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

PART I. THE STEREOTAXIC INSTRUMENT

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During the last few years the achievements of neurophysiology are closely bound together with improwing and spreading of methods of research on the central nervous system. The method of three dimensional localization of the anatomical structure in the skull cavity has its important place in this research.

The creators of this method are R. H. Clarke and V. Horsley, who described it in 1906. During the following years the three dimensional localization was improved by its creators, mainly by Clarke (Horsley and Clarke 1908, Clarke and Henderson 1911, 1920 and Clarke 1920), and later by several other research workers.

The method of three dimensional localization consists of three basic elements: 1. the stereotaxic instruments, 2. the electrodes for implantation in the basal ganglia by means of the instrument in drastic and chronic experiments, and 3. the stereotaxic atlases.

Several authors worked on the stereotaxic atlases of the animal brain and on the construction of the stereotaxic instruments for such laboratory animals as monkeys, cats, rats and rabbits, and modified these instruments. There are works by Ingram and collaborators (1932a, 1932b), G. Clark (1939), Kaufman and Waller (1949), Jiminez-Castellanos (1949), Carpenter and Whittier (1952), Olszewski (1952), Stellar and Krause (1954), Sawyer and collaborators (1954), Reinoso (1954), Greer and collaborators (1955), Loewenfeld and Altman (1956), Jasper and Ajmone-Marsan, Spires (1957), and Desmedt and Franken (1958).

During the last few years the method of three dimensional localization has been applied in neurosurgery. Stereotaxic instruments for humans are

described by Spiegel and collaborators (1947), Jasper and Hunter (1949), King and Trufant (1949), Hayne and Meyers (1950), Lister and Sherwood (1955), and Becker and collaborators (1957). Talairach with collaborators worked out the stereotaxic atlas of the human brain (1957).

When the stereotaxic method is applied, the experiments are mostly executed on cats and some species of monkey. This is because of the relatively small individual deviation between these animals in the anatomical structure of the skull and the brain.

However the most convenient object for the chronic experiments is the dog. A whole division of neurophysiology — the physiology of the higher nervous activity, was based especially during the initial period, on experiments on dogs. Large individual deviations in the skull shape of the dogs prevented the researchers from a wider application of three dimensional localization on these animals. Great differences in the size and shape of the skull of different breeds are apparent, e. g. in the pekinese, the bulldog and the spaniel.

In consideration of these differences, Hume and Ganong (1956) worked out a method of electrode implantation into the dog's hypothalamus, not based on the fixed space dimensions, but on an X-ray picture of the third ventricle taken every time the experiment was done. The Hume and Ganong method is therefore not exactly a stereotaxic method, according to the principles worked out by Clarke and Horsley, and may be applied to the localization of the structures situated close to the lumen of cerebral ventricles only.

When working out the method of the implantation of the cannula into the lateral ventricle (1957), we tried simultaneously to apply the method of three dimensional localization to dogs. The initial research lead to the conclusion that dogs as well as other animals may be used for stereotaxic experiment but the animals have to be selected.

As a criterion for selection, the absolute dimensions of the skull have been fixed, its length and width, reciprocal proportion of these two dimensions, and the weight of the animal. For the stereotaxic method operations long-skull mongrels (Dolichocephali) are chosen, with the proportion of the width of the skull to the length not larger than 0,6 and the absolute dimensions approx. from 11 to 20 cm., weight from 18 to 20 kg. Extreme dimensions within 10—11,5 cm. for the width and 18—22 cm. for the length of the skull are admissible. The width of the skull is measured by taking the distance between both zygomatic arches, and the length — the distance between the alveolar process of the upper jaw incisor and the external occipital protuberance. The deviation in the weight of the animal within the limits of a few kilograms does not disqualify the animal for

stereotaxic research as long as the skull corresponds to the dimensions chosen.

When the selection of the animals is made in accordance with the above criteria, the relative individual deviations in the size of the dog brain should not be larger than those of cats — Reinozo (1954), and Loewenfed and Altman (1956).

