

EFFECT OF HALOTHANE ANESTHESIA ON MESENTERIC INTRALYMPHATIC PRESSURE IN THE RAT

T. Takeshita, M. Kawahara, S. Akita, T. Moriyama, K. Fujii, M. Sinozaki, M. Morio

Division of Dental Anesthesia, Hiroshima University Dental Hospital (TT, MK, SA, TM) and Department of Anesthesiology, Hiroshima University School of Medicine (KF, MS, MM), Hiroshima, Japan

ABSTRACT

The effect of halothane on mesenteric intralymphatic pressure was examined in 20 rats. Following administration of 1.5% halothane, lymph pressure decreased from a control value of $7.6 \pm 1.5 \text{ cmH}_2\text{O}$ to $3.8 \pm 1.8 \text{ cmH}_2\text{O}$. On the other hand, a lower concentration of halothane (1%) did not alter lymph pressure. In conjunction with earlier findings, these data suggest further that lymph propulsion is suppressed during halothane (> 1.5%) anesthesia.

Although halothane is a widely used inhalational anesthetic, its effect on lymph pressure is unknown. Whitwan (1) and Schad (2) and their colleagues reported that the administration of halothane was associated with decreased lymph flow from the thoracic duct, and we also noted earlier than halothane depressed lymphatic contractility (3). To pursue the possible adverse effects of halothane on lymph dynamics, we now examined the effect of halothane on intralymphatic pressure in the small bowel mesentery of the rat.

MATERIALS AND METHODS

Twenty male Wistar rats (body weight 100-140g) were used. Under halothane-oxygen anesthesia, tracheostomy was performed and the femoral artery and vein were cannulated for direct arterial pres-

sure recording, and intravenous fluid and drug administration respectively. Halothane anesthesia was then discontinued (after an average duration of 30 minutes) and sodium pentobarbital (20mg/kg) was administered intramuscularly. After administering pancuronium bromide (0.1mg) intravenously, the lungs were artificially ventilated with 100% oxygen. The PaCO_2 was maintained at 30-40mmHg. The rats were placed on a microscope stage and rectal temperature was maintained at $37.0 \pm 1.0^\circ\text{C}$ by an external heating pad. The small intestine was exposed and the mesentery was spread on a transparent plastic block and kept moist with mammalian Ringer's solution at 37°C .

Lymphatic pressures were measured by the method of Shinozaki (4). With the aid of a manipulator, the lymphatic vessel (approximately $90\mu\text{m}$ in diameter) was punctured under microscopic observation using a micropipette (approximately $17\mu\text{m}$ in diameter) filled with 1M NaCl solution. The micropipette was connected to a reservoir containing 1M NaCl. By raising or lowering the reservoir, the pressure applied to the micropipette was able to be regulated.

The electrical resistance of the micropipette was measured by an ohmmeter (S-4482; Nihonkohden Co., Tokyo). When an acute change in the electrical resistance of the micropipette was detected, the height of the solution in the reservoir

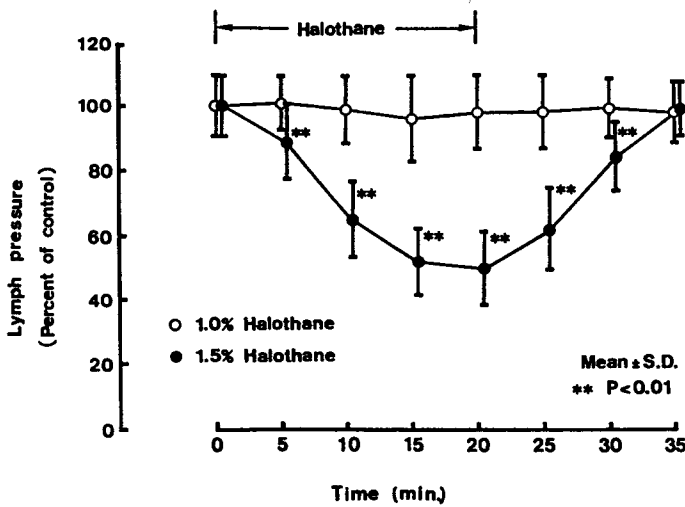


Fig. 1. Time course of the effect of halothane (1% and 1.5%) on mesenteric intralymphatic pressure in the rat. Lymph pressure was suppressed by 1.5% halothane (but not by 1% halothane) and promptly recovered after discontinuation of halothane. Each point represents the average of 10 rats.

