

Title: Influence of Anesthesia on Pacing Induced Ischemia Threshold

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The effects of anesthetics on regional function of myocardium with compromised blood flow have been investigated by dose response relationships (1). The heart rate at which ischemia occurs is a reliable indicator of tolerance to ischemia. We tested the hypothesis that different anesthetic techniques result in a difference in the threshold of pacing-induced ischemia.

Methods: 8 dogs were anesthetized with halothane (HAL), intubated, and a left thoracotomy was performed. The heart was isolated, suspended in a pericardial cradle, and instrumented so as to measure left ventricular and central aortic pressures as well as regional myocardial function by means of sonomicrometry in the apical region of the left ventricle, supplied by the left anterior descending coronary artery (LAD). The sinus node was crushed and the heart was paced at 100 bpm from the right atrium. End-tidal HAL, isoflurane (ISO) and CO₂ were continuously determined by infrared analysis. A critical constriction was applied to the LAD such that no deterioration in regional function occurred despite the loss of LAD reactive hyperemia after a 10 s total occlusion (1). At end-tidal HAL 0.7% and 1.1%, at end-tidal ISO 1.1% and 1.5%, as well as during fentanyl (0.1 µg/kg-min)-midazolam (1 µg/kg-min) infusions (FM), the pacing induced ischemia threshold was determined by increasing the pacing rate in steps of 10 bpm, starting at 100 bpm up to a maximum of 160 bpm. Ischemia was defined as a decrease in systolic

shortening greater than 20%, an increase in post-systolic shortening of more than 15% of total shortening, or the occurrence of pulsus alternans (2). Randomized block analysis of variance with Least Square Means test was used to compare data between the anesthesia conditions, with $p < 0.05$.

Results: The heart rate (HR), at which ischemia occurred was not different in the 5 anesthesia conditions investigated. Mean arterial (MAP) and left ventricular end-diastolic pressure (LVEDP) as well as maximum positive LV dP/dt (dP/dt) showed no statistically significant differences between the 5 anesthesia conditions at the ischemic threshold (table).

Discussion: The threshold of pacing induced ischemia was not affected by the type nor by the depth of anesthesia. None of the investigated anesthesia conditions therefore increased the ischemia tolerance or showed a detrimental effect upon myocardium with compromised blood flow.

Table: Hemodynamics at ischemia [mean (SD)]

	HAL 0.7%	HAL 1.1%	ISO 1.1%	ISO 1.5%	F-M
HR [bpm]	135 (16)	133 (18)	136 (17)	132 (18)	136 (16)
MAP [mmHg]	64 (8)	60 (13)	76 (13)	63 (13)	69 (13)
LVEDP [mmHg]	9 (4)	7 (4)	7 (2)	6 (4)	7 (3)
dP/dt [mmHg/s]	897 (282)	836 (262)	1174 (336)	964 (256)	1146 (413)

References: 1) Lowenstein et al, *Anesthesiology*, 55:349, 1981
2) Crozatier et al, *Basic Res. Cardiol.*, 74:639, 1979

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Title: Effects of Hemodilution and Anesthesia on Regional Function of Compromised Myocardium

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Acute normovolemic hemodilution is encountered clinically, yet controversy exists regarding the critical level of hemodilution, below which blood component therapy must be administered, particularly in patients with coronary artery disease. We tested the hypotheses that 1) the critical level of hematocrit is below 30% with coronary artery disease, and 2) increased depth of anesthesia protects the compromised myocardium during hemodilution.

Methods: 24 dogs were anesthetized with halothane, intubated, and underwent a left thoracotomy. The heart was isolated, suspended in a pericardial cradle, and instrumented so as to measure left ventricular and central aortic pressures and regional myocardial function (sonomicrometry) in the apical region of the left ventricle supplied by the LAD. End-tidal halothane and CO₂ were continuously measured by infrared analysis. A critical stenosis (CC) was applied to the LAD such that no deterioration of apical function occurred despite the loss of LAD reactive hyperemia to a 10 s total occlusion, as previously described (1). Normovolemic hemodilution was then performed to target Hct's of 35%, 25%, and 15%. A randomized incomplete block design was used; thus at each Hct level the animal was exposed to 3 of 4 end-tidal halothane concentrations chosen at random. The halothane concentrations examined were: 0.7%, 0.9%, 1.1%, and 1.3%. Mean arterial pressure (MAP), heart rate (HR), peak positive LV dP/dt were recorded, and regional myocardial function (systolic shortening, SS, and post-systolic shortening, PSS) were

calculated as previously described (1). The data were collected and digitized on a microcomputer. Analysis of variance with Least Squares Means test was used to compare critical constriction and hemodilution data, with $p < 0.05$.

Results: Increasing halothane concentration resulted decreases in arterial pressures and LV dP/dtmax, yet halothane had no effect on regional myocardial function at different hemodilution stages. Data for Hct was compared over all halothane concentrations. MAP decreased and HR increased at 15% Hct. Significant decreases in SS and increases in PSS occurred at 15% Hct. 6 animals died prior to data collection at 15% Hct.

Discussion: The critical level of hemodilution in compromised myocardium is lower than previously thought, with evidence of regional myocardial dysfunction indicative of ischemia only with 15% Hct. The depth of halothane anesthesia had no effect, either beneficial or detrimental, to the ischemic myocardium.

	CC	35%	25%	15%
HR (bpm)	123.1 ± 2.1	123.4 ± 1.1	125.7 ± 1.1	130.0 ± 1.3*
MAP (mmHg)	84.0 ± 1.9	81.9 ± 0.9	76.9 ± 0.9*	68.3 ± 1.1*
LV dP/dt (mmHg/s)	1279 ± 40	1272 ± 20	1285 ± 20	1254 ± 23
SS (% of EDL)	19.1 ± 1.1	17.3 ± 0.6	17.4 ± 0.6	11.1 ± 0.7*
PSS (% of TS)	6.6 ± 3.3	7.5 ± 1.6	10.4 ± 1.6	30.8 ± 2.0*

SS is in units of percentage of end-diastolic length; PSS is in units of percentage of total segmental shortening.

Reference: 1) Lowenstein et al, *Anesthesiology*, 55:349, 1981

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