Measurement of Left Ventricular Performance in Langendorff Perfused Mouse Hearts

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Summary
Protocol

Summary: This protocol describes the procedure used by the AMDCC for measuring left ventricular performance in isolated retrogradely perfused mouse hearts.

Protocol:

Langendorff Heart Perfusion Protocol

Hearts are isolated and the aorta is cannulated using a 20g steel cannula. Hearts are perfused at a constant pressure of 60 mmHg by an aortic cannula delivering warm (37°C) Krebs buffer containing (in mM) 118 NaCl, 4.7 KCl, 25 $NaHCO_3$, 1.2 $MgSO_4$, 1.2 KH_2PO_4, 2 $CaCl_2$ gassed with 95% O_2, 5% CO_2. Hearts are perfused with glucose 11mM as sole substrate or in combination with 1 or 1.2 mM palmitate. The pulmonary artery is transected to facilitate coronary venous drainage. A left ventricular polyethylene apical drain is inserted through a left atrial incision to allow thebesian venous drainage. Left ventricular pressure is monitored from a water-filled balloon placed through the left atrial appendage and connected to a Millar transducer. The volume of the balloon is adjusted to obtain a left ventricular diastolic pressure of 7 mmHg. Heart rates are adjusted to 360 beats/min by pacing at 6 Hz at the level of the atria.

Inotropic stress protocol. After 30 min stabilization, data are acquired under baseline conditions (buffer calcium concentration =2 mM). The hearts are then switched to a second buffer containing 4 mM $CaCl_2$. Contractile parameters are again measured after 20 min of stabilization. The langendorff protocols yield the following parameters:

(1) Left ventricle systolic pressure (LVSP): Units mmHg.
(2) Left ventricle developed pressure (LVDP or LVDevP), which is LVSP – LV Diastolic pressure: Units mmHg.
(3) Heart Rate (HR): Units beats per minute
(4) Rate Pressure Product (RPP), which is LVDP x HR. Units mmHg/sec
(5) dP/dt_{min} and dP/dt_{max}, which are the maximal rates of LV pressure decay and LV, pressure development respectively. Units mmHg/msec.

(6) Coronary Flow (ml/min). This is determined by measuring the coronary effluent from the perfused heart.

Myocardial oxygen consumption (MVO_2). Coronary effluent is sampled from the pulmonary artery using a capillary tube. Oxygen content was measured using an Oxygen foxy probe (OceanOptics) and calculated using the formula:

$$MVO_2 = \%\ O_{2\ perfusat} - \%\ O_{2\ pulmonary\ artery} \times Coronary\ Flow \times Atmospheric\ Pressure / 760 \times O_2\ Solubility \times O_2\ Density$$

Where O_2 solubility and O_2 density are 23.9 μl/ml and 0.03933 μmol/μl respectively in a solution at 37°C respectively.
Cardiac efficiency is calculated as the ratio of RPP/MVO_2 expressed as a percentage.