

**TITLE:** HALOTHANE AND ISOFLURANE DO NOT IMPAIR ARTERIAL OXYGENATION DURING ONE LUNG VENTILATION IN PATIENTS UNDERGOING THORACOTOMY

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**INTRODUCTION:** It was recently shown that administration of the inhalational anesthetics (IH-ANES) Halothane (H) and Isoflurane (IF) to intravenously anesthetized (IV-ANES) patients during stable one-lung ventilation conditions (1LV), did not change  $P_{aO_2}$ . In this previous study, end-tidal concentrations ( $F_{ET}$ ) of H and IF were held constant at 1.45 and 1.15 MAC, respectively, for approximately 20 min so that arterial concentrations were 1.20 and 0.88 MAC, respectively, and venous concentrations were 0.95 and 0.82 MAC respectively. However, in view of the relatively short duration of IH-ANES administration, it is possible that clinically relevant tissue concentrations of IH-ANES were not achieved. The purpose of this study was to re-examine the question of the effect of IH-ANES on  $P_{aO_2}$  during 1LV conditions by first anesthetizing 1LV patients with IH-ANES ( $F_{IH-ANES} > 1$  MAC for >1 hour) and then switching to IV-ANES (for >1 hour so that  $F_{IH-ANES} \rightarrow 0\%$ ).

**METHODS:** Eight consenting adult patients, requiring thoracotomy and 1LV (via a double-lumen tube) in the lateral decubitus position for various thoracic surgical procedures, had peripheral venous, systemic arterial and pulmonary artery catheters inserted under local anesthesia. The patients were alternately assigned to either a H (n=4) or IF (n=4) study group. Anesthesia was induced and maintained with the assigned IH-ANES and 100%  $O_2$  (see first table below). Steady state two-lung<sup>2</sup> ventilation (2LV) conditions were achieved (Step 1; 2LV, IH-ANES) with  $F_{I,O_2}=1.0$ , tidal volume=12 ml/kg (peak airway pressure 25+3 cm H<sub>2</sub>O) and respiratory rate adjusted so that  $P_{CO_2}=41\pm 2$  mm Hg. When the pleura was opened, 1LV was initiated with  $F_{I,O_2}=1.0$ , tidal volume=10 ml/kg (peak airway pressure 34+3 cm H<sub>2</sub>O) and rate adjusted so that  $P_{CO_2}=42\pm 2$  mm Hg. Serial arterial and mixed venous<sup>a</sup> blood gases documented achievement of steady state 1LV conditions during IH-ANES (Step 2; 1LV, IH-ANES). IH-ANES was then discontinued and IV-ANES administered with fentanyl 5 ug/kg, diazepam 10 mg and intermittent boluses of Na thiopental 50 mg until  $F_{ET,H}$  and  $F_{ET,IF}$  were <0.08% (Step 3; 1LV, IV-ANES). Step 3 was completed before any pulmonary vessels were ligated. At the end of the procedure the atelectatic lung was re-expanded and 2LV re-instituted (Step 4; 2LV, IV-ANES). Hemodynamic profiles and arterial and mixed venous blood gases were measured at the end of each experimental step.

**RESULTS:** The first table shows the temporal and IH-ANES depth profile for each experimental step.

Experimental Step	Time (min) Elapsed	$F_{ET,H}$ %	$F_{ET,IF}$ %
1) 2LV, IH-ANES	20	0.74	0.71
2) 1LV, IH-ANES	60	1.08	1.13
3) 1LV, IV-ANES	120	0.08	0.08
4) 2LV, IV-ANES	140	0.03	0.02

The second table shows the  $P_{aO_2}$  (mean±SD) at each

experimental step in both the H and IF groups.

Experimental Step	$P_{aO_2}$ Mean ± SD	
	H Group	IF Group
1) 2LV, IV-ANES	472+57	476+55
2) 1LV, IH-ANES	126+76	228+139
3) 1LV, IV-ANES	158+86	236+115
4) 2LV, IV-ANES	409+131	419+132

Initiation of 1LV (Step 2) caused a significant decrease in  $P_{aO_2}$  (p<0.05). There was no significant change in  $P_{aO_2}$  when the IH-ANES was discontinued (Step 2 compared to 3). Serial  $P_{aO_2}$  measurements taken between the values shown for Steps 2 and 3 in the second table also showed no significant changes. Return to 2LV (Step 4) significantly increased  $P_{aO_2}$  (p<0.05). There was no significant difference in  $P_{aO_2}$  at each experimental step between the H and IF groups. The third table shows that discontinuance of IH-ANES (Step 2 compared to 3) (H and IF groups together) did not cause a significant change in hemodynamic parameters. Lung compliance during 1LV (Steps 2-3) did not change.

Experimental Step	Hemodynamic Variable, Mean ± SD		
	CO L/min	$P_{V,O_2}$ mm Hg	$P_{pa}$ mm Hg
2) 1LV, IH-ANES	5.9+1.8	49+4	17+5
3) 1LV, IV-ANES	5.3+1.6	48+5	16+5

All patients were awake within one hour of the operation and there were no complications.

**DISCUSSION:** There are several possible reasons why no significant change in  $P_{aO_2}$  occurred when either H or IF was discontinued during stable 1LV conditions. First, the IH-ANES did not inhibit HPV in the atelectatic lung. Second, IH-ANES inhibited HPV in the atelectatic lung but we did not allow adequate time for tissue washout of IH-ANES. Although IH-ANES tension gradients are from tissue to blood to expired gas during washout, we consider this second possibility unlikely in view of the fact that the lung is very vessel rich and we allowed  $F_{IH-ANES}$  to decrease to <0.08% after 60 min of  $F_{ET}$  IH-ANES washout. Third, it is possible that IH-ANES inhibited HPV in the atelectatic lung but also caused or was associated with some other effect which increased  $P_{aO_2}$ . These other possible effects include a decrease in  $P_{pa}$ , an increase in  $P_{V,O_2}$ , improved V/Q relationships in the ventilated lung and surgical compression of the vessels in the atelectatic lung. These possibilities are unlikely because we found no significant change in the above measured variables and we made our measurements in the absence of surgical interference. Fourth, there may have been no HPV in the atelectatic lung. Comparison of observed and predicted shunt fractions between 2LV and 1LV with and without a normal amount of HPV indicates that this possibility is also unlikely. We conclude that H and IF do not impair  $P_{aO_2}$  during 1LV in patients undergoing thoracotomy, probably due to a lack of effect on HPV.