J Anesth (2012) 26:449–452
DOI 10.1007/s00540-012-1324-7

CLINICAL REPORT

Anesthetic management during tracheotomy in a child with respiratory distress caused by severe intubation-induced glottic stenosis

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Received: 6 June 2010 / Accepted: 4 January 2012 / Published online: 5 February 2012

Abstract We provided anesthetic management during a tracheotomy procedure for a child who demonstrated labored respiration during inspiration because of severe glottic stenosis and bilateral vocal cord paralysis caused by tracheal intubation. A 4-year-old boy developed acute respiratory depression associated with influenza pneumonia and had been under respiratory management with mechanical ventilation with tracheal intubation for 3 days. Following extubation, an upper-airway obstruction immediately appeared. The symptoms later worsened because of development of a common cold, and the patient underwent an emergency tracheotomy. For anesthetic management, we used a combination of ketamine with low-concentration sevoflurane inhalation. The tracheotomy was performed safely without respiratory complications by employing manual-assisted ventilation, while spontaneous breathing was preserved by use of a face mask.

Keywords Tracheal intubation · Complications · Severe glottic stenosis · Tracheotomy · Ketamine

Introduction

Vocal cord edema and paralysis, along with glottic or subglottic stenosis, are frequently observed as complications following tracheal intubation [1–3]. However, an emergency tracheotomy is required in some cases because of progress of the disease state or development of a smothering infection symptom. We report anesthetic management during an emergency tracheotomy procedure in a pediatric patient who developed progressing vocal cord paralysis and severe glottic stenosis after extubation.

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Case presentation

The patient, a 4-year-old boy (height 105 cm, weight 16.8 kg) with no remarkable previous illness, visited a local physician with chief complaints of cough and dyspnea. Percutaneous oxygen saturation (SpO_2) measured at that time was 70%.

On admission to our hospital, chest X-ray images showed atelectasis and pneumonia. After determining that mechanical ventilation was required, tracheal intubation was performed under sedation. The tracheal tube was changed twice (5.0, then 5.5 ID non-cuffed tube) by an emergency room physician, as air leakage was severe. Finally, a 6.0 ID cuffed tube (Intermediate, Tyco Health Care, Japan) was used, without inflating the cuff, over a 3-day period.

Following extubation, inspiratory stridor, labored respiration, and extended inspiration were observed. Under a diagnosis of transient vocal cord edema following a tracheal intubation procedure, inhalation therapy with epinephrine and steroid was started. His symptoms were improving, but 5 days after extubation, the symptoms worsened suddenly, and SpO_2 declined remarkably to 60%. Tracheal reintubation was then performed smoothly using a 5.0 ID non-cuffed tube, which was removed the next day, as his breathing became stabilized, although inspiratory

stridor remained. A later laryngoscopy examination revealed that vocal cord edema remained severe. Cervical computed tomography (CT) findings on the 20th day after the first tracheal intubation revealed swelling of the epiglottis, vocal cords, and subglottic anterior wall with associated airway stenosis (smallest diameter, 1.4 mm) (Fig. 1). A tracheotomy was considered; however, his parents strongly requested that such a procedure could be avoided. Thus, the patient was only given inhalation therapy and was discharged from the hospital on the 60th day after admission.

A common cold developed on the 10th day after discharge, and the patient was hospitalized again with respiratory distress. A laryngoscopy examination revealed that the vocal cords were fixed nearly at the midline, then an emergency tracheotomy procedure was scheduled.

The patient was taken to the operating room after securing a peripheral route without any premedication. Atropine at 0.01 mg/kg was given intravenously, and he was kept in a sitting posture for 10 min under pure oxygen administration through a face mask. Next, we administered 1 mg/kg ketamine intravenously. By fitting the mask carefully, the jaw was lifted and the neck was extended. Under an administration of pure oxygen and 1.5% sevoflurane, spontaneous breathing could be maintained at 10–14/min, and SpO_2 was kept at 97–100% with manual mask ventilation. At 6 min after the start of surgery, a surgical incision was made on the trachea, and SpO_2 declined to 70%, as mask ventilation became impossible due to transient breath holding. However, spontaneous breathing resumed immediately, SpO_2 recovered quickly up to 95%, and 0.5 mg/kg ketamine was added as the respiration rate increased. In 10 min after the start of surgery, the airway was secured by inserting a 5.0 ID cuffed tube directly into the trachea. Thereafter, the dose of sevoflurane was increased to 2% and 3 μg/kg fentanyl was infused intravenously. Direct laryngoscopy revealed edema at the false vocal midline because of fixation of the vocal cords (Fig. 2). The surgery was completed in 1 h 23 min. The patient was able to take liquid and food orally by that evening, and did not require oxygen the following day.

