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A RECORDING PROCEDURE FOR CHRONIC MICROELECTRODES IN THE PARALYZED CAT[1]

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Numerous techniques have been described for recording of units in cortical and subcortical structures in the unanaesthetized animal (e.g. Davis, 1956; Hayward *et al.*, 1964 ; Evarts, 1968 ; Lamarre *et al.*, 1970). The advantages of the method described here are 1) the miniaturization of the recording chamber which minimizes animal discomfort in the interval between sessions ; 2) the ease of installing the chamber ; and 3) good rigidity of the animal's head providing stable and painless immobilization during long-lasting recording sessions, without the use of earbars. Moreover, this technique allows reusing the animals and also the recovery of the chamber. Most of the existing chambers are bulky and in our experience cause the animal discomfort (e.g. Lamarre *et al.*, 1970). We noticed that in the period between sessions animals implanted with bulky devices try to rid themselves of these (they are constantly knocking them on the cage) and seem distressed by the height of the chamber. A miniaturized set-up is less likely to cause the animal discomfort and is less likely to be knocked off or damaged. Furthermore, some techniques (e.g. Lamarre *et al.*, 1970), although very good, involve a certain amount of difficulty in the surgical implant. The ease of our implant technique along with painless and barbiturate-free immobilization makes good recordings available to anyone.

DESCRIPTION OF THE CHAMBER

The chamber is made out of stainless steel tubing. Three (3) bendable tabs at the base of the chamber allow it to be firmly attached to the skull ; two (2) sturdy tabs at the top of the chamber bolt the animal into a brass ring which in turn mounts in a standard stereotaxic apparatus. The design of a chamber used to gain access to the visual cortex and lateral geniculate nucleus of the cat is shown in Figure 1A. The two adjacent tabs straddle the midsaggital ridge, with the third lying anteriorly on the midline. The 15° angle on the base brings the top plane of the chamber horizontal. The details of the design may be varied to suit the intended animal and implantation site. It is helpful to work from the skull of another animal of similar size, and final adjustments of the tabs may be made by bending at implantation if needed. Construction is possible in a small shop equipped with unimat and brazing torch. Begin with a piece of stainless steel sheet for the base tabs. Pierce and

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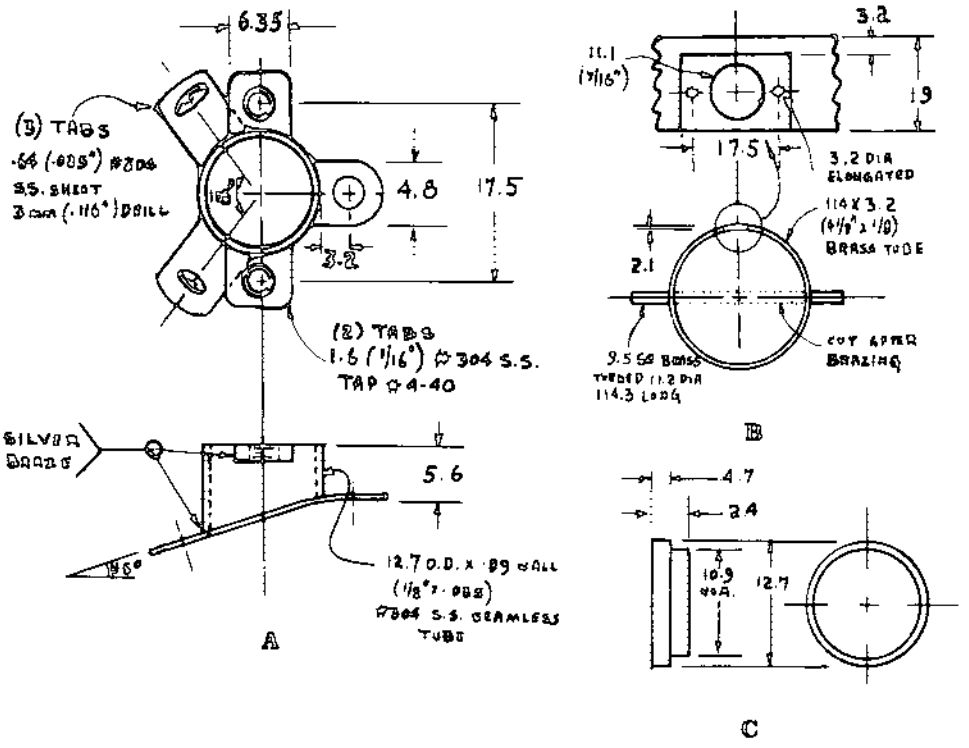

