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Title : HALOTHANE AND ENFLURANE CONCENTRATIONS AT EXTUBATION

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Introduction. Yakaitis and colleagues demonstrated that the end-tidal concentration for endotracheal intubation in children was 30% greater than MAC for both enflurane and halothane^{1,2}. They postulated that both agents have similar anesthetizing potencies on the upper airway over a wide range of concentrations. This study was undertaken to evaluate airway reflex suppression at concentration below MAC. The end-tidal concentration at which extubation would usually be performed, either awakening or spontaneous coughing, whichever appeared first (MAC EXT) was determined for each agent. The study was performed on dogs to eliminate all stimulation except the presence of the endotracheal tube.

Methods. Five healthy beagle puppies weighing 6.5 to 10.5 kg received the two agents in random order at least one week apart. Induction was performed with the agent and O₂, the trachea being intubated without relaxants. The same size endotracheal tube was used on both occasions, the cuff being inflated to the point of just preventing a leak during positive pressure ventilation. The dogs were ventilated and the end-tidal CO₂ constantly monitored by a Beckman LB-2 medical gas analyzer and maintained between 4.5 and 5.5%. Rectal temperature was maintained within 1°C of its preanesthetic value. Halothane and enflurane concentration were measured on a precalibrated Beckman LB-2 medical gas analyzer. The end-tidal concentration at which movement occurred in response to a standard tail clamp (MAC) was determined as described by Eger et al³. Halothane was decreased in 0.1% and enflurane in 0.2% increments. Each concentration was maintained for 15 minutes. After movement occurred in response to tail clamping, the concentrations continued to be decreased in the same manner until either coughing or awakening occurred (MAC EXT). The dogs were extubated at this point and all maintained their airways. Statistical analysis was performed using a "t" test for paired data.

Results. Table 1 contains the MAC and MAC EXT as measured. From these values the ratio of MAC EXT/MAC was determined.

TABLE 1

DOG	HALOTHANE			ENFLURANE		
	MAC	MAC EXT	MAC EXT / MAC	MAC	MAC EXT	MAC EXT / MAC
1	1.05	0.75	0.72	2.10	1.30	0.62
2	1.10	1.00	0.91	1.95	1.75	0.90
3	1.00	0.80	0.80	1.90	1.10	0.58
4	1.15	0.55	0.48	2.30	1.50	0.65
5	1.05	1.05	1.00	1.90	1.50	0.78
MEAN	1.07	0.83	0.782	2.03	1.43	0.71
±SD	0.06	0.20	0.20	0.17	0.24	0.13

There was no statistically significant difference between the two agents.

Discussion. Halothane and enflurane are equally effective at preventing reactions to an endotracheal tube at concentrations below MAC. Our values for coughing or spontaneous movement are slightly higher than the MAC Awake values described by Stoelting et al for methoxyflurane, halothane, ether and fluroxene⁴. They showed MAC Awake to be about 0.58 of MAC, but made no mention of spontaneous coughing before their patients opened their eyes to command. We conclude that extubation in response to the usual clinical signs occurs at the same level of anesthesia with either halothane or enflurane. This level is approximately 25% below MAC.

References.

1. Yakaitis RW, Blitt CD, Angiulo JP: End-tidal halothane concentration for endotracheal intubation. *Anesthesiology* 47: 386-388 1977.
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3. Eger EI, Saidman LJ, Brandstater B: Minimum alveolar anesthetic concentration: A standard of anesthetic potency. *Anesthesiology* 26: 756-763, 1965.
4. Stoelting RK, Longnecker DE, Eger EI: Minimum alveolar concentrations in man on awakening from methoxyflurane, halothane, ether and fluroxene anesthesia: MAC Awake. *Anesthesiology* 33: 5-9, 1970.