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BRIEF COMMUNICATION

Technique for Chronic Electrode or Cannula Implantation in Decorticate Animals[1]

J. ROGER WILSON[2], RICHARD M. VARDARIS AND G. EDWARD SCHWEIKERT, III

Mental Health Research Institute, University of Michigan, Ann Arbor, MI

AND

Departments of Psychology at Kent State University, Kent, OH and Susquehanna University Selinsgrove, PA

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WILSON, J. R., R. M. VARDARIS AND G. E. SCHWEIKERT, III. *Technique for chronic electrode or cannula implantation in decorticate animals.* PHYSIOL. BEHAV. **14**(6) 875–877, 1975. – A surgical technique is described which enables chronic recording of electrophysiological activity and chemical or electrical stimulation in the decorticated animal. This procedure circumvents the problems of inadequate electrode/cannula patency and of the short-term debilitating consequences of cortical ablation. These features make it possible to analyze the relationships between neuroelectrophysiology, behavior and the central mechanisms underlying the restitution of function following brain damage. The procedure appears to be suitable for a wide range of mature laboratory animals and offers several advantages over the few techniques currently available.

Decortication Acrylic skull cap Electrode/cannula implantation

THE analysis of central mechanisms underlying behavioral recovery from decortication has drawn attention to functions performed by the remaining parts of the brain [1, 4, 6]. However, the evaluation of subcortical function in decorticated animals presents a number of problems. For instance, the fact that extensive decortication involves removing parts of the cranium which are needed for support of an electrode/cannula assembly has discouraged the use of chronic implantations. Few efforts to solve this problem have been reported. Reid and Porter [7] and Rice and Campbell [8] observed hypothalamic self-stimulation and stimulus-bound eating in rats before and after frontal ablations. No details were given about the duration of postoperative recovery, but the ablations were small and distal to the site of electrode entry and therefore the electrodes would be anchored to the intact skull. Huston and Borbely [5] have examined the effects of more extensive decortication on hypothalamic self-stimulation in rats. Again no details were provided, but their technique generally involved positioning the electrode after decortication, filling the remaining cavity with hemostatic cotton and then closing it with acrylic cement. This preparation is patent for no longer than a few days during which time the subjects are experiencing the debilitating side-effects of surgery. Thus, only very simple head and tail displacements or gross body movements could be reinforced.

Recently, Wilson and Vardaris [12] were able to stimulate and record electrical afterdischarge activity in rats from electrodes chronically implanted in the dorsal hippocampus for periods as long as two weeks following posterior decortication. Schweikert [9] used the same procedure for examining the influence of hippocampal stimulation on spatial reversal performance by frontally lesioned cats. This method will be described in detail because it is simple and has proved valuable in the analysis of neurophysiological substrates of behavior.

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[2] Address reprint requests to: J. Roger Wilson, Department of Psychiatry, Mental Health Research Institute, University of Michigan Medical Center, Ann Arbor, MI 48104.

FIG. 1. Photographs illustrating the surgical procedure for molding the acrylic foundation or cap for chronic electrode/cannula implantation in the decorticated rat: (A) Prior to decortication 5 jewelers screws are threaded into the skull: four laterally positioned anchor screws and the single centrally located target screw. (B) After lubricating the skull with mineral oil the acrylic cement mixture should be carefully applied over the exposed cranium and around the anchor and target screws. This is allowed to cure. Then the cap is removed and the target screw discarded. (C) Following the removal of the cranium circumscribed by the 4 anchor screws and the aspiration of the desired underlying neural tissue (not illustrated), the acrylic cap can be reattached to the skull using the anchor screws. The hole left by the discarded target screw offers an access port for insertion of the electrode/cannula assembly. (D) Additional acrylic cement over the acrylic skull cap seals off the anchor screws, fastens the assembly to the prosthetic skull, and thereby assures permanent patency of the implantation.

