TITLE: **CORONARY MICROVESSEL SEGMENTAL RESISTANCES DURING VASODILATION BY ISOFLURANE, NITROGLYCERIN AND ADENOSINE IN DOGS.**

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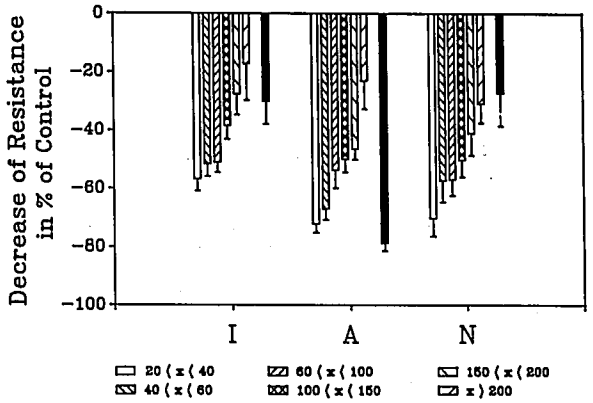
Introduction: Isoflurane (I), nitroglycerin (N) and adenosine (A) decrease coronary vascular resistance (CVR) in the normal myocardium by actions on the microvessels. However, the arteriolar vessel segments responsible for the reduction in CVR are poorly defined, yet. We determined changes in coronary microvessel segmental resistances during vasodilation by I, N and A by intravital microscopy. Results were compared with the decrease in CVR.

Methods: 15 dogs (mean b.w. 26.5 kg) were studied during general anesthesia with a narcotic. Catheters were placed for measurement of myocardial blood flow by radioactive microsphere technique (diam: 9μm).The left ventricular surface was exposed for intravital microscopy through a left side thoracotomy. Plasma was stained by FITC labelled Dextrane (MW 150.000 Dalton). Microscopic images were recorded by a high sensitive TV-camera and stored on videotape for off-line analysis. Recordings were obtained at control (narcotic only) and during deliberate hypotension by I, N and A with mean arterial pressures (MAP) of 60 mmHg. Microvessel segmental resistances were calculated from diameter changes, CVR from MAP, left atrial pressure and left ventricular blood flow. The sequence of experimental steps was randomized. Statistical analyses were performed by Friedman rank analysis of variance.

Results: CVR was reduced from its control value of 0.71±0.05 mmHg*100g*min/ml to 0.47±0.04 (I), 0.44±0.07 (N) and 0.12±0.01 (A). The endo:epi blood flow ratio was unchanged from control (1.05) with I and N, but decreased slightly with A (0.8). Changes in microvascular segmental resistances were calculated in more than 300 epicardial arteriolar vessels with diameters between 20 and 400 micron.

The figure shows coronary microvessel segmental resistances and CVR (black column) during hypotension as % of control (narcotic only).



Discussion: I, N and A dilated coronary microvessels. Diameter changes, and hence reductions in segmental resistance were most pronounced in the smallest arterioles which could be visualized (20-40 microns). The most striking finding is the discrepant behaviour of CVR and segmental resistance: CVR and segmental resistance decreased comparably with A, but CVR decreased considerably less with I and N. A transmural redistribution of flow with I and N can be excluded by the unchanged endo:epi ratio. The relatively high CVR with I and N, therefore, suggests a correspondigly high resistance to flow in arterioles with diameters below 20 micron and a maintained capacity for flow regulation in these vessels. However, this is not the case with A, which even dilates the smallest precapillary vessels.

TITLE: **BLOOD FLOW TO SPLANCHNIC ORGANS AND TISSUE OXYGENATION OF LIVER AND PANCREAS DURING ENFLURANE INDUCED HYPOTENSION**

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Introduction: Volatile anesthetics reduce splanchnic blood flow and impair hepatic tissue oxygenation (1,2). Previous work indicated that hepatic O_2 supply is worsened by the reduction of hepatic arterial blood flow as well as by the reduced O_2 supply via the portal vein. The impaired portal O_2-supply may be caused by both a reduction in total portal venous blood flow and a reduced O_2-content. In this study we looked for regional differences in the splanchnic circulation during enflurane induced hypotension. This we did by measuring blood supply to splanchnic organs and tissue O_2-pressures of liver and pancreas.

