Bipolar Diathermy:
From Coagulation to Glaucoma Surgery

Industry-physician cooperation helps cultivate surgical advancements.

BY THOMAS BOSSHARD

In the 1960s and 1970s, Rudolf Klöti, MD (Figure 1), of the University of Zurich, Switzerland, was a pioneer of vitrectomy surgery in Europe.1,2 At that time, one of the primary challenges associated with the procedure was how to stop bleeding in the vitreous and at the retina. In response, the concept of bipolar endodiathermy was born. The first application of high-frequency bipolar diathermy in ophthalmic surgery3 occurred as a result of cooperation between Dr. Klöti and Heinz A. Oertli, founder of Oertli Instrumente AG.

The development of high-frequency bipolar diathermy combined three disciplines: instrument design, electrical generator conception, and medicine. In the process, several questions arose, including which frequency, energy, power, and power modulation should be used; what materials work best for electrodes and isolation; and what the optimum shape should be. It was a classic situation for empirical development methods and cooperation between a small, innovative company and a creative surgeon.

THE DEVELOPMENT PROCESS

Dr. Klöti proposed that various frequencies be tested; therefore, several power generator circuits were built, as broadband frequency sources were not available in the late 1960s. It soon became apparent that the 500-kHz current yielded optimal results. This frequency had not been evaluated before for the simple reason that the US Federal Communications Commission forbade its use. Luckily, this regulation did not apply in Europe.

Prototype instruments, coaxial configurations of two separated electrodes, were produced by Oertli using materials such as steel, plated copper wire, and polytetrafluoroethylene tape. The heating effect was tested on raw beefsteaks using saline solution to create flow of high-frequency current and energy. The effects of power settings and on-off modulation were tested, and the influence of surface treatment of the electrodes was studied with regard to tissue adherence to the instrument tip.

Having gained knowledge of basic function and settings, Dr. Klöti proceeded carefully to patient application. The result of this cooperation between a skilled instrument manufacturer and a gifted inventor of posterior segment surgical procedures was a high-frequency bipolar wet-field diathermy instrument, which set the standards of 500-kHz modulated power delivery and platinum electrodes.3

After several years of successful application of the instrument for coagulation, Dr. Klöti became convinced that specially shaped tip electrodes and modified power settings would make this technology suitable for tissue dissection, in particular for capsulotomy. At a time when the standard method for opening the anterior capsule was the Christmas tree or can-opener capsulotomy, Dr. Klöti approached Oertli again, and a high-frequency capsulotomy device was developed in another joint industry-physician effort (Figure 2).4-6 Although manual capsulorrhexis became the standard technique for capsulotomy in the ensuing years, high-frequency capsulotomy continues to be used, particularly for indications such as hypermature or intumescent cataract, capsular phimosis, weak zonules, narrow pupils, and pediatric surgery.
CONTINUED COLLABORATION

Positive experience with the high-frequency technology prompted Bojan Pajic, MD (Figure 3), then of Clinic Pallas and now of Orasis Clinic in Reinach, Switzerland, to develop an ab interno method for glaucoma surgery. His concept involved producing a connection from the anterior chamber angle to Schlemm canal or, even better, through the canal to the sclera using the tissue-cutting properties of the high-frequency bipolar device. Dr. Pajic explained his idea to Oertli, and yet another collaboration began. The instrument design was evaluated in porcine eyes and constructed so that access to the chamber angle became possible through a 1-mm corneal or limbal incision opposite the point of application. Because the use of high-frequency energy was already standard in the anterior chamber for high-frequency capsulotomy, it seemed safe to apply it in the chamber angle. In the first trials in porcine eyes, nicely confined and controlled cavities were created. The tips were empirically modified in shape and size until optimally placed and formed cavities could be achieved. The first patient application occurred in 1999.

Early study results demonstrated the efficacy of this method, which was initially described as sclerothalamotomy ab interno.7,8 The early clinical results were so positive that Dr. Pajic and Oertli have worked on modifications of the tip and generator to make the procedure, now called high-frequency deep sclerotomy ab interno, easier to perform, particularly in combination with cataract surgery (Figure 4; see HFDS Glaucoma Surgery). A prospective, randomized, multicenter study is currently being conducted.

CONCLUSION

Both Drs. Klöti and Pajic brought novel ideas to industry, where they combined their expertise with the skills and know-how of engineers and instrument makers to advance surgical technique. These collaborations serve as examples of how basic ideas can be successfully implemented by the joining of forces among surgeons and ophthalmic device companies.

HFDS GLAUCOMA SURGERY

High-frequency deep sclerotomy (HFDS) glaucoma surgery is an ab interno procedure to lower IOP in patients with open-angle glaucoma. Using high-frequency energy, six small pockets are formed; these pockets significantly reduce the outflow resistance for aqueous humor, penetrating through the trabecular meshwork and Schlemm canal and ending in the sclera. The target point for the application is the incision angle opposite to the incision, normally nasal. The probe design also allows access to the lower orbital area. HFDS can be used for combined cataract and glaucoma surgery and is applied after completion of the cataract procedure, with the IOL in place and pupil narrowed. HFDS can be performed as a stand-alone procedure as well; in this case, the use of a high-viscosity ophthalmic viscosurgical device and pupil-narrowing drops are recommended. For a video of the procedure, visit eyetube.net/?v=guraq.

TAKE-HOME MESSAGE

• Both Drs. Klöti and Pajic brought novel ideas to industry to combine their expertise with the skills and know-how of engineers and instrument makers.
• These collaborations serve as examples of how basic ideas can be successfully implemented by the joining of forces among surgeons and ophthalmic device companies.

Figure 3. Bojan Pajic, MD.

Figure 4. The Abee tip for high-frequency deep sclerotomy glaucoma surgery.

Thomas Bosshard is the Head of Marketing and Sales at Oertli Instrumente AG. He may be reached at phone: +41 71 747 42 71; fax: +41 71 747 42 90; or e-mail: thomas.bosshard@oertli-instruments.com.