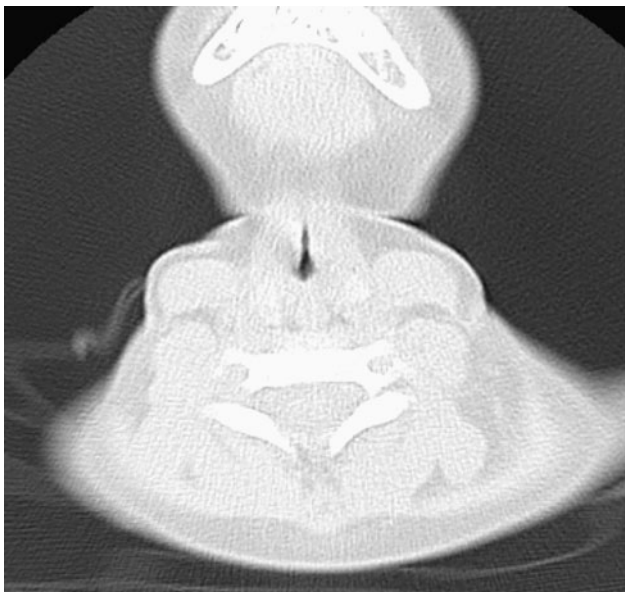

Fig. 1 Computed tomography findings revealed narrowing of the trachea at horizontal plane level of glottis cartilage (anterior part, 1.4-mm diameter; posterior part, 2.5-mm diameter)

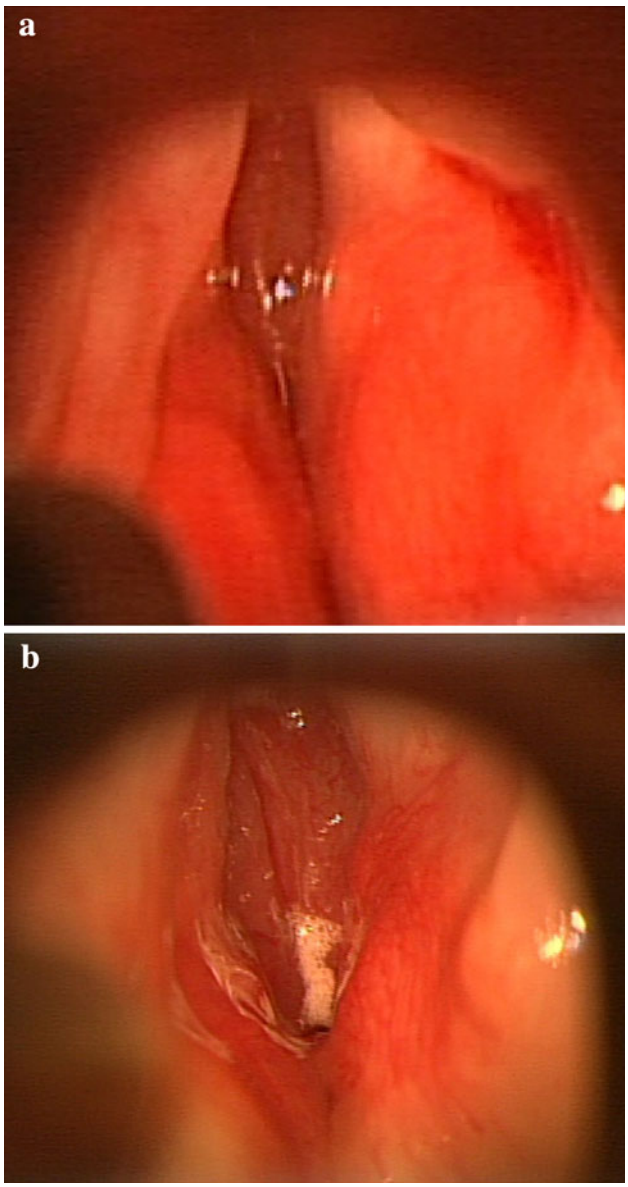

Fig. 2 Laryngoscopic observations: severe swelling of false vocal cord (**a**); complete fixation of vocal cords (**b**)

Discussion

Glottic or subglottic stenosis is an obstructive airway condition caused by tylosis of the soft tissue and dysplasia of the annular cartilage. It consists of the congenital and acquired types, with the latter induced by tracheal intubation and other factors.

Vocal cord paralysis and airway stenosis are frequently observed as post-intubation complications. Above all, subglottic stenosis develops easily, especially in children, as the cricoid cartilage is the narrowest part of the airway in children. It is likely that excessive pressure might be exerted on the mucosa of the cartilage even if the endotracheal tube passes through the glottis. Damage to the mucosa from excessive pressure and tube movement causes local blood flow obstruction, edema, necrosis, and further granulation, which results in subglottic stenosis. In addition, some complications are caused by stenosis associated with intubation manipulation, as well as excessive pressure on the mucous membrane of the vocal cord by movement and bucking [1–3].

