

HIGH-FREQUENCY JET VENTILATION : EFFECTS OF CHANGING THE INTERNAL DIAMETER OF THE INJECTOR CANNULA

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INTRODUCTION :

During High-Frequency Jet Ventilation (HFJV) using a proximal injection, different sizes of injector cannula can be used. Conflicting data has been published on the effects of changing the internal diameter of the injector cannula in animals under HFJV. Both absence (1) and presence (2) of size-related effects on airway pressure and gas exchange have been reported.

In this prospective study we compared 4 injector cannulas with different internal diameter in adults under HFJV.

METHODS :

**Patients :** Six critically ill patients with respiratory failure were studied after informed consent had been obtained. All were intubated with a single lumen endotracheal tube and were sedated with Pentanyl 50 mcg.kg<sup>-1</sup> and Pancuronium 0.1 mg.kg<sup>-1</sup>.

**Equipment :** HFJV was provided as previously described (3), using an Acutronic Ventilator MK 800 and a 3-way swivel adapter allowing a bias flow of additional gases of 30 l.min<sup>-1</sup>. A proximal injection was achieved using an injector cannula 4 cms in length fixed to the proximal tip of the endotracheal tube via the 3-way swivel adapter.

**Measurements :** Operating pressure (O.P.) -ie the pressure between the solenoid valve and the injector cannula- was measured using a high-pressure calibrated transducer connected on-line to a storage oscilloscope. Injected volume (Vinj) -ie the jet volume delivered by the ventilator- was directly measured by connecting the injector cannula to a water-sealed spirometer, the bias-flow being closed. Tidal volume (VT) was measured by connecting the entire system -injector cannula plus bias flow- to the water-sealed spirometer. Entrainment was calculated as E (%) :  $\frac{V_T - V_{inj}}{V_T}$ . Airway pressure was measured using a catheter advanced into the endotracheal tube 10 cm beyond the distal tip of the injector cannula. Since the entire measuring system had a resonant frequency of 3 Hz, mean airway pressure only (Paw), obtained by electronic damping of the signal will be reported. Mean alveolar pressure (MAP) and mean pulmonary volume above FRC (ΔFRC) were measured using the "clamps method" previously described (4).

**Procedure :** In each patient 4 injector cannulas with various internal diameters -14 gauge (1.8 mm), 16 gauge (1.6 mm), 18 gauge (1.4 mm), 20 gauge (1.2 mm)- were used at random. The following ventilatory settings were kept constant throughout the study : driving pressure -ie the pressure before the solenoid valve- 3.5 bars, inspiratory:expiratory ratio 0.43, frequency 100.min<sup>-1</sup>. After a steady state of 20 minutes at FIO2 1, Vinj, VT, E, O.P., Paw, MAP, ΔFRC and arterial blood gas were measured. The mean and stan-

dart deviation were calculated for all values and data were computed using a two-way analysis of variance completed by a modified t-test.

RESULTS are summarized in the Table (\*p < 0.05) :

Injector size (gauge)	14	16	18	20
Paw (cmH2O)	17±3	15±2*	13±2*	12±2*
M.A.P. (cmH2O)	17±3	16±2*	13±2*	13±2*
ΔFRC (ml)	1399±513	1256±487*	1028±447*	892±473*
Vinj (ml)	136±5	106±12*	81±16*	73±8*
VT (ml)	339±30	290±9*	257±21*	243±5*
E (%)	60±4	64±4*	69±7*	70±3*
O.P. (bars)	2.0	2.2*	2.4*	2.6*

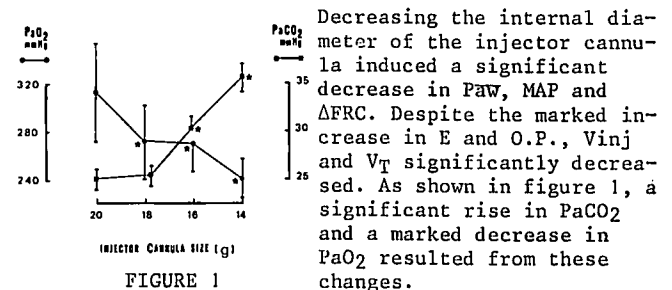


FIGURE 1

Decreasing the internal diameter of the injector cannula induced a significant decrease in Paw, MAP and ΔFRC. Despite the marked increase in E and O.P., Vinj and VT significantly decreased. As shown in figure 1, a significant rise in PaCO2 and a marked decrease in PaO2 resulted from these changes.

DISCUSSION :

These results demonstrating deterioration of oxygenation and CO2 elimination when decreasing cannula size, are in keeping with previous experimental studies concerning dogs with respiratory failure (2). Therefore in adults with acute respiratory failure a 14 gauge injector cannula should be preferentially used. The data also demonstrates that an increase in E and O.P. tends to limit the decrease in Vinj induced by narrowing the injector cannula and consequently prevents a dramatic fall in VT despite the reduction in pulmonary volume. This beneficial effect could incite the use of small injector cannulas when HFJV is indicated in pediatrics.

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