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Bipolar coagulation with modified conventional electrocoagulators

Technical note

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✓ In a series of animal experiments, current loops resulting from monopolar electrocoagulation in close proximity to vital central nervous system tissues resulted in a sudden rise in blood pressure, irregularities in respiration and cardiac rate, and cardiac arrest. A simple additional circuit provides bipolar electrocoagulation, which permits precise clinical hemostasis and the use of the monopolar electrosurgical knife or loop without side effects.

KEY WORDS · bipolar coagulation · unipolar electrosurgery

ALTHOUGH the neurosurgeon is quite aware of the dangers of electrocoagulation in close proximity to the brain stem, spinal cord, or other sensitive structures, the "two-point coagulation" described by Greenwood[1-3] has not yet been accorded the recognition this method deserves. Malis[10] designed a special insulation unit for his "bipolar coagulation" especially developed for microsurgery, and showed that with this technique hemostasis is possible even under saline irrigation. Gurdjian, *et al.*,[4] reported the construction of a unit with an Electronic Control Center, activated by a number of pushbuttons located on the forceps. Furthermore, Pool[11] and Kempe[5] mentioned the advantages of bipolar electrocoagulation for the removal of acoustic tumors. Since no commercial unit was available, the authors embarked upon the development of a simple, safe method for bipolar electrical coagulation for the routine use in neurosurgery.[6-9]

The effect of various types of electrocoagulation of vessels on the surface of the brain stem, such as the basilar artery and the inferior cerebellar arteries, was investigated by the authors on a number of animals (cats and rabbits), while monitoring blood pressure, respiration, and the electrocardiogram. Merely touching the ventral surface of the pons and medulla oblongata or the floor of the fourth ventricle resulted in pronounced changes in the monitoring records.

Conventional unipolar electrocoagulation on the surface of the brain stem caused instantaneous cardiac and respiratory changes in all the animals tested, frequently resulting in cardiac arrest (Fig. 1). The authors attributed this effect to the coagulating current flowing through vital areas in the brain stem (Fig. 2 A). No changes in the respiratory

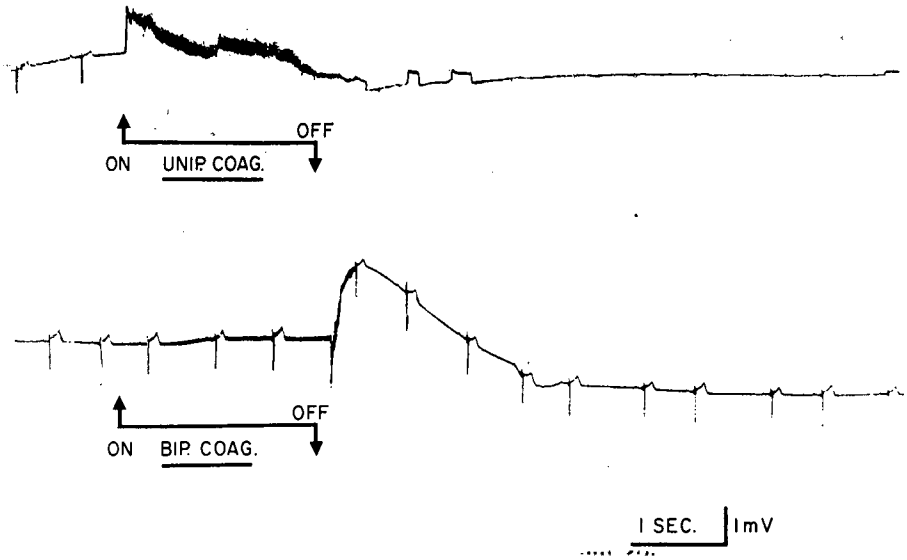

FIG. 1. Electrocardiogram of the cat, showing comparison between the effects of conventional (*Unip. Coag.*) and bipolar (*Bip. Coug.*) electrocoagulation of identical areas on the floor of the 4th ventricle.

rate, blood pressure, or ECG could, however, be detected if the identical vessels or nervous tissues were coagulated up to a depth of 4 mm with the bipolar forceps from which current spread is negligible (Fig. 2 B). Histological sections showed no destruction of ganglia cells near areas coagulated with the bipolar technique; a phenomenon frequently observed with unipolar coagulation.

This experience proved very valuable in the operating room. For the past 4 years all electrical hemostasis in close proximity to vital areas has been performed with this

