High-Frequency Jet Ventilation in Preterm Infants: Is There Still Room for It?

Despite undeniable progress in health care for very-low-birthweight infants using antenatal steroids and surfactant therapy, chronic lung disease remains the major cause of mortality and morbidity in this population. The immature lung exposed to a wide range of volume and toxic levels of oxygen are determinants of chronic lung disease.[1] Accordingly, high-frequency ventilation arose as an interesting ventilatory strategy, because it uses a volume below dead space in extremely high frequencies (between 5 and 15 Hz; 300–900 cycles/min), therefore enabling the attainment of higher mean pressure in the airway but with minimum volumetric variation in the alveolus.[2]

Of the modes of high-frequency ventilation, high-frequency oscillatory ventilation (HFOV) is currently the most used. Through the movement of an electromagnetic diaphragm, this mode of high-frequency ventilation generates pressure in the ventilator circuit with active inspiratory and expiratory phases. Although initial studies on the use of HFOV in preterm infants have shown discouraging results,[3] more recent studies have reported the safety and effectiveness of this mode of ventilation in preterm infants with severe lung involvement. Earlier removal of mechanical ventilation and potential to reduce the incidence of chronic lung disease were findings of those studies.[4-6]

High-frequency jet ventilation (HFJV) is significantly different from HFOV. Through a pneumatic valve, it releases short jets of gas in the inspiratory circuit, and expiration is passive. The inspiratory-expiratory ratio is adjustable, which can be of interest for cases of hypercapnia. It is used in conjunction with conventional mechanical ventilation, with application of PEEP. During HFJV, it is possible to combine fast and low-volume inspirations with relatively long expirations and an inspiratory-expiratory ratio as low as 1:12.[7]

Studies comparing HFJV with conventional mechanical ventilation in preterm infants have reported conflicting results, from an increase in the occurrence of air leak with no clinical benefit in relation to conventional mechanical ventilation to a reduction in chronic lung disease incidence and reduced use of home oxygen.[8,9] Differences in the study models, no utilization of antenatal steroids and tracheal surfactant therapy in some studies, and the use of distinct ventilator strategies (with and without maintenance of the lung volume) make it difficult to compare these studies. Current evidence does not allow recommendations for using HFJV routinely in preterm infants with respiratory distress syndrome, and its use is very restricted.[10]

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In a 4-y retrospective study, Wheeler et al[11] sought to identify measurable physiological factors to predict the successful use of HFJV as a rescue ventilation mode in subjects with acute hypercapnic respiratory failure. Lower gestational age, the use of lower peak inspiratory pressure in the previous conventional mechanical ventilation, reduction in F_{IO_2} and in capillary P_{CO_2}, and improvement in pH during the first hour of HFJV were predictors of better outcome. Increases in the oxygen saturation index and F_{IO_2} in 4 h were associated with worse outcome to HFJV. According to the study by Wheeler et al,[11] an increase in the oxygen saturation index within 4 h under HFJV might be an indicator of the need for changes in the ventilation strategy, through either an increase in PEEP, an increase in mean airway pressure, or an unnecessary extension of the period of use of HFJV.

In contrast, considering the small reduction in capillary P_{CO_2} in this study as a positive response (reduction in capillary $P_{CO_2} \geq 10\%$) and the increase in the peak inspiratory pressure by 3–5 cm H_2O when subjects were moved from conventional mechanical ventilation to HFJV, it is not possible to state unequivocally that HFJV improved ventilation in those preterm infants. It is likely that optimization of conventional mechanical ventilation could result in the same effect. Similarly, patients receiving HFOV receive a breathing frequency of 15 Hz (900 cycles/min). It is known that in HFOV, the higher the breathing frequency, the lower the tidal volume. Therefore, it is likely that simply reducing breathing frequency with HFOV could reduce capillary P_{CO_2}.

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Many questions remain unanswered. What is the actual purpose of HFJV to prevent neonatal morbidity, specifically chronic lung disease? Are there subgroups of preterm neonates who could benefit? Would there be advantages of using HFJV over other modes of high-frequency ventilation, such as HFOV, which is used more commonly, or even advanced conventional modes of mechanical ventilation, such as guaranteed volume/controlled pressure?

Randomized controlled studies are required to answer these questions. The studies should target populations at higher risk of developing chronic lung disease. The likely long-term effect of different modes of mechanical ventilation, specifically on neurodevelopment and lung function, also needs studied. In conclusion, there is still much to be learned, but meanwhile, studies such as that by Wheeler et al[11] may help to identify groups of preterm infants who can benefit from HFJV and, moreover, identify early the ones who do not respond to this mode of mechanical ventilation and, therefore, need changes in the ventilation strategy.

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