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THE STEREOTAXIC INSTRUMENT FOR THE DOG AND ITS APPLIANCE AT OPERATIONS ON THE ANIMALS USED FOR CHRONIC EXPERIMENTS

PART II. THE METHOD OF ELECTRODE IMPLANTATION INTO THE BASAL GANGLIA

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In chronic experiments done on animals, two methods of electrode implantation into the basal ganglia are generally used. The first method Clark and Horsley's (1906) depends on implantation of the electrode into the chosen region by means of a stereotaxic instrument, and then on destroying this region electrolytically. The implantation of the electrodes is based on the same principle, by means of which the basal ganglia may be stimulated, or their spontaneous electrical activity recorded. This method has been applied by Harris (1948), Hume (1953), Delgado (1955), Bradley and Elkes (1953), Grastyan, Lissak and Kekesi (1956) and others.

Another method of electrode implantation was worked out by Hess in 1931. It consists of fixing to the skull bone of the cat a special instrument which enables implanting the electrodes into the brain and fixing them permanently at the depth required. During the last few years the method of Hess has been used for experiments carried out not only on cats, but also on rabbits Gangloff and Monnier (1955), on dogs Andersson and McCann (1956), and on sheep and goats Larsson (1954); Andersson and Larsson (1956); Andersson and Wyrwicka (1957).

Besides these, there are other methods described of the implantation of the electrodes into the basal ganglia on experimental animals. Kogan (1949, 1952) described a method of electrode implantation on cats, and Lurie and Trofimow (1956), on dogs.

The most often applied methods of electrode implantation, the stereotaxic and the Hess methods, have their advantages and disadvantages. The method by means of the stereotaxic instrument assures a better loca-

lization of the electrode tips, but at the same time it is impossible to lower the electrode into the depth of the brain after the implantation. In the Hess method the localization of the electrode tips depends to a degree on the individual structure of the skull bone, but it enables the pushing of the electrodes several times deeper into the brain in the direction of the base of the skull.

Our stereotaxic instrument for the dog combines the method of electrode implantation by means of a stereotaxic instrument, with the Hess method. By means of the instrument we fix within the skull bone the multiple electrode carriers, without implanting at the same time the electrodes into the basal ganglia. The carrier performs the task of the Hess instrument and ensures an accurate space localization for the electrodes implanted in the brain at a later date.

So far we have usad two-electrode carriers for the electrode implantation into the hypothalamus, and five-electrode carriers for the electrode implantation into the corpus striatum. If necessary, carriers with other quantities of electrodes may be used.

Acrylic resin (Methylic polymetacrylan) is used for the production of the carriers. The channels bored in the carriers must be exactly parallel to one another. The diameter of each channel is 3 mm., in the lower part of the carrier it tapers to 0,6 mm. The axis of the channels are apart from one another by 4 mm. In the wall of each of the channels there is a setting screw, by means of which the socket of the implanted electrode is immobilized. The two-electrode carriers are closed at the top by a screwed-in lid, and in the five-electrode carriers the lid is fixed by means of four screws.

The electrodes, made of stainless steel of 0,5 mm. diameter, and set in special sockets also of stainless steel, are inserted through the channels of the carriers. The electrodes and the sockets are coated with varnish and then dried in the oven. The varnish is removed 1 mm. from the tips of the electrodes and the electrodes are electrolytically sharpened. The same electrodes may be prepared by the method described by Bishop and Collin (1951) and in this way micro-electrodes will be obtained.

The implantation of the electrode carriers into the skull bone is done after the Evipan anaesthesia by intravenous injection.

A deep anaesthesia is developed the ear bars are inserted, and the upper jaw is fixed in the holders of the stereotaxic instrument.

