deep sclerotomy is performed directly after cataract surgery, using the same incisions. After cataract surgery is complete, the surgeon simply refills the anterior chamber with a cohesive OVD—making the pupil miotic—and proceeds by using the four-mirror gonioscopic lens to place the diathermic probe nasally or inferiorly. Six deep sclerotomies are then performed. This procedure adds less than 3 minutes to cataract surgery.

We have treated hundreds of eyes using a combined cataract-HFDS approach. What we have seen is that the decrease in IOP continues for up to 6 months, not just 4 to 6 weeks as with other surgical interventions such as trabeculectomy or nonpenetrating procedures. Based on our initial study of 53 eyes with open-angle glaucoma treated with HFDS, mean IOP decreased from 25.6 ±2.3 mm Hg preoperatively to 14.7 ±1.8 mm Hg 72 months postoperatively; this change was statistically significant. Additionally, 77% of patients achieved more than a 30% reduction in IOP at 72 months, and 84.9% achieved more than a 20% reduction. Most of these patients underwent HFDS after cataract surgery.

**BENEFITS**

HFDS is a unique glaucoma intervention because it avoids stimulation of the episcleral and conjunctival tissue. Therefore, in the event that a second intervention is needed to control IOP, the surgeon is free to perform trabeculectomy or other conventional glaucoma procedures. There are rarely complications associated with HFDS, compared with the incidence of hypotony after trabeculectomy and penetrating or nonpenetrating deep sclerectomy. Additionally, this minimally invasive procedure provides fast visual rehabilitation for the patient. Patients have good results after HFDS, and the IOP typically continues to decrease over the first 6 months after surgery. As we have seen with our initial 53 cases, results were stable at 72 months, and 79.2% of patients did not require antiglaucomatous eye drops to further control IOP.

With the Abee Glaucoma Tip, the surgeon has additional treatment zones, including within the anterior part of the angle. The heat generated at the tip (130°C) is modulated by a 500-kHz current, providing high-frequency power dissipation only in the close vicinity of the tip.

**CONCLUSION**

Using a minimally invasive technique, HFDS is a viable solution for lowering IOP in patients with open-angle glaucoma. It can be combined with cataract surgery to reduce the number of surgical interventions in the same eye. One of the biggest benefits to this procedure is that it is performed nasally and/or inferiorly, allowing the surgeon to intervene with trabeculectomy or another conventional glaucoma treatment if further IOP-lowering effects are needed.

**TAKE-HOME MESSAGE**

- HFDS triggers an outflow of fluid through the trabecular meshwork and into Schlemm canal.
- HFDS avoids bleb formation and fibroblast movement toward the area of the sclerotomy.
- One challenge with the procedure is that it is performed nasally while looking temporally at the four-mirror gonioscopic lens.