Journal of Tropical Pediatrics, 2016, 62, 165–168
doi: 10.1093/tropej/fmv088
Advance Access Publication Date: 27 December 2015
Case Report

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CASE REPORT

Nasal HFOV with Binasal Cannula Appears Effective and Feasible in ELBW Newborns

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ABSTRACT

Non-invasive ventilation has been used increasingly in recent years to reduce the duration of endotracheal ventilation and its complications, especially bronchopulmonary dysplasia. Nasal continuous positive airway pressure and nasal intermittent positive pressure ventilation are the most common non-invasive modalities, and nasal high-frequency oscillatory ventilation (n-HFOV) is relatively new but it seems effective and feasible. We present three premature cases who were ventilated with n-HFOV with Neotech RAM Cannula as interphase. In two cases, we used n-HFOV with good results to prevent extubation failure, and in one case, we used it to avoid intubation with success. n-HFOV may be useful both in early times of respiratory failure and also to facilitate extubation particularly in patients with prolonged intubation.

KEYWORDS: nasal HFOV, premature, binasal cannula.

INTRODUCTION

Preterm infants often need mechanical ventilation because of lung immaturity, surfactant deficiency and immature respiratory control mechanisms. Non-invasive ventilation including nasal continuous positive airway pressure (n-CPAP) and nasal intermittent positive pressure ventilation (n-IPPV) has been successfully used in neonatal intensive care units (NICUs) to reduce bronchopulmonary dysplasia (BPD), ventilator-associated pneumonia, air-leak syndromes and subglottic stenosis [1, 2]. n-IPPV has been found to be more effective in decreasing extubation failure compared with n-CPAP [3]. However, both modes may fail in some cases and subsequent invasive positive pressure ventilation may be needed owing to respiratory failure.

On the other hand, endotracheal high-frequency ventilation (HFV) including high-frequency positive pressure ventilation (HFPV), jet ventilation or high-frequency oscillatory ventilation (HFOV) is used in newborns in whom conventional mechanical ventilation fails [1]. HFOV is effective in eliminating CO_2 with low tidal volumes presumably with less pulmonary damage. The lung protective effects of HFV has also raised the idea of using it as nasal HFV either with nasal HFPV or n-HFOV with limited clinical data.

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We present three extremely low birth weight infants; two of whom were successfully extubated to n-HFOV after prolonged periods of endotracheal HFOV and repeated extubation failures and one was treated to avoid intubation after a 10 day period of n-IPPV since birth. The ventilatory support was provided by Dragaer Babylog 8000 (Drager Medical GmbH, Germany) ventilator with integrated HFOV option in all patients.

CASE 1

A 900 g female infant was born at 28 weeks of gestational age (GA) to a 27 year old primigravida with twin gestation by caesarean section owing to preeclampsia. The mother had received a full course of antenatal steroids. The APGAR scores were 6 and 8 at first and fifth minutes, respectively. The baby was not resuscitated in the delivery room and was transferred to a NICU on n-IPPV. Chest X-ray was compatible with respiratory distress syndrome (RDS) so she was intubated and given surfactant; continued to be ventilated by pressure support ventilation combined with volume guarantee. On the second day of life, endotracheal HFOV was started owing to CO_2 retention and low oxygenation. She required HFOV for 9 days for she did not tolerate conventional ventilation. On the 11th day of life, n-HFOV was attempted with Neotech RAM Cannula. The ventilatory settings and blood gas parameters before and within 24 h of n-HFOV are shown in Table 1. FiO_2 was regulated to achieve a peripheral O_2 saturation of 90–93% by pulse oximetry. n-HFOV was used for 4 days and was successful to prevent reintubation. Afterwards, patient was ventilated with n-IPPV and n-CPAP and reintubation was prevented. No hypotension was observed during n-HFOV. Transfontanelle ultrasound scan was normal. Patient was discharged at 36 weeks corrected age and continues to grow normally.

CASE 2

An 830 g female infant was born at 29 weeks of GA to 31 year old gravida 5, parity 3 preeclamptic mother by caesarean section. The mother had received full course of antenatal steroid. She was resuscitated and intubated in the delivery room and transferred to NICU on conventional ventilation. RDS and pulmonary interstitial emphysema was detected on the first plain radiography and surfactant was given. At 12 h of life, pneumothorax was diagnosed, chest tube was inserted, followed by HFOV. When pneumothorax regressed, conventional ventilation was tried but owing to CO_2 retention and deterioration in saturation, HFOV was restarted. She was ventilated by HFOV for 46 days with multiple attempts for extubation all resulting in failure, then was extubated to n-HFOV with Neotech RAM Cannula. The ventilatory settings and blood gas parameters before and within 24 h of n-HFOV are shown in Table 1. Blood pressure was normal during n-HFOV. Patient needed reintubation after 4 days for intractable apnea owing to nosocomial sepsis, and ventilated with synchronized intermittent mandatory ventilation + volume guarantee mode instead of endotracheal HFOV. Transfontanelle ultrasound

Table 1. Data on respiratory support and blood gases in the first 24 h of n-HFOV of three patients

	Case 1			Case 2			Case 3		
	nHFOV Time 0	nHFOV 4 h	nHFOV 24 h	HFOV Time 0	nHFOV 4 h	Nhfov 24 h	nHFOV Time 0	nHFOV 4 h	nHFOV 24 h
pH	7.27	7.31	7.25	7.32	7.24	7.26	7.25	7.26	7.31
PCO_2	53	47.5	45.7	30.8	35.5	36.6	46	45	42
pO_2	63.5	61.7	100	58.8	67	59.1	31.8	55	82
FiO_2	27	50	30	30	30	30	30	26	21
Amplitude	70	100	85	85	85	85	100	100	90
MAP	10	13	10	10	10	10	10	10	9
Duration of nHFOV		96 h			96 h			42 h	

nHFOV = nasal high-frequency oscillatory ventilation; MAP = mean air-way pressure.

scan at 2 weeks of life revealed periventricular leucomalacia. Patient was discharged at 44 weeks corrected age, and follow up exams are consistent with mild developmental delay.

