

HIGH-FREQUENCY JET VENTILATION : A COMPARATIVE STUDY OF PROXIMAL AND DISTAL INJECTION

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INTRODUCTION :

Different types of endotracheal tubes can be used during High-Frequency Jet Ventilation (HFJV). A conventional single-lumen tube is most frequently used with a proximal injection using a 14-gauge injector cannula. The recent introduction of double-lumen tubes specifically designed for HFJV allows a distal injection which has been said to improve CO₂ elimination¹. In this prospective study we compared both proximal and distal injections in patients under HFJV.

METHODS :

Patients : Eight critically ill patients with respiratory failure were studied after informed consent had been obtained. All were intubated with a HI-LO Jet Mallinckrodt endotracheal tube, characterized by 2 separate insufflation and airway pressure monitoring lumens. At the time of the study, they were sedated with Fentanyl and paralysed with Pancuronium.

Equipment (numbers () refer to figure 1) : HFJV was provided as previously described², using an Acutronic Ventilator MK 800 (1) and a 3-way swivel adapter (6) allowing a bias flow of additional gases of 30 l.min⁻¹ (7). When proximal injection (2) was administered, the ventilator was connected to a 14-gauge injector cannula (9) fixed to the proximal tip of the endotracheal tube (5) via the 3-way swivel adapter. In the case of distal injection (3), the ventilator was directly connected to the jetting channel of the endotracheal tube (4).

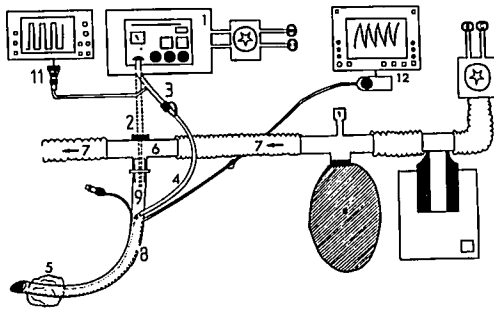


FIGURE 1

Measurements : Operating pressure (O.P.) -ie the pressure between the solenoid valve and the injection system- was measured using a high-pressure calibrated transducer (11) connected on-line to a storage oscilloscope. Injected volume (Vinj) -ie the jet volume delivered by the ventilator- was directly measured by connecting the injection system to a water-sealed spirometer, the bias flow being closed. Tidal volume (VT) was measured by connecting the entire system -injector system plus bias flow- to the water-sealed spirometer. Entrainment was calculated as :

$E (\%) = \frac{V_T - V_{inj}}{V_T}$. In both types of injection, mean airway pressure ($\overline{P_{aw}}$) was measured using the third channel of the Mallinckrodt tube (8), ending 5 cms beyond the extremity of the jetting channel which was connected to a calibrated Quartz transducer (12). Since the entire system had a resonant frequency of 5 Hz, $\overline{P_{aw}}$ only, obtained by electronic damping of the signal, will be reported.

Procedure : Proximal and distal injections were used at random. With each method the following ventilatory settings were kept constant : driving pressure -ie the pressure before the solenoid valve- 3 bars, inspiratory:expiratory ratio 0.43, frequency 300.min⁻¹. After a steady state of 20 minutes at FIO₂ = 1, Vinj, VT, E, O.P., $\overline{P_{aw}}$ and arterial blood gas were measured. The mean and standard deviation were calculated for all values and the Wilcoxon test was used to compare distal and proximal injections.

RESULTS are summarized in the table (* p < 0.05).

	Proximal	Distal	Although Vinj was
Vinj. ml	50 ± 2	60 ± 1*	significantly
VT ml	80 ± 3	70 ± 4*	greater in the
E %	38 ± 2	25 ± 4*	case of distal
O.P. bars	1.8	1.3 *	injection, VT was
$\overline{P_{aw}}$ cmH ₂ O	17 ± 5	12 ± 3*	significantly less
PaO ₂ mmHg	320±71	287±61	because of a signi-
PaCO ₂ mmHg	37 ± 7	39 ± 6	ficant decrease in

E. These changes were paralleled by a significant decrease in O.P.. The distal injection also induced a significant decrease in $\overline{P_{aw}}$ and an insignificant decrease in PaO₂. PaCO₂ was similar in both methods of injection.

DISCUSSION :

This study demonstrated that the distal injection enables CO₂ elimination as efficient as the proximal injection does, but with lower $\overline{P_{aw}}$ and lower tidal volume. The decrease in VT, related to a lower O.P. induced decrease in E was counteracted by the proximity of the injection to the carina¹. Therefore, the distal injection using double-lumen endotracheal or tracheostomy tubes, may be the method of choice in critically ill patients under HFJV.

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