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Title : INTRACRANIAL PRESSURE EFFECTS OF LOW AND HIGH FREQUENCY VENTILATION

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Introduction. Intracranial pressure (ICP) is influenced by changes in intrathoracic pressure (ITP). During mechanical ventilation ITP changes are enhanced and large fluctuations in ICP or disturbing brain surface movement can occur in neurosurgical patients. Since high frequency ventilation (HFV) minimizes both ITP and blood pressure fluctuations,[1] it may also minimize ICP fluctuations. We thus compared the effects of HFV on ICP with those caused by traditional low frequency ventilation (LFV).

Methods. 7 cats, anesthetized with 30-40 mg/kg pentobarbital i.p. were paralyzed, intubated with a 5.0mm ID cuffed endotracheal tube, and ventilated with O_2:air (FiO_2=.4). LFV used a tidal volume of 15ml/kg and rate sufficient to keep $PCO_2 \cong 30$ torr. The HFV system used a rodent ventilator that delivered a fixed tidal volume via a 15 gauge catheter that terminated at the distal end of the tracheal tube. Expiration was passive but valved, with I:E=1:2. Tidal volume and rate were adjusted to yield the lowest airway pressure compatible with a $PCO_2 \cong 30$. A connector allowed switching between LFV and HFV in 1-2 sec, without opening the airway. Monitored variables were arterial and central venous pressure (BP & CVP), heart rate (HR), EKG, EEG, $F_{ET}CO_2$, airway pressure, temperature (controlled at 37°), and blood gases (ABG's). ICP was measured with a catheter in the right parietal subarachnoid space and an epidural balloon in the left parietal region was used to raise ICP. Skull defects were sealed with acrylic cement. Transducers were zeroed at midchest and with the head fixed 10cm above that level. The protocol involved a comparison of values recorded before, and 4-5 min after an abrupt change in the mode of ventilation. To eliminate the effect of order, both HFV to LFV and LFV to HFV were made. If PCO_2 varied by 3 torr, the run was discarded. Comparisons were made at the following levels of ICP: 5 torr (baseline), 15 torr and 30 torr.

Results. The electrical mean ICP, CVP, and BP (measured at end-expiration for LFV) did not change with frequency of ventilation. However, HFV effectively eliminated ventilation-related fluctuations in ICP, CVP, and BP (Fig.1) and significantly reduced peak ICP's (Fig.2). Fluctuations in ICP during HFV reflected transmitted arterial pulse pressure, while with LFV these were superimposed on a widely fluctuating ITP associated baseline. As ICP was raised the stabilizing effect of HFV was more pronounced No statistically significant difference in ABG's or HR was present and there was no effect of order. In 2 cats, observation of the exposed cortex under a microscope revealed clearly diminished brain movement under HFV.

Conclusions. HFV clearly reduces fluctuations in ICP, CVP and BP and reduces peak ICP as compared to LFV. These effects are more pronounced as compliance is reduced. At normal ICP, HFV also seems to reduce brain movement. The mechanisms seem secondary to the stabilizing effect rapid rate and low tidal volume have on venous return and blood pressure. The pathophysiologic significance is uncertain, but reducing peak ICP may be beneficial in some patients, while a reduction in brain movement is helpful during microsurgery. Ultra-HFV (rates of 20-50Hz) may be even more valuable. Thus, while this work is preliminary, it suggests that HFV may find an important place in future neuroanesthetic practice.

Reference.

1. Sjostrand U: Experimental and Clinical Evaluation of High Frequency Positive Pressure Ventilation. Acta Anaesth Scand 64:7-27, 1977

Fig.1 - Stabilizing effect of HFV on ICP, BP, and CVP. Effect on airway pressure is also illustrated.

Fig.2 - No change occurred in mean ICP (p>.05). Maximum and minimum ICP values were significantly different (p<.05, paired-T test) between LFV and HFV.

CODE:

------ Maximum ICP of respiratory cycle (±SEM)

——— Mean ICP (LFV and HFV, ±SEM)

·········· Minimum ICP of respiratory cycle (±SEM)

Fig.1

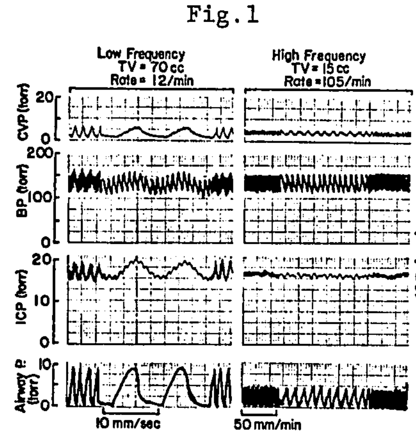

Fig.2