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K.E. Leach, L. Prud'homme-Lalonde and R.K. Harding
Nuclear Effects Section
Protective Sciences Division

M. Bosc-Davie
Department of Experimental Surgery
Faculty of Health Sciences
University of Ottawa

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ABSTRACT

A surgical procedure has been developed for the implantation of chronic cannulae in the carotid artery and the jugular vein. The method is simple to perform and allows serial blood samples to be drawn. Infusions of various drugs may be done at the same time as blood pressure recordings on conscious, free-moving or lightly restrained dogs.

RÉSUMÉ

Une méthode chirurgicale pour l'implantation de canules dans l'artère carotide et dans la veine jugulaire a été développée. Cette méthode est facile à exécuter et permet l'échantillonage de sang et l'infusion de différents composés tout en enregistrant la pression artérielle sur des chiens conscients, mobiles ou légèrement restreints.

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INTRODUCTION

Physiological studies in dogs often require the ability to record blood pressure, to administer various drugs and chemical agents via an arterial cannula and to withdraw repeated blood samples for hematological, biochemical and pharmacological studies. The cannulae must be non-restricting to the normal activities of the dog, and accessible for maintenance and performance of experimental procedures. The surgical procedure must be simple and brief to allow for a quick recovery. Our experiments involving the study of nausea and emesis require the implantation of chronic cannulae in the carotid artery and the jugular vein. In methods described by other investigators (1-2), the exteriorized cannulae were wrapped around the neck of the dog and protected with bandage gauze. These methods were not suitable for our study as the dogs are free-moving and there is the ever-present possibility that they might dislodge the cannulae. We have developed a method to permit blood pressure monitoring, arterial administration of drugs and blood sampling in conscious, free-moving or lightly restrained dogs.

MATERIALS AND METHODS

Animals

Adult beagle dogs (Marshall Farms, New York, and Woodlyn Labs, Guelph) of either sex were used and weighed 9-12 kg at time of surgery. They were housed individually, and Purina Dog Chow and tap water were available ad libitum.

Pre-operative Preparation

The dog was fasted overnight. Prior to surgery, the animal was injected with a tranquilizing Pre-Mix solution of atropine (Agri-Vet Pharmaceuticals Limited, Weston) and Innovar-Vet (M.T.C. Pharmaceuticals, Mississauga) i.m.. The animal was intubated and connected to the anaesthetic machine; surgical anaesthesia was maintained using a mixture of oxygen and halothane. A slow intravenous drip of lactated Ringer's was maintained during surgery. The right side of the neck and an area below the right scapula were shaved and washed with antiseptic soap, dried and brushed with an iodine solution. The animal was draped and full sterile technique was observed.

Cannulation of the Jugular Vein

An incision, approximately 6 cm long, was made in the neck. The right jugular vein was exposed by blunt dissection causing little trauma to the surrounding tissue. Two braided umbilical tapes were placed around the vessel, one proximal and one distal, to control bleeding during the insertion of the cannula. A purse-string suture was placed on the outer side of the vein using 6/0 silk (Fig. 1). A small hole was made in the centre of the purse-string with an 18-gauge hypodermic needle, bevel up. A polyvinyl cannula (Canus Plastics Limited, Ottawa; 0.08cm ID, 0.15cm OD, approximately 1m long) was inserted caudally. At this point, the cannula was flushed with a diatrozoate meglumine solution (Hypaque-M 60%, Winthrop Laboratories, Aurora) and its position in the vessel was determined using a fluoroscope (Siemens Siremobil 2). The cannula was then pushed down into the thoracic vena cava, flushed with sterile heparin saline (4U/ml) and then connected to a Statham P23 ID pressure transducer in order to monitor the pressure on a Grass Model 7 Polygraph (Grass Instruments, Mass.). Once an appropriate response was observed, the purse-string suture was tied and a few drops of polymethylmethacrylate adhesive were applied around the site of the cannula entry to secure the knot and buttress the site. Sterile saline was squirted onto the glue to hasten polymerization. The cannula was flushed with sterile heparin saline and sealed with a small stainless steel pin. The jugular vein and the cannula were replaced in the neck and the umbilical tapes removed. The end of the cannula was marked to enable later identification.

