EFFICIENCY OF INTRAPULMONARY GAS DISTRIBUTION DURING HIGH-FREQUENCY VENTILATION

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The type of high-frequency ventilation developed by our group, high-frequency positive-pressure ventilation (HFPPV), is characterized by a ventilatory frequency of 60/min and a relative insufflation time of 22% of the period time (1). So far, it has been used clinically mainly for bronchoscopy and for laryngoscopy under general anaesthesia (2) and in a limited number of patients with adult respiratory distress syndrome (3). Recent studies of central and peripheral circulation in dogs and in patients have not shown any hemodynamic differences between HFPPV and conventional mechanical ventilation (3).

On the other hand, studies comparing HFPPV with other forms of ventilation have shown a more efficient washout of N₂ during HFPPV. In patients undergoing diagnostic bronchoscopy because of suspected or verified pulmonary disease, intrapulmonary gas distribution showed improvement during HFPPV as compared with spontaneous breathing (SB; 4). In patients requiring mechanical ventilation because of respiratory failure the intrapulmonary gas distribution improved as compared with mechanical ventilation at a frequency of 20/min (5).

The aim of this paper is - on the basis of those studies (4, 5, 6) - to analyze the methods and indices used and the mechanisms which may explain the differences in gas exchange and intrapulmonary gas distribution between ventilation at high and at low ventilatory frequencies.

Nine patients scheduled for diagnostic bronchoscopy were examined by means of a non-rebreathing multiple breath nitrogen washout technique (4). The experimental arrangements are shown in Fig. 1. Each investigation started with the patient awake and breathing spontaneously, then under general anaesthesia, endotracheal intubation and muscular relaxation with HFPPV. A momentaneous change from air to oxygen breathing was made and oxygen breathing was then continued until end-expired N₂-concentration had reached 2%.

The efficiency of nitrogen washout was higher during HFPPV as compared with SB (Fig. 2). Nitrogen washout delays (NWOD) were 218.6 ± 112.1% during SB and decreased to 85.8 ± 70.5% during HFPPV. This measure of efficiency of intrapulmonary gas distribution is obtained from resolution of semilogarithmic plots of NWOD-curves into compartments with different ventilatory rates, i.e. different alveolar dilution factors (Fig. 3). However, those compartments are not anatomical realities but functional compartments with different nitrogen clearance rates. If there is only one compartment, the method of analysis gives no delay at all (NWOD = 0%) no matter how fast or slow the actual clearance rate of nitrogen is. When there are two or more compartments with different clearance rates, the delay percentage expresses

Fig. 2. NWOD during SB and during HFPPV. p<0.01. From Eriksson & Sjöstrand 1980.