Title : INFLUENCE OF ANESTHETIC ON MICROVASCULAR RESPONSES TO HEMORRHAGE

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Introduction. Intense peripheral vasoconstriction, resulting in tissue ischemia and hypoxia, is a major component in the pathophysiology of hemorrhagic shock. The intensity of peripheral vasoconstriction has an important influence on survival after hemorrhage.[1] In general, those drugs which enhance peripheral vasoconstriction (norepinephrine, for example) result in decreased survival, while those drugs which block vasoconstriction (steroids or alpha-adrenergic blocking drugs, for example) also improve survival. Since anesthetics also influence survival after hemorrhage[2], the present study was designed to test the hypothesis that anesthetics may alter the microvascular responses to hemorrhage.

Methods. 73 male rats were anesthetized with one of three anesthetics: ketamine, 125 mg/kg IM plus 30 mg/kg supplements as needed; halothane, 1.2 vol percent inspired; or enflurane, 2.2 vol percent inspired. The inspired concentrations represent approximately MAC values of anesthesia in young rats. All animals breathed room air, or room air plus anesthetic, spontaneously. The cremaster muscle was prepared for microscopy and its image was displayed on a video monitor at a magnification of 625 X. Small arteries in the cremaster muscle were identified according to successive orders of branching, with the central vessel designated as the first-order artery. The internal diameters of one of three orders of arteries (first-, third-, or fourth-order) were measured at 30 sec intervals before, during, and after hemorrhage. The protocol consisted of a 20 min control period, 30 min of hemorrhage at a mean arterial pressure of 30 torr, and a 20 min recovery period following return of the shed blood.

Results. Microvascular responses to hemorrhage are summarized in the accompanying table. Principal responses during hemorrhage were: (a) first-order arteries constricted in all animals; (b) third-order arteries were unchanged during halothane or ketamine anesthesia, but constricted slightly during enflurane anesthesia; and (c) fourth-order arteries dilated progressively during ketamine anesthesia but constricted during halothane or enflurane anesthesia. The fourth-order arteriolar responses were significantly different ($p<0.05$) between animals receiving ketamine and those anesthetized with either halothane or enflurane.

Discussion. Responses of first-order (generalized constriction) and third-order (no change or slight constriction) arteries were similar among the three anesthetic groups. However, fourth-order arteries dilated during hemorrhage in rats receiving ketamine, but these vessels constricted in animals breathing halothane or enflurane. The fourth-order responses are especially important since these precapillary vessels have a dominant effect on vascular resistance and capillary flow. Since arterial pressures were identical in all groups during hemorrhage, the results are compatible with the hypothesis that ketamine, as compared with halothane or enflurane, results in less tissue ischemia during hemorrhage.

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References

1. Zweifach BW, Fronek A: The interplay of central and peripheral factors in hemorrhagic shock. Prog Cardiovasc Dis 18:147-180, 1975

2. Longnecker DE, Sturgill BC: Influence of anesthetic agent on survival following hemorrhage. Anesthesiology 45:516-521, 1976

Microvascular Responses to Hemorrhage
(Expressed as percent of their respective control values):

	MIN OF HEMORRHAGE 10	20	30
First-order arteries			
Ketamine	81±2*	80±3*	83±4*
Halothane	90±4*	85±3*	86±3*
Enflurane	83±4*	86±3*	64±3*
Third-order arteries			
Ketamine	99±4	102±3	105±6
Halothane	100±2	97±5	97±4
Enflurane	93±1	93±2	94±2*
Fourth-order arteries			
Ketamine	114±9	120±10	121±9*
Halothane	96±2*	90±3*	90±2*
Enflurane	84±4*	88±1*	92±2*

(* $p<0.05$, paired t-test)