TECHNICAL NOTE

*A RESTRAINT SYSTEM FOR CHRONIC STUDY OF
THE BABOON¹*

Laboratory studies using combined behavioral and physiological techniques in larger primates continue to present numerous problems in the proper restraint of the subject. The difficulties of restraint increase markedly with the use of electric shock, indwelling cannulae and other surgical preparations, particularly where long-term experimentation is required. The basic primate chair originally devised by Mason (1958), even with modifications as suggested by Thompson, Seal, and Bloom (1966) and Forsyth and Rosenblum (1964), contains inherent difficulties, namely, limited access to the animal, restricted body movements, and difficult protection of cannulae, sensors, surgical incisions, and/or equipment.

The present report describes a system based upon an arm cuff device that serves both to hold the subject and to give control over the hands. Once the subject's arms are controlled and their reach limited, additional control of the head and feet may be accomplished easily and flexibly. Our general approach has been to anchor the arm cuffs on a movable track along with a waist plate and seat. This confines the baboon to a sitting position on a movable cart and allows ready transfer in and out of an experimental chamber.²

Approximately 16 baboons and six rhesus monkeys, ranging in weight from 7 to 20 kg, have been restrained in this manner for lengthy periods. Several animals with arterial catheters continue in good condition after 1.5 yr of continuous experimentation and considerable gain in weight and size. General features of the system are shown in Fig. 1 and 2.

The Arm Cuff Device

Initially, we attempted to restrain rhesus monkeys without tight fitting bands or plates likely to produce abrasions. It was found that a monkey could be held comfortably if its arms were inside a loose copper elbow fitting made from commercial pipe joints; an approximate 90° bend would not allow the animal to straighten its arms sufficiently to remove them from the assembly. In fact, restraint required only rings around the upper arm and forearm, provided these rings were held at a proper axis with respect to each other, and located at proper distance from the elbow

joint. The eventual cuff assembly used both with baboons and monkeys is shown in Fig. 2. Each cuff assembly is an "L" shaped phenolic plate slotted to allow the upper and forearm rings to be adjusted for different size primates and to obtain the proper angle between the rings. The pillow blocks holding the cuff assembly to the side of the cart are attached to one side of this base plate. The aluminum upper ring is attached to the base plate opposite from the pillow block and pivoted to allow the animal some lateral movement by allowing the rings to adjust to the changing angles of its arms. This upper arm ring is 2 in. deep (5 cm) for baboons and 1 in. deep (2.5 cm) for rhesus monkeys, made from $\frac{3}{8}$ in. hardened aluminum. Each upper arm ring is compressed into an elliptical shape to conform better to the measurements of the upper arm. For the baboon, the inside dimensions of the ring are approximately 8 cm by 7 cm. The phenolic forearm ring prevents removal of the arm from the upper ring by preventing the arm from being straightened at the elbow more than approximately 90 degrees. The arm guard attached to the bottom and rear of the base plate prevents the animal from pushing the upper ring to its shoulder, which might enable it to slip the wrist out of the forearm cuff. The cuff rings may be quite loose and still preclude escape, thus allowing for considerable growth.

The sliding movement of the cuff assemblies over the steel rod attached to the cart sides allows up to 18 in. (46 cm) of arm travel parallel to the cart sides, but limits movement in other directions to the range of the wrist and finger. Hand movement is sufficient to enable the animals to manipulate switches and to feed themselves from feeder magazines attached to the cart or mounted before them on intelligence panels.

The Cart Arrangement

The base of the cart consists of a 12 by 24 by 10 in. (30.7 by 61 by 25.6 cm) iron frame on wheels. The lower section of the frame serves as a carrier for the removable waste pan. The front of the frame is cut away where a footrest is mounted. A handle is attached to the rear enabling the cart to be moved easily. In the middle of the frame, two parallel rods are placed crosswise to which the seat is attached. The seat consists of three parallel aluminum bars spaced 1 in. (2.5 cm) apart, and a three-sided Plexiglas box. The front side of the box is closed by a steel bar placed across the top of the animal's legs; this keeps it from climbing out of the seat. There are adjustments to the Plexiglas box to move it in all directions, and to adjust the steel

¹Supported in part by grants from NIH: HE-06945; SGO: DADA 17-68-C-8133; and NASA: NGR 21-001-069.

