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Postextubation airway management with nasal continuous positive airway pressure in a child with Down syndrome

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Abstract
We describe our experience with use of variable-flow nasal continuous positive airway pressure (NCPAP) to manage postextubation stridor in a 31-month-old child with Down syndrome (DS). Although it has been recognized that children with DS tend to develop obstruction of the upper airway postoperatively, little is known concerning appropriate management of this situation. Although there are surprisingly few reports of use of variable-flow NCPAP for children older than preterm infants, we successfully treated postextubation ventilatory complications by providing variable-flow NCPAP without complications such as pneumothorax.

Key words Down syndrome · Nasal continuous positive airway pressure · Post-extubation stridor

Introduction

Although it has been generally recognized that children with Down syndrome (DS) tend to develop obstruction of upper airway postoperatively [1], specific recommendations for management of this complication have not yet been offered. We report that variable-flow nasal continuous positive airway pressure (NCPAP) improved postextubation stridor and retraction in a 31-month-old child with DS.

Case report

A 31-month-old male patient (81.7 cm, 11.1 kg) with DS presented for elective radical repair of an endocardial cushion defect. Obstructive sleep apnea syndrome (OSAS) was suspected, because he suffered from partial sleep apnea and had many predisposing factors for OSAS, as do other children with DS: he was hypotonic and had hypertrophic adenoids and tonsils. Moreover, he had paralysis of the right recurrent laryngeal nerve as a complication of pulmonary artery banding at the age of 1 month.

Anesthesia was provided using air/oxygen (75%/25%), sevoflurane, and fentanyl (total dose, 600 μg), and an endotracheal tube (internal diameter, 4.5 mm) was placed. The surgical procedure was completed, and he was transferred to the ICU with the tracheal tube in place. The trachea was extubated because he had emerged sufficiently from anesthesia 3 h after the end of surgery and his general condition was good. There were no signs of upper airway obstruction immediately after extubation. However, 14 h after extubation, stridor and intercostal/subcostal retraction developed without good cause immediately after he fell asleep. He became agitated with labored breathing (about 30 breaths·min^{-1}), and oxygen saturation ($S_{p_{O_2}}$) began to fall below 90% despite nasal application of O_2 at 3 l/min. His airway could not be kept open even by displacing his mandible anteriorly with the cervicooccipital joints extended.

NCPAP was administered with an Infant Flow Driver (IFD·VIASYS Healthcare, CA, USA) (Fig. 1). He never made any complaint about NCPAP and fell asleep again. A continuous flow rate of 10 l·min^{-1} generated approximately 5 cmH_2O of continuous distending pressure (CDP). His airway patency improved, respiratory rate decreased to 15 breaths·min^{-1}, and $S_{p_{O_2}}$ recovered to 98% ($F_{I_{O_2}}$, 50%) in response to NCPAP. Peak airway pressure decreased gradually over half a day, and NCPAP was discontinued. After cessation of NCPAP, airway patency was maintained and $S_{p_{O_2}}$ remained 98%. NCPAP was successfully applied to this infant without complications such as pneumothorax or nasal injury.

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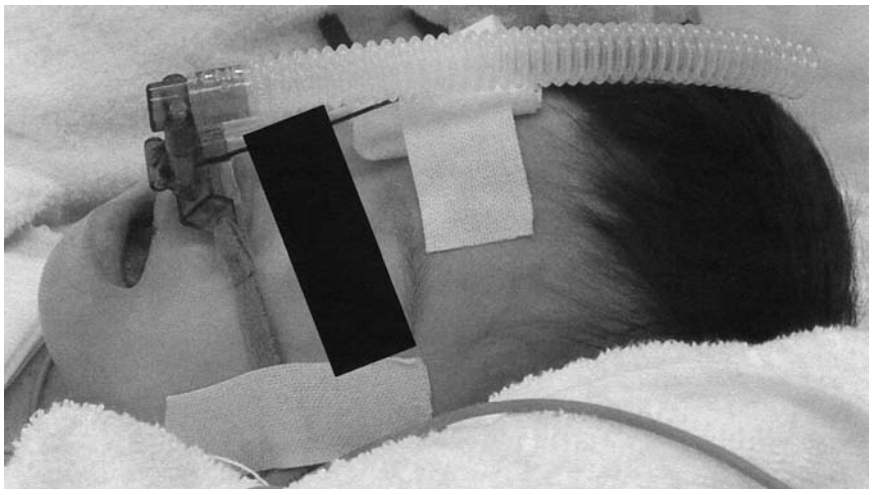

Fig. 1. Patient with Infant Flow Driver in use

Discussion

We have described our experience using NCPAP to manage post-extubation stridor in a child with DS. A previous study showed that children with DS have smaller airways than healthy children and recommended use of smaller endotracheal tubes to prevent laryngeal edema or subglottic stenosis [2]. However, few special attempts to manage postextubation stridor have been made so far.

NCPAP enabled us to keep our patient's upper airway open. It was vital in this patient to avoid airway obstruction and the resultant hypoxia and respiratory acidosis, which could lead to pulmonary hypertensive crisis. He initially had no ventilatory problems after extubation of the trachea, but stridor and retraction appeared after he fell asleep. We administered NCPAP because it has been demonstrated to manage OSAS successfully in children [3]. NCPAP immediately resolved the airway obstruction, whereas the tip-up was ineffective. His respiratory condition improved with provision of NCPAP as measured by Sp_{O_2} and physical signs. We did not perform endotracheal reintubation, because most patients with DS have subglottic or midtracheal stenosis and their prolonged intubation often causes mucosal injury or laryngeal edema.

We believe that variable-flow NCPAP serves not only to relieve airway obstruction but also to reduce the work of breathing by the patient. On inspiration, negative pressure in the nasal cavity created by the patient gives rise to a pressure gradient between the patient's nasal cavity and the respiratory circuit, and inspiratory jet flow goes into the airway, which thus relieves inspiratory effort. On expiration, positive pressure in the nasal cavity directs the jet flow toward the exhaust duct; this is based on the "Coanda effect" theory [4]. It has been demonstrated that variable-flow NCPAP is more effective to restore functional residual capacity [5] and to decrease work of breathing [6] than constant-flow NCPAP. We thought that these effects of NCPAP might improve ventilation dysfunction although the patient was hypotonic and his respiratory effort was weak.

Other studies showed that the IFD is superior to constant-flow NCPAP in managing respiratory distress syndrome (RDS) in newborns [7]. However, there have been surprisingly few studies on the use of variable-flow NCPAP in older children. The reasons for this might be as follows: (i) it has been thought that the inspiratory flow rate of the machine is not fast enough for such larger children, and (ii) it has been taken for granted that children will not accept NCPAP due to its discomfort. However, we were able to use the IFD for a 31-month-old child who weighed 11.1 kg and whose symptoms of upper airway obstruction disappeared after administration of NCPAP. He tolerated NCPAP well and exhibited no signs of discomfort.

In conclusion, variable-flow NCPAP improved postextubation stridor and retraction in a relative large child with DS. Use of the NCPAP appears to be feasible to manage postoperative ventilatory complications in Down syndrome.

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