KOPF
CARRIER
June, 1993
PUBLISHED BY DAVID KOPF INSTRUMENTS • TUJUNGA, CALIFORNIA • NO 35

Technique for the Cannulation of the Lateral Ventricle of the Brain in Swine

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INTRODUCTION

During the 1930s, anatomy and physiology of the hypothalamus was intensively studied. New discoveries of hypothalamic function were made by the use of stereotaxic procedures. These discoveries demonstrated that specific areas within the hypothalamus were involved in sexual behavior, feeding and drinking behavior and temperature regulation (1). In 1951, Bargmann and Scharrer (2) published their classic summary of the concept of neurosecretion. Four years later, Harris published his classic monograph entitled "Neural Control of the Pituitary Gland" (3). These landmark discoveries marked the birth of modern neuroendocrinology. In recent years, identifying specific components of the central nervous system (CNS) which modulate pituitary hormone secretion has been the subject of intensive investigation (4). Most studies to date have been conducted utilizing rodents as an experimental model (5). There have been limited attempts to access the CNS for the purpose of studying neuroendocrine regulation of anterior pituitary gland function in domestic farm animals. Therefore, this report describes a reliable and effective method for accessing the CNS of the domestic pig.

MATERIAL AND METHODS

In a preliminary study, stereotaxic coordinates for the lateral cerebral ventricles were determined from measurements of heads and brains of eight pigs (approximately 100 kg body weight) obtained from an abattoir. Animals are anesthetized with 10% solution of thiopental sodium and placed in ventral recumbency. After endotracheal intubation, surgical anesthesia is maintained on a closed circuit system of halothane and oxygen. The forehead is shaved and prepared for surgery by aseptic techniques. The head is placed in a stereotaxic instrument originally fabricated by Kopf, Inc. (Tujunga, CA) with adaptations patterned after a unit described by Poceta et al. (6; Figure 1). These modifications included fabrication of ear bars to replace the zygomatic arch clamps. The ear bars support the head at the bony ear canals. The external ear canals of the pig enter the skull 40° ventral to the horizontal plane

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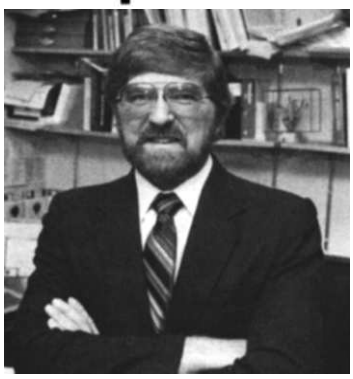

Editor's Column

Spring is upon us here in Athens, Ohio. It has been about the most beautiful spring I can remember in our 16 years here. We have a large magnolia tree in our back yard. This year for the first time since we have lived here, it bloomed fully. Usually the frost gets the blooms just as they are about to come out. It was truly beautiful.

This is also the last spring we will spend in Athens. In July, we will be moving to Kansas City to join the College of Osteopathic Medicine of the University of Health Sciences. I have accepted a position there as Professor of Osteopathic Principles and Practice where I will continue teaching in the osteopathic curriculum and with our re search. The UHS-COM is a free standing osteopathic school which was founded in the early days of the osteopathic profession shortly after the turn of the century, and which continues to have a very strong commitment to training primary care physicians. My wife and I are looking forward to the new challenges and surroundings of a larger city and different school. We appreciate all the support and encouragement we have received from Carrier readers over the years and look forward to continuing the relationship at our new location.

I have included our new address in this column, below, and invite any of you who have suggestions for articles or who would like to contribute an article to the Carrier, to get in touch with me as soon as possible. We will be at the new address after July 15. Until that time, we can still be reached at the Athens, OH address. I look forward to hearing from you.

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and 19° rostral to the coronal plane through the external auditory meati. The ear bars were constructed of 14 mm square stainless steel rod, tapered and angled so as to lodge tightly in the bony ear canal. The location of the anterior-posterior (AP) bars of the original unit were repositioned so as to run in a true anterior posterior direction with respect to the skull. In addition, the height of the AP-bar was reduced to 18.8 mm above the base of the apparatus. The head is oriented by means of ear bars and adjustable mouth bar such that the forehead of the pig rises anterior to posterior 30° to the horizontal plane (Figure 1). A circle of skin and underlying periosteum, 35 mm in diameter, centered 41 mm anterior to the ear bar tips of the stereotaxic unit and 3 mm lateral to midline is excised from the frontal-parietal bone with a trephin and periosteal elevator. A 2 mm diameter hole is drilled through the skull at the center of this circle 90° to the surface of the skull and an 18 gauge, 29.5 mm long stainless steel guide tube is inserted. The guide tube is anchored to the skull with stainless steel screws and acrylic cement. A 22 gauge injection cannula 80 mm long is attached to a vertically-held, 30 mm long silicone tube filled with .9% saline. The cannula is slowly lowered stereotaxically through the guide tube until an influx of fluid is observed indicating entrance into ventricular space. Each individual cannula is then cut to the appropriate length based on the distance from the surface of the skull to a lateral ventricle. This averaged 53+ 2 mm for pigs (n=11) weighing 99 + 6 kg.