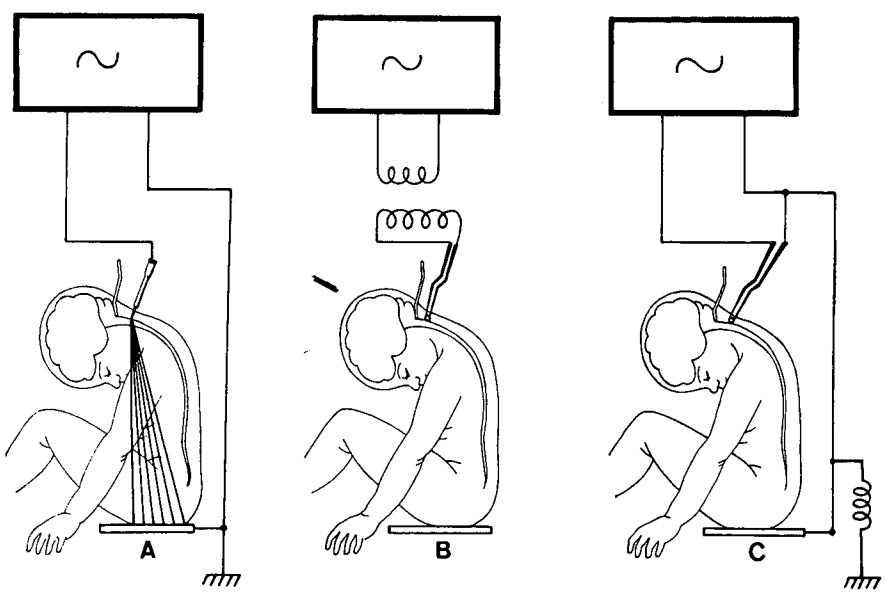

FIG. 2. Diagram showing current distribution during electrocoagulation on the surface of the brain stem. *A*. Unipolar: Current passes through brain stem causing severe damage to vital areas. *B*. Bipolar: Insulation unit limits current to vessel. *C*. Modification suggested by authors enabling bipolar coagulation and monopolar cutting through choice of tips by surgeon.

method in our neurosurgical department; unfortunately, however, the insulation units did not permit the use of the electrosurgical knife or loop frequently required for piecemeal extirpation of tumors. Figure 2 C shows a method of combining both advantages, namely, bipolar coagulation and unipolar electrosurgery, without additional insulation units. A radiofrequency choke is shown connected between one of the outputs of the radiofrequency source and the ground, thus providing effective dc-grounding while maintaining high frequency insulation. Some larger electrocoagulators are already equipped with this choke at the factory. As the coagulating current is limited to the shortest path between the tips of the bipolar forceps, a minimum of current spreads into the surrounding tissue; it is hence safe to maintain patient grounding as usual.

To avoid the possibility of accidentally cutting currents entering the coagulating forceps, different pins are used on the electrosurgical tip (Fig. 3); in this fashion the surgeon determines the type of current desired by simply changing from forceps to cutting tip (electrosurgical knife or loop) (Fig. 4).

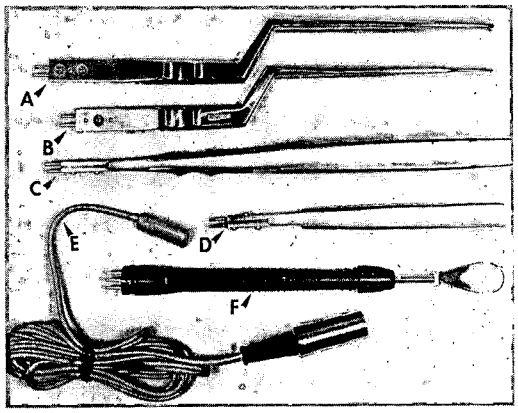

FIG. 3. Forceps designed for bipolar electrocoagulation (*A, B, C, D*) with two pins for contact cable (*E*) and monopolar cutting loop with three pins (*F*).

Summary

The authors have described a simple method of bipolar coagulation adaptable to most available electrocoagulators while preserving the capacity for unipolar electrosurgery when desired.

In summary, the advantages of bipolar electrocoagulation are: 1) minimal current spread to adjacent tissues; 2) only a fraction of the current is necessary; 3) elimination of undesired secondary burns; 4) effective coagulation under irrigation; 5) no assistance necessary for switchover from electrocoagulation to electrosurgery; and 6) coagulation only between the tips of the forceps, hence accidental branch contact with the margin of the operation site is harmless.

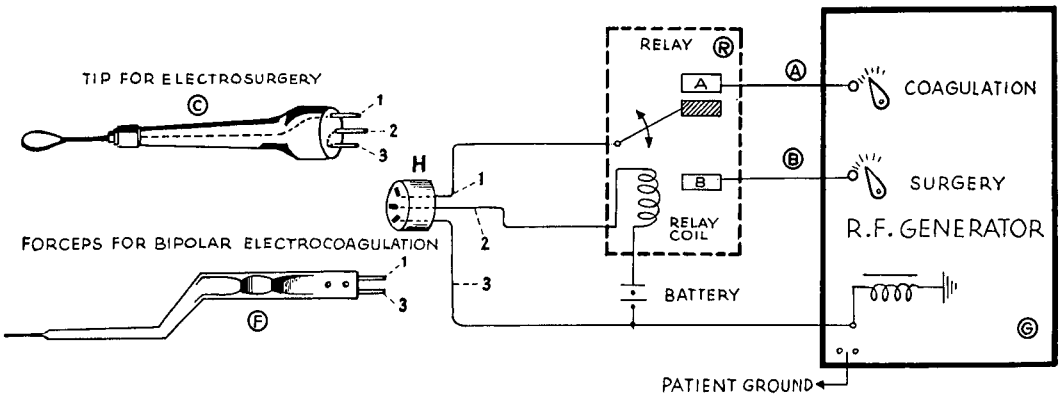

FIG. 4. Schematic diagram of setup. Most commercially available radiofrequency generators for surgical purposes (*G*) have separate outputs for electrocoagulation (*A*) and electrosurgery (*B*). The relay (*R*) is connected as an output selector. If bipolar coagulation is desired, one merely inserts the bipolar forceps (*F*) into the handle (*H*). For electrosurgery, the forceps is replaced by the cutting tip (*C*). This tip has a shorting bar between legs 2 and 3 and thus closes the circuit that energizes *R;* leg 1 is hence automatically connected to the cutting current. This setup enables the surgeon to select the appropriate current without the necessity for an unsterile aid and, most important, prevents cutting current accidentally entering into the coagulation forceps and vice-versa.

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