Title : EFFECTS OF HYPEROXEMIA ON MYOCARDIAL BLOOD FLOW AND OXYGEN CONSUMPTION IN AN ISOLATED RABBIT HEART.

Authors : J.F. Baron, M.D., E. Vicaut, M.D., X. HOU, M.D., P. Viars, M.D., M. Duvelleroy, M.D.

Affiliation : Laboratoire de Biophysique. Hôpital Fernand Widal - Paris - FRANCE. Département d'Anesthésie-Réanimation. Groupe Hospitalier Pitié-Salpétrière - Paris -

INTRODUCTION. Breathing an enriched O2 mixture is usually recommended in patients with coronary artery disease (CAD) during the perioperative period. Indeed, breathing O2 may decrease coronary blood flow (CBF) as a result of a reduction in myocardial O2 consumption (MVO2) due to a decrease in heart rate mediated by the automatic nervous system (1). However, the decrease in CBF, might also be the consequence of a direct vasomotor effect from arterial O2 partial pressure (PaO2) (1). In this hypothesis, high PaO2 might paradoxically limit myocardial O2 supply. A denervated isolated heart preparation is a well suited model to test this last hypothesis.

METHODS. Standard human stored blood was washed, centrifuged and resuspended in Krebs-Henseleit Buffer. Blood was equilibrated and oxygenated to achieve a normal acid-base balance, PaO2 and O2 content (CaO2). Then, blood was shared into 2 separate oxygenation circuits to achieve 2 distinguishable PaO2 levels : CONTROL BLOOD and HIGH PaO2 BLOOD. Hemoglobin concentrations (Hb) were adjusted to obtain the same O2 content for the 2 PO2 levels. Nine New Zealand albino male rabbits were anesthetized with ether. The heart was quickly excised by thoracotomy and prepared for canulation under immersion in a cold isotonic saline solution. The aorta was mounted on a cannula and retrograde perfusion was performed with control blood. The speed of the coronary pump, which reflects coronary blood flow (CBF), may vary to maintain a perfusion pressure (PP) of 70 mmHg constant (FREE CBF). The coronary sinus drainage was collected via a cannulated pulmonary artery. A cannulated fluid-filled balloon was placed via a left atrial incision in the left ventricle (LV) and attached to a pressure transducer to monitor LV pressure. The balloon was inflated to maintain constant LV volume and to produce a LV end-diastolic pressure (LVEDP) of 15 mmHg. The right ventricle was paced at a constant rate of 190 b/min. After a rewarming period of 30 min, the first set of measurements was performed under CONTROL BLOOD. The second set was obtained after switching to HIGH PAO2 blood.

Additional experiments were conducted in 6 hearts. In these experiments, coronary blood flow was maintained constant (CONSTANT CBF). The perfusion pressure may vary and reflects changes in coronary vascular resistances. Measurements were performed at the 2 levels of PaO2.

Measurements included : CBF, LV developed pressure (LV systolic pressure minus LVEDP) (LVDevP) and its first positive and negative derivatives (dP/dt max and dP/dt min), PaO2, CaO2, coronary sinus PO2 (PcsO2) and O2 content (CcsO2). MVO2 was derived. Data were analysed using the paired Student's t-test, and expressed means ± SD.

RESULTS are expressed in table 1.

Switching from CONTROL to HIGH PaO2 BLOOD with FREE CBF induced a significant decrease in CBF and MVO2. LVDevP and its positive and negative derivatives did not vary significantly. These effects were reversible.

Switching from CONTROL to HIGH PaO2 BLOOD with CONSTANT CBF induced a significant rise in perfusion pressure. CcsO2 significantly increased and MVO2 decreased. No change in myocardial performance was observed.

DISCUSSION. Since the heart was denervated, the coronary vasoconstriction in response to high PaO2 at a constant CaO2, observed in these experiments cannot be explained by reflex adaptations mediated by the autonomous nervous system. Although its main determinants did not change, a decrease in MVO2 was associated with the coronary vasoconstriction. In addition, experiments at constant CBF excluded an influence of O2 supply on MVO2. This decrease may be likely explained by either a decrease in capillary density or an increased flow heterogenity. Thus, high PaO2-induced vasoconstriction might be explained by a direct vasomotor effect of PaO2 (arteriolar PO2 sensors) (2). These results may be clinically relevant when an enriched O2 mixture is administered in patients with CAD.

Table 1 : Coronary hemodynamics, myocardial performance and consumption.

	FREE CBF		CONSTANT CBF	
	CONTROL	HIGH PAO2	CONTROL	HIGH PAO2
PaO_2 mmHg	125 ± 6	380 ± 27**	148 ± 3	432 ± 28**
CaO_2 ml/100ml	12.8 ± 0.2	13.0 ± 0.2	15.3 ± 0.3	15.2 ± 0.2
CBF ml/min/g	2.55 ± 0.37	1.91 ± 0.24**	1.98 ± 0.12	1.98 ± 0.12
PP mmHg	74 ± 2	75 ± 1	80 ± 2	104 ± 4**
PvO_2 mmHg	37 ± 1	39 ± 1	30 ± 1	32 ± 1
CvO_2 ml/100ml	10.2 ± 0.5	10.2 ± 0.5	8.5 ± 0.2	9.4 ± 0.2*
MVO_2 ml/min/g	0.10 ± 0.01	0.08 ± 0.01**	0.13 ± 0.01	0.11 ± 0.01*
LVDevP mmHg	78 ± 6	74 ± 6	81 ± 3	79 ± 2
dP/dtmin mmHg/s	1132 ± 109	1141 ± 117	1532 ± 142	1493 ± 116
dP/dtmax mmHg/s	-673 ± 32	-687 ± 46	-920 ± 76	-912 ± 64

* : $p < 0.05$ vs CONTROL, ** : $p < 0.01$ vs CONTROL

REFERENCES.
1. FEIGL EO. : Coronary Physiology. Physiol Review 63 : 1-205, 1983
2. JACKSON WF., DULING BR. : The oxygen sensitivity of hamster cheek pouch arterioles. Circ. Res. 53 : 515-525, 1983