Placement of the cannula in a lateral ventricle confirmed in each pig by roentgenogram (Figure 2; Toshiba X-ray Unit, Model KCD-10MO7A; Tustin, CA) after intraventricular injection of 1 ml radiopaque medium (metrizamide, 400 mg iodine/ml .9% saline; Sigma Chemical Co., St. Louis, MO). The injection cannula is replaced with a 22 gauge, 29.5 mm long trocar. The guide tubes, injection cannulas and trocars described above, were designed by members of the Animal Physiology Unit.

Postoperative prophylactic treatment of penicillin G and oxytetracycline is utilized. The week prior to the experiment, animals are habituated to Panepinto slings (7) modified to fit large animals (slings limit movement; Figure 3). On the day of experimental treatment pigs are placed in slings, trocars are replaced with intraventricular injection cannulas and treatments administered.

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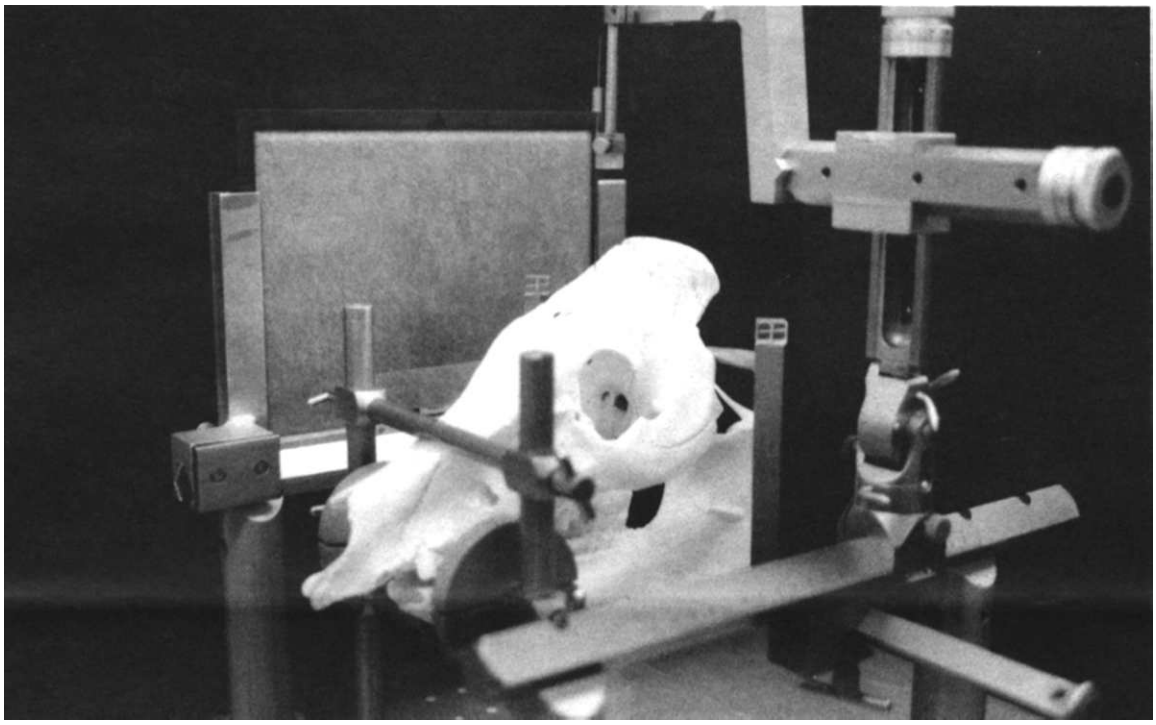

Figure 1. Stereotaxic head holder for mature domestic pig originally fabricated by Kopf, Inc. with adaptations patterned after those described by Poceta et al. (6). The head is oriented by means of ear bars and adjustable mouth bars such that the forehead of the pig rises anterior to posterior 30° to the horizontal plane.