CASE 3

An 890 g female infant was born at 27 weeks of GA to a 39 year old, gravida 5, parity 3 mother by caesarean section owing to decompensated liver cirrhosis. The mother had not received antenatal steroids. The baby was transported to NICU on n-CPAP. She was given surfactant with INSURE technique, then was followed on n-IPPV. The second dose of surfactant was given at 24 h by MIST method. On the sixth day of life, the baby's clinical condition deteriorated with increased retractions and increased oxygen requirement. n-HFOV was tried with Neotech RAM Cannula, which resulted in improved oxygenation, and at the end of 24 h, FiO_2 was 21%. The ventilatory settings and blood gas parameters before and within 24 h of n-HFOV are shown in Table 1. n-HFOV was used for 42 h and was successful to prevent intubation and improve oxygenation. Afterwards, patient was ventilated with n-IPPV and n-CPAP, respectively. Blood pressure was normal throughout n-HFOV period. Transfontanelle ultrasound scan was normal. Patient was discharged at 37 weeks corrected age and has been found to develop normally.

DISCUSSION

Non-invasive nasal ventilatory support modes are being used more frequently in preterm newborns to reduce the risks of prolonged intubation and mechanical ventilation. After n-CPAP, the incidence of intubation and BPD has been shown to decrease. However, it has also been shown that 43–80% of neonates with moderate to severe respiratory insufficiency initially treated with n-CPAP eventually needed mechanical ventilation [4] or have failed extubation in 16–40% of cases [4, 5]. These findings have brought the idea of n-IPPV to prevent extubation failure, and this method has been shown to be more effective than n-CPAP [2, 3]. The infants ventilated by n-IPPV after surfactant therapy have needed less reintubation, less oxygen during hospitalization and shorter hospital stay compared with infants ventilated by conventional ventilation [2].

HFOV is a mode of mechanical ventilation that supports ventilation with small tidal volumes less than dead space at a supraphysiological respiratory frequency providing a constant lung expansion. It is an effective modality for CO_2 elimination [1]. Therefore, n-HFOV could be a good combination of being non-invasive and yet allowing alveolar ventilation with constant lung expansion.

So far, n-HFOV has been studied in lung models under controlled conditions, in animals and in few clinical trials, all of which provide evidence in support of the potential benefit(s) of n-HFOV. De Luca *et al.* in their neonatal lung model have found that during n-HFOV, nasal prong diameter had great impact on delivered tidal volume [2]. In a mannequin similar to term newborn, Mukerji *et al.* [1] have shown that n-HFOV is superior to n-CPAP or n-IPPV for CO_2 elimination. Prolonged n-HFOV administration as long as 21 days has been found to be effective and lung protective in preterm lambs [3].

n-HFOV studies in newborns have been published in English literature since 1998, all of which have used single nasopharyngeal tube as interface. Van der Hoeven *et al.* have used n-HFOV in 21 preterm newborns with GA 27–32 weeks and mean birth weight 1010 g all with moderate respiratory insufficiency. Their study demonstrated that n-HFOV applied with single nasopharyngeal tube inserted to 3–4 cm was effective in reducing CO_2 and could be used to decrease the need for invasive mechanical ventilation [4]. A preterm newborn with prolonged intubation was successfully extubated to n-HFOV applied by Draeger Babylog 8000 [2]. Another study in which the efficacy of n-HFOV was assessed in 14 stable very low birth infants on n-CPAP, a period of n-HFOV for 2 h was effective in decreasing CO_2 [5].

Recently [6] investigated the feasibility of n-HFOV immediately after extubation in difficult-to-wean preterms. They used n-HFOV in 20 mechanically ventilated neonates with median GA 25.3 weeks (23.7–27.6 weeks) at high risk for extubation failure. The mean duration of

n-HFOV was 136 h. Nasopharyngeal tube was used as interface. They found that n-HFOV can be tried to wean premature infants from mechanical ventilation [6].

A survey done in five European countries showed that in a number of European NICUs, clinicians have been using n-HFOV mostly with binasal prongs as interface, and n-CPAP failure was the most common indication. This survey was the first study searching for side effects of n-HFOV. Abdominal distension and upper-airway obstruction due to secretions were the most common side effects reported [7]. In our three patients, we also detected increased upper-airway secretions and mild abdominal distension.

Our three cases differed from the above clinical studies for we used Neotech RAM Cannula as interphase, and the duration of n-HFOV was longer than most of the reports. In two cases, we used n-HFOV with good results to prevent extubation failure, and in one case, we used it to avoid intubation with success. n-HFOV may be useful both in early times of respiratory failure and also to facilitate extubation particularly in patients with prolonged intubation. Randomized controlled trials comparing n-HFOV with n-IPPV or n-CPAP may be planned for both clinical conditions.

INFORMED CONSENT

Informed consent was obtained from all individual participants included in the study.

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