The data acquired have authorised us to construct a stereotaxic instrument for dogs which is destined for chronic experiments. Considering its application, the construction of this instrument differs from the construction of the stereotaxic instrument for other laboratory animals. The stereotaxic instrument is so constructed as to ensure immobility of the head, and only the devices for the three dimensional localization, and for the implantation of the electrodes are mobile. However such a type was inconvenient at the operations on dogs destined for chronic experiments, therefore we created an instrument constructed on the following principles:

1. The position of all the points of the brain is determined in relation to one zero point, the latter being the zero point of the three space dimensions. Through the zero point both axes cross: the longitudinal axis and the biauricular axis.

2. The longitudinal axis of the head lies on the section of the sagittal plane with the horizontal plane and the biauricular axis of the head on the section of the frontal plane with the horizontal plane. The horizontal plane is fixed from the rear by the biauricular axis of the head joining the lumen of the external auditory meatus, and from the front — fixed by the lower margin of the orbit. The sagittal and frontal planes are perpendicular to the horizontal plane.

3. The head of the dog placed in the instrument may be rotated at an angle around the biauricular axis and the longitudinal axis.

4. The space position of the zero point is constant and independent of the rotations of the head around the biauricular or longitudinal axes, or around both axes simultaneously.

The stereotaxic instrument for a dog consists of two basic parts: I) the holdersfixing the space localization, and II) the head-fixing mechanism which at the same time allows its rotation at an angle around both axes.

I) The instrument has three holders: longitudinal, diagonal and vertical. The holders are supplied with a millimetre scale with verniers. The holders are moved by means of screws. After reducing the scales to zero on all three holders, the tip of the standard needle (lenght 50 mm.) marks the zero point of the three dimensions.

II) The mechanism for fixing and rotating the head consists of a plate, on which two vertical supports are placed. The supports have movable

horizontal ear bars. These ear bars are supplied with a millimetre scale. The axis joining the bars marks the biauricular axis of the head.

On the plate, besides the ear bar holders, there is a device for fixing the upper jaw and for moving the head up or down round the biauricular axis. The upper jaw is held between the clamps which rest on the lower margin of the orbit, and fix the jaw from above, while it is fixed from

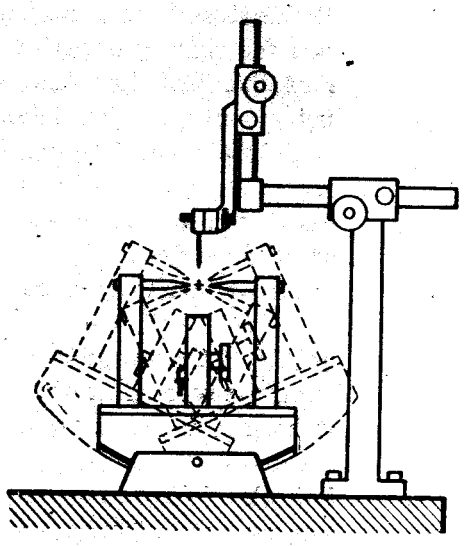

Fig. 1. Diagram of the instrument (rear view).

below by clamps at the oral surface of the maxilla. If we raise the clamp at the oral surface of the maxilla by means of screws, the upper jaw is pressed to the orbital clamp and fixed in this position.

A device permitting rotation of the head around its longitudinal axis is placed under the plate.

Both devices which enable rotation around the longitudinal and biauricular axis are supplied with a graded scale.

On the side of the plate, there is an X-ray cassette. The instrument is constructed to take side X-ray pictures of the dog's head. Only the ear bar holders and the ear bars fixed in them are on the way of the X-rays, and cover a part of the skull base. The cassette with X-ray film may be put in and removed during the operation regardless of the position of the head in the instrument. It permits a radiological check of the electrode implantation during the operation.

The stereotaxic instrument has been used for implantation of the electrodes into the basal ganglia, for implantation of the cannula into the lateral ventricle and in the cisterna magna, and for the implantation of the multiple electrode carriers into the bone of the skull. It has proved

its usefulness for these operations, and there has been no difficulty in keeping aseptic conditions during the operation.