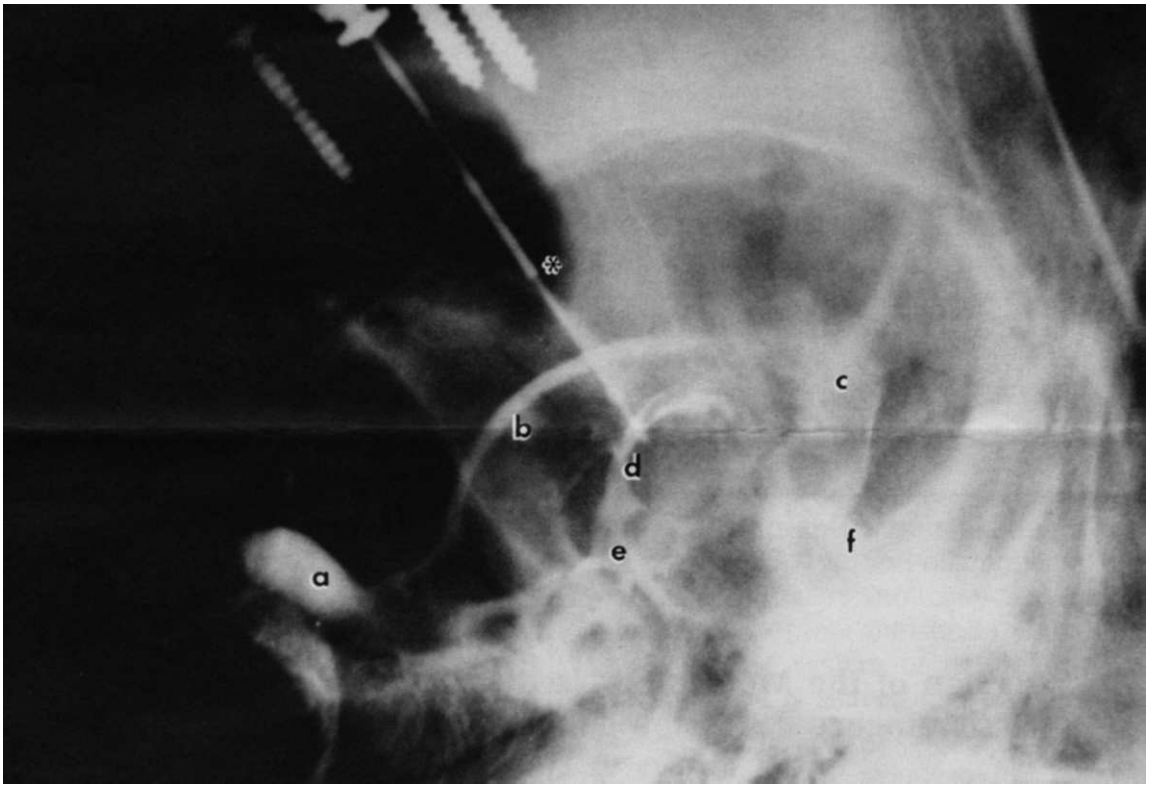

Figure 2. Lateral cranial roetgenogram of a mature gilt implanted with an intraventricular cannula. Ventricles were highlighted by introducing metrizamide. These ventricular landmarks are used to maximize the accuracy of placing ventricular cannulae. A is the olfactory stem of a lateral ventricle; B is the rostral horn of a lateral ventricle; C is the body of a lateral ventricle; D is the interventricular foramen (foramen of Monro); E is the infundibular region of the third ventricle; F is the cerebral aqueduct (aqueduct of Sylvius); * is the tip of the guide tube with extruded cannual.

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CONCLUDING REMARKS

The techniques described provide a reliable and effective method for accessing the CNS of the domestic pig. However, a number of problems that are unique to the pig were encountered during development of the procedure. First, the size of the pig's head necessitated remodeling of the stereotaxic unit. Non-rupture ear bars were required to insure complete rigidity of the head. Secondly, an anchoring system (i.e., stainless steel screws and acrylic cement) that will prevent the pig from dislodging chronically implanted cannulae is required. Lastly, a fast, efficient and non-stressful method of restraining the pig is required in order to administer treatment via the ventricular cannulae. It was determined by trial and error that a modified Panepinto sling was the most efficient and least stressful of several methods attempted.

