TITLE: COMPARISON OF HIGH FREQUENCY JET VENTILATION WITH CONVENTIONAL VENTILATION FOR BRONCHOPLEURAL FISTULA IN ACUTE RESPIRATORY FAILURE

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Introduction. High frequency jet ventilation (HFJV) has been used to successfully ventilate patients with large bronchopleural fistulas (BPF). Because of the high mortality associated with bronchopleural fistula occurring during mechanical ventilation for acute respiratory failure, we initiated a study to determine whether we could decrease the leak through the BPF using HFJV and thus hopefully produce faster closing of the BPF. We hypothesized that HFJV would lower peak flows across the fistula and consequently speed closure of the fistula. We hoped to randomize patients to 3 days of either HFJV or CV following a trial period of each.

Methods. We studied seven patients with acute respiratory failure who were receiving mechanical ventilation and had a persistent BPF demonstrated by an air leak persisting more than 24 hours after the insertion of a chest tube. Consent was obtained from the patient's nearest relative following procedures established by the institution's human subjects review board. The patients' endotracheal tube (ETT) was replaced with a Hi-Lo Jet Tracheal Tube (NCC) to permit monitoring of distal tracheal pressures. Conventional mechanical ventilation (CV) consisted of assisted ventilation at the settings which had produced optimal gas exchange as defined by the physicians caring for the patients. Baseline measurements were made of arterial blood gas tensions, mean and peak pressures at the distal end of the ETT, gas leaked via the BPF, and gas exhaled via the ETT. Leaked gas (V_L) was measured using a previously described method by collecting the thoracostomy output into a 120-ℓ (Warren E. Collins, Braintree, MA) spirometer using 20 cmH_2O suction.[1] Exhaled gas was collected into an 100-ℓ atmospheric balloon and evacuated into the spirometer to quantify it. Following baseline measurements, patients were switched to HFJV and the measurements repeated after 30 minutes. HFJV was conducted at a rate of 100 and an inspiratory time of 33%. Driving pressure was intentionally adjusted to provide a mean pressure in the distal trachea identical to that achieved during CV, since our goal was to assess leaked volume at comparable mean tracheal pressures. We used a prototype HFJV machine (Bear Medical Systems) and injected the flow via a 16 gauge cannula at the ETT adaptor with additional gas entrained from a conventional ventilatory circuit. A priori, a failure of one mode of ventilation relative to the other, mandating escape from randomization, was defined by one of three criteria: 1) $PaCO_2$ increased to the extent that pH decreased to less than 7.30; 2) PaO_2 decreased 20% below baseline levels; and 3) volume leaked via the BPF increased by 50% or more. Comparisons between HFJV and CV were performed using Student's t-test for paired samples.

Results. Of the patients studied, five had a BPF which occurred during CV for adult respiratory distress syndrome, one had a subsegmental bronchial tear following trauma, and one had a persistent BPF following pleural decortication. Peak inspiratory pressures averaged 58 ± 15 cmH_2O during CV and 34 ± 9 cmH_2O during HFJV ($p < 0.05$), whereas mean tracheal pressures were 22 ± 7 cmH_2O during CV and 21 ± 6 cmH_2O during HFJV. Leaked volume was not significantly different between the modes although there was a tendency towards higher leaks during HFJV (5.8 ± 4.7 ℓ during CV vs. 7.0 ± 5.1 ℓ during HFJV, $p > 0.05$). In none of the patients was the leak as much as 50% greater during one mode than the other. Oxygenation deteriorated in all but one patient during HFJV, with the mean ratio of PaO_2 to FiO_2 dropping from 227 ± 63 to 133 ± 38 ($p < 0.05$). In four patients, the deterioration was greater than our 20% criterion. In three other patients, all of whom had markedly elevated physiologic dead space, $PaCO_2$ rose rapidly creating an intolerable acidosis. However, mean $PaCO_2$ over the entire group did not show a significant difference. In summary, because of substantial deterioration in either oxygenation or carbon dioxide excretion, we could not randomize any of our patients and all remained on CV.

Discussion. While none of our patients could be supported with HFJV at comparable mean airway pressures to those noted during CV, we later demonstrated that some of them could be supported at higher mean airway pressures (data not reported here). However, the goal of our study was to assess whether HFJV would be useful as a method of lowering flows across the BPF in an attempt to speed closure. Thus, we decided to use comparable mean airway pressures under the presumption that higher pressures would very likely result in higher leaked volumes. Unfortunately, we could not randomize patients to one mode or the other because of the clear superiority of CV at comparable mean airway pressures. The difference between this study and prior reports of successful ventilation of BPF patients with HFJV may be due to the very substantial degree of parenchymal disease in our patients requiring high ventilatory pressures for noncompliant lungs plus our limitation of the airway pressures used. We conclude that in our patients with respiratory failure and BPF, CV was superior at comparable mean airway pressures and did not result in greater BPF leak than did HFJV.

Reference.

1. Ritz R, Benson M, Bishop MJ: Measurement of leak from bronchopleural fistulae during high frequency jet ventilation. Crit Care Med 12:836-837, 1984