After the instrument has been constructed, we started on preparing the stereotaxic atlas of the dog brain with the adopted dimensions of the head.

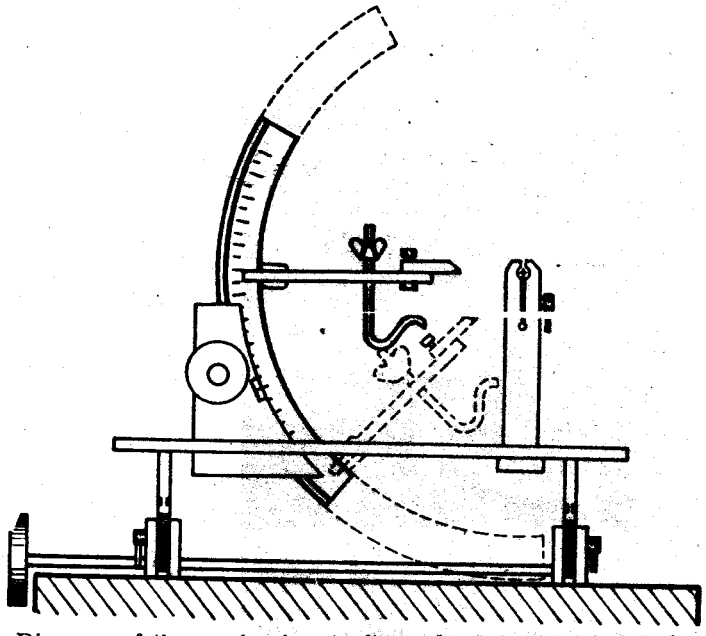

Fig. 2. Diagram of the mechanism to fix and rotate the head (side view).

The construction of the stereotaxic instrument for a dog permits:

1. Implantation of the electrodes into the basal ganglia through a chosen part because of the rotation of the head around the longitudinal and biauricular axis.

2. Easy access during the operation to the different parts of the skull, and particularly to the occipital and temporal regions.

3. Choice of the most convenient place in the skull bone to fasten the multiple electrode carriers for the electrodes implanted into the basal ganglia.

4. The taking of side X-ray picture during the operation.

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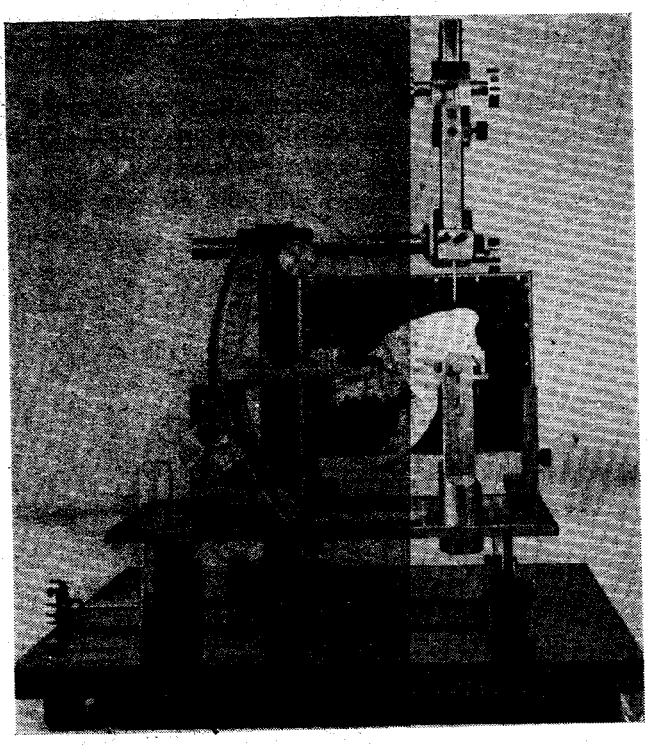

Fig. 3. Stereotaxic instrument for the dog.

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