above the level of the micropipette's tip was defined as the lymph pressure at that point. Following a 5-minute control period, halothane (1% or 1.5%) was administered for 20 minutes through a calibrated vaporizer (Halomatic; AIKA Co., Tokyo). Throughout the experiment, the mesenteric intralymphatic pressure was averaged every 5 minutes. The averaged values at 0-5, 5-10, 10-15, and 15-20 minutes of halothane inhalation were taken as the lymph pressures at 5, 10, 15, and 20 minutes, respectively. The averaged values at 0-5, 5-10, and 10-15 minutes following discontinuation of halothane inhalation were taken as the lymph pressures at 25, 30, and 35 minutes, respectively.

Statistical significance was assessed by the Student's t-test.

RESULTS

No significant change occurred in mesenteric lymph pressure following 20 minutes of 1% halothane inhalation. However, following 20 minutes of 1.5% halothane inhalation, lymph pressure gradually decreased from a control value of 7.6 ± 1.5 to 3.8 ± 1.8 cmH₂O. Fifteen min-

utes after discontinuing the halothane, intralymphatic pressure returned to 7.5 ± 1.3 cmH₂O (Fig. 1).

DISCUSSION

Intralymphatic pressure has been recorded in the wing of the bat (5) as well as in the intestinal mesentery of the cat and rat (6). In initial lymphatics or lymphatic vessels of small animals, punctures were made by a micropipette (6) and lymph pressures were measured according to the method of Landis (7) or Wiederhielm (8). Zweifach (6) recorded a lymph pressure in the rat mesentery using the servo-null procedure developed by Wiederhielm. The range of these intralymphatic pressures were from 2 to 10 cmH₂O. Our values in 20 rat mesenteric lymphatics were similarly in the range of 4 to 10 cmH₂O.

Factors that determine intralymphatic pressure include lymphatic resistance, lymph flow, and lymphatic contractility. Our studies suggest that halothane adversely influences these factors. Concerning the effect of lymphatic resistance on lymph pressure, Browse (9) demonstrated

that sympathetic nerve stimulation increased intralymphatic pressure and speculated that the rise in pressure was related to increased lymphatic resistance. Because halothane has an inhibitory effect on the autonomic nervous system depressing the central nervous system and sympathetic ganglionic transmission while inhibiting norepinephrine release from sympathetic nerve endings (10,11), it may be assumed that lymphatic resistance is decreased by administration of halothane (>1.5%).

In considering the relation of lymph pressure to lymph flow, Shinozaki (4) observed that an intravenous infusion of saline (a maneuver associated with expansion of lymph volume and greater lymph flow) increased lymph pressure. Because halothane depresses lymph flow in the thoracic duct (1,2), it seems likely that with diminished intralymphatic mesenteric pressure that lymph flow in the rat mesentery was also reduced by halothane.

On the other hand, halothane also influences intrinsic contractile motion of lymphatics. Hall (13) and Zweifach (6) noted that intralymphatic pressure corresponded to rhythmic lymphatic contractions. We earlier demonstrated that administration of halothane significantly suppressed contractility of mesenteric lymphatics (3), an inhibitory effect likely to promote a decrease in lymph pressure.

In summary, administration of >1.5% halothane adversely effects lymph dynamics including intralymphatic pressure, intrinsic contractility, and lymph flow.

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Dr. Takahisa Takeshita
Division of Dental Anesthesia
Hiroshima University Dental Hospital
1-2-3, Kasumi, Minami-ku, Hiroshima
JAPAN 734