Chapter 96

ELECTROCAUTERY FOR SPINAL OPERATIONS

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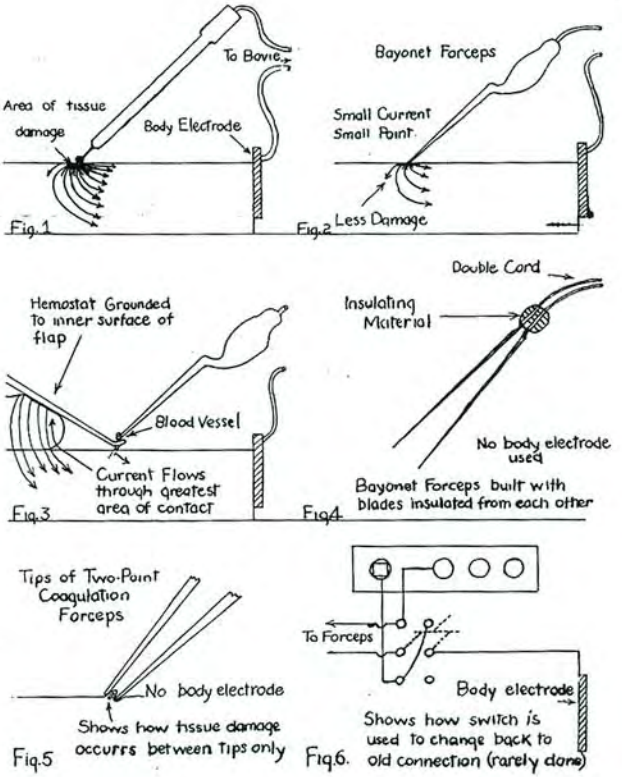

Figures 1 - 6. Original drawings of two point coagulation by James Greenwood, Jr.

Introduction

Hemostasis was an essential part of the earliest attempts at modern surgery, and electrocautery proper originated with d'Arsonval and Oudin in the 1890's. In 1897, Nagleschmidt made a modified apparatus to treat circulatory disease. In 1900, Riviere applied the method to tumors and tubercular lesions. Doyen's apparatus in 1920 included the significant addition of a second electrode to provide a ground for the electrical current that had been passed through tissue. A monopolar apparatus employs only a single active electrode; without a second electrode, the energy travels unpredictable routes through the body randomly impacting other tissue as it passes into the table, floor, and ground.[1]

On October 1, 1926, Harvey Cushing[2] reoperated and successfully removed

a highly vascular brain tumor with the aid of an electrosurgical generator constructed by William Bovie. The extremely cumbersome device had a higher cutting current and a lower current for hemostasis. When the current was strong enough in the active electrode to produce coagulation, there was some damage to surrounding tissues since the spread must pass to the common electrode applied to the patient's body. Damage to the surrounding tissue, including carbonization, necrosis, and local reaction, was particularly undesirable in the brain.

In 1940, Greenwood[3] (Figs. 1 - 6) described two point coagulation with a forceps divided and the blades insulated from each other to remedy some of the problems with the unipolar system. Using a switch, he attached one blade to the active side of the Bovie generator and the other blade to the ground connector and disconnected the ground plate. The coagulating current was varied to use the smallest possible effective amount. There still was some carbonization and spread of current until a bayonet forceps allowed tissue damage only between the tips.

Malis[4] (Fig. 7), in 1951, independent of the work by Greenwood,[3] built a low power spark gap generator for bipolar coagulation with a forceps constructed of insulated blades to avoid interference with electrophysiology recordings of the cortex in animal experiments. About two years later, the unit was brought into

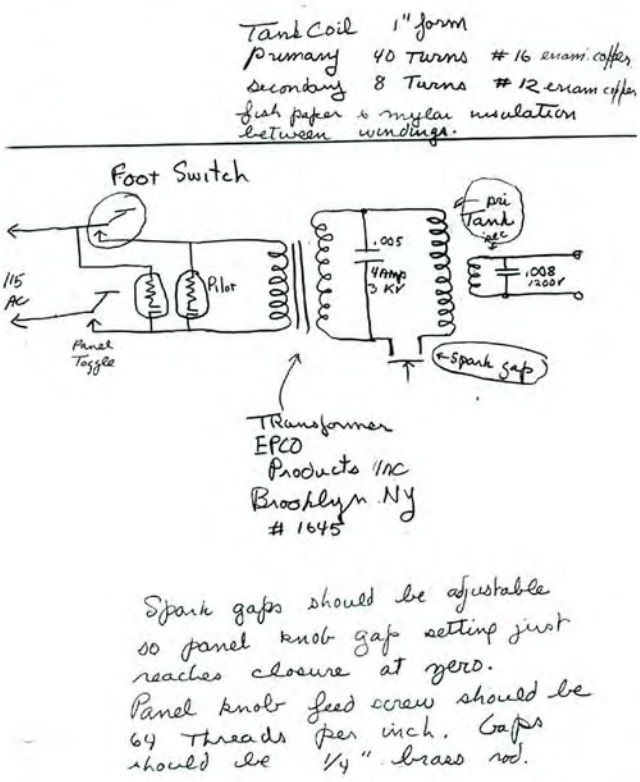

Figure 7. Original diagram of spark gap generator designed by Leonard Malis for bipolar unit.

the operating room at The Mount Sinai Hospital. Coagulation was performed with continuous saline irrigation which cooled the neural tissue and aided in the prevention of carbonization.

