# T400-Series Surgical Protocol

## Mouse Ascending Aorta: Chronic Blood Flow Measurement

### APPLICATION BASICS

| | |
|---|---|
| Site: | Ascending Aorta |
| Species: | Mouse |
| Body Weight: | 20 - 50 grams |
| Duration: | Chronic |
| Vessel Diameter: | 1.2 - 1.3 mm |
| Length: | 2.5 - 3.0 mm |

### PROBE

| | |
|---|---|
| Size: | 1.5 mm |
| Reflector: | J |
| Connector: | 4-pin |
| Cable Length: | 60 cm |
| Catalog #: | MC-1.5PSL-JN-WC60-CA4S-GC |

### FLOWMETER

TS420 Perivascular Module

## Implantation Techniques

Continuous beat-to-beat measurements of mouse cardiac output (minus coronary flow) can be made directly with the 1.5PSL flow Probe positioned on the ascending aorta. Surgeries on this scale are performed with the aid of a surgical microscope. The Flowmeter displays mean flow; recorded waveform data are used in calculations of stroke volume, peak flow, aortic flow acceleration dF/dt, aortic input impedance, systemic vascular resistance and heart rate. Flow measurements with pressure data are used to determine pressure volume relations in cardiac function and can now be applied in transgenic mouse models.

### PROBE PLACEMENT

Under anesthesia and after the mouse has been properly ventilated on a respirator, a right thoracotomy is performed in the third intercostal space to expose the lungs in the thoracic cavity. The right lung is packed clear of the surgical field with a small piece of surgical sponge. The ascending aorta lies directly under the thymus gland. Carefully dissect the ascending aorta with blunt dissection using microsurgical vessel dilators to free the vessel from connective tissue. The vessel can be manipulated most easily by grasping the small fat pad at the base of the pulmonary artery. After the aorta has been isolated from the pulmonary artery, two pieces of surgical silk are passed under the vessel to aid in placing the vessel within the lumen of the Probe. The Flow Probe is introduced into the thoracic cavity and the vessel lifted into the Probe lumen so that the J-shaped

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## Flow Ranges Observed

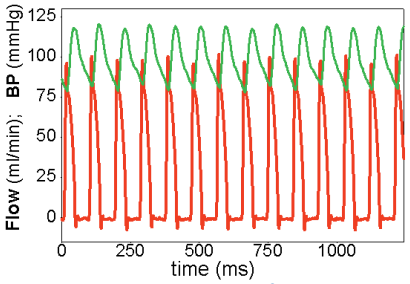


Fig 1: Ascending aortic blood flow and pressure in a conscious mouse 7 days after implantation.
Courtesy, B. Janssen, Univ. of Maastricht

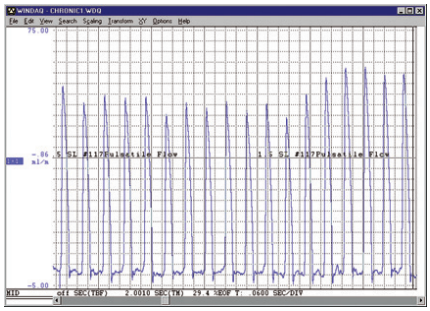

Fig 2: Chronic CO in the Mouse: Transonic 1.5PSL Probe on Ascending Aorta Flow 14.2 ml/m; Heart Rate 510 bpm; SV = 28 µl.

Fig 3: 1.5PSL Probes are designed specifically for chronic implantation on the ascending aorta of the mouse. The transducer housing is less than 5 mm and is easily accommodated in the mouse thoracic cavity. The non-constrictive fit does not interfere with the ascending aorta or pulmonary artery. For connector exteriorization, the Probe's flexible cable is tunneled under the skin.

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# Mouse Asc. Aorta: Chronic Blood Flow Measurement Cont.

## Implantation Techniques cont.

reflector encircles the aorta. After confirmation of vessel placement, the sutures can be removed and the 1.5PSL Probe is rotated so the Probe cable exits laterally to the right. The thoracotomy can be closed over the Probe to establish negative pressure in the thoracic cavity and improve venous return and cardiac output.

For acute measurements, an acoustic coupling gel injected into the Probe lumen is used to transmit the ultrasound signal. Gel is not required for chronic applications; fibrous tissue encapsulation of the Flow Probe will provide good signal transmission after the animal recovers (3-5 days) and is ready for measurement and experimentation.