FIG. 1 : Description of the chamber. A — upper diagram : view from the top; lower diagram : lateral view; B — adapter ring; C —cap.

file a suitable hole, and braze in the tube, using 1 mm (1/32 inch) diameter silver solder. Drill the mounting holes, and leave the tabs by grinding and filing excess material. The upper tabs are made by brazing on a pair of strips, then drilled, tapped and cut to length. A clamping fixture and mandrel enable the ends to be faced off in a lathe.

The adapter ring (Fig. 1B) has a pair of posts which take the place of the ear bars in the stereotaxic apparatus. Flats are milled on either side of the ring at the top to provide attachment surfaces for the top two tabs of the chamber.

After implantation, the animal's head is passed through the ring, and the upper tabs are securely bolted to the ring. The hole in the top of the ring allows access to the chamber.

A cap (Fig. 1C) closes hermetically the chamber when not in use. The smaller diameter is turned to be a finger tight fit in the bore of the chamber.

INSTALLATION OF THE CHAMBER

Under deep general anaesthesia (Diabutal, 25 mg/ml i.v.), the animal's head is rigidly mounted on a stereotaxic apparatus. A hole, 1 cm diameter, is then trephined above the chosen brain area. The dura is left intact. The tabs of the chamber (Fig. 1A) are adjusted with pliers to exactly fit the curvature of the skull and the chamber is positioned adequately. The position of the tabs are marked with a pencil and, using a dentist drill, holes are started to allow an easy placing of the stainless steel retaining screws. Use the

right length of screws to avoid damage to the underlying dura. Acrylic is then poured over the screws and around the exterior walls of the chamber. The opening of the device is closed hermetically with a fitted cap (Fig. 1C). Thereafter the skin is approximated around the chamber using « Michel » clips. The animal receives a postoperative i.m. injection of Bicillin (600 000 units) and this treatment is repeated every two days for the duration of the animal's use. The animal is allowed one week recuperation. Fig. 2 shows the animal equipped with a chronic implantation unit.

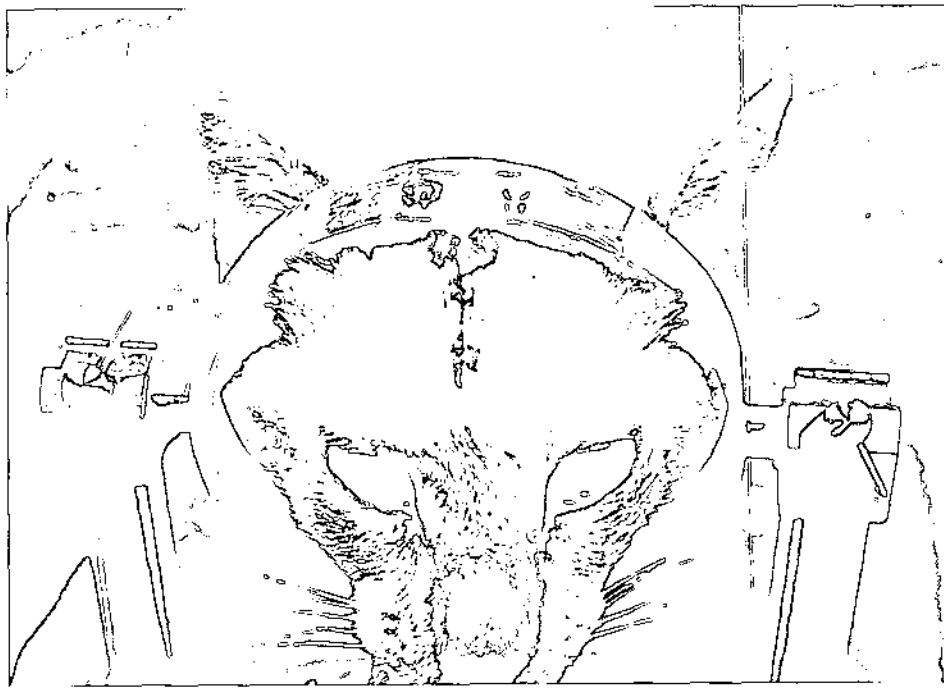

FIG. 2 : Animal equipped with the device and mounted on the supporting ring.