Causes of intubation-induced airway stenosis include edema of the vocal cords, larynx, and uvula, which occurs immediately after extubation, and granulation, which is often associated with inflammation and infection 1–3 weeks later. Edema immediately after extubation is frequently improved by epinephrine inhalation and steroid administration. However, that caused by granulation hardens not only the subglottis but also the vocal cords, and vocal cord paralysis frequently requires surgical treatment [4]. In the present case, the respiratory difficulty that occurred after removal of the first tracheal tube might have been caused by airway edema. On the other hand, we speculated that the consequent respiratory difficulty might have been caused by paralysis and fixation of the vocal cords, which had hardened because of subglottic granulation. In this case, perhaps the timing of extubation was too early, and we should have postponed the extubation or replaced with a smaller-sized tube if there was little or no leakage. However, it was difficult to prevent the latter type of stenosis, even if the cuff leak test was satisfactory.

A tracheotomy under local anesthesia would likely caused fear and psychological stress, as the patient was only 4 years old and lacked understanding of the surgery. After taking other factors into consideration, such as excitement that might further aggravate the respiratory state and frequent movements during the delicate pediatric tracheotomy procedures that could make the operative procedure more difficult, we considered that the choice of general anesthesia was essential. In our preoperative airway evaluation conducted on the basis of laryngoscopy and CT findings, as well as clinical symptoms, we were concerned that the vocal cords might be nearly closed and that subglottic stenosis might be present. We also considered that a tracheal tube of proper size for sufficient ventilation might not pass through the glottic gap, and that sufficient positive-pressure ventilation might be difficult under muscular relaxation, while spontaneous breathing might not be possible. Therefore, we performed respiratory management to preserve spontaneous breathing by avoiding the use of a muscle relaxant.

For respiratory management during surgery, we selected assisted manual ventilation with a face mask. In a prospective study of the frequency of airway complications encountered when using a laryngeal mask, tracheal intubation, or a face mask, of 1,996 infants who underwent general anesthesia, complications such as glottic spasm and tube trouble were observed in 157 (7.87%). The rates of incidence amounted to 10.2% for a laryngeal mask, 7.4% for tracheal intubation, and 4.7% for a face mask. Thus, it was concluded that a face mask provided the greatest amount of safety [5].

Ketamine used for maintaining anesthesia has a low degree of respiratory depression. Furthermore, it causes bronchodilatation and has strong analgesic actions for superficial perception [6], which enables anesthetic management while preserving spontaneous breathing. A demerit is an increase of secretion. However, we did not encounter any problem when atropine was administered 10 min before anesthesia induction. Moreover, low-concentration sevoflurane inhalation can be used safely, as it has a lower degree of respiratory depression [7]. Nevertheless, countermeasures should be prepared for cases in which ventilation might be impossible, such as an intravenous indwelling needle and an intravascular sheath to be inserted into the trachea to replace the tracheal tube, as well as an emergency surgical airway and jet ventilation [8].

For selecting a properly sized tube, air leakage around the tube is usually checked under bag pressurization of 20–30 cm H_2O after endotracheal intubation. We are likely to change the tube when a leak is present at a pressure of 10 cm H_2O. However, it is rather risky to change the tube size by confirming the presence of air leakage after tracheal intubation.

Recently, the American Heart Association guidelines for Pediatric Advanced Life Support recommend use of a small-sized cuffed tube for children [9]. Non-cuffed tubes have a number of problems, contaminate the room with anesthetic gas, have a risk of aspiration, and cause fluctuations in ventilatory volume by air leakage. Those problems can be solved by use of a cuffed tube [10–12]. On the other hand, the disadvantages of a cuffed tube include elevated airway resistance because of the smaller diameter and high cuff pressure that is likely to damage the airway mucosa. However, possible damage to the airway and tracheal mucosa have been reported when using non-cuffed

tubes [13, 14]. Accordingly, we need to know the merits/demerits of both tubes.

Now (10 months after the operation), he still needs tracheostomy; however, the bilateral laryngeal nerve paralysis is gradually improving, and he can speak with a speech cannula. The ENT doctor says that it is possible to close the tracheotomy soon.

In conclusion, we provided general anesthesia during an emergency tracheotomy procedure without serious problems in a child with glottic stenosis and bilateral vocal cord paralysis caused by tracheal intubation. We found that assisted ventilation with a face mask and administrations of ketamine and low-concentration sevoflurane were effective.

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