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The Optiflow™ interface for chronic CPAP in infants

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ABSTRACT

Continuous positive airway pressure (CPAP) is increasingly used in infants. However, the limited number of commercially masks available for infants is challenging. The use of the Optiflow™ nasal cannula (Fisher & Paykel) with a regular CPAP device has been recently reported for chronic CPAP in children, with an objective improvement in polysomnographic events. However, this interface has not been used in young infants. We report here our experience of 4 infants aged between 3 and 8 weeks, who were treated with home CPAP with the Optiflow™ nasal cannula during a few months, before they could be successfully weaned. This pilot study reinforces the findings of the beneficial use of this nasal cannula in very young infants in whom nasal masks are scarce and not always suitably adapted. However, as this interface is not intended to be used with home CPAP, further studies are necessary to prove its clinical benefice and safety of use with home CPAP devices.

1. Introduction

Continuous positive airway pressure (CPAP) is increasingly used in children with severe obstructive sleep apnea (OSA), in France and worldwide. However, there is still a paucity of industrial masks designed for infants, and the existing masks may not always fit adequately, which is challenging as an optimal interface is crucial for treatment success [1, 2]. Recently, a study reported the experience of the use of the Optiflow™ nasal cannula (Fisher & Paykel) for chronic CPAP in children [3]. This interface consists of a nasal cannula designed for the delivery of heated and humidified nasal high flow therapy with specific devices. However, the cannula can also be connected to ventilators that deliver high flow therapy. This study investigated the potential use of the nasal cannula with a home CPAP device in 9 children aged 7 months to 15 years old. Only 1 child was aged 7 months old, and the nasal cannula were not used in younger infants. In this population, there are even less available industrial masks than for older children. Strategies to allow the use of home CPAP in these infants should therefore be explored. We report here our experience of the use of the Optiflow™ nasal cannula with a home CPAP device in younger infants, aged between 3 and 8 weeks. The report of this case series was approved by our Ethics Committee.

2. Results

The first patient was a boy born prematurely at 33 GA + 2, with a severe Pierre Robin sequence. He required 6 days of noninvasive ventilation (NIV) after birth because of acute respiratory failure. At the age of 6 weeks, he presented clinical symptoms of upper airway obstruction and difficult feeding. A nocturnal transcutaneous oxycapnography recording revealed a mean pulse oximetry (SpO_2) of 96%, minimal SpO_2 of 80% with 2 % of the time spent with a SpO_2<90%, and a 3% oxygen desaturation index (ODI) at 36 events/h (Fig. 1A). The transcutaneous carbon dioxide pressure ($PtcCO_2$) was normal, with a mean and maximal $PtcCO_2$ at 31 and 36 mmHg, respectively. CPAP was therefore started using a nasal mask (Respireo™ Soft Baby XXS, Air Liquide) and a home CPAP device at a pressure level of 7 cmH_2O. However, the patient did not tolerate the nasal mask despite several attempts. We therefore switched the mask for the Optiflow™ Junior 2 interface (M size) (Fig. 2). The nasal cannula was chosen in order not to completely obstruct the nostrils (obstruction between 60 and 70%), to allow a correct nasal breathing in case of an occlusion of the cannula. The CPAP pressure was increased at 8 cmH_2O to guarantee a better CPAP efficiency with the nasal cannula. The CPAP was well tolerated with a daily usage between 5 and 10 h, during the first week after CPAP