The Advent of Microneurosurgery

In 1965, M. Gazi Yasargil,[5] a Turkish neurosurgeon, was able to study microvascular techniques with Dr. R.M.P. Donaghy at the University of Vermont. Within 6 months, Dr. Yasargil was able to perform all types of reconstructive surgery on small vessels in the extremities of rats and rabbits. Applying these microtechniques to reconstruct brain arteries in the dog was unsuccessful because of the difficulty in obtaining the necessary and precise hemostasis in the surgical field with the available Bovie coagulator. Budget limitations did not allow the laboratory to buy a new coagulator for $500; instead, a small reconditioned unit that had been damaged and taped up was purchased for $150. The quality of the bipolar coagulator was immediately evident, because it provided controlled hemostasis in an artery or vein without any adverse effect on the vessel wall and adjacent structures and maintained a clean and clear surgical field. The Bovie instrument had charred and destroyed all evidence of the anastamosis as soon as any attempt was made to stop any bleeding in the surgical site.

During a lecture in the Neurosurgical Department of The Mount Sinai Hospital on arteriovenous malformation of the spine operated with operating microscope, Dr. Yasargil emphasized that better surgical results could be achieved with bipolar coagulation. Sitting in the back of the room was a colleague, who kept smiling throughout his entire presentation. At the end, he stood up and said, "Gazi, I am Len Malis. I enjoyed listening to you, and I would like to tell you, first of all, that this type of spinal AVM surgery was performed in 1910 here by Dr. Charles Elsberg. Second, I appreciated the fact that you are using my bipolar coagulator, which I constructed and manufactured years ago." Ever since then, in many publications and lectures, Dr. Yasargil always emphasized the importance of the bipolar coagulation technique in his own series of thousands of microneurosurgical procedures and recommended that every neurosurgeon become familiar with the Malis coagulator.[4]

Endoscopic Electrosurgery

Technological advances have made the application of thermal modulation effective and safe intradiscally. Particularly, the use of high frequency radio waves has proven efficacious in minimally invasive spine technique. The first cold cutting device with high frequency radio wave energy was developed in the 1970's (Ellman Innovations, Oceanside, NY). Ultrahigh frequency radio wave energy is delivered through modified monopolar and bipolar tools. The energy is filtered back to the electrosurgery unit with no adjacent tissue damage.

The forceps of traditional bipolar instruments were impractical for the small

spaces afforded by endoscopes to work intradiscally. A flexible tip bipolar instrument (Ellman Innovations, Oceanside, NY) has been designed with two proprietary metal wires—one serving as the active electrode, and the other as the passive electrode (Fig. 8). At the instrument's tip, the wires are brought into close enough proximity to complete the electrical circuit with just enough space between them to pass the current through intradiscal tissue observed directly with an endoscope. The current travels only the distance between the two wires with no diffusion to surrounding tissue. Furthermore, the tip is aligned at an angle, and may be extended, retracted, or turned 360°.

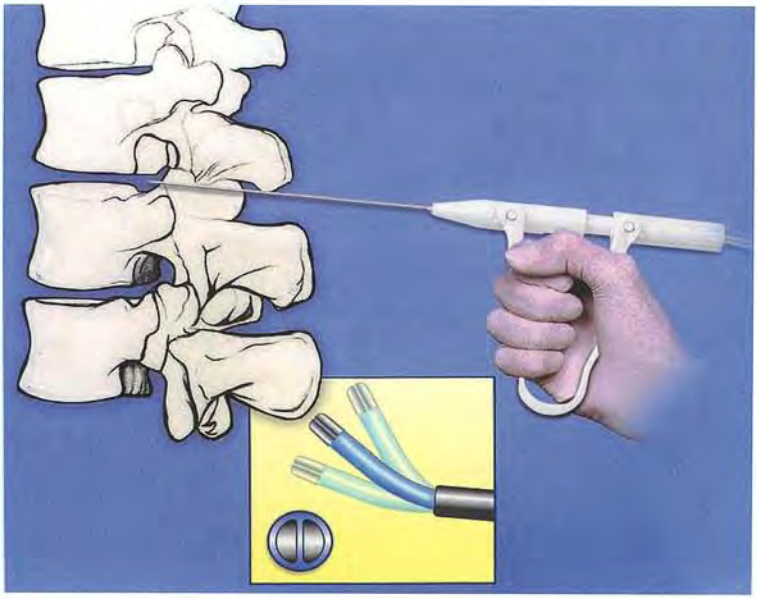

Figure 8. Ellman Trigger-Flex Navigational Bipolar System.

Summary

The use of thermal energy to modulate and ablate tissue is not new. Cautery derives from the Greek term *kauterion* or a branding iron which was employed to stem bleeding during an amputation. Advanced high frequency radiowave technology offers superior precision and sparing of healthy tissue. Spinal surgeons have rapidly embraced combined monopolar and bipolar functions for endoscopic procedures.

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