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PHRENIC NERVE STIMULATION DURING HALOTHANE ANESTHESIA - EFFECTS ON ATELECTASIS.

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Introduction. Densities in dependent lung regions have been demonstrated in anesthetized patients by means of computed tomography (1), and the magnitude of right-to-left shunt correlates with the size of the dense region (2). We suggest that the densities represent atelectasis, caused by loss of supportive forces rather than resorption of trapped gas. In the present study we have investigated whether an increase in diaphragmatic muscle tone by right-sided phrenic nerve stimulation (PNS) during general anesthesia reduces the size of atelectasis in dependent lung regions.

Methods. Twelve subjects, 3 women and 9 men, with an age of 48 ± 12 years (X ± SD) were studied during halothane anesthesia and muscle paralysis. The right phrenic nerve was stimulated percutaneously by means of a bipolar electrode positioned on the neck. Computed tomography was used for the recording of atelectasis.

Results. I. PNS with occluded tube. - During PNS at FRC with an occluded tube, airway pressure was reduced by approximately 3 kPa (23 mmHg). The atelectasis on the right side was reduced in seven patients and was unchanged in one patient (control: 5.1 ± 1.1% of the intrathoracic area; PNS: 3.8 ± 0.8% P<0.05). II. PNS compared to iso-volumic inflation. - When PNS was undertaken with the airway open, permitting lung volume to increase; there was a significantly smaller atelectatic area on the right side than during mechanical inflation with a similar volume as inhaled during PNS (mean 0.55 l)(PNS: 3.5 ± 0.9%, mech. inflation: 5.2 ± 1.1%, P < 0.01). III. Regional area changes. The attenuation in non-dependent and dependent (above the atelectasis) circular regions of interest was compared between control and PNS. PNS increased regional lung volume in the dependent, lower region (more negative attenuation; control: -621 ± 33 Hounsfield units (HU); PNS: -695 ± 39 HU, p<0.01) whereas non-dependent, regional volume tendend to be reduced (control -848 ± 12 HU; PNS -821 ± 29 HU; p=0.09.

Conclusion. This study has shown that PNS reduces dependent atelectasis during halothane anesthesia and muscle paralysis, and that it increases regional volume in dependent lung regions and tends to reduce volume in non-dependent regions. The findings support the hypothesis that relaxation of the diaphragm causes the transmission of the abdominal vertical pressure gradient into the thoracic cavity, and increases basal, dependent pleural pressure.

References.

1. Brismar B et al. Anesthesiology 62:422-428, 1985.
2. Tokics L et al. Anesthesiology 66:157-167, 1988.

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TITLE: CAN AN ANESTHESIA MACHINE FLUSH VALVE PROVIDE FOR EFFECTIVE JET VENTILATION?

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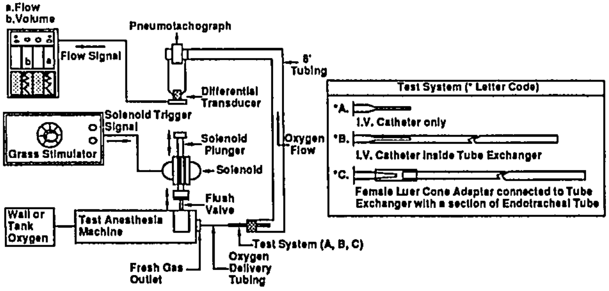
INTRODUCTION: Jet ventilation (JV) using a percutaneously inserted intravenous (IV) catheter for the cannot ventilate/cannot intubate situation or using a jet stylet for changing endotracheal tubes (ETT) is an extremely valuable therapeutic option. The JV system must have a sufficiently high pressure O_2 source to drive oxygen through noncompliant tubing and the relatively small IV catheter and/or tube exchanger in order to achieve adequate ventilation and oxygenation. Three power sources have been considered acceptable for JV : 1) a jet ventilator powered by central wall pressure; 2) a jet ventilator powered by a high or low flow tank regulator; 3) utilizing the fresh gas outlet of the anesthesia machine by activating the flush valve. Although the first two power sources have been proved to provide enough flow ($\dot{V}$) and tidal volume (TV) for effective JV, no JV data exists for the third power source. This study determined the $\dot{V}$, TV and minute ventilation ($\dot{V}_E$) through 3 sized IV catheters and 3 sized tube exchangers (adapted for JV in two ways) that could be generated by activating the flush valve of the Dräger and Ohmeda anesthesia machines.

