Title: SYNCHRONOUS VERSUS ASYNCHRONOUS DIFFERENTIAL LUNG VENTILATION FOLLOWING UNILATERAL HYDROCHLORIC ACID ASPIRATION IN THE DOG

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Introduction. Differential Lung Ventilation (DLV) is an advanced respiratory care technique for the ventilatory support of severe, asymmetrical lung disease. By the selective application of PEEP to the more severely injured lung, improved gas exchange has been provided. Where two ventilators are used, both synchronized and nonsynchronized ventilator systems have been reported. As the use of DLV with two nonsynchronized ventilators is easier to establish than a synchronized system, we compared synchronous and asynchronous DLV in dogs with a unilateral lung injury.

Engineering Methods. To provide a versatile means of delivering DLV, a computer controlled system was constructed to allow a variety of ventilation protocols as well as to record and monitor relevant physiologic variables. Two Siemens 900B Servo Ventilators were modified for synchronous/asynchronous operation and computer (DEC MINC) control of minute volume and respiratory rate. Feedback control was used to maintain PaCO2 equal to 35 torr, as measured by an intra-arterial electrode (Biochem), and to keep total tidal volume equal to 15 ml/kg.

Our synchronous DLV operation used simultaneous cycling of the two ventilators, so that start of inspiration occurred at the same time in both lungs. To establish a clinically relevant asynchronous protocol, we set one ventilator to be under feedback control of PaCO2; the other ventilator always had a frequency 5% higher. Thus there was a constantly shifting phase angle between the two ventilators. The ventilators were in phase once every 20 breaths. Tidal volume was divided equally to the two lungs.

Animal Model. Six dogs were anesthetized with pentobarbital, and their trachea intubated with a Rusch canine endobronchial tube. The dogs were ventilated with 40% O2. Isolation of the two lungs was confirmed by a cross ventilation check. To create a unilateral pulmonary injury, 2.5 ml/kg of 0.1 N HCl was given through one lumen of the endobronchial tube. The synchronous and asynchronous DLV systems were evaluated in these dogs with equal numbers in each group and equal numbers of left and right sided injuries. The assignment of synchronization and side of injury was made from a random number table. Following lung injury the dogs were ventilated for four hours; 10 cm H2O PEEP was added to the injured lung one hour after injury and maintained for the next three hours. Data was collected every thirty minutes. Multivariate analysis of variance statistical methods were used to analyze the data by software developed for the MINC system. Multiple comparisons were performed by a Scheffe confidence interval test. The null hypothesis was rejected for <0.05.

Results and Comments. All animals developed severe unilateral injury and survived through the experimental period. Comparisons of the synchronous and asynchronous system were made by contrasting PaO2 and venous admixture (Qva/QT).

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\begin{align*}
\text{PaO2 (torr: mean ± SD)} \\
1 \text{ hr.} & 2 \text{ hrs.} & 3 \text{ hrs.} & 4 \text{ hrs.} \\
\text{Synchronous} & 90±14 & 101±7 & 114±26 & 116±16 \\
\text{Asynchronous} & 105±19 & 118±38 & 123±32 & 128±32 \\
\text{Qva/QT (\%: mean ± SD)} \\
1 \text{ hr.} & 2 \text{ hrs.} & 3 \text{ hrs.} & 4 \text{ hrs.} \\
\text{Synchronous} & 22±2.7 & 14±2.9 & 14±8.0 & 11±2.1 \\
\text{Asynchronous} & 21±6.7 & 11±5.5 & 13±5.8 & 10±6.9 \\
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There was no difference in PaO2(F4,1=0.086; 0.9723) or Qva/QT (F4,1=0.132; p = 0.9485) between the 2 groups over the four hours. Synchrony of DLV has no superiority over asynchronous DLV for at least four hours following injury. This suggests that if DLV is used in patients, a system to synchronize the two ventilators is unnecessary.

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References.