METHODS

IMPLANTATION OF ELECTRODES IN THE BRAIN OF WHITE RATS IN EXPERIMENTS OF LONG DURATION

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A method of implantation of electrodes in the brain for long periods of time has been described only in cases of comparatively large experimental animals – dogs, cats and rabbits [1, 2, 3]. It appeared desirable to devise a method of implanting electrodes for a long period of time in the brain of white rats, which are suitable subjects for many experimental investigations.

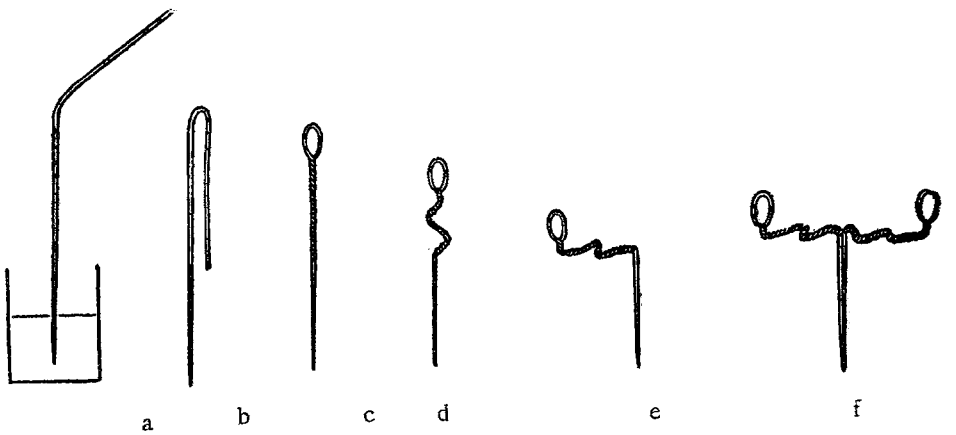

Fig. 1. General view of the electrodes and the stages in their preparation.

The essence of the suggested method consists of the creation of a firm base on the skull for attachment of the electrodes. For this purpose a specially prepared perforated plate, made of organic glass, to which the bipolar electrodes are attached, is affixed subcutaneously to the bones of the skull.

Preparation of the supporting perforated plate. A solution of organic glass in chloroform (1: 1) is poured into a Petri dish so that after slow evaporation of the chloroform a plate no more than 1 mm in thickness was obtained. Next, cellophane is inserted between several prepared plates, which are then flooded with 96% alcohol. The plates stay very flexible and transparent for a long time. At the time of operation trapezoidal plates are cut out with scissors from these, corresponding in size to the area of the vault of the skull of the rats undergoing operation. Next the plate is perforated by means of a specially adapted cork-borer in order to obtain 4 oblong holes.

Preparation of the electrodes. The electrodes are so shaped that they can be attached to the perforated supporting plate. These electrodes are prepared from sections of steel wire (the E string of a violin) 5 cm long.

The sections of wire are immersed at one end in a weak solution of sulfuric acid, as a result of which this end is thinned to a diameter of less than 0.05 mm (Fig. 1, a). Stocks of electrodes are then dipped in tin of a high degree of purity. The other end of the steel wire is doubled over (see Fig. 1, b), twisted for a distance of 2 cm (see Fig. 1, c) and bent in a zigzag shape in order to give the wire a form of flat surface (see Fig. 1, d). At the beginning and end of the manipulated part of the electrode it is bent into a right angle (see Fig. 1, e).

In order to insulate the electrodes they are immersed once in a solution of organic glass of a syrupy consistency and dried at room temperature. The insulated electrodes are joined in pairs (see Fig. 1, f) with silk thread in their upper part and again immersed in the organic glass solution. The reliability of the insulation is tested with an ohm-meter. Next the points of the electrodes are carefully cleaned free from insulation by means of filter paper soaked in chloroform. After drying, the electrodes are tested for conductivity.

Operation of implantation of the perforated plate and electrodes. Under ether anesthesia a midline incision is made in the skin over the vault of the rat's skull. The skin is easily separated by blunt dissection from the periosteum and is retracted to the side with hooks; in this way the temporal muscles are exposed on the right and the left, enclosinga trapezoidal area of the vault of the skull which is covered only by periosteum. A piece of the supporting plate is cut out to the shape of this area. The perforated plate is fixed by 4 sutures to the temporal muscles. In young animals it is possible to insert the sutures directly into the skull behind the bony crest formed on each side by the area of the vault of the skull and the temporal bone. In this case the needle enters the bone at the level of the zygomatic process and emerges at the site of attachment of the temporal muscle

