Avoidance of Reintubation by Using Sedation during Noninvasive Positive Pressure Ventilation in a 3-Month-Old Infant with Postoperative Respiratory Failure

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Abstract

Maintaining alertness during noninvasive positive pressure ventilation (NPPV) is important, but there are no established guidelines for the use of sedation. We report our first experience of an infant with postsurgical vocal cord paralysis, severe stridor and breathing difficulties, who was reintubated after NPPV treatment without sedation, but who avoided a third reintubation through the use of sedation with the second NPPV treatment. NPPV treatment with the proper sedation can improve blood gas data in those patients with severe dyspnea, which can occur during respiratory care in several situations, and can affect not only infants, but also adults including elderly patients.

Key words: cardiovascular surgery, noninvasive ventilation, sedation, vocal cord paralysis

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Case Report

A 3-month-old boy with trisomy 21 and coarctation of the aorta (COA), cardiac atrial (ASD) and ventricular septal defect (VSD), patent ductus arteriosis (PDA) and severe secondary pulmonary hypertension (height, 48.4 cm [-2.8 SD]; weight, 2.9 kg [-3.0 SD]; human atrial natriuretic peptide level, 261.0 pg/mL; human brain natriuretic peptide level, 192.6 pg/mL) underwent cardiovascular repair surgery (that is, COA repair, closure of ASD and VSD, and PDA ligation) and was transferred postoperatively to the intensive care unit with conventional mechanical ventilation. Chest X-ray showed left upper lobar collapse. Flexible optical bronchoscopy (FOB) revealed extrabronchial compression causing mild obstruction in the left main bronchus, which was thought to have resulted from the aorta repair. On postoperative day (POD) 7, the endotracheal tube was removed, followed by slight stridor and gradual arterial carbon dioxide retention (Fig. 1). On POD 10, percutaneous oxygen saturation fell to 85% while he was breathing 12 L/minute oxygen via a face mask. He exhibited respiratory distress and loud stridor and NPPV was immediately started with 12 L/minute oxygen in timed mode (30 breaths/minute, inspiratory positive airway pressure (IPAP) 11.0 cm water, expiratory positive airway pressure (EPAP) 7.0 cm water) with a nasal mask of infant size (ResMed, Bella Vista NSW, Australia). Oxygen saturation remained around 93% and otolaryngeal examination revealed unilateral vocal cord paralysis (UVCP). Tracheal intubation was repeated and conventional mechanical ventilation applied. A repeat FOB on POD 15 showed only mild stenosis in the left main bronchus; the left upper lobar collapse improved, although remained during mechanical ventilation (Fig. 2a). On POD 17...
after endotracheal tube removal, NPPV was applied immediately to prevent postextubation failure in timed mode (the same setting as above). Within a few hours, severe respiratory distress and stridor developed. Asynchrony was apparent between NPPV and the patient when awake. As we thought that reintubation might worsen the UVCS and that the increased work of breathing was causing stridor and the worsening oxygenation, intravenous midazolam (0.18 mg/kg/h) and chlorpromazine (0.3 mg/kg/h) were administered with NPPV. The level of sedation was determined by the clinical assessment of a decrease in the excessive effort of breathing. Good synchronization with the NPPV instrument was achieved, the stridor resolved and his condition stabilized. Atelectasis disappeared on chest X-ray (Fig. 2b). NPPV was shifted toward nocturnal use on POD 28 and weaning from NPPV occurred on POD 42 (Fig. 2c). Vocal cord movement was normal on otolaryngeal examination on POD 64. The patient was discharged from hospital on POD 67.

Discussion

The safety of sedation in patients receiving NPPV treatment, who do not tolerate NPPV well, has not been established definitively. Because of this, in the past in our hospital, we have not sedated patients experiencing severe respiratory issues, including adults, the elderly, children and infants under 1 year of age (1-4). In practice, however, sedatives are occasionally administered with care to infant cases experiencing severe agitation or anxiety (5-7). However, in Asian countries (including Japan) there have been no reports of the use of sedative drugs during NPPV treatment either in children or in adult patients. Recently, the result of a survey of sedation practices during NPPV treatment for acute respiratory failure has been reported (8). In this survey, sedation during NPPV treatment was administered to patients with COPD exacerbation, cardiogenic pulmonary edema, do-not-intubate, extubation failure, neuromuscular disease, obesity, hypoventilation, and others. However, Australia/Asia accounted for only 3.3% of the total responders. In addition, we could find no report in the English abstracts of papers published from the Asian region, including Japan, on the use of sedative drugs during NPPV treatment either in pediatric or adult cases. Thus, further investigation is required worldwide, including the Asian region.

