Title: PERIPHERAL BLOOD FLOW DURING CONTROLLED HYPOTENSION

Authors: B. Nohejl, M.D., J. L. Plewes, M.D., and L.E. Farhi, M.D.

Affiliation: Departments of Anesthesiology and Physiology
State University of New York at Buffalo, Buffalo, N.Y. 14214

INTRODUCTION: During controlled hypotension, maintenance of oxygen delivery to critical organs depends not only on maintenance of cardiac output, but on appropriate distribution of this output to the periphery. The present study was designed to determine the effects of two commonly used hypotensive agents, sodium nitroprusside (SNP) and trimethaphan camsylate, on cardiovascular function and peripheral blood flow distribution during halothane anesthesia.

METHODS: Mongrel dogs were anesthetized with 1% halothane in 40% oxygen, and mechanically ventilated to maintain PaCO2 at 30 torr. Catheters were placed in the femoral artery and vein, left atrium and ventricle, and pulmonary artery. Following a control period of 2 hours, the animals were made hypotensive(mean arterial pressure (MAP)=55 torr) with infusions of either SNP(N=8) or trimethaphan(N=7) and studied for a further 90 minutes. They were then allowed to recover for 60 minutes before final studies were made. At each period of study we measured cardiac output (thermodilution), arterial, venous, and left ventricular pressures, blood gases, and urine output. Radioactive-labelled microspheres (15u) were injected into the left atrium at each period of study. After the experiment was completed, the animals were sacrificed, and organs removed. Brain, heart, and kidney were sectioned into functional components (eg.endo, mid, and epicardial layers in the heart) in an attempt to determine if any redistribution of flow within each tissue group had occurred. Several random samples were taken from each of the other major organs. Absolute organ flows were calculated on the basis of the isotope activity in arterial blood samples withdrawn during each injection period.

RESULTS: In both groups, mean arterial pressure was decreased to the same extent. PaO2 was always >90 torr, but due to increases in physiological dead space during the trimethaphan infusion increases in minute ventilation were needed to maintain PaCO2 at 30 torr. Animals made hypotensive with trimethaphan showed a 20% decrease in cardiac output (P<.001), associated with falls in stroke volume (P<.02) and peak dP/dt (P<.001). Neither left atrial pressure (LAP) nor systemic vascular resistance (SVR) changed. In the nitroprusside group, peak dP/dt fell (P<.001), as did LAP(P<.01), but cardiac output was maintained. There was a marked fall in SVR(P<.001).

The changes in regional flows are shown in Table 1. There were no changes in the intra-organ distribution of flow in the heart, or renal cortex, but several significant changes occurred in the brain.

TABLE 1-Changes in Regional Blood Flows

Tissue Bed	%Change from Control	
	SNP	Trimethaphan
Heart	80 (p<.01)	-36 (p<.01)
Kidney	-	-37 (p<.01)
Duodenum	92 (p<.01)	-21 (p<.02)
Ileum	56 (p<.01)	-
Caecum	-	-
Adrenal	-	-32 (p<.01)
Hepatic	-	-
Pancreas	62 (p<.01)	-
Spleen	-57 (p<.01)	-61 (p<.01)
Whole Brain	50 (p<.01)	-
Gray Matter	30 (p<.05)	12 (p<.02)
Caudate	18 (p<.02)	12 (p<.01)
Thalamus	30 (p<.01)	15 (p<.01)
Mesencephalon	20 (p<.02)	15 (p<.01)
White matter	-	-

DISCUSSION: Cardiac output is maintained during hypotension with SNP, but there is a marked redistribution of blood flow to the periphery, with increases in flow to brain, heart, liver, and intestines. This redistribution presumably occurs at the expense of peripheral tissue beds such as muscle and skin. During trimethophan-induced hypotension, there is a 20% fall in output, and similar falls in renal and coronary flow. These decreases may simply be a response to the sympathetic blockade produced, or may represent loss of the ability of these organs to autoregulate their blood flows. We are pursuing these possibilities by measurement of venous blood gases, lactate, and pyruvate concentrations from these organs. The reasons for, and implications of the selective redistribution of blood flow into cortical gray matter, caudate, thalamus, and mesencephalon, in the face of either unchanged (trimethaphan) or markedly increased total cerebral flow (SNP) are not obvious at this time.

This study was supported by NIH Grant #HL23190,the Parker B. Francis Foundation, and the Buswell Foundation.