Support of Spontaneous Breathing during High-Frequency Oscillatory Ventilation

Motivation:

High-frequency oscillatory ventilation (HFOV) is a protective method of mechanical ventilation: High ventilatory frequencies and small tidal volumes used during the ventilation imply low changes in pressure in the airways. HFOV thus reduces mechanical damage to a patient’s lungs which occurs frequently when conventional modes of mechanical ventilation are used.

Preservation of spontaneous breathing during HFOV is beneficial as it improves oxygenation, reduces need of sedation of a patient and shortens the time of a patient’s ICU stay. However, spontaneous breathing during HFOV is not well tolerated by the ventilator: A patient’s respiratory effort (work of breathing) raises, and high changes in pressure inside the ventilator circuit can even stop functioning of the ventilator.

Aim:

To create a device, called the Demand Flow System (DFS), which facilitates spontaneous breathing of a patient during high-frequency oscillatory ventilation without impeding function of the high-frequency mechanical ventilator and which decreases a patient’s work of breathing.

Methods:

The DFS automatically compensates for the changes of gas volume inside the ventilator circuit caused by a patient’s spontaneous breathing. The DFS evaluates the change in pressure related to the gas volume decrease during a patient’s inhalation or its increase during a patient’s exhalation. A regulator controls the inflow of gas into the ventilator circuit (Fig. 1), so that the mean pressure in the circuit at a patient’s airway opening remains unaltered.

Results:

Simulations show the ability of the DFS to maintain the constant mean pressure in the ventilator circuit and in the airways during a patient’s spontaneous breathing (Fig. 2). Animal experiments prove reduction in work of breathing with DFS in use.
Conclusions:

The designed Demand Flow System facilitates spontaneous breathing of a patient during high-frequency oscillatory ventilation, and may contribute to a better utilization of the protective method of mechanical ventilation in clinical care.

Publications:


Support:

The project is supported by grants no. MSM6840770012, GAČR 102/08/H018, and SGS11/171/OHK4/3T/17.