METHODS: A 5 mm ETT connector was inserted into the fresh gas outlet of the Dräger and Ohmeda anesthesia machines and connected by high pressure O_2 delivery tubing via a male Luer-lock connector to 3 test systems (Figure):



System A) 14, 16 and 18 gauge IV catheters (reference system); System B) Wedging 14, 16 and 18 gauge IV catheters into large, medium and small Sheridan tube exchangers, respectively; System C) Inserting a female Luer-lock barbed cone adaptor into the proximal ends of 4.0 cm lengths of 5.0, 4.0 and 3.0 ID ETT. The distal ends of the ETT fit snugly over large, medium and small Sheridan tube exchangers, respectively. All 3 test systems were connected by a no leak system to a pneumotachograph. The flow signal was electronically amplified, integrated and displayed on a strip chart recorder as V and TV. The flush valve was activated by a solenoid mechanical thumb that was electronically driven and precisely set to an I:E ratio of 1:1 (unit of time = 1 sec, respiratory rate of 30 breaths/min). The $\dot{V}$ and one second TV were measured through each of the 3 sizes for each of the 3 test systems with both the Dräger and Ohmeda anesthesia machines powered by tank and central wall pressure (n=36).

RESULTS: Identical $\dot{V}$ and TV were attained for each anesthesia machine using tank vs. wall pressure to power the flush valve for all test situations. The table shows that the Dräger anesthesia machine generated 2-3 times higher $\dot{V}$, TV and $\dot{V}_E$ than the Ohmeda anesthesia machine for all 3 test systems and system C generated greater $\dot{V}$, TV and $\dot{V}_E$ than either system A or B. The largest $\dot{V}E$ for any of the test systems using the Dräger and Ohmeda anesthesia machines were 24 and 9.6 L/min, respectively.

Test Anesthesia Machine	Ventilation Parameters	TEST SYSTEM								
		A-Catheter Only			B-Catheter with Tube Exchanger			C-Tube Exchanger with Adapter		
		14	16	18	14 Lrg.	16 Med.	18 Sml.	Lrg.	Med.	Sml.
DRÄGER	$\dot{V}$ (L/min)	46	32	21	46	32	21	54	44	24
	TV (ml)	680	520	320	680	520	320	800	600	400
	$\dot{V}_E$ (L/min)	20.4	15.6	9.6	20.4	15.6	9.6	24.0	18.0	12.0
OHMEDA	$\dot{V}$ (L/min)	14	8	5	14	8	4	18	11	8
	TV (ml)	240	160	100	240	160	80	320	200	120
	$\dot{V}_E$ (L/min)	7.2	4.8	3.0	7.2	4.8	2.4	9.6	6.0	3.6

DISCUSSION: This study quantifies the differences in $\dot{V}$, TV and $\dot{V}_E$ that can be attained by JV through IV catheters and tube exchangers using the flush valve of the Dräger and Ohmeda anesthesia machines. The differences are due to the internal construction of the two anesthesia machines. Even though a driving pressure of ~45 psi (tank) to 55 psi (wall) is used, the flush valve of the Dräger anesthesia machine is flow limited at 55 L/min whereas the flush valve of the Ohmeda anesthesia machine is pressure limited at 7-8 psi. Although both machines can deliver adequate flows when there is no external resistance, adding a JV resistance to the Dräger anesthesia machine porportionately decreases flow whereas with an Ohmeda anesthesia machine any JV resistance disporportionately decreases flow. Thus, the Dräger anesthesia machine can be used for effective jet ventilation but the Ohmeda anesthesia machine cannot for the majority of clinical situations.