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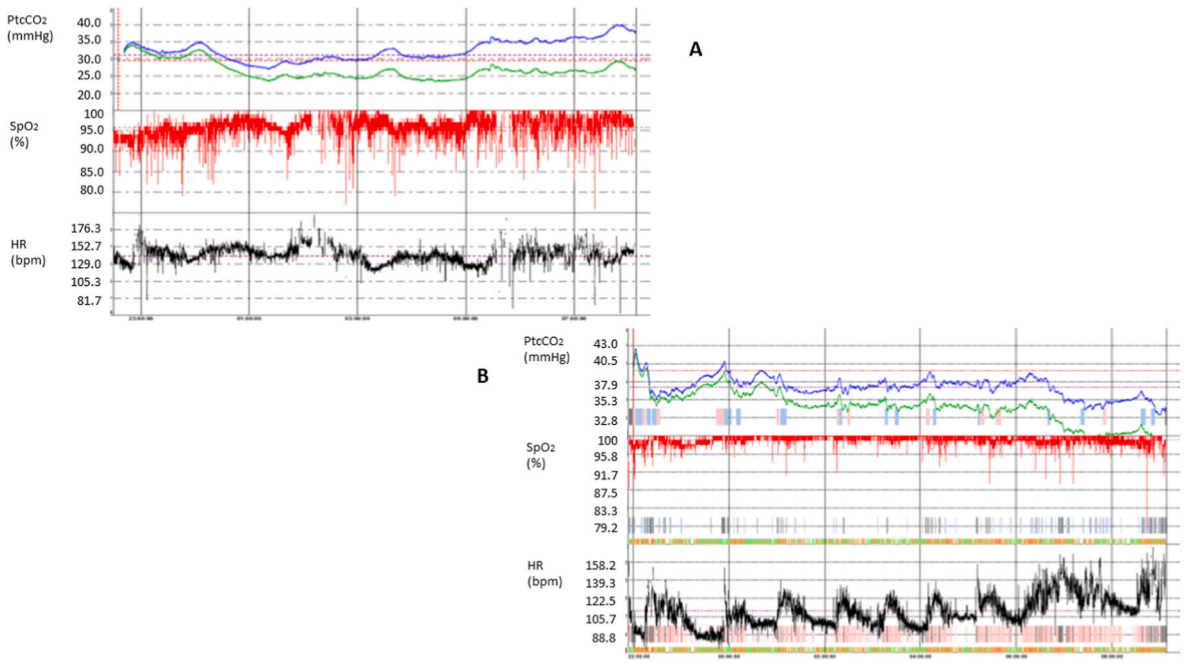

Fig. 1. Overnight transcutaneous oxycapnography before CPAP initiation and with CPAP in an infant. A. $PtcCO_2$, SpO_2 and HR tracings of a 6-week-old boy with Pierre Robin sequence showing repeated oxygen desaturations until 80%. B. The same tracing with CPAP at 8 cmH_2O with the Optiflow™ nasal cannula. Note the normalization of the SpO_2 tracing, with a very few desaturations mainly above 90%. Abbreviations: CPAP, continuous positive airway pressure; SpO_2, pulse oximetry; $PtcCO_2$, transcutaneous carbon dioxide pressure; HR, heart rate.

Fig. 2. Schema of the connection system between the CPAP device and the Optiflow™ nasal cannula.
The Optiflow™ interface (Fisher & Paykel) is connected to the ventilator tube using a connector 22F/22F or 15F/22F, depending on the size of the cannula, and a whisper swivel (Philips Respironics).

initiation. A nocturnal transcutaneous oxycapnography recording, performed with CPAP, showed a mean SpO_2 of 99%, minimal SpO_2 of 90%, and an ODI of 6 events/h (Fig. 1B), and a normal $PtcCO_2$. The infant was discharged home at the age of 2.5 months, and CPAP was continued during 5 months until weaning.

The second infant was a girl with Binder syndrome and chondrodysplasia punctata, born at term. She required 12 days of invasive ventilation, 2 days of NIV and 23 days of continuous CPAP at 7 cmH_2O, with nasal prongs (Fisher & Paykel) because of an obstructive respiratory distress. She did not tolerate an infant nasal mask. She could not be weaned from CPAP because of respiratory distress with persistent hypercapnia. She was then switched to a home CPAP device with a nasal mask (Respireo™ Soft Baby XXS), at the age of 7 weeks in order to be transferred to an intermediate care unit. The nasal mask was not tolerated. The Optiflow™ Junior 2 (XL size) interface was therefore tested with the CPAP device, at a pressure level of 9 cmH_2O, which was well tolerated. An overnight transcutaneous oxycapnography recording, performed with CPAP, showed a mean SpO_2 of 96%, minimal SpO_2 of 86%, but with no time with a SpO_2<90%, and an ODI at 9 events/h and a normal $PtcCO_2$. The CPAP could be discontinued during daytime after

1 month, and used only during sleep periods. The infant was then discharged home at the age of 3.5 months, and CPAP was continued during 2 months until weaning.

The third infant was a boy diagnosed with macroglossia associated with Simpson-Golabi-Behmel syndrome. At 1 month of age, a nocturnal transcutaneous oxycapnography showed a median SpO_2 of 93%, an ODI of 30 events/h and no evidence of hypoventilation. The median $PtcCO_2$ was 40 mmHg, with no time spent above 50 mmHg. One month later, a polysomnography revealed a severe apnea-hypopnea index (AHI) of 59 events/h, with an obstructive apnea-hypopnea index (OAHI) of 36 events/h. An upper airway examination showed isolated macroglossia without laryngomalacia, nor hypertrophy of the adenoids or tonsils. A CPAP titration was performed, starting with a pressure of 4 cmH_2O which was progressively increased until 7 cmH_2O with a nasal mask (Respireo™ Soft Baby XS). A nocturnal transcutaneous oxycapnography, with CPAP at 7 cmH_2O and the nasal mask, showed no SpO_2 desaturations. Unfortunately, the infant did not tolerate CPAP despite various strategies to improve adherence. One month later, adherence remained poor and a new CPAP titration was proposed using the Optiflow™ adult nasal cannula (Small size). Thereafter, the interface was well tolerated for 2 months but no transcutaneous oxycapnography was performed during this period. Ultimately, the patient was discontinued from the respiratory support and a subsequent transcutaneous oxycapnography showed a normalization with a median SpO_2 of 99%, an ODI of 5 events/h and a median $PtcCO_2$ of 44 mmHg.