²Units similar to those described below will be commercially available from Powell Laboratories, Silver Spring, Maryland.

Fig. 1. Baboon confined to restraint cart by arm cuffs and waist plate. The arm cuffs may be moved forward and backward on a track and allow considerable freedom in movement of the upper body.

bar to different size animals. With catheterized animals, an adjustable Plexiglas waist plate is also employed for additional assurance that the animal will remain in the seat. This waist plate is attached to the side plates of the cart. For delivery of electric shock, the animal is fitted with a waist electrode. All other metal parts, such as the cuff, seat, *etc.*, are grounded and used as a second electrode for delivery of electric current. Each animal is fitted with a neck collar, swivel and chain for control of head movement during routine examination, cleaning of cart, *etc.* In animals with surgically implanted catheters, EKG leads or other sensors, all necessary connections of tubing or leads are from the middle of the upper back. In the present system, this area is ideally inaccessible to the animal. Catheters, for example, are allowed to hang free with the distal end attached to a flat plate at the back of the cart. This rear plate serves two functions. First, it keeps the long tail of the baboon from possibly becoming entangled with the catheter and secondly, it serves as a table for necessary valves, tubing connectors, transducers, *etc.* As extra protection for catheters, a rod or set of rods is attached behind the animal between the side plates near shoulder height, to prevent excessive arching of the back and lowering of the head into the rear area of the cart.

Fig. 2. Schematic view of arm cuff device.

General Advantages and Adaptations

The present system has proven reliable and flexible primarily because of the unique features of the cuff assembly. No animal has been removed because of abrasions on the arms and no animal has escaped. One bite was incurred from a rhesus monkey due to carelessness. None of the animals have incurred buttock sores. Two monkeys and one baboon did develop inguinal hernias shortly after being placed in the restraining carts, but these were non-recurrent after surgical repair. The major problems encountered have not been with the welfare of the animal, safety in handling, or in protection of cannulae or equipment, but rather problems of proper initial adjustment and routine maintenance of cleanliness and replacement of worn or defective parts.

The system has proven useful for both behavioral and physiological studies. In one instance, a cart was devised with a track that allowed the animal either to sit or to recline in a prone position. In another instance, seats were adapted for continuous collection of urine samples and in still another modification, a neck plate has been added to restrain the head and serve as a platform for a closed circuit oxygen consumption measurement system. Although not without limitations, the present system would seem to provide several advantages over other available systems for work with larger primates.

REFERENCES

- Findley, J. D. An intermediate restraining device for working with monkeys. *Journal of the Experimental Analysis of Behavior*, 1959, 2, 121-125.
- Forsyth, R. P. and Rosenblum, M. A. A restraining device and procedure for continuous blood pressure recordings in monkeys. *Journal of the Experimental Analysis of Behavior*, 1964, 7, 367-368.
- Kelleher, R. T., Gill, C. A., Riddle, W. C., and Cook, L. On use of the squirrel monkey in behavioral and pharmacological experiments. *Journal of the Experimental Analysis of Behavior*, 1963, 6, 249-252.
- Mason, J. W. Restraining chair for the experimental study of primates. *Journal of Applied Physiology*, 1958, 12, 130-133.

Thompson, T., Seal, D., and Bloom, W. A suspended platform for use in chronic restraint monkey. *Journal of the Experimental Analysis of Behavior*, 1966, 9, 146.

Werdegarr, D., Johnson, D. G., and Mason, J. W. A technique for continuous measurement of arterial

blood pressure in unanesthetized monkeys. *Journal of Applied Physiology*, 1964, 19, 519-521.

J. D. FINDLEY

W. W. ROBINSON

W. GILLIAM

*Johns Hopkins University
School of Medicine*