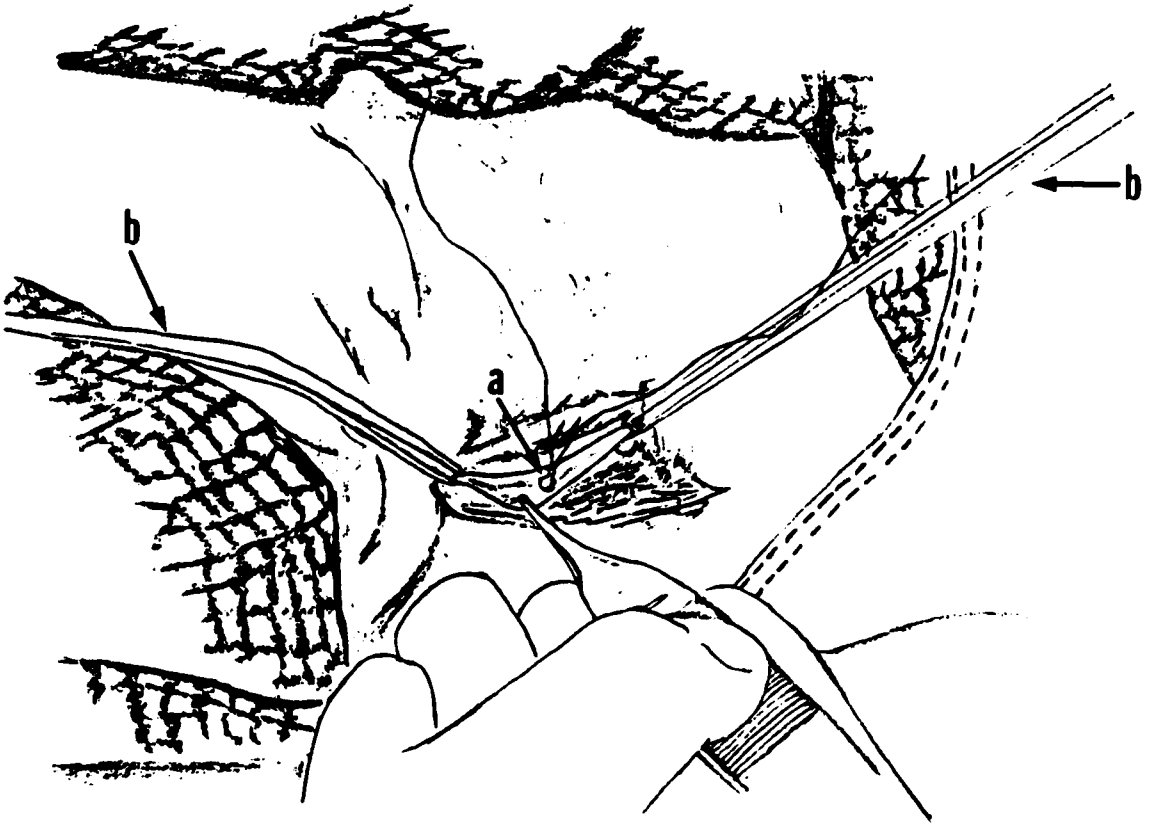

Figure 1: Jugular cannulation showing purse-string suture (a) and umbilical tape (b).

Cannulation of the Carotid Artery

The right carotid artery was exposed by blunt dissection through the same incision site. Once the artery was exposed, the vagus nerve was carefully separated. Two umbilical tapes were placed around the vessel, one proximal and one distal, to provide traction and to elevate the vessel to facilitate cannulation. A small bulldog clamp was placed proximally to occlude blood flow. A purse-string suture was placed as described previously, then a hole was made and the polyvinyl cannula inserted up to the bulldog clamp. The clamp was removed while applying traction on the proximal umbilical tape and the cannula was pushed down into the aortic arch. The purse-string suture was tightened and the position of the cannula was checked and corrected, if necessary, by fluoroscopy; pressure was measured by use of the polygraph, as described previously. The cannula was secured in the same fashion as the jugular cannula. In addition, one 2/0 silk ligature was placed below the purse-string to secure the cannula and occlude the vessel. The cannula was marked for identification and the vessel was returned to its normal position.

