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TITLE: Halothane and Ischemic Regional Myocardial Wall Dynamics

AUTHORS: T. Behrenbeck, M.D., M. Nugent, M.D., A. Quasha, M.D., E. Hoffman, B.S., E. Ritman, M.D., J. Tinker, M.D.

AFFILIATION: From the Departments of Physiology and Anesthesiology, Mayo Clinic, Rochester, Minnesota 55901. Supported in part by Grants GM 24531, HL 04664, RR00007 and DFG BE 803/1.

Profound impairment of regional ventricular function during anterior myocardial ischemia produced in dogs anesthetized with halothane was recently reported by Lowenstein et al.[1] The question remains as to whether this is an enhanced depressant effect of halothane on ischemic myocardium, or whether this resulted as a consequence of decreased perfusion due to halothane's general myocardial and peripheral effects. Theroux et al[2] have shown that myocardium tends to increase its vigor of contraction, i.e., to compensate in response to opposite wall ischemia. Our experimental approach included graded decrements of posterior wall perfusion and permitted simultaneous measurements of regional wall dynamics of both the normally perfused anterior and the ischemic posterior walls by computerized roentgen videometry. Our purpose was to quantify the effects of different doses of halothane on regional contractile function in the presence of myocardial ischemia.

Methods

Mongrel dogs were anesthetized with 1 MAC halothane and paralyzed with a succinylcholine infusion. The rib cage was opened and the left circumflex coronary artery cannulated and perfused via calibrated roller pump with femoral artery blood. Regional contractile function was estimated from monoplanar ventriculograms recorded on videotape and analysed with the videometric method of Dumesnil et al.[3] Ventriculograms were evaluated for peak systolic wall thickening rate (dTw/dt), left ventricular end-diastolic and systolic volumes and ejection fraction (2-6 cardiac cycles averaged per ventriculogram). In 7 dogs, the effects of reductions in circumflex coronary perfusion from 5 to 1.25 or 1.50 ml/min/kg, were studied at various anesthetic doses. The anesthetic sequence was 0.5, 1.0, 0.5, 1.5, and 0.5 MAC halothane consecutively. Each perfusion step was maintained for 5 minutes before ventriculography. Between each perfusion step, the circumflex coronary artery was perfused for 10 minutes at control flow. The cannulated and contralateral walls each served independently as their own controls. Aortic, left ventricular end-diastolic pressures and ECG's were recorded throughout the experiments. Mean arterial pressure was always > 90 mmHg, PaO_2 was held between 100-150 mmHg. $PaCO_2$ averaged 39 ± 1 mmHg. End-tidal halothane concentrations were measured with an infrared analyser (Beckman LB2).

Results (Table 1)

Angiograms obtained after returning flows to control and anesthetic concentrations to former values indicated no significant prep deterioration. Increasing halothane (during control coronary flows) from 0.5 to 1.0 MAC resulted in a 27% decrease in posterior wall dTw/dt (from 33 ± 3 to 24 ± 3 mm/sec, $p < .01$). A similar 26% decrease was seen in non-cannulated anterior wall dTw/dt (42 ± 7 to 31 ± 5 mm/sec, $p < .05$) when halothane was increased from 0.5 to 1.0 MAC. At 0.5 MAC halothane with regional ischemia (~ 25% of control flow), dTw/dt of the posterior wall decreased from 33 ± 3 to 15 ± 5 mm/sec, $p < .001$. At 1.0 MAC halothane, the corresponding reduction in dTw/dt was from 24 ± 3 to 17 ± 5 mm/sec, $p < .05$. The dTw/dt values were not significantly different during ischemia at the two different halothane concentrations.

In the non-cannulated anterior wall during opposite wall ischemia, although dTw/dt did not change significantly at either 0.5 or 1.0 MAC halothane (from 42 ± 7 to 34 ± 7 mm/sec for ½ MAC; from 31 ± 5 to 31 ± 6 mm/sec for 1 MAC), a trend toward compensation at the higher halothane concentration was noted.

Discussion

Similar depression (~ 26%) in anterior and posterior regional wall dynamics occurred during control coronary flows when halothane was increased from 0.5 to 1.0 MAC. Using controlled non-pulsatile perfusion, we found that regional wall dynamics of the ischemic ventricular walls were not significantly different at 1 MAC than at ½ MAC steady-state halothane concentrations. Our model provided a constant perfusion to the cannulated artery, and allowed reduction in afterload during increased anesthetic concentrations due to halothane's general myocardial depression and peripheral effects. We believe that if halothane produces severe depression in situations wherein there is ischemic myocardium, it is due to a combination of peripheral effects and generalized myocardial depression. We conclude that halothane does not produce greater functional depression in regions of myocardial ischemia by a direct effect.

References

1. Lowenstein E, Foëx P, Francis CM, et al: ANESTHESIOLOGY 51:S62, 1979
2. Theroux P, Franklin D, Ross J, et al: Circ Res 35: 896-908, 1974
3. Dumesnil J, Ritman E, Frye R, et al: Circulation 50:700-708, 1974

Table 1.

Left Ventricular Regional Wall Dynamics
Maximum Rate of Wall Thickening (dTw/dt) mm/sec

	Posterior Wall (Circumflex Coronary Artery Cannulated)		Anterior Wall (LAD Coronary Artery Non-Cannulated)	
Halothane MAC	Control	Ischemic	Control	Ischemic
0.5	33 ± 3*	15 ± 5	42 ± 7	34 ± 7
1.0	24 ± 3	17 ± 5	31 ± 5	31 ± 6

* Mean ± SEM for seven dogs