Title: DIFFERENTIAL LUNG VENTILATION WITH PEEP FOLLOWING UNILATERAL HYDROCHLORIC ACID ASPIRATION IN THE DOG

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Introduction. In patients with unilateral or asymmetrical acute respiratory failure requiring ventilatory support, maintenance of adequate gas exchange may become very difficult. With progressive unilateral restrictive disease, mechanical ventilation via a single endotracheal tube is diverted to the unjured or less injured lung. Published reports have shown an improved pulmonary gas exchange if differential lung ventilation (DLV) with PEEP via a double lumen endobronchial tube is used in the supportive care of patients with severe unilateral or asymmetrical lung disease. Once the provision of selective PEEP to the two lungs is accomplished, the best method of partitioning the tidal volume between the two lungs is unknown. We have evaluated three different tidal volume partitioning protocols during DLV with PEEP in dogs unilaterally injured with HCL.

Engineering Methods. To provide a versatile means of delivering DLV, a computer controlled system was constructed to test a variety of ventilation protocols with differential PEEP as well as to record and monitor relevant physiologic variables. Two Siemens 9008 Servo Ventilators were modified for synchronous operation and computer (DEC MINC) control of minute volume and respiratory rate. Feedback control was used to adjust respiratory rate to maintain PetCO2 equal to 35 mmHg and to keep total tidal volume equal to 15 ml/kg. Three tidal volume partitioning protocols were developed for use with differential PEEP. The first (I) delivered equal tidal volumes to both lungs; the second (II) allocated tidal volumes to match the end tidal CO2 concentrations of both lungs; and the third (III) distributed the tidal volume to match driving pressures (End Inspiratory Pause Pressure - PEEP) in the two lungs.

Animal Methods. Twelve dogs were anesthetized with pentobarbital, and their trachea intubated with a Rusch Canine Endobronchial Tube. Isolation of the two lungs was confirmed by a cross ventilation test. The dogs were kept supine and ventilated with 30% O2. 2.5 ml/kg of 0.1 N HCL was given through one lumen of the endobronchial tube. The DLV system with PEEP was evaluated using four dogs for each tidal volume partitioning protocol and equal numbers of left and right sided injuries. Following injury, the PEEP was set at 0 cm H2O for one hour. The dogs were then given 7.5 cm H2O and 15 cm H2O PEEP for two hours in a cross over fashion. The assignment of the tidal controller, the side of injury, and the PEEP sequence was made from a random number table. Data was collected every 30 minutes. The data collected was analyzed using multivariate analysis of variance statistical techniques with a software package developed for the system. Multiple comparisons were performed by Scheffe confidence interval test. The null hypothesis was rejected for p<0.05.

Results and Comments. All animals developed severe unilateral injury. The three controllers produced differential tidal volumes. Controllers II and III essentially shut down ventilation to the injured lung. Comparing changes in PaO2 (Figure 1) with steps of PEEP from 0 cm H2O to 7.5 cm H2O and from 7.5 cm H2O to 15 cm H2O in all three groups simultaneously showed an improvement in PaO2. (p 2.0,3. = 0.81557, p<0.01). In particular in group I there was improvement in PaO2 with both PEEP steps; in group II there was increased PaO2 for the lowest PEEP step; in group III, there was no improvement in PaO2 with either PEEP step. At least for short term ventilation with PEEP following acute unilateral injury, equal tidal volume to the two lungs appears to be optimal for DLV, compared to the other two methods of partitioning tidal volume.

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References.