The fourth patient was a girl born prematurely at 24 GA + 6, presenting a severe bronchopulmonary dysplasia, who required a therapy by high-flow nasal cannula (Optiflow) at 6 L/min. A nocturnal transcutaneous oxycapnography, performed with Optiflow at 39 GA + 1 of corrected age, showed a median SpO_2 of 94%, with 10% of the time spent with a SpO_2 <90%, an ODI at 69 events/h, and the whole time spent with a $PtcCO_2$ >50 mmHg (median $PtcCO_2$ of 55 mmHg). At 41 GA + 6 of corrected age, another nocturnal oxycapnography with Optiflow at 6 L/min showed that 70% of the nighttime was spent with a $PtcCO_2$ >50 mmHg (median $PtcCO_2$ of 54 mmHg). Because of the small head circumference (34 cm) and dolichocephaly, the nasal mask interface was not tested. A CPAP titration was therefore performed, and CPAP was set at a level of 4 cmH_2O (device: Luisa, Löwenstein Medical; Optiflow™ Junior 2 nasal cannula, Infant size). The nocturnal oxycapnography improved, with a median $PtcCO_2$ of 47 mmHg and 2% of the time spent with a $PtcCO_2$ >50 mmHg. The patient is currently under CPAP at 4 cmH_2O.

3. Discussion

Our report highlights the successful use of the Optiflow™ nasal cannula with chronic CPAP in young infants, in agreement with the findings of Overbergh et al. [3]. A whisper valve was always added to prevent CO_2 rebreathing, even though some leaks were present around the nasal cannula, but also to avoid the obstruction alarm activation by some ventilators. Nasal cannula appears to be an interesting alternative to the "classical" interface for children, in case of nasal mask intolerance or inadequate nasal mask fitting. The parents felt very comfortable with the use of this interface, which they reported to be small, adequate for their child and easier to manage than the nasal mask. However, the tolerability and safety, i.e. with regard to CO_2 washout, should always be checked, and potential skin injuries regularly monitored.

A limitation of the study was that we did not perform a polysomnography to diagnose OSA and/or to assess CPAP efficacy in all the patients. However, due to the clinical situation of the second and fourth patients, baseline polysomnography was not feasible in spontaneous breathing. Moreover, oxycapnography has been used to screen for sleep disordered breathing in infants with obstructive clinical patterns, with good results [4,5]. Finally, the follow-up of CPAP with oxycapnography has also been shown to be efficient [6,7]. A limitation of the use of nasal cannula is that it was not always possible to have a breath-by-breath analysis of airflow using built-in software of CPAP devices, due to the lack of airflow detection with some devices. Therefore, only trends data of CPAP use and leaks may be useable.

In conclusion, this pilot study confirms that the Optiflow™ interface may constitute an interesting alternative for nasal masks for chronic CPAP use in young infants. At the present time, the Optiflow™ interface Ventilator Transition Kit is designed to be used with ventilators that deliver only heated and humidified nasal high-flow therapy. Therefore, it is not intended to be used with ventilators that deliver CPAP. This interface should thus not be proposed as a first choice. Oxycapnography should be performed to assess the efficacy of CPAP when using this interface. Further studies are thus necessary to prove the clinical benefice, the efficacy with regard to the correction of OSA, and the safety of Optiflow™ interface with home CPAP devices.

CRediT authorship contribution statement

Sonia Khirani: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Plamen Bokov:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Marine Dosso:** Writing – review & editing, Visualization, Validation, Investigation, Data curation. **Lucie Griffon:** Writing – review & editing, Validation, Investigation, Data curation. **Clément Poirault:** Writing – review & editing, Validation, Data curation. **Benjamin Dudoignon:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Brigitte Fauroux:** Writing – review & editing, Validation, Data curation.

Ethics statement

Ethical approval obtained (CPP Sud Ouest et Outre-mer IV; CPP2021-01-013a/2020-A003083-36) and written consent obtained from parents. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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