MICROSURGICAL TECHNIQUES

Permanent Catheterization of the Jugular Vein / Carotid Artery in Mice

Author: Edwin Spoelstra, M.Sc. (European Sales Director Instech Solomon)

1. INTRODUCTION

Catheterization of the jugular vein and carotid artery is achieved by mobilizing the vein and sliding a catheter through a V-shaped hole in the vein or artery till the tip of the catheter reaches the level of the heart right atrium in the vena cava cisterna or the aortic arch.

2. REFERENCES

2.1 Jugular Vein Catheterization

- Permanent cannulation of the jagular vein (acc. to Steffens); R. Remie, J.J. van Dongen and J.W. Rensema; Manual of microsurgery on the laboratorium rat, part 1, 1990, Elsevier Science Publishers B.V. (biomedical division)
- A method for frequent sampling of blood and continues infusion of fluids in the rat without disturbing the animal; A.B. Steffens; Physiology and behavior 1969, vol 4, pp. 833-836
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- A novel chronic and detachable indwelling jugular catheterization procedure for mice; B.M. Kelley, A.L.E. Bandy and L.D. Middaugh; Physiology and behavior, vol. 62, no. 1, pp.163-167, 1997
- A method for frequent sampling of blood and continuous infusions of fluids in the rat without disturbing the animal. Steffens, A.B.,1969,Physiol. Behav. 4: 833-836
- Long term intracranial cannula stabilization in mice with light cured resin composites.Groseclose, G.H. et al,1998, J. Neurosc. Meth. 79: 31-36

2.1 Carotid Vein Catheterization

- Permanent cannulation of blood vessels in mice. Popovic P., Sybers H. and Popovic V.P. Journal of applied Physiology 25: 626-627, 1968.
- A new method for measurement of blood pressure, heart rate, and activity in the mouse by radiotelemetry. Mills PA, Huetteman DA, Brockway BP, Zwiers LM, Gelsema AJ, Schwartz RS and Kramer K., J Appl Physiol 88: 1537-1544, 2000.
- Blood sampling methodology is crucial for precise measurement of plasma catecholamines concentrations in mice. Grouzmann E, Cavadas C, Grand D, Moratel M, Aubert JF, Brunner HR and Mazzolai L., Pflugers Arch 447: 254-258, 2003.

3. EQUIPMENT

3.1 Fuji Plus system (permanent head attachment)

-	mixer	:	Fuji Mixer
-	applier	:	Fuji Applier; two kinds (Instech Solomon)
-	capsules	:	Fuji Plus; pack of 50 (Instech Solomon)

3.2 Skin Attachment System

- Skin Attachment : Covance Harness (Instech Solomon)

3.3 Surgical instruments

- straight anatomical forceps
- micro scissors
- curved jewellers forceps
- straight jewelers forceps
- vessel stretcher
- small vascular clip
- preparation scissors straight
- scalpel
- cotton wool sticks
- gauze compresses
- sutures (6-0)

3.4 Solutions

- chlorhexidine solution (100 mg/ml)
- hydrochloric acid (1 M)
- saline
- heparinezed Saline (25 ie/ml)
- glycerol solution with 500 ie/ml heparin (catheter lock solution)

3.5 Catheter systems

- Jugular Vein Catheter	Silicone (Instech Solomon)
- Carotid Artery Catheter	Polyurethane (Instech Solomon)
- Couplers / Plugs	Stainless steel (Instech Solomon)
- Connecting tubing	Polyethylene (Instech Solomon)
- (L-Shaped) Adaptors	

4. PROCEDURES

The surgical procedure can be divided in 4 parts namely:

4.1 preparation crown of the head; permanent head attachment (procedures are the same for carotid artery)
4.2 catheterization of the jugular vein / carotid artery
4.3 subcutaneously tunneling of the catheter (procedures are the same for carotid artery)
4.4 fixating the catheter to the skull (procedures are the same for carotid artery)

NB: Before commencing surgery make sure that the animal is shaved (neck and head), disinfected (chlorhexidine) and anaesthetized (absence paw reflex). Instruments and materials used should be sterile.

4.1 Preparation of the crown of the head

- Make a longitudinal incision of 2 cm on the head
- Apply local anesthesia
- Push aside connective tissue and the membrane overlaying the skull using cotton wool sticks (pain full procedure)
- Scratch the skull using a scalpel
- Rinse the skull with saline to ensure that no blood remains on the skull; all bleeding should be stopped before applying the Fuji Plus cement.

