A Technic for the Permanent Implantation of Electrodes on the Heart.* (19783)

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Previous investigators(1-6) have studied the excitability cycle of the heart in acute open-chest experiments. After the sinus node was destroyed, a pair of electrodes was fixed for driving the heart, and another pair or the same pair was used to apply the testing shocks at different times in the cycle.

Since a more physiological preparation is desirable to obtain data on the excitability of the heart, a technic is presented which offers the following advantages: 1. Minimal tissue damage. 2. Fixed position of the electrodes in order to carry out repeated experiments in the same preparation under identical conditions. 3. Physiological condition of the preparation. *i.e.*, closed chest, spontaneous heart beat and respiration. 4. Current spread during stimulation is avoided by short distances (1 mm intervals) between the points of stimulation.

Technic. The technic for permanent implantation of multilead electrodes developed by one of us to study cerebral function has been used in the rat, cat, dog, and monkey (Delgado)(7). It has been modified to study the excitability of the heart.

Preparation of the electrodes. A piece of polyethylene tubing (No. PE 205, Clay Adams Co., Inc., New York) was opened and flattened to form a small plate 5 x 10 mm in size. A sharp needle lightly warmed was used to make 6 holes 1 mm apart in the midline of the plate. Six pieces of enameled stainless steel wire (Driver-Harris Company, Harrison, N. J.) approximately 6 inches in length and

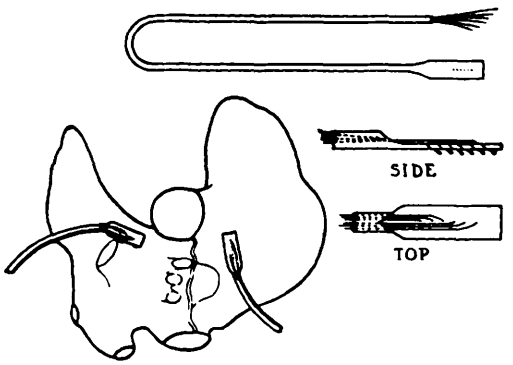

FIG. 1. Electrode is composed of 6 stainless steel wires isolated and protected by enamel, plexiglass and polyethylene. The plate is sutured to the epicardium.

0.12 mm in diameter were straightened by stretching. One end of each wire was melted to form a small ball (Riley)(8). The ends of the wire bearing the balls were threaded through the holes of the prepared plate. The other ends, coming to the opposite surface of the plate, were glued together by means of a thin solution of plexiglass. Thus only one surface of the plate presented the ball points. The wires were encased in polyethylene tubing 1.5 mm in diameter (No. PE 90).

The tubing near the plate and distal to the plate was fused by heat. In order to identify the points on the plate with the free ends of the wires, the latter were varied in length. The ball points on the plate were abraded with a fine emery wheel to make flat surfaces. The wires were checked for leakage with an ohmmeter. The electrodes made in this fashion (Fig. 1) were further prepared for implantation by making a small hole at each corner of the plate for subsequent suturing to the epicardium.

Surgical technic. Plate electrodes were sterilized in Zephiran (1:1000) over night. Dogs were anesthetized with nembutal, an endotracheal tube was inserted for positive pressure breathing. The chest was shaved

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and opened under aseptic conditions. Through an intercostal space (for auricular implantation the 3rd, and for ventricular the 5th, were most suitable) the pleura was opened and the ribs were retracted. The pericardium was slit over the site of the implantation and stay sutures were passed for retraction. With the aid of a 20 mm Carrel arterial needle, the sutures (000,000 silk) were inserted as follows: the needle was passed through one distal hole of the plate, then through the superficial epicardium, out the other distal hole, and tied over the plate. The proximal holes were then similarly treated. Thus the electrode was secured by only 2 sutures.

The pericardium was closed and the free ends of the electrodes brought out through an interspace anterior or posterior to the incision. The ribs were approximated and a fine rubber tubing was temporarily inserted in the pleural space for subsequent evacuation of air. The chest wall was closed in layers, the intrapleural space evacuated, and the rubber tubing removed after which the skin was sutured.

The free end of the electrode outside the body was covered with a gauze square the edges of which were sealed to the skin by means of collodion, thus allowing easy access to the electrodes, and at the same time protecting them from breakage due to the animals' activities.

Comment. The results of studies using this technic have been reported(9). The presence of the electrodes does not interfere either with the movements nor with the health of the subject. Microscopic examination of the hearts of animals autopsied at varying intervals after implantation revealed no reaction except a slight thickening of the pericardium overlying the plate of the electrode.

The excitability determinations may be carried out by the methods described(10) without the use of any anesthetic agents provided the animals are trained to lie quietly. In addition to fulfilling the advantages stated above, this technic also makes it possible to study the conduction velocities of the different regions and the effects of pharmacological agents on both conduction velocities and excitability cycle determinations.

Summary. A technic has been described for the study of the excitability cycle of the heart employing permanent implantation of electrodes.

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Propagation of Coxsackie Virus on the Chorioallantoic Membrane of Embryonated Eggs.* (19784)

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