When five-electrode carriers are implanted on both sides, the skin on the head is cut in the middle line and the temporal muscles are partly removed. Then the head is moved in the stereotaxic instrument around the longitudinal axis at a 20° angle, and by means of the holders of the instrument the place for the trepanation is marked. After the head is

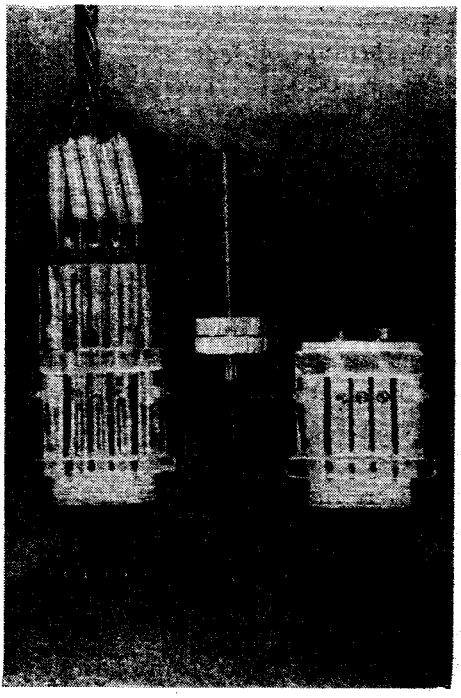

Fig. 1. Five-electrode carriers and electrodes with plugs connecting the electrodes with the electroencephalograph. On the left, the carrier with inserted electrodes connected with the electroencephalograph. In the centre, electrode with the holder. On the right, the five-electrode carrier closed on the top by the lid.

Fig. 2. Dog prepared for operation, with head fitted in the stereoxic instrument.

moved around the longitudinal axis in the opposite direction, the place for the trepanation on the other side is marked. In the marked regions trepanation apertures in the skull bone are then cut, two on each side. The apertures in the skull bone are cut by a tap.

By means of a bone-cutting forceps, both apertures are joined together, thus forming on each side an aperture 23 mm. long and approx. 11 mm. wide.

Near these apertures, another small aperture is cut on each side reaching to the diploe. In these small apertures silver screws are screwed in.

The five-electrode carrier is fixed on the vertical holder of the instrument in such a way that the central channel shall exactly fit in the place of the standard needle. The vertical holder together with the fixed electrode carrier is lowered down in such a way that the whole lower surface of the electrode carrier adheres to the dura mater. If the front part of the lower surface of the electrode carrier does not adhere to the dura mater, the head should be moved several degrees around the biauricular axis to raise the upper jaw. Such process is allowed at the implantation of the electrodes in large structures, e. g. in the caudate nucleus.

When implanting the electrode carriers in small and deeply placed structures, a correction should be made on account of the angle of rotation (of the head) —.i. e. the carrier should be accordingly shifted in the sagittal direction.

The gap between the electrode carrier and the skull bone is then filled with liquid acrylic resin „Duracryl". „Duracryl" should at the same time cover the silver screw near the trepanation aperture, to fix the carrier more securely. When fixing the carrier by means of „Duracryl" care should be taken, that the acrylic resin does not get between the dura mater and the lower surface of the electrode carrier. The polymerisation of the acrylic resin may be quickened by watering it with a warm solution of physiologic salt.

Once the „Duracryl" is hardened, the electrode carrier is set free from the vertical holder of the stereotaxic instrument; of course the height of the upper surface of the carrier must be checked before removing the holder.

Then, the channels are filled with liquid paraffin wax and the carriers are closed at the top by the lid. The implantation on the other side of the head is carried out in the same way. The skin is stitched above the electrode carriers. After the whole incision is sewn, apertures are cut out in the skin for the carriers to protrude.

The implantation of the two-electrode carriers is carried out in the same way, with the difference that only one round trepanation aperture is made in the bone, in which the carrier is subsequently fixed.

Between the implantation of the electrode carrier and the implantation of the electrodes into the corpus striatum, or into the hypothalamus, a long period may elapse, from a few weeks up to twenty or more.