The intra ventricular cannulas have retained patency and the recipient pigs have remained in good health for as long as five months to date. This procedure has proven reliable for animals ranging from 60 to 120 kg in body weight. In addition, this technique has been employed by our laboratory to investigate the role of endogenous opioids in modulating pituitary hormone secretion in the pig (8,9,10). The use of this technique has facilitated studies designed to elucidate neuroendocrine mechanisms controlling anterior pituitary gland function, such as the recent development of push-pull perfusion of the pituitary gland (11).

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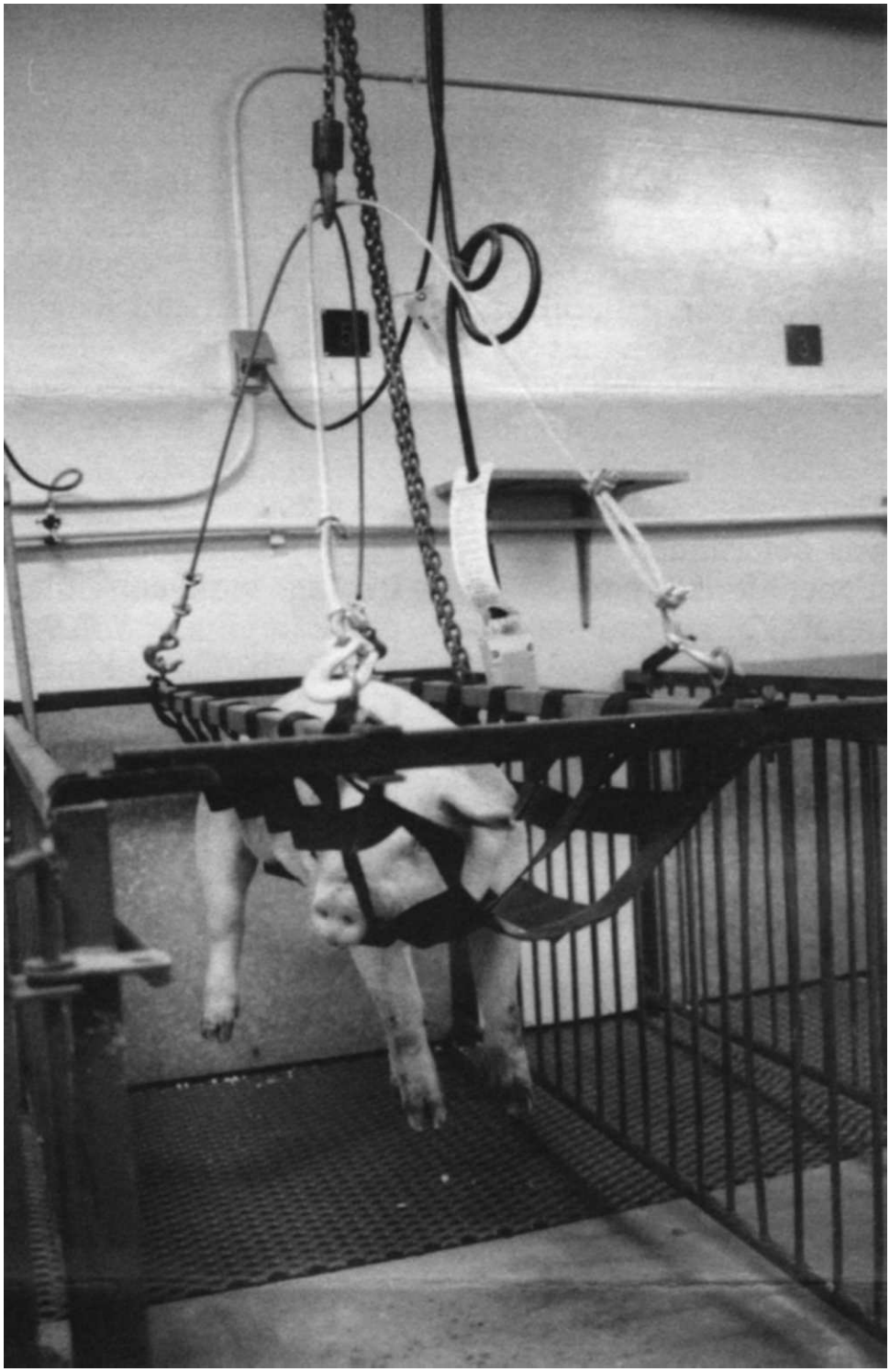

Figure 3. Panepinto Sling (7) modified to fit the large domestic pig. The sling is equipped with an electric hoist system.

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