Routing of the Cannulae

A small incision was made through the skin on the upper back between the scapulae. A vascular passing instrument (VPI) was tunnelled under the skin, from this entry point to the neck incision. The cannulae were snared with a loop of umbilical tape and drawn through the tunnel using the VPI, taking the cannulae from the neck to the back incision. A small loop of each cannula was left in the neck to allow for movement of the dog's head. The neck incision was closed with 3/0 chromic interrupted suture for the fascia and the subcutaneous layers, and 3/0 Prolene (Ethicon Sutures Limited, Peterborough) subcuticular for the skin. The back incision was closed with 3/0 Prolene subcuticular. Cannulae were wrapped in adhesive tape in a butterfly fashion (about 2x3 cm) and the wings were anchored to the skin with 3/0 Prolene. The jacket (described below) was put on the dog and the cannulae were passed through the mesh of the jacket, placing one in each side-pocket (Fig. 2). Each cannula was connected to a miniature infusion pump (Ealing Scientific Limited, Montreal) weighing approximately 0.5kg which continually infused small volumes (15-20ml/day) of sterile heparin saline (4U/ml) to maintain free-flowing cannulae. The pumps were then stored in the side-pockets of the jacket.

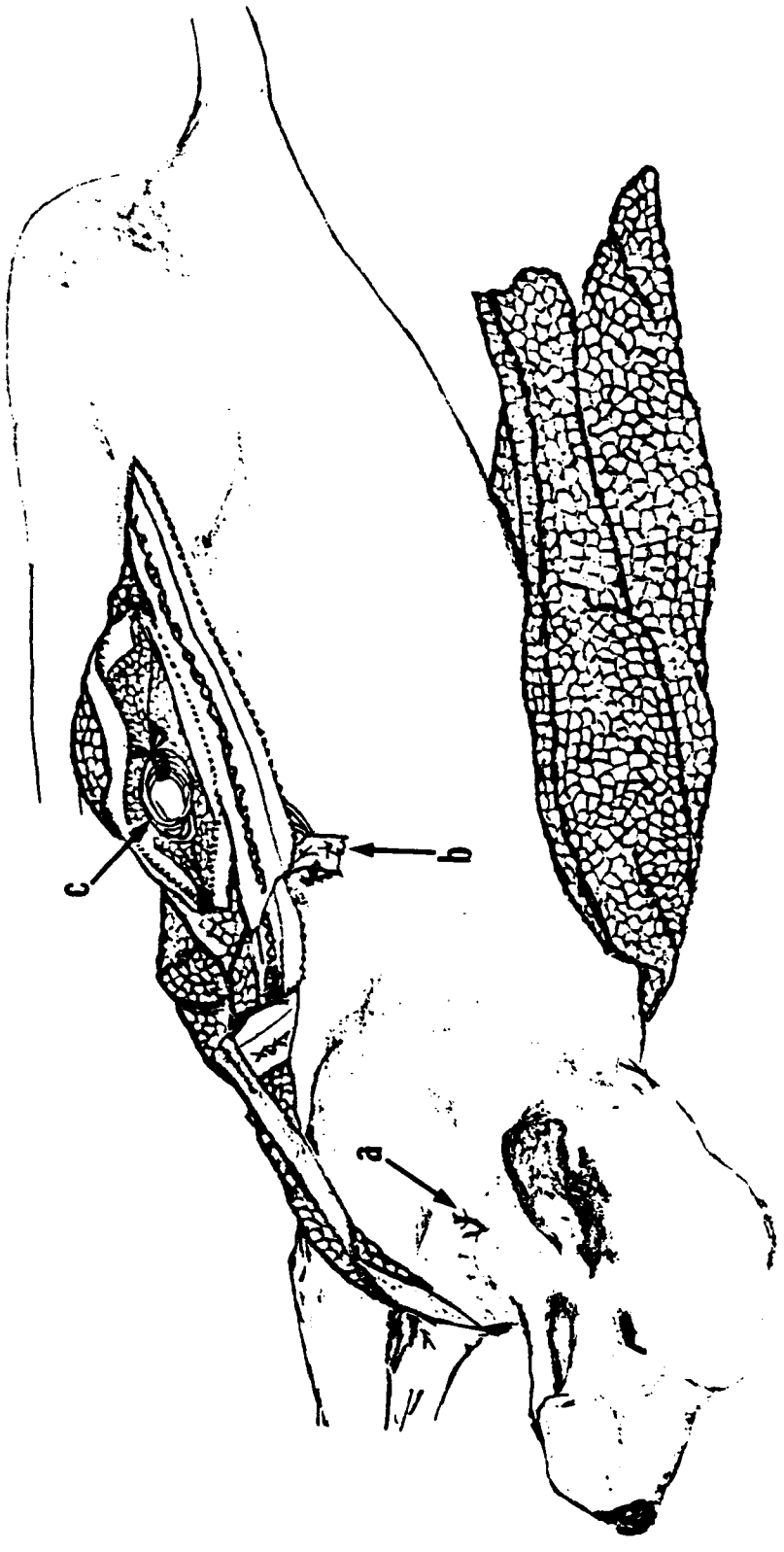

Figure 2: Illustration indicating neck incision (a), butterfly tape (b) and cannulae stored in pocket (c).

Dog Jacket Assembly

A dog jacket (Alice King Chatham Medical Arts, Los Angeles) was used to protect the skin area where the cannulae were exteriorized, as well as to provide pockets in which to store the miniature infusion pumps. The jacket was made of nylon net with two pockets, one on each side. The pockets were 9x18x4 cm with a top-closing zipper 23 cm long (Figure 3). The jacket was closed centre back by a zipper with laces along each side allowing the jacket to be adjusted to fit the dog. A tethering anchor (Alick King Chatham Medical Arts, Los Angeles) was secured to the left side above the scapular region. This provided an attachment point for a flexible metal tether. The jacket was worn continuously and was well tolerated.