In the present case, vocal cord stenosis due to unilateral vocal cord paralysis might have generated highly negative pressure, which based on Bernoulli’s principle, might have possibly exacerbated vocal cord stenosis and severely increased the work of breathing (9). The benefits of sedation were partly due to relief from excessive respiratory effort that might increase vocal cord stenosis; therefore, NPPV
could easily open the vocal cords and assist ventilation. As described in our previous report, when NPPV is given to children, especially infants, this age group of patients generally refuses it initially, but will eventually come to accept the treatment once they see how it alleviates their symptoms such as dyspnea (1, 2). However, in the present case, the patient had never accepted NPPV treatment for his severe dyspnea as this could not be alleviated by NPPV. It is important to choose treatment carefully when deciding if a patient should receive NPPV under sedation or conventional mechanical ventilation via thoracostomy. In recently published original research papers and reviews, both intubation and tracheostomy were said to be associated with a number of adverse effects and, particularly in the pediatric population, complication rates of mechanical ventilation were as high as 40% (9), and those of tracheostomy as high as 51% (10). In addition, in our considerable and successful experience of NPPV treatment in pediatric patients (1-4), we generally use NPPV initially while we monitor and fully prepare for the conversion to endotracheal ventilation. In addition to NPPV treatment, however, sedation proved helpful for the current patient as mentioned above, and his symptoms and extent of lung collapse improved, as shown on the chest X-ray. During NPPV treatment of pediatric patients, including this case, it is important to watch for abdominal distension, which could induce vomiting and aspiration. To protect against these problems developing, we regularly check abdominal X-rays, in addition to careful physical inspection. We usually use a nasal mask and insert a gastric tube if necessary. Such cases may also occur in adults. At the start of treatment with NPPV, patients sometimes hesitate to use it because of discomfort. In such situations, we should intubate these patients, and use a ventilator if required (11). However, if the patient does not want to be intubated, it might be necessary to continue NPPV treatment (12). In these situations, NPPV treatment with sedation

Figure 2. Chest X-ray showing change in the left upper lobar atelectasis on a) postoperative day (POD) 15 and b) POD 27. Photo of patient on ventilator is shown in c). Notice that atelectasis existed during mechanical ventilation on POD 15 (Fig. 2a) but was not present during NPPV treatment on POD 27 (Fig. 2b).
may be helpful.

Monitoring sedation is an important issue. We used sedation to decrease the patient’s excessive effort of breathing, which was thought to be worsening his stridor. Thus, we monitor our patients by the clinical assessment of the effort of breathing and stridor. It has been reported that most physicians monitor patients who are sedated during NPPV treatment by the clinical end points rather than by using a sedation scale widely used in ICU practice (8, 13). In the future, a sedation scale for NPPV treatment should be developed according to the accumulated experience. In addition, morbidity with symptoms might be improved by NPPV (12), as indeed was observed in this case.

UVCP is not an uncommon cause of perioperative postextubation failure, and its incidence after pediatric cardiac surgery ranges between 0.7% and 8.8% (14). One-third of patients with iatrogenic UVCP recover vocal function within 1.5 to 6.6 months (15). In the present patient, NPPV with sedation was effective not only in postextubation management of UVCP, but also in improving atelectasis, which is contrary to previous no-sedation strategies. Postoperative vocal cord paralysis occurs not only in infants, but also in adults. Therefore, we may encounter similar cases in adults as what we have described here in a 3-month-old infant (16-19).

Despite the limited clinical experience, this case clearly illustrates the utility of sedation in NPPV for a patient with postoperative vocal cord paralysis. In addition, NPPV with the proper sedation may be given to adult patients, including the elderly, who do not wish to be intubated. Proper sedation means that which appears to lead to a decrease in several symptoms such as dyspnea, discomfort, and anxiety and would allow the patient to continue to receive NPPV treatment. Because patients have worse outcomes, including death, when they fail on NPPV treatment, compared with those who avoid endotracheal intubation, the maintenance of a patient’s comfort in the absence of insufficient respiratory drive is an important goal of the therapy in order to optimize the chances of successful NPPV treatment (5-8).

References