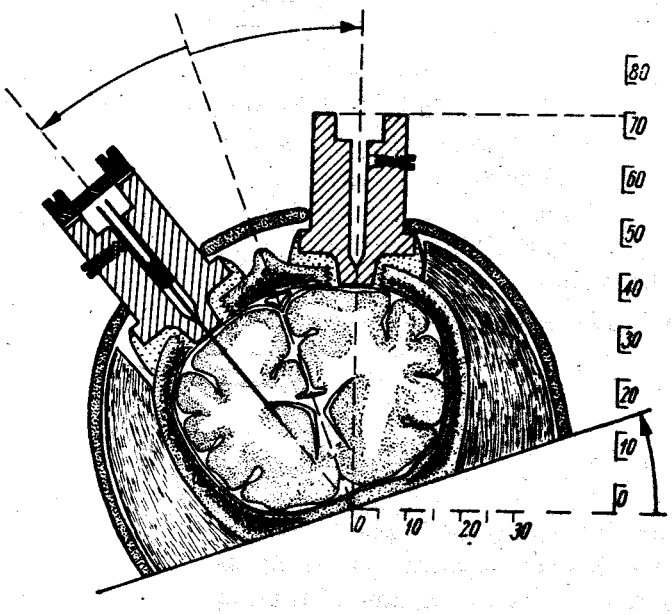

Fig. 3. Frontal section of dog's head with five-electrode carriers implanted on both sides.

Fig. 4. A dog with implanted electrodes.

The implantation of the electrode carriers is carried out on dogs first anaesthetized with morphia, and later by an intramuscular injection of Phenobarbitel Sodium. After the electrode carriers are opened and the liquid paraffin wax cleaned from the channels the dura mater is stabbed through, 1% Procaine Hydrochloride is injected under it, and the elec-

trodes are implanted. During the implantation, the sockets of the electrodes are screwed to a special holder, which limits the depth of the implantation. The sockets of the electrodes are fixed within the channel by means of a screw, and the holder is taken out.

If it is necessary to lower the electrodes into the depth of the brain, the holder is again screwed into the electrode socket. A suitable adjustment of the limiting screws on the carrier allows to lower the electrode in the direction of the skull base to the required depth. When the electrode is lowered, the socket is again fixed in the channel of the carrier. From their initial upper position, the electrodes may be lowered as much as 6 mm.

CONCLUSION

1. The method of electrode implantation on dogs is especially advantageous for long chronic experiments. From the time of the implantation of the electrode carriers, to the time of the implantation of the electrodes, a long period may elapse.

It safeguards against the effects of a too long (often unnecessary) period of the electrode's remaining in the brain tissue.

2. The electrodes may be implanted through any chosen area, and avoid, for instance, the lumen of cerebral ventricles, heavily vascularizated areas, or other brain structures.

3. The electrode carrier anables not only the implantation of the electrodes at a required depth, but also their gradual lowering (once or several times) into the brain.

4. The implanted electrodes may be used for stimulation by electrical current, as well as for recording spontaneous electrical activitv of the brain.

REFERENCES

1. *Andersson B., McCann S. A.:* Acta Physiol. Scand. 1956, 35, 312. — 2. *Andersson B., Larsson S.:* Acta Physiol. Scand 1956, 36, 377. — 3. *Andersson B., Wyrwicka W.:* Acta Physiol. Scand. 1957, 41, 194. — 4. *Bishop P. O., Collin R.:* J. Physiol. 1951, 112, 8 P. — 5. *Bradley P. B., Elkes J.:* EEG a. Clin. Neurophysiol. 1953, 5, 451. — 6. *Clarke R. H., Horsley V.:* British Med. J. 1906, 2, 1799. — 7. *Delgado J. M. R.:* EEG a. Clin. Neurophysiol. 1955, 7, 637. — 8. *Gangloff H., Monnier M.:* Pflügers Archiv. 1955, 261, 421. — 9. *Grastyan E., Lissak K., Kekesi F.:* Acta Physiol. Acad. Scient. Hungaricae, 1956, 9, 133. — 10. *Harris G. W.:* J. Physiol. 1948, 107, 418.

11. *Hess W. R.:* Le sommeil. Comt. Rend. Hebdomadaires Soc. de Biol. 1931, 107, 1333. — 12. *Hume D. M.:* Annals of Surgery, 1953, 138, 548. — 13. *Kogan A. B.:* Elektrofiziołogiczeskoje issledowanije centralnych mechanizmow niekotorych słożnych refleksow, Moskwa, 1949. — 14. *Kogan A. B.:* Metodika chroniczeskogo wżiwlenija elektrodow dla otwiedienija potenciałow i razdrażenija mozga, Moskwa, 1952. — 15. *Larsson S.:* On the hypothalamic organisation of the nervous mechanism regulating food intake. Part I. Acta Physiol. Scand. 1954, 32, suppl. 115, 1. — 16. *Łurie R. N., Trofimow L. G.:* Fiziol. Żurn. SSSR, 1956, 42, 348.

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