## Surgical Implantation of 1.5PSL Flowprobe on the Ascending Aorta

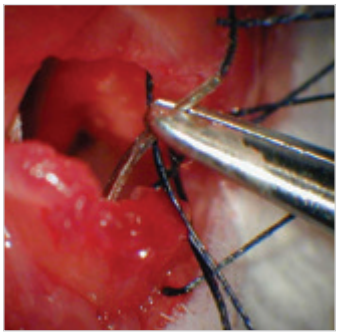

Fig 4: After the mouse has been anesthetized and properly ventilated, a right thoracotomy is performed in the 3rd intercostal space. Closure sutures are placed in the muscle layers at the beginning of the procedure.

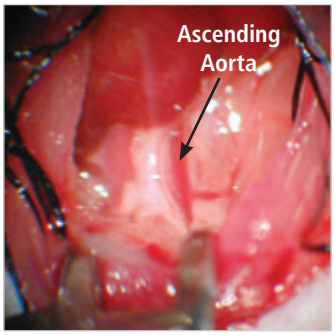


Fig 5: A modified rib retractor is inserted to visualize the heart and ascending aorta. The ascending aorta lies directly under the thymus gland.

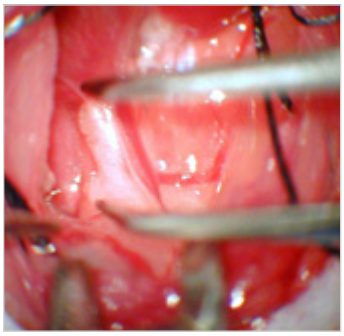

Fig 6: Careful dissection along the ascending aorta is performed by blunt dissection using microsurgical vessel dilators to free the vessel from connective tissue.

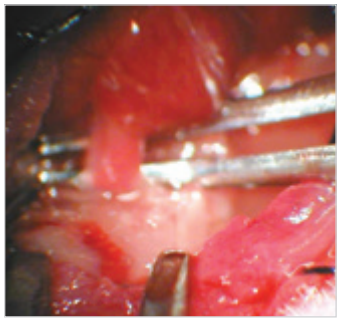

Fig 7: The aorta has been isolated from the pulmonary artery. Gently lift under the aorta to pass surgical silk under the vessel to aid in placing the vessel in the lumen of the Probe.

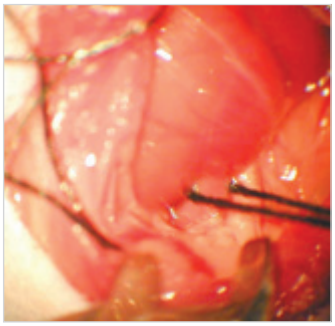

Fig 8: Note the surgical silk around the ascending aorta at the base of the heart.

Fig 9: The retractors are removed and the 1.5PSL Flowprobe is introduced into the thoracic cavity.

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## Surgical Implantation of 1.5PSL Flow Probe on the Ascending Aorta cont.

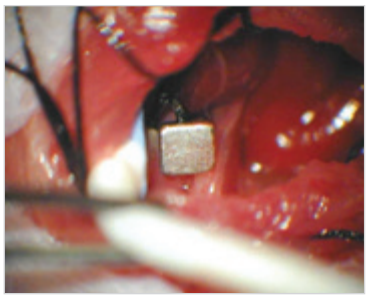

Fig 10: The aorta is gently lifted into the opening of the flow Probe. Confirm that the vessel is within the Probe by gently rotating the Probe. Remove the surgical silk from around the aorta to prepare for closure.

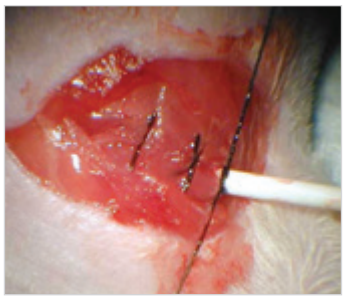

Fig 11: The cable is rotated laterally to the right and the thoracotomy closed over the Probe. Reapproximate the muscles. A suture is passed around the Flowprobe cable to stabilize the Probe in position.

**Measurement of Ascending Aorta Blood Flow in the Mouse Protocol©**
Courtesy of TL Smith, Dept. of Orthopaedic Surgery, Wake Forest University School of Medicine, Winston-Salem, NC. Wake Forest University School of Medicine, Department of Orthopaedic Surgery; used with permission.