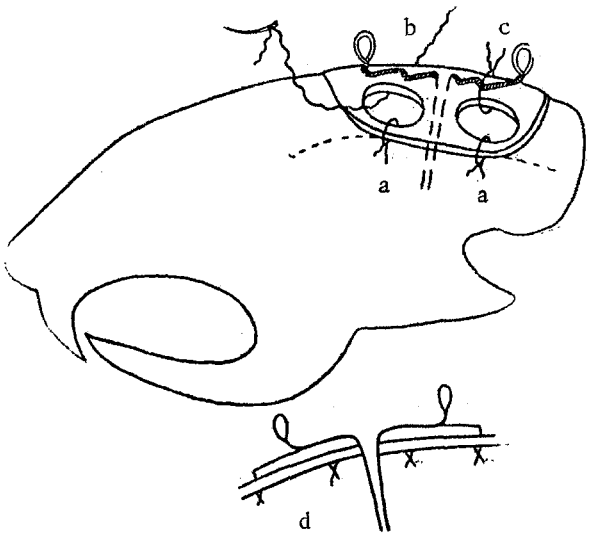

Fig. 2. Diagram showing the attachment of the perforated supporting plate and electrodes to the skull of a white rat. a) suture attaching the plate to the temporal muscle or the bony crest; b) ligature passing through a hole in the plate (between the plate and the skull); c) ligature fastened over the electrodes; d) diagram showing the position of the supporting plate and electrodes in sagittal section.

to the bones of the vault of the skull, i.e. to the bony crest (Fig. 2, a). At the time of operation the plate is readily bent to the shape of the skull. After the short time necessary for loss of the chloroform the plate hardens and henceforward keeps its acquired shape. The holes in the organic glass plate enable the attachment of a skin flap over the plate and restrict its horizontal displacement, since connective tissue grows through them.

By means of a No. 3 spherical dental drill a burr hole is made through the plate and at the same time through the underlying bone of the vault of the skull. Then, using a slightly curved needle 2 ligatures are passed under the plate (through its holes (see Fig. 2, b). The plate is coated in the midline with organic glass solution; the manipulated parts of the electrodes are also coated with the same solution. The ends of the

electrodes are then passed through the burr hole and carefully buried in the brain substance until the horizontal arms of the manipulated parts of the electrodes no longer remain poised over the surface of the supporting plate.* The electrodes are fixed to the plate by ligatures passed beneath it (see Fig. 2, c) and left for a few minutes in order to become adherent to the plate. After this time the periosteum is scarified by means of a sharp hook or a dental drill through the hole in the plate; this encourages further dense adhesion formation between the skin and the periosteum. The operation is concluded by suturing the skin; the emerging loops of the electrodes pass between the sutures.

The electrodes are thus firmly fixed to the animal's skull by their horizontal manipulated parts although these parts are not directly attached to the bones of the skull since they are joined only with the substance of the supporting plate which in the course of time becomes more and more firmly embedded.

To connect the electrodes to the stimulating or recording apparatus a fine lead is used, which is suspended on fine elastic, and a terminal hook by means of which the loop of the electrode is seized for convenient soldering of the lead thereto. In place of tinned steel electrodes, those of silver or constantan may be used; in this case the electrodes are soldered to the manipulated part of the steel wire.

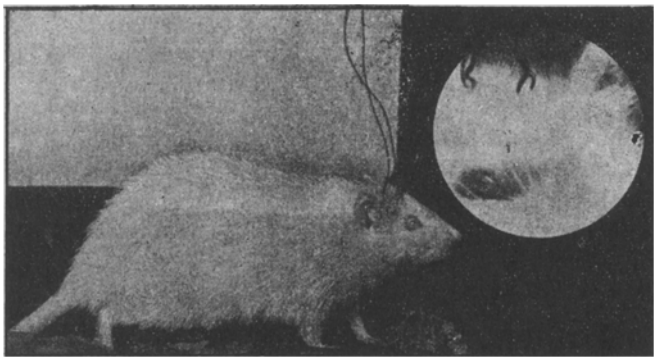

Fig. 3. A rat with electrodes in situ, 8 months after operation. On the magnified film of the head of the rat the electrode loops are seen among the growing fur.

We used the method described on white rats weighing from 50 to 200 g. The reliability of the attachment may be judged by the fact that during observations on these animals for 8 months the electrodes remained firmly in position (Fig. 3). Implantation of the electrodes in the brain of white rats by this method may also be used for stimulation of suitable nerve structures and for tapping potentials during experiments of long duration.

SUMMARY

A method of implantation of electrodes into the brain of white rats in a chronic experiment is described. Rats weighing from 50 to 200 g may be subjected to this operation. Stable fixation was followed up for 8 months.

LITERATURE CITED

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*Corresponding to the required depth of insertion of the electrodes, they are used in suitable lengths.

**In Russian.