Title : HALOTHANE; EFFECT ON MYOCARDIAL K^+ DURING ISCHEMIA

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Introduction. Halothane has been shown to decrease the severity of experimentally induced myocardial ischemia (1). Our group has recently shown that myocardial ischemia can be monitored with the use of an electrode that continuously measures myocardial extracellular potassium concentrations (MEK^+). (2) During ischemia, drugs that reduce myocardial oxygen demand should restore the MEK^+ towards normal. To test this hypothesis, we studied the effects of halothane in modifying MEK^+ during constant flow ischemia in a swine model.

Methods. Eight adult swine were anesthetized with halothane/oxygen, paralyzed with pancuronium bromide (0.1 mgm/kgm) and ventilated to maintain a $PaCO_2$ of 38 ± 3 mm Hg. Halothane was administered through a Dräger vaporizer, and the inspired concentration was continually monitored with an infrared analyzer. The initial concentration of halothane was 0.5% to 0.7% (Low H). Hemodynamic monitoring included systemic, pulmonary and left ventricular pressures, ECG, and the first time derivative of the ventricular pressure (dp/dt). Heart rate was controlled with atrial pacing. After heparin was administered to the animal, the distal left anterior descending coronary (LAD) and carotid arteries were cannulated, and a "shunt" was established via a rotary pump. The LAD proximal to the shunt was ligated, and the distal LAD was perfused initially with a flow of 50 cc/min. MEK^+ was continuously measured at two sites with intramyocardial electrodes. One electrode (ischemic zone - IZ) was placed in the area of myocardium supplied with blood by the cannulated LAD. A second electrode (normal zone - NZ) was placed in an area of normally perfused myocardium. After a stabilization period of at least 20 minutes, we gradually reduced flow through the shunt until an abrupt increase in MEK^+ occurred in the IZ. Shunt flow was then held constant throughout the experiment. Arterial blood gases, hematocrit, serum K^+ and hemodynamic measurements were recorded for Low H. The halothane concentration was increased to 1.5% - 2% (Hi H), and after a stabilization period, measurements were again recorded. Paired T-tests were used to calculate significance.

Results. The MEK^+ values are presented in Table 1.

Table 1. MEK^+ in Normal and Ischemic Myocardium During Low and High Halothane

	MEK^+ (meq/L)			
	ISCHEMIC ZONE K^+		NORMAL ZONE K^+	
Animal #	Low H	Hi H	Low H	Hi H
1	9.1	7.0	4.5	4.5
2	7.0	4.2	4.7	4.9
3	7.5	4.6	4.0	4.3
4	9.9	5.8	4.2	4.2
5	5.1	4.2	3.6	3.2
6	7.6	6.2	4.7	4.7
7	7.6	5.8	4.8	5.0
8	7.0	5.5	ND	-
MEAN	* 7.6	5.4	4.4	4.4
S.D.	±1.4	±1.0	±.4	±.6

*$p<.001$

There was a 29% decrease in IZK^+ and no change in NZK^+ as a result of increasing the halothane concentration. The LV systolic pressure decreased from 86 ± 17 mm Hg to 47 ± 13 mm Hg ($p<.001$); the rate-pressure product decreased from 10,284 ± 2,335 to 5,537 ± 1,573 ($p<.001$); and the dp/dt decreased from 1,159 ± 297 mm Hg/sec to 412 ± 161 mm Hg/sec ($p<.001$). There was no change in LVEDP.

Discussion. As the halothane concentration was increased, MEK^+ decreased in the ischemic zone while no change in MEK^+ occurred in the normal zone. This phenomenon probably resulted from a net improvement in myocardial oxygen balance as a result of the effect of halothane on one or more of the determinants of myocardial oxygen demand. With improvement in oxygen balance, transmembrane equilibrium of K^+ was restored. The K^+ electrode provides an accurate and sensitive method for studying the effects of anesthetic drugs on myocardial ischemia.

References.

1. Bland JH, Lowenstein E: Halothane-induced decrease in experimental myocardial ischemia in the non-failing canine heart. Anesthesiology 45:287-293, 1976.
2. Hill JL, Gettes LS: Effect of acute coronary artery occlusion on local myocardial extracellular K^+ activity in swine. Circulation 61:768-778, 1980.