

Title: MYOCARDIAL OXYGEN BALANCE DURING ENFLURANE AND ISOFLURANE ANESTHESIA FOR CORONARY ARTERY SURGERY

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Introduction. The use of inhalation anesthetics in patients with myocardial ischemia is controversial, since these agents produce a dose-related depression in myocardial function and coronary perfusion pressure. While halothane appears to be a safe anesthetic for coronary revascularization in patients with unimpaired left ventricular function (1), little is known about the effects of enflurane on myocardial blood flow in these patients and isoflurane has been reported to produce myocardial ischemia in patients with coronary heart disease (2). The present study was designed to compare the effects of enflurane and isoflurane on myocardial oxygen balance in patients undergoing coronary artery surgery.

Methods. Twenty patients undergoing three vessel coronary artery bypass surgery, ranging in age from 51-67 years and in weight from 66-89 kg, were studied after approval by the Human Investigations Committee and informed patients consent. In all patients the ejection fraction was greater than 55% and the pre-angiogram left ventricular end-diastolic pressure was less than 12 mmHg. All patients were receiving maintenance doses of beta-receptor antagonists up to the night prior to surgery. In ten patients anesthesia was induced with thiopental, pancuronium, nitrous oxide in oxygen and enflurane and maintained at enflurane concentrations aimed at retaining normotension, while the remaining ten patients received isoflurane instead of enflurane. Measurements included coronary blood flow (argon washin), myocardial oxygen and lactate uptake and cardiovascular dynamics. Measurements were performed and blood samples were taken with the patients awake (I), 15min after the induction of anesthesia and before any surgical stimulation (II) and during sternotomy (III).

Results (table 1 and 2).

Table 1. Myocardial and hemodynamic variables during enflurane anesthesia (mean \pm S.E.M.)

	I	II	III
MBF (ml/min·100g)	119	69*	89*
	± 11	± 6	± 8
MVO ₂ (ml/min·100g)	13.4	7.5*	10.3*
	± 1.5	± 0.9	± 1
MR-Lactate (mmol/min·100g)	0.19	0.1*	0.18*
	± 0.04	± 0.03	± 0.03
O ₂ -Sat.cor.ven. (%)	33.7	40.6*	31.7*
	± 1.7	± 1.1	± 1.2
MDAP (mmHg)	94	71*	90*
	± 3	± 2	± 3
CVR (mmHg/ml·min ⁻¹ ·100g ⁻¹)	0.74	0.9	0.95
	± 0.08	± 0.07	± 0.1
CI (l·min ⁻¹ ·m ⁻²)	2.94	2.25*	1.97*
	± 0.2	± 0.14	± 0.18
SVI (ml/m ²)	47	35*	28*
	± 2	± 2	± 3
HR (min ⁻¹)	62	67	71
MAP (mmHg)	104	77*	101*

Enflurane and isoflurane decreased myocardial blood flow, oxygen consumption, lactate uptake, coronary perfusion pressure, cardiac index and mean arterial

pressure to a similar extent. During sternotomy myocardial blood flow and myocardial oxygen consumption increased to pre-induction levels. Myocardial lactate production was observed with isoflurane in 3 patients, but not with enflurane.

Table 2. Myocardial and hemodynamic variables during isoflurane anesthesia

	I	II	III
MBF (ml/min·100g)	85	65*	87*
	± 4	± 9	± 7
MVO ₂ (ml/min·100g)	9.4	7.1*	7.5*
	± 0.8	± 0.5	± 0.9
MR-Lactate (mmol/min·100g)	0.13	0.08*	0.056*
	± 0.03	± 0.03	± 0.04
O ₂ -Sat.cor.ven. (%)	30.4	39.2*	40.8*
	± 2	± 2	± 3.3
MDAP (mmHg)	95	72*	81*
	± 5	± 2	± 4
CVR (mmHg/ml·min ⁻¹ ·100g ⁻¹)	1.03	0.98	0.84
	± 0.07	± 0.08	± 0.06
CI (l·min ⁻¹ ·m ⁻²)	2.84	2.29*	2.24*
	± 0.11	± 0.14	± 0.14
SVI (ml/m ²)	44	32	32
	± 2	± 2	± 2
HR (l/min)	64	72	72
	± 3	± 4	± 4
MAP (mmHg)	107	81*	91*
	± 4	± 4	± 4

MBF=myocardial blood flow, MVO₂=myocardial oxygen consumption, MR-Lactate=metabolic rate of lactate, MDAP=mean diastolic arterial pressure, CVR=coronary vascular resistance, CI=cardiac index, SVI=stroke volume index, HR=heart rate, MAP=mean arterial pressure. I=awake, II=15min after induction, III=during sternotomy. *p < 0.01.

Discussion. Enflurane and isoflurane anesthesia were associated with a significant decrease in the oxygen consumption of the left ventricle together with a corresponding decrease in coronary blood flow, both changes being a result of a decreased hemodynamic load on the myocardium and a decrease in contractility. Myocardial ischemia could not be demonstrated in both groups after induction of anesthesia. During sternotomy myocardial oxygen consumption and coronary blood flow increased in both groups due to cardiovascular stimulation. While myocardial oxygen balance was well maintained with enflurane, myocardial lactate production was observed in three patients with isoflurane indicating myocardial ischemia, probably due to a redistribution of myocardial blood flow.

References: 1. Hilfiker, O., Larsen, R., Sonntag, H.: Myocardial blood flow and oxygen consumption during halothane-nitrous oxide anaesthesia for coronary revascularization. Br. J. Anaesth. 55:927, 1983
2. Reiz, S., Balfors, E., Sorensen, M.B. et al.: Isoflurane - a powerful coronary vasodilator in patients with coronary artery disease. Anesthesiology 59:91, 1983