Methods: Experiments were performed in 11 Sprague-Dawley rats (mean b.w. 365 g) during mechanical ventilation (FiO_2 = 0.3; end-expiratory pCO_2 = 35mmHg). Basal anesthesia was achieved by i.v. fentanyl. Catheters were inserted into the tail artery, a jugular vein and the left ventricle via a carotid artery. Cardiac output, blood flow to the splanchnic organs and distribution of cardiac output were determined by radioactive microsphere technique (diameter: 15μm).Access to the hepatic and pancreatic surfaces was via a laparotomy. Oxygen tensions were measured by use of multichannel oxygen sensitive electrodes. Enflurane was used to lower mean arterial pressures (MAP) to 70, 50 and 30 mmHg. Control recordings were performed without enflurane. The experimental steps were randomized.

Results: At a MAP of 50 mmHg, hepatic arterial blood flow (HABF) was reduced by 45%, portal-venous blood flow (PVBF) by 14% (table). Changes were even more pronounced at MAP 30 (HABF -81%; PVBF -53%). In contrast, pancreatic blood supply (PBF) remained unchanged from control. The decrease in PVBF was due to a reduced perfusion of stomach, spleen, small and large intestine. The maintained PBF was accompanied by an increased fraction of CO from 2.0 ± 0.2% to 3.5 ± 0.5%, whereas the preportal fraction of CO decreased from 30 ± 4% to 25 ± 2% at MAP 30. As a result, oxygen pressures on the pancreatic surface were unchanged during enflurane. In contrast, enflurane induced hypotension resulted in a dose dependent leftward shift of the ptO_2-histograms and hence a deterioration of hepatic tissue oxygenation. A significantly increased number of hepatic surface ptO_2-values between 0-5mmHg was obtained during hypotension by enflurane. In contrast, no low ptO_2-recordings were obtained on the pancreatic surface.

Enf	3.2 ± 0.4	1.4 ± 0.4	0.3 ± 0.2	0
MAP	30 ± 2	50 ± 4	70 ± 6	80 ± 2
CO	42 ± 6	56 ± 4	51 ± 7	76 ± 14
HABF	10 ± 2	29 ± 3	28 ± 5	53 ± 4
PVBF	81 ± 7	148 ± 11	177 ± 23	172 ± 23
THBF	91 ± 8	177 ± 11	205 ± 24	225 ± 18
PBF	91 ± 11	119 ± 17	106 ± 19	97 ± 10
ptO_{2panc}	48 ± 4	63 ± 4	53 ± 6	57 ± 6
ptO_{2hep}	3 ± 1	14 ± 3	29 ± 3	26 ± 6

Legend: *Enf = Enflurane (Vol% insp); MAP = mean arterial pressure (mmHg); CO = cardiac output (ml/min); HABF = hepatic arterial blood flow; PVBF = portal-venous blood flow; THBF = total hepatic blood flow; PBF = pancreatic blood flow (all in ml*min^{-1}*100g^{-1}); ptO_{2panc} = pancreatic tissue pO_2; ptO_{2hep} = hepatic tissue pO_2 (mmHg).*

Conclusion: During enflurane induced hypotension the leftward shift of the hepatic ptO_2-histogramms with an increase in hypoxic surface sites (0-5mmHg) shows an imbalance between hepatic oxygen supply and metabolic demand. This is predominantly the result of reduced portal venous and hepatic arterial blood supplies. While blood flow to most preportal organs decreased dose dependently with enflurane, pancreatic flow and tissue oxygenation remained unaltered even at low perfusion pressures. The results confirm the reduction in splanchnic blood flow and the deterioration in hepatic tissue oxygenation during volatile anesthetic induced hypotension. However, there are pronounced regional differences favouring the pancreas.

1 Gelman et al., Anesth Analg 63: 557-565, 1984
2 Conzen et al., Anesthesiology 69: 643-651, 1988