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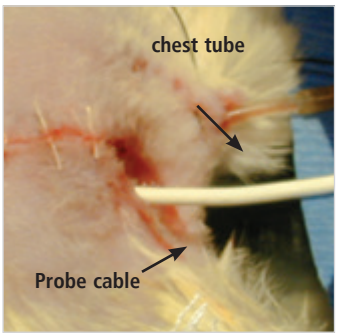
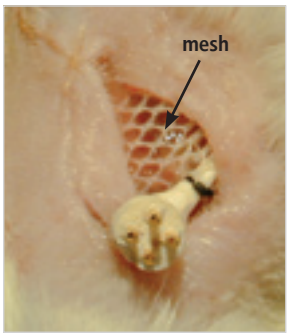
## Final Closure Procedures




Figs 12, 13: A chest tube attached to a negative pressure system can be monitored for bubbles indicating pneumo-thorax. Close the skin incision. For chronic monitoring, the Probe connector is passed under the skin to the midscapular area by creating a subcutaneous tunnel using a pair of straight hemostats and gently grasping the CA4S connector. Dacron mesh is placed under the skin at the connector and the incision closed. A button cuff is installed over the connector and sutured in place through the dacron mesh.

Fig 14: The mouse can be monitored for cardiac output after recovery in 3 - 5 days. During this time, the flow Probe will encapsulate in fibrous tissue to provide good signal transmission.

Fig 15: Mouse attached to Dragonfly swivel for flow measurement recording.

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## Continuous Conscious Cardiac Output in Mice

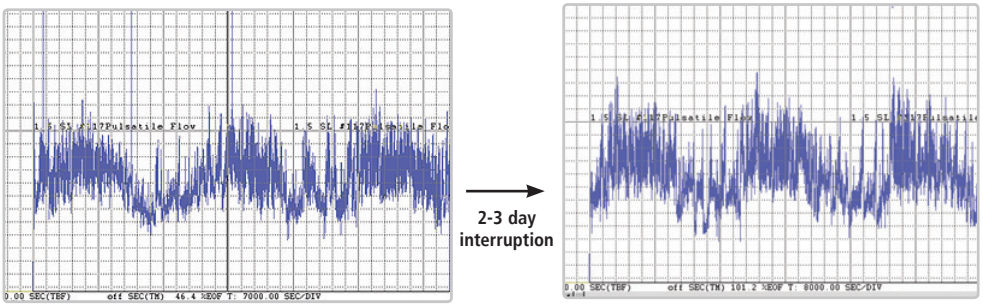


Fig 16: Recording over ~ 8 days with one 2-3 day interruption in recording; 0.1 Hz; 10 samples/sec. Note circadian cycles in flow.

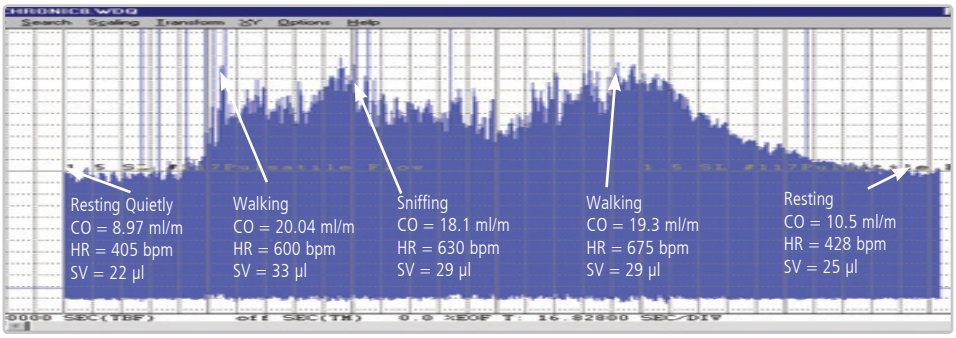


Fig 17: 8 Minute Recording Of Cardiac Output: Dramatic variability demonstrates dynamic range of mouse CO related to activity which cannot be recognized under acute anesthetized protocols.

## ACKNOWLEDGEMENT

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Surgical Protocol (Video)
T.L. Smith, Ph.D,

Detailed procedural video showing step-by-step surgery for implantation of the Transonic® 1.5PSL Flowprobe on the mouse ascending aorta.

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