METHOD

Surgical Supplies and Equipment

Standard animal surgical instruments are required (e.g., scalpel, rongeurs, hemostats, reactors and trephining drill accessories), gelatin sponge (Gelfoam, Upjohn) aspiration pump and drawn glass pipettes, Thrombin (Upjohn), stereotaxic apparatus, acrylic dental cement and fluid (Plastic Products Corp.), mineral oil, 0.80 in. × 1/8 in., stainless steel jewelers screws (New York Fasteners Corp.), size 58 (0.042 in.) drill bit and pin vise (No. 240-A Starrett).

Procedure

An adult rat was anesthetized with an intraperitoneal injection of sodium pentobarbital (50 mg/ml). Its head was shaved, and positioned in the stereotaxic earbars. A 3 cm midline incision was then made and the underlying periosteum was cleared away. The skin and temporalis muscles were then gently retracted laterally therby exposing the dorsal and lateral surfaces of the cranium.

Four holes were bored into the skull using the drill and pin vise: two positioned bilaterally, rostral to either the

bregmoid suture or to the anterior extent of the intended decortication on the frontal bone; and two positioned bilaterally caudal to the lambdoid suture on the interparietal bone. Stainless steel jewelers screws were then inserted into the holes by only 1 1/2 (1.5 mm) rotations so as to protrude above the skull surface. These four screws will be referred to as anchor screws. After inserting these anchor screws an additional hole was bored in the skull at the medial-lateral (M-L), and anterior-posterior (A-P) coordinate estimates of the electrode/cannula target site. The dorso-ventral (D-V) zero coordinate estimate was then determined relative to the dura and a fifth jewelers screw was inserted as described above. This will be called the target screw and together with the anchor screws is shown in Fig. 1 A. The entire exposed surface of the skull was then liberally lubricated with mineral oil. A thin paste of acrylic cement and its solvent was then carefully poured over the lubricated surface of the skull. It was removed from the heads of the 5 screws, and allowed to cure as illustrated in Fig. 1 B. The finished acrylic cap was then removed by simply unscrewing all the stainless steel jewelers screws. The product is a prosthetic calvarium containing 5 holes: four to permit anchoring the cap to the part of the skull that remains following decortication, and the fifth to enable implantation of an electrode or cannula in a subcortical target region.

An extensive craniectomy was performed within the area circumscribed by the four anchor-screw holes overlying the cortical tissue intended for aspiration. A thin midsaggital strip of the cranium was spared in order to minimize the potential irritation of the superior saggital sinus by the acrylic cap. The exposed dura was then cut and removed. The decortication was performed by aspiration using a standard drawn glass pipette and vacuum pump. The fenestra was then filled with hemostatic cotton or gelatin sponge soaked with Thrombin to minimize excessive bleeding. Following this the cap was firmly reattached onto the skull with the 4 anchor screws. As shown in Fig. 1 C the electrode/cannula assembly was then repositioned in the stereotaxic apparatus according to the predetermined M-L and A-P target coordinates. The assembly was then lowered into the target location through the hole in the cap left by the removed target screw. Additional acrylic cement was then applied around the electrode/cannula assembly and allowed to cure before removing the stereotaxic support. This served to secure the pedestal to the acrylic skull cap and to seal off the anchor screws as illustrated in Fig. 1 1-D. Finally, the incision was sutured and a topical antibacterial save, Furacin (Morton-Norwich Product), was applied to minimize infection.

GENERAL COMMENTS

Since extensive decortication has been shown to produce hyperreactivity, aphagia, adipsia and related motor dysfunctions (e.g. [2, 3, 10]) for a period of nearly a week following surgery two precautions should be taken. First, the rats should be housed in tall or open-ended boxes. The minimizes the opportunity for striking their heads against the ceiling. However, if the acrylic caps were securely anchored to the skull and the head assembly is not damaged, the preparation should remain patent for the animal's life span. Secondly, to avoid excessive weight loss the rats should be maintained on a liquid food mixture of eggs, sugar and condensed milk [11] until it is capable of chewing standard laboratory chow.

This technique is designed for the morphologically mature animal. It also requires an ossified, rather than cartilaginous, type of skull tissue to provide the foundation for screw threading. Therefore, it may be of limited value on avian, reptilian, or amphibian species, but is generally applicable to most other conventionally used laboratory animals.

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