PROCEDURE FOR RECORDING

On the day of recording, the animal is intubated (endotracheal tube, Rusch Co., W. Germany) under Pentothal anaesthesia (18 mg/kg i.v.) and with an anaesthetic spray on the glottis (Cetacaine, Cetylite, Ind., N.Y.). Venous canulation is performed with an intravenous catheter (Deseret, Angiocath, 22 gauge 1 in.) and the skin around the insertion of the neddle is infiltrated with Xylocaine (2 %, Astra Pharmaceutical Products). The animal is secured on the supporting ring via the chamber (Fig. 2). The supporting ring itself fits exactly on the stereotaxic apparatus thus allowing stereotaxic placement of the microelectrodes. With the animal's head rigidly secured, an initial dose of Flaxedil (2 cc, Davis and Geck) is given intravenously and respiration is maintained artificially. Usually, before recordings starts, the animal is out of the effects of the

Pentothal. No further drugs are administered after paralysis except that the Flaxedil is automatically delivered by a motor syringe (Harvard Apparatus, rate : 2cc/hr). Moreover, the physiological parameters (heart rate, EEG, rectal temperature) of the subject are continuously monitored. The respirator is set to distribute the right amount of stroke-volume per body weight according to the chart of Kleinman and Radford. Jr. Special care is taken to avoid blocking of the tracheal tube. After the recording session, the animal is revived, and its behavior is normal between recording sessions.

CONCLUSION

With the technique described above, the animals usually undergo two to three recording sessions of 24 hours each, with a minimum of one week between successive sessions. We think that with this method the problem of stress and fear experienced by a conscious but paralyzed animal undergoing artificial respiration (see Lindholm, 1969) is minimal. The fact that our animals sometimes fall asleep (as indicated by the EEG monitoring) during the sessions, and the normal behavior they display after revival indicates that they are not experiencing a severe discomfort. Moreover, the post-mortem examination didn't reveal any gastric ulcers, even in animals which were kept for a period of three months. On the other hand, the necessity for not using any barbiturates or even a mixture of nitrous oxide and oxygen (as is usually done) was made relevant in recent publications (Bartlett and Doty, 1974) Indeed, these authors have shown that 1) nitrous oxide is wholly inadequate as an anaesthetic ; and 2) it drastically affects the behavior of single units in the striate cortex (concentrations used : 60 % N_2O — 40 % O_2 and 80 % N_2O — 20 % O_2). In our experiment, we found that the firing of the units is much more stable without any N_2O than with the classically used concentration of 70 % N_2O — 30 % O_2. Our chamber thus makes the use of N_2O unnecessary while keeping the animal in a comfortable state.

This preparation has been very successful in recording cortical and geniculate units in the cat and can be quite easily used in the paralyzed monkey. The recording stability is very good. Moreover, it minimizes the action of the barbiturates on neurons with minimal discomfort for the animals, thus following the rules of the animal care and protection society. Finally, in the long run, this technique is economically sound.

Abstract. A method is described for repeated recording sessions of cortical thalamic units in the unanaesthetized but paralyzed animal. Because the recording chamber is miniaturized, it is well tolerated by the subject between sessions. The system also permits painless and stable immobilization of the head without the use of earbars, avoiding surgical preparation during the actual recording sessions and allowing long periods of recording Between sessions the animals always display normal behavior.

Abrégé. **Méthode d'enregistrement à partir de microélectrodes implantées de façon chronique chez le chat paralysé.** Les auteurs décrivent une méthode permettant des séances d'enregistrement répétées d'unités centrales chez l'animal non anesthésié et paralysé. La chambre d'enregistrement est miniaturisée permettant ainsi au sujet de bien la tolérer. Ce système permet aussi d'avoir une immobilisation de la tête à la fois stable et sans douleur pour l'animal. De plus, la préparation chirurgicale pendant la session actuelle d'enregistrement est réduite au minimum. Enfin, dans l'intervalle entre les sessions, l'animal se comporte normalement.

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