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TITLE: CIRCULATORY EFFECTS OF GRAVITATIONAL ROTATION IN OLEIC ACID INDUCED LUNG INJURY

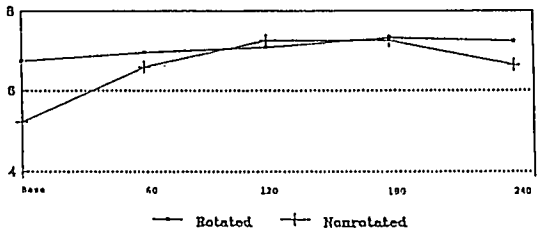
AUTHORS: DK Cope MD, CE Baisden MD, RF Fortier-Bensen MD, SL Bifano PhD, AL Picone, MD

AFFILIATION: Anes Section, VAMC, Cardiothor Surg and Clin Res Lab, USAF-Kessler, Biloxi, MS 39531

Continuous oscillation on a kinetic treatment table has been reported in a number of studies to decrease the incidence of atelectasis, pneumonia, and ARDS in ICU patients. Groups with improved pulmonary status and decreased ICU stay after from rotational therapy (RT) have included: head and spinal cord injury, stroke, blunt trauma, and orthopedic injuries. It is postulated that immobilization favors pulmonary edema formation in dependent portions of the lung. Unfortunately, in clinical studies, it has been difficult to study patient groups with the same type or degree of pulmonary trauma. This study standardizes injury by experimentally inducing oleic acid permeability changes which mimic those seen in patients with ARDS.

Methods: 12 fasted dogs were anesthetized, intubated and ventilated. After instituting invasive monitoring and observing baseline measurements, oleic acid (.05 ml/kg) was infused into the right atrium. The treatment group then underwent continuous RT for four hours. Control dogs were immobile. Hourly assessment of systemic and pulmonary parameters included: BP, P, CO, SVR CVP, Ppa, Pc, Pw, PVR, pH, PO_2, PCO_2, SAO_2, mvO_2, Hb, DO_2, VO_2. Pc was determined from the pressure inflection point (PIP) method and ra and rv calculated. Data were subjected to two factor repeated measures ANOVA and Newman/Keul's range test.

Results: After oleic acid infusion all dogs evidenced significant changes consistent with ARDS such as: ↓PaO_2, ↓mvO_2, and ↓CO. The wedge pressure (Pw) and CVP were unchanged. In the pulmonary circulation, Pc, unlike Pw, increased after injury as a function of the significantly increased post capillary PVR (rv). Most significantly 1/3 of the nonrotated dogs died before completion of the protocol compared to no fatalities in the RT group. Of the survivors, there was a significant difference between groups in O_2 extraction (VO_2). Rotated dogs maintained a stable VO_2 while nonrotated dogs showed significant variability in O_2 extraction as shown below.



Discussion: Pulmonary arterial hypertension associated with permeability injury may increase microvascular filtration by increasing capillary pressure and pulmonary venous resistance. RT, by rotating the dependent portion of the lung, may decrease morbidity and mortality by lessening the effects of elevated capillary hydrostatic pressure on damaged endothelium.

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OPTIMAL RELEASE TIME DURING PEDIATRIC AIRWAY PRESSURE RELEASE VENTILATION

L.D. Martin, M.D., R.C. Wetzel, MB BS, FCCM
Depts. of Anesth/Crit Care Med and Peds, The Johns Hopkins Medical Institutions, Baltimore, MD 21205

Introduction: Airway pressure release ventilation (APRV) provides mechanical ventilation augmenting alveolar ventilation by intermittently decreasing airway pressure and lung volume[1]. In previous adult studies, airway pressure has been released for 1.5 sec [2,3]. Excessively long release times (T_r), in infants who are prone to airway closure and atelectasis, would result in lung volume loss and hypoxemia. Insufficient T_r could result in inadequate alveolar ventilation and hypercapnia. This study was designed to evaluate the effects of T_r on ventilation and oxygenation in a neonatal acute lung injury (ALI) model[4].

Methods: Eight sheep <4 days of age (wgt 5.1±0.3 kg) were anesthetized with ketamine, paralyzed with pavulon, and instrumented. APRV was started with a frequency of 30 breaths/min and airway plateau pressure (AP) was set to deliver a tidal volume (TV) of approximately 15 ml/kg with release to atmospheric pressure. T_r was started at 1 sec and decreased in 0.2 sec increments to 0.2 sec, at 10 min intervals. Cardiorespiratory data was collected at the end of each 10 min period. To obtain the respiratory time constant (τ), the lungs were inflated to a pressure of 30 cm H_2O and passive expiratory flow was integrated to volume, which was plotted against time. ALI was induced with oleic acid infusion (52.9±5.2 mg/kg) over 30 min. Following a 90 min stabilization, the experimental protocol was repeated. In 3 animals, prior to ALI, an expiratory flow resistor (ER) was inserted in the circuit to lengthen τ. The experimental protocol was repeated. Data (mean ± SEM) were analyzed by ANOVA and least significant difference tests ($^*p<0.05$).

Results: τ was different between groups (control 150±15, ALI 123±7, ER 259±13 msec, $p<.001$). ALI resulted in a decreased lung compliance (control 9.9±0.8 vs ALI 7.5±0.7 ml/cm H_2O, $p=0.04$). $PaCO_2$ was dependent on T_r (see table). $T_r < 3\ \tau$ were associated with increased $PaCO_2$ for all three conditions ($>3\tau$ 31.6±0.6 vs $<3\tau$ 40.4±1.3 torr, $p<.001$). PaO_2 decreased with shorter T_r despite increased Paw (see table).

Release Time		1.0	0.8	0.6	0.4	0.2
$PaCO_2$	control	31±1	31±1	33±2	35±1	46±3*
	ALI	30±1	30±2	32±1	34±1	50±3*
PaO_2	control	102±6	100±5	101±4	96±6	79±5*
	ALI	93±6	92±6	91±7	89±7	69±5*

Conclusions: In this neonatal ALI model, a $T_r>3\tau$ resulted in optimal CO_2 clearance and oxygenation. Despite the possibility of airway closure with long T_r, oxygenation was maintained with $T_r>5\tau$. T_r much shorter than those used in adults are effective in neonates during APRV.

References:
1. Crit Care Med 15:459-461, 1987.
2. Crit Care Med 15:462-466, 1987.
3. Chest 94:779-782, 1988.
4. Crit Care Med 19:373-378, 1991.