Pediatric Microcuff Tube for Neurosurgical Procedures: A Boon or Bane?

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Abstract

Pediatric Microcuff endotracheal tubes have come into vogue in the last few years. It overcomes the problems faced with the uncuffed or conventional cuffed tubes used in the pediatric population. In addition, the more distal placement of the polyurethane cuffs in these tubes eliminates the risk of airway mucosal injury and hence postoperative stridor. This makes it an attractive option for neurosurgical patients where there is a high incidence of cranial nerve deficit, airway edema, and the requirement of prolonged postoperative ventilation. But due to this particular design, Murphy's eye is not incorporated in the tube, which can potentially hamper ventilation, especially when used for long duration surgery. With the help of our case report, we would like to warn the readers regarding this life-threatening complication that resulted in hypoxia in a 1-year-old child in the postoperative period.

Keywords
- intracranial pressure
- Microcuff tube
- pediatric patients

Introduction

Brain tumors in the pediatric age group are often infratentorial, which require a prone position for surgical resection and can lead to airway edema and lower cranial nerve deficits in the postoperative period. A pediatric Microcuff tube can be used to overcome the problem of aspiration and airway mucosal injury and postoperative stridor. We report a case of airway obstruction due to the use of this Microcuff tube seen in the postoperative period of a 1-year-old child operated for a fourth ventricular tumor in the prone position.

Case Report

An 18-month-old child, weighing 7 kg, born of normal delivery, presented with a