Cannula Maintenance

Post-surgery dogs were housed in large individual pens in a group room in sight of, but not adjacent to neighbouring animals. The pump casing held a rechargeable battery and a 60-ml drug reservoir bag and tubing set (Ealing Scientific Limited, Montreal). Every second day, the bags were refilled with sterile heparin saline, and the batteries were recharged as required.

Pressure Monitoring and Blood Sampling

For short-term studies (up to two hours), the animal was lightly restrained in a modified Pavlov sling. The ends of the cannulae were connected to manifolds (Cobe Industries Incorporated, Scarborough) fitted with valves which continued to provide a non-perturbing flow of heparin saline throughout the experiment. The valves provided attachments for pressure transducers which were connected to a Grass polygraph producing recordings of arterial, mean arterial and venous pressures, as well as heart rate. The manifold also permitted blood draws and bolus injections of drugs and various chemical agents. The three-way valves permitted intra-arterial infusions (rate of 0.1 ml/min) while at the same time still recording the arterial pressure with no effect on the level of the pressure recorded.

For long-term studies (up to six hours), the cannulae were routed through the tethering anchor mentioned above. The cannulae were connected to a swivel using two sterile Cordis #7 cannulae (Dimension Laboratories, Mississauga) threaded through the 1-meter flexible metal tether. This set-up permitted the animal to turn at will and protected the cannulae. The animal was housed in a 1x2 metre enclosure and a hinged boom was secured to a side wall above the animal. When the swivel was attached to this boom, it moved in an arc, allowing the animal to move freely and lie down at will. The swivel was connected to the previously described manifold. The same procedures as described above were carried out to allow longer term recordings.

