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Cardiac Catheterisation in Rats

SCOPE

Cardiac catheterisation allows assessment of heart function in vivo with direct measurements of aortic blood pressure, left ventricular pressure and the rates of left ventricular contraction and relaxation. Catheterisation is a terminal procedure and is therefore only performed as an endpoint to a study. After completion of the procedure, animals are euthanased by anaesthetic overdose.

AUTHORISATION TO UNDERTAKE PROCEDURE

Authorisation must be given by AEC for persons to undertake this procedure.
The investigator must be named in an AEC approved protocol and if training is required this must be provided by a person experienced in this technique.

PROCEDURE

Induction of Anaesthesia

Animals will be anaesthetised by intraperitoneal injection of pentobarbitone 60 mg/Kg. This anaesthetic induces a deep anaesthesia allowing this procedure to be completed (usually 60 minutes). During the procedure the degree of muscular relaxation will be constantly monitored, and skin and mucous membrane colour, respiratory pattern (rate and depth), the pedal reflex and the response to toe pinch will be frequently assessed in order to monitor the depth of anaesthesia. If supplemental doses are required, approx. 1/3 to 1/4 of the initial dose will be administered.

Catheterisation

Once anaesthetised, rats are placed in a supine position on a heat pad at 37C and intubated, a light source is directed over the throat region to facilitate visualisation of the vocal cords, enabling placement of a plastic 16 gauge catheter in the trachea. The anaesthetised animal will be connected to a rodent ventilator via the protruding end of the catheter and will receive room air. A midline incision is made in the skin overlying the neck, and the muscle overlying the trachea is blunt dissected on the right side to expose the right carotid artery. The carotid artery is then separated from the vagus nerve and cleared of any other connective tissue making catheterisation easier.

Three 4-0 silk sutures (length 20cm) are placed around the carotid artery. The distal suture (closest to the bifurcation) is tied to occlude flow and kept taut in order to tether the artery. The proximal suture (closest to aorta) is hitched around the artery so as to occlude flow. A clamp may also be applied to ensure occlusion. The third suture is loosely tied and place in the between the other two, this suture will hold the catheter securely in the aorta.

A 26G needle bent at right angle (90 degrees) half way down is inserted into the lumen of the carotid artery toward the distal end (head), and the needle lifted up toward the ceiling and away from the animal to create an entrance for the tip of the Millar catheter to be inserted. The catheter is advanced well into the carotid prior to securing the catheter tight enough to hold it in place and prevent bleeding, and also to allow forward movement of the catheter toward the heart. At this point the proximal clamp\suture can be removed and a pressure trace should become apparent.

The catheter can now be advanced toward the heart keeping it parallel to the carotid artery. Advance the catheter to just above the aortic valve, where it will begin to pulsate. At this point readings can be taken to measure aortic pressure.

To obtain left ventricular pressures the catheter is advanced into the left ventricle of the heart, this is achieved by pulling back slightly on the catheter (about 1cm) and pushing forward. Repeat until a change in the pressure trace is observed indicating left ventricular pressure. Once the left ventricle has been entered, hold the right hand steady and advance the Millar catheter another 0.5cm before releasing and obtaining the information as required.

Intravenous drug administration

If intravenous infusion is required, tape back the back right paw. Cut skin over the thigh to expose the vein. The vein will be dark and close to the midline. Cannulate with a butterfly needle, and keep moist with Saline.

Techniques for pressure volume loop acquisition:

1. Parallel conductance

   For parallel conductance measurements, the junction of the right internal jugular vein and the right subclavian vein is recommended. The skin between the right “shoulder” and the midline is cut away and the subcutaneous fat carefully cut or blunt dissected away to reveal the junction. The fat and connective tissue over the jugular vein leading to the head are dissected away to expose a clear segment of vein (0.5-1cm) above the junction with the right subclavian vein. Hitch one suture around the jugular vein towards the head and secure to the ends with tape to provide tension on the vein. Place a second suture, loosely tied, at the junction with the right subclavian vein. With the vein taut, use a 26 gauge needle bent halfway at right angles to pierce into the lumen of the jugular vein toward the heart. Lift the needle up toward the ceiling creating a small hole in the vein to insert the 4-5 tip of a 20cm length of PVC tubing filled with saline connected to a pump. Gently relax the suture so there is some back bleeding, allowing the vein to fill, and then proceed to feed the catheter directly caudally into the right atrium. The distance from the vein to right atrium should be estimated by aligning the catheter and estimating the distance from vein to right atrium (approx. 2 - 3 cm).

   For a rodent 225gm, 0.1 ml of 15% saline should suffice to obtain parallel conductance, injected slowly.

2. Preload Reduction

   In order to reduce preload, first occlude the inferior vena cava (IVC) above the insertion of the right and left renal veins. This is best achieved by making a 4cm midline skin incision starting at the xiphisternum, directed caudally. A wet piece of gauze should be used to wrap the mesentery in, and this is placed to the left side. The IVC is visible as a blue vein approx. 8mm in diameter, and should be seen to enter the liver. With blunt

dissection, use a fine pair of forceps to free the IVC from surrounding connective tissue. Then place a piece of cotton thread under the IVC above the renal veins to create a "sling". Place a second cotton sling around the portal vein close to where to drains into the IVC. Once achieved, the mesentery should be placed into the abdomen, and the muscle and skin loosely opposed with a clamp with the ends of both slings protruding from the abdomen. In order to reduce preload, the ends of the "sling" are pulled up and IVC flow is reduced. After 5 seconds the slings should be relaxed to allow flow to continue. The rodent should be disconnected from the ventilator in order to reduce respiratory variation in loops achieved whilst preload reduction is occurring.

Once measurements have been completed, the catheter is removed and the artery is tied with the suture and the animal is euthanased with an overdose of pentobarbitone, as per SOP 26 *Euthanasia of Mice and Rats*.

ASSOCIATED PROCEDURE/S

SOP 26: *Euthanasia of Mice and Rats*

REFERENCES

Australian code for the care and use of animals for scientific purposes (8th Edition 2013)

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