Title: CEREBRAL BLOOD FLOW DURING HFPPV AND IPPV AT NORMAL AND ELEVATED ICP

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Introduction. High frequency positive pressure ventilation (HFPPV) has gained clinical application in both anesthesia and intensive care settings(1). The work of Babinski et al(2) and Todd et al(3) indicate that ventilatory synchronous fluctuations in intracranial pressure (ICP) and brain surface movement are diminished during HFPPV at both normal and elevated ICP. The possible use of HFPPV during microneurosurgical proceedures has been suggested. Therefore, direct measurements of cerebral blood flow (CBF) during HFPPV during normocapnia, under normal and elevated ICP, were made. Similarily, renal, pulmonary and cardiac blood flows were compared to blood flows observed during intermittent positive pressure ventilation (IPPV).

Methods. Five mongrel dogs (mean BW 19 kg) were anesthetized with thiopental 25 mg/kg followed by infusion of 2.5-5 mg thiopental/kg/h. Abdominal aortic (AP), central venous (CVP), pulmonary arterial (PAP) and capillary wedge (PCWP), intracranial (ICP, cisterna magna), and airway (AWP, distal end of tracheal tube) pressures were measured. Cardiac output (CO) was measured using a thermodilution technique. Blood flow measurements were made by injecting Co^{57}, Sn^{113}, Ru^{103}, or Sc^{40} labelled 15 u microspheres into the left ventricle. A small burr hole was placed over the right temporal lobe through which a balloon-tipped 18 Fr Foley catheter was inserted. ICP was elevated by filling the balloon with 6-12 ml isotonic saline. The dogs received 15-20 ml/kg of balanced salt solution with 5% dextrose during surgery, thereafter 3-4 ml/kg/h. Animals were either ventilated with IPPV (Servo Ventilator 900C, Siemens-Elema AB, Sweden) set at a ventilatory frequency (f) of 20/min, or HFPPV (Bronchovent® Special, Siemens-Elema AB) with f of 100/min(1). After arterial blood gas and hemodynamic stabilization, data were recorded. The ventilatory mode was switched and the proceedure repeated. ICP was then elevated (>30 mmHg) and maintained for 2 h. Again, following arterial blood gas and hemodynamic stabilization, pressures and organ flows were recorded for both modes of ventilation. Analysis of variance and Student's t-test were used.

Results. Mean $PaCO_2$ during both ventilatory modes at normal and elevated ICP was 40 ± 3 mmHg. pHa and PaO_2 were also within normal limits (7.36 ± 0.03 and 91 ± 20 mmHg). At normal and elevated ICP, mean values for AP, CVP, PAP, PCWP and stroke volume/kg for both modes of ventilation remained unchanged. CBF during HFPPV (52.1 ± 16.3 ml/100g/min) was comparable to the CBF during IPPV (49.8 ± 18.5 ml/100g/min). Following an increase in ICP to a mean of 44 ± 18 mmHg, mean CBF fell to 22.6 ± 11.0 during IPPV, and 21.7 ± 13.2 ml/100g/min during HFPPV. At normal or elevated ICP, no differences in cerebral, pulmonary, renal or cardiac blood flows were observed between the two modes of ventilation.

Discussion. In anesthetized dogs at normal ICP, cerebral perfusion is maintained at the same normal levels during HFPPV as in IPPV. In the compromised brain where ICP is elevated, CBF is severely reduced but again there are no differences with respect to the two modes of ventilation. As there are no differences in CBF, HFPPV may be considered for clinical use as an alternative mode of ventilation to IPPV. The clinical significance of reduced ventilatory synchronous brain movement during HFPPV has not yet been evaluated.

As far as the dog model is concerned, the results of this study suggest that HFPPV may be equally as effective and acceptable to the surgical patient as conventional ventilation (IPPV) but provide for more favorable surgical accessibility.

References.

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3. Todd M, Toutant S, Shapiro H: The effect of high frequency positive-pressure ventilation on intracranial pressure and brain movement in cats. Anesthesiology 54:496-504, 1981.