Automatically controlled bipolar electrocoagulation – “COA-COMP”

Bertil Välfors and Björn Bergdahl

Department of Neurosurgery, University of Göteborg, Göteborg, Sweden

Summary

Modern bipolar electrocoagulation has certain limitations, especially regarding the regulation of the short coagulation course. Studies on the electrical parameters of tissues during heating led to the conclusion that impedance changes in a typical and reproducible way. Furthermore, the impedance value proved to be close to minimal at the moment of coagulation. Laboratory tests were performed to correlate the pressure strength of the sealed artery to the impedance change. The tests proved that strong seals were achieved when the coagulation was interrupted soon after minimum impedance. Good seals were also achieved with later interruption of the heating but the well-known phenomena of sticking of the forceps to tissues and charging of the tips with charred tissue became more prominent. Further electrocoagulation gives carbonisation, fulguration and risk of new haemorrhage. Based on these results, microcomputerized equipment was built which cut off the coagulation soon after minimum impedance, i.e. when good strength without sticking was achieved. This equipment was tested clinically and the trials showed that the method is practical and most reliable. The microcomputer also allows automatic start of the coagulation as needed during opening or closing of wounds, as well as providing a built-in test of the equipment. This equipment saves time and labour and increases safety.

Keywords: Bipolar electrocoagulation, bipolar diathermy, diathermy, electrocoagulation, micro-computerized.

Bipolar electrocoagulation is relatively young. It was introduced by Greenwood in 1940 but was not then generally accepted [1]. In 1958 Leonard Malis made the first bipolar generator for neurosurgery with acceptable performance [2]. Since then technical development has been rapid, allowing further improvement of the technique [3]. In bipolar electrocoagulation high frequency (HF) current is passed through the tissue between the forceps points, and energy is thereby produced in the form of heat, as in the element of an electric cooking-plate (Fig. 1). When the tissue is heated to 60°C the proteins will coagulate and contract and if heating is continued the tissue will dry out because of boiling. Further heating will carbonize the tissue.

The very fast heating with conventional bipolar equipment makes it difficult to break manually at the right moment. Those working with bipolar equipment are well aware of the technical problems like adhesion of the forceps and rebleeding on loosening the forceps, which are then covered with charred tissue. Sometimes the cabling is broken by too many sterilizations. These problems make neurosurgery time-consuming, difficult to learn and sometimes dangerous.

The aim of this work was to find a method of switching off the diathermy power when full vessel strength is achieved and prior to sticking of the forceps and
Fig. 2. Impedance as a function of time during heating of tissue. Z-MIN, the impedance minimum, is closely correlated to the point of coagulation. The “Coa-Comp” principle is to break the current soon after this minimum by micro-computer technique.

Charring of the tissue. Because the coagulation is done with electrical HF-energy, it was considered and advantage if the electrical coagulation current itself could be used as a feedback of what was going on in the vessel.

The course of events is shown in Fig. 2, where the impedance change during heating of tissue is shown as a function of time. At time zero, when the current is switched on, the voltage rises to a constant value and if it is sufficiently high heating starts. The impedance then decreases and reaches its minimum close to the point of coagulation and then increases again with desiccation of the tissue. When the surface layer of the tissue has dried out, conditions for fulguration from the forceps to underlying tissue will occur. In other words, the increase in voltage which occurs at decreased load with many generators may cause sparks to jump from the forceps through the insulating layer. By desiccation and fulguration, the forceps will stick to the tissues. It is therefore necessary to break the heating after coagulation at about seventy to ninety degrees, and despite the extremely short duration of this procedure, which is only about one to two seconds, this is possible by means of the microcomputer. Our experiments in animals, with coagulation of vessels and consecutive pressure loading of the seals, show that strong seals are achieved even when the current is turned off briefly after the impedance minimum. If current supply is continued, the well-known phenomena of sticking and charring of the forceps will occur. Thus, the most important feature of this new equipment is that it breaks the current at the right moment.

Prototypes of a computerized coagulator were built and tested in different surgical situation. The method proved to be practical for many kinds of surgery, especially neurosurgery and precision surgery. After final adjustment of the software, the “COA-COMP” was made commercially available (Figs. 3, 4, 5).

Since the microcomputer of the equipment could make decisions, it seemed logical to utilize it to make further improvements to the system. Thus, the equipment can detect whether tissue is grasped within the forceps, and if start permission is given it can also start coagulation automatically. This is convenient and time-saving during opening and closing of wounds, when many coagulations have to be done within a short period of time. In microsurgery, however, the forceps are needed for manipulations as well as for coagulations, and for that purpose the start permission can easily be changed from automatically controlled to surgeon-controlled by brief depression of the pedal. Coagulation will then start.