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Learning and responsiveness at subanesthetic concentrations of isoflurane and nitrous oxide.

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Isoflurane but not nitrous oxide (N_2O) at 0.6 MAC prevents awareness and recall [1,2]. In the present study we quantitated this difference in preventing learning and voluntary response to command.
METHODS Twelve healthy volunteers aged 18-34 yrs breathed isoflurane at 0.15, 0.3, 0.45 and 0.15 MAC consecutively and, with a weeks separation, N_2O at 0.3, 0.45, 0.6 and 0.3 MAC (anesthetic order random). Before each exposure, subjects were asked 20 interesting questions (e.g., which state has a leash law for elephants?) without revealing the answers. After 15 min at each end-tidal concentration, taped answers to five (experimental) questions (randomly assigned) were presented via headphones and voluntary response to verbal command was tested. At one randomly assigned concentration, no answers were provided (control questions). The day after anesthesia, five answers (one correct) to each questions were shown to the subjects who were asked to choose the correct answer.
RESULTS MAC-awake (the MAC-fraction abolishing voluntary response in 50 of subjects) was 0.38±0.07 MAC for isoflurane and 0.64±0.07 MAC for N_2O (means±SD) ($P<0.05$). The 0.64 value may be an underestimate because several subjects responded at 0.6 MAC N_2O and we assumed that 0.75 MAC N_2O abolished movement. Learning (assessed by comparing the % answers correct for experimental versus control questions, Wilcoxon rank-sign test) occurred at all doses except 0.45 MAC isoflurane but decreased with increasing anesthetic dose (Fig 1). Isoflurane decreased learning and responsiveness at lower MAC-equivalent doses than N_2O.

1. Anesth Analg 1991; 72: S60.
2. Anesthesiology 1957; 18: 290-299.

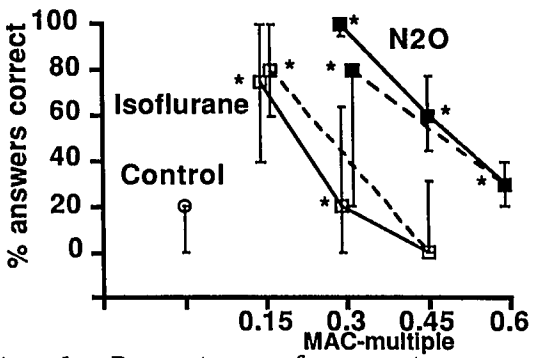

Fig. 1. Percentage of correct answers to experimental and control questions (interrupted line indicates decreasing concentration) (medians, quartiles). * $P< 0.05$ compared to control.

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TITLE: EFFECTS OF INHALATIONAL ANESTHETICS ON THE ISCHEMIC KIDNEY IN RATS

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The effects of inhalational anesthetics on the kidney of rats with induced renal ischemia were studied in order to select appropriate anesthetics for use in minimizing renal circulatory disturbances.

The left renal artery was clamped with a clip for 30 minutes, under anesthesia of 1.3 MAC of halothane, isoflurane, enflurane or sevoflurane, to produce ischemia in male Wistar rats. The animals were anesthetized for another 90 minutes after cessation of ischemia. Twenty-four hours after anesthesia, the ischemic kidney was examined for necrosis. The severity of the damage was divided according to the per centage of necrotic tissue in the kidney into four grades; grade 0: 0%, 1: 0 − 10%, 2: 10 − 50%, 3:>50%. Urinary γ-GTP and NAG activity were examined after anesthesia and serum creatinine levels were examined 24 hours after to determine renal dysfunction. In the groups anesthetized with each anesthetic a sham group was prepared by separation of the left renal artery only.

Necrosis was greatest in the inner cortex, followed by the medullary collecting duct, and the outer cortex. The degree was highest in the group anesthetized with enflurane, and significantly lower in the isoflurane group (Table 1). Table 2 shows urinary enzyme activity after anesthesia. Urinary γ-GTP and NAG activity did not necessarily reflect the severity of renal dysfunction at certain affected sites. A report[1] has shown that the activity of urinary γ-GTP is low with severe ischemia while it is markedly increased with moderate ischemia, showing an inverse correlation with the severity of the renal disorder.

From these findings, isoflurane is considered to be the most desirable inhalational anesthetic in case of impaired renal circulation.

References
1. Japanese J. Urology 77:1726-1732, 1986

Table 1 Degree of Necrosis

	Halothane(n=10)	Isoflurane(n=10)	Enflurane(n=9)	Sevoflurane(n=9)
Inner Cortex	2.80±0.13	2.10±0.28	2.78±0.15	2.78±0.15
Outer Cortex	0.40±0.22	0	1.56±0.18	0.89±0.35
Medulla	0.64±0.28	0.20±0.20	0.89±0.30	1.11±0.35
Total	3.90±0.38	2.30±0.40	5.22±0.40	4.78±0.64

Table 2 Activities of Urinary Enzymes

		Anes Cont(n=6)	Pre Ischemia	sham (n=9)	Ischemia (n=9)
γGTP (IU/L)	Halothane	95±22 ▼	29±9	201±69 •	979±276 ▪▪ ○○
	Isoflurane	362±82 ▼	67±24	1356±441 •	3991±900 ▪▪ ○○
	Enflurane	548±161 ▼▼	12±5	42±11 ▪ ○	588±228 ▪ ○
	Sevoflurane	503±161	68±21	37±26 •	1215±433 ▪ ○
NAG (U/L)	Halothane	31±5 ▼	19±3	80±20 •	36±7
	Isoflurane	43±3 ▼	24±4	143±35 ▪ ○	114±17 ▪▪ ○○
	Enflurane	44±5 ▼▼	35±11	144±82 ••	44±4
	Sevoflurane	53±18	32±9	129±55	151±81

▼▼ $p<0.01$, ▼ $p<0.05$ vs control •• $p<0.01$, • $p<0.05$ vs pre ischemia
▪▪ $p<0.01$, ▪ $p<0.05$ vs anesth control ○○ $p<0.01$, ○ $p<0.05$ vs each sham