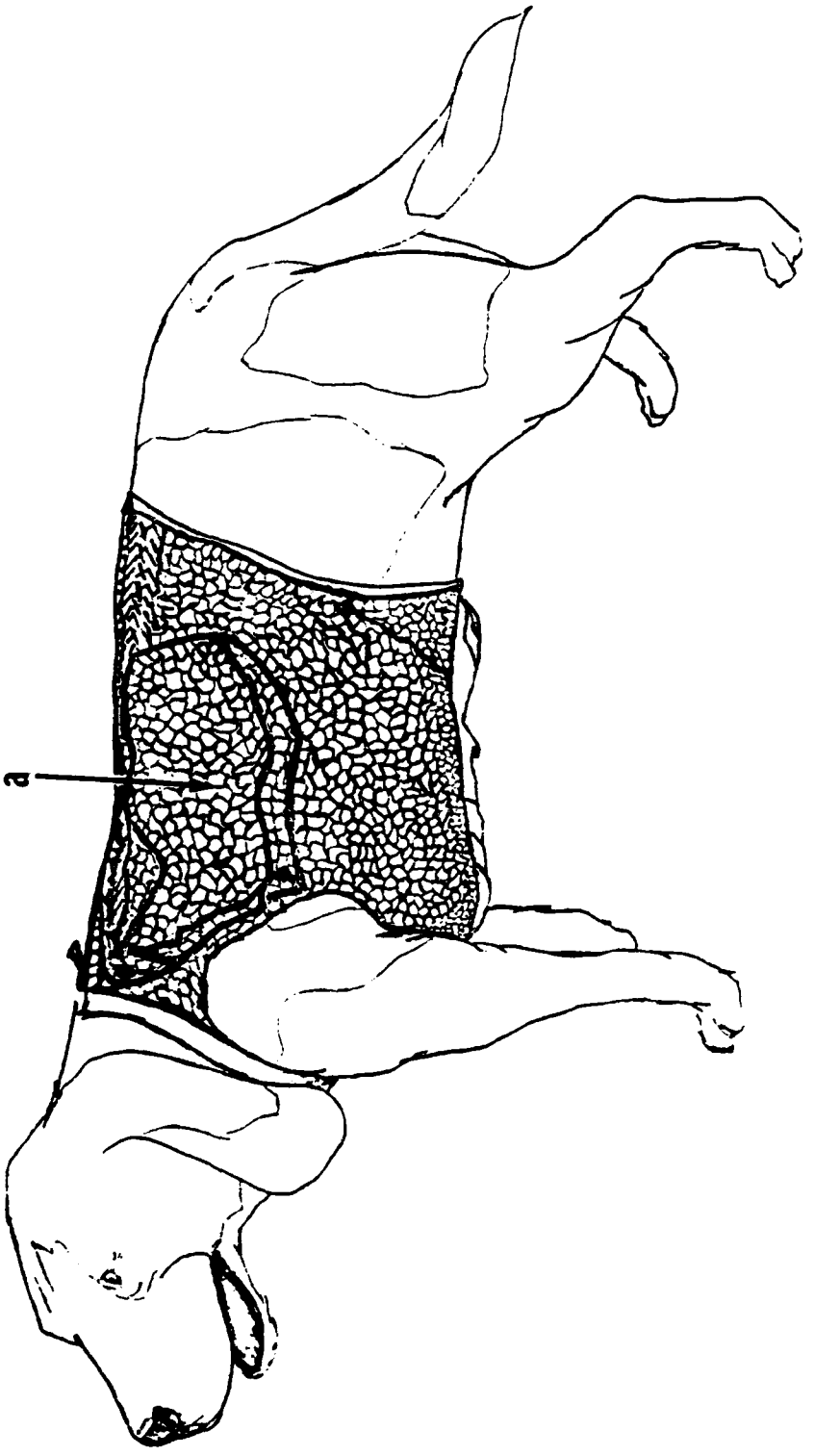

Figure 3: Dog jacket assembly with pockets (a).

RESULTS AND DISCUSSIONS

These techniques have proved to be successful and cannulae have remained functional for a period of four weeks. Some problems and suggested solutions are discussed below.

To date, 11 dogs have been cannulated. The first five dogs were not connected to pumps; the cannulae were flushed daily with sterile heparin saline but this flushing once a day was not sufficient to prevent clotting in the cannulae. In the next six dogs, the use of the miniature mobile infusion pumps was initiated to continually flush the cannulae with minute volumes of sterile heparin saline. This modification has more than doubled the funcitonal life of the cannulae.

The mobile infusion pumps provide the ability to continually infuse various drugs in small doses over a prolonged period of time.

Because the animal was free-moving, the cannulae gradually worked their way out of the vessels, rendering them useless. A modification to the method (3) will soon be introduced, involving the use of perivascular muffs to anchor the cannulae more securely. This will hopefully extend the useful life of the cannula. In the three cases where this problem occurred, no morbidity or mortality was observed.

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