4.2 Catheterization of the jugular vein

- Shave the neck on the right and disinfect with chlorhexidine

- Shave the top of the head and disinfect with chlorhexidine (see later)
- Make an incision with preparation scissors just above right clavicle of approximately 1 cm
- Push aside connective and adipose tissue with curved anatomical forceps and expose the internal jugular vein, inferior to the bifurcation and approximately 3 mm superior to the pectoral muscles (bifurcation recognizable by small lymph node)
- Mobilize the vessel for a distance of 2 mm
- Clamp the vessel by putting a ligature caudal to the bifurcation and tighten the ligature. Put the ligature under minimum of tension in the rostral direction.
- Put a second ligature around the vessel, 2 mm caudal from the bifurcation.
- Cut a V –shaped hole 1 mm rostral to the bifurcation with iridectomy scissors
- Prior to the implantation, the sterilized catheter is connected to a 1 ml syringe and filled with heparinized saline solution (no bubbles in catheter)
- Dilitate vessel with vessel stretcher and slide the catheter between legs of forceps in the vessel till silicon ring or T-connector reaches the V-shaped hole
- Tighten rostral ligature and connect both ligatures with another over the silicon ring or T-connector
- Check whether the catheter is in place (respiratory-induced fluid movements and superimposed heart frequency), draw a little amount of blood (30 grams mouse has approximately 4 ml of blood)
- Flush the cannula with 50 µl of heparinized saline solution, syringe can be removed and catheter secured with small vascular clip

4.2 Catheterization of the carotid artery

- Make a longitudinal incision along the ventral midline and open the membrane overlying the glands
- Pushed aside the glands with curved jewellers forceps, the right carotid artery can be found lateral to the muscles overlying the trachea.
- Mobilized the carotid artery for a distance of 5 mm caudal from the bifurcation and make sure that the vagal nerve - next to the artery - is carefully dissected from the carotid artery without damage.
- Ligate the artery with two 6-0 non absorbable ligatures. Tighten the distal ligature and put the ligature under minimal tension in the rostral direction
- Place a vessel clamp 5 mm caudal from the bifurcation; this will prevent extensive bleeding when the vessel is cut.
- Cut a V-shaped hole 1 mm caudal from the bifurcation using micro-scissors, this bifurcation acts as a landmark for estimating the insertion length of the catheter.
- Prior to its insertion into the vessel, the catheter is connected to a 1 ml syringe filled with heparinized saline solution (no air bubbles in the catheter)
- Dilated the vessel by means of a vessel stretcher, slid the catheter between the legs of the vessel stretcher and gently push into the vessel, a modified 25 G needle with its tip bend to a 90 degrees angle can also be used to puncture and subsequently catheterize the vessel.
- Insert the catheter till the proximal tip of the catheter reaches the vessel clamp. The proximal ligature is tied with the first half of a square knot, this will prevent the catheter of being pushed out (blood pressure) when the vessel clamp is released, while it is still possible to further insert the catheter into the artery, till the silicon ring reaches the V-shaped hole.
- To be sure that the catheter is not pushed out, the inserted part of catheter can be held in place with the vessel stretcher while the catheter is pushed further using an anatomical forceps.
- Tie the second half of the square knot.
- Ensure that the catheter cannot be moved, one drawstring of each ligature should be tied crossing over the silicon ring.
- Flush the catheter with approximately 0.1 ml of heparinized saline and fill the catheter with catheter lock solution
- Close the wound using three resorbable 7-0 sutures.

4.3 Subcataneously tunneling of the catheter

(The cannula should be tunnelled to emerge at the top of the head)

- Push a small artery forceps under the skin by the head incision and turn it with an angle of 90 degrees in the direction of the neck incision, artery forceps should be closedvduring tunneling
- Take the cannula in the artery forceps and pull the cannula thought the tunnel to the head incision, take care that the cannula is not twisted.
- Fill the cannula with catheter lock solution and secure the L-shaped adapter with a one side closed connector

4.4 Fixating the catheter to the skull

- Activate the capsule by pushing the plunger. Place the capsule in the mixer and mix for at least 15 seconds but never longer than 30 seconds; polymerization starts when capsule is activated.
- Place the capsule in the applier and directly start with applying the cement beginning with the skull. Ensure that a large area of skull is covered.
- Stabilize the L-shaped adapter into the cement.
- Wait till the cement is dry; approximately 1 minute.
- Close the wound using sufficient sutures.

5. SAFETY

NB: Workers should be familiar with hazardous solutions and take appropriate safety precautions.

5.1 Hazardous solutions in this work instruction

- Capsules; Alumino-Silicate Glass, 2-Hydroxyethylmethacrylate, Polyacrylic acid and Triethylene Glycol Dimethacrylate
- Hydrochloric acid (1M)

6. Appendixes

6.1 Insertion lengths (to be investigated for carotid artery or fixed at 5 mm)

C57B1/10	20 grams	Y = 11,5 mm
♂	30 grams	Y = 12,7 mm
	40 grams	Y = 14,0 mm
C57BL/6J	30 grams	Y = 10,0 mm
♂		
C57BL	18-20 grams	Y = 12 mm
♂	21-24 grams	Y = 13 mm
	25-30 grams	Y = 14 mm
C3H	18-20 grams	Y = 11 mm
♂	21-24 grams	Y = 12 mm
	25-30 grams	Y = 13 mm
DBA/2	18-20 grams	Y = 10 mm
♂	21-24 grams	Y = 11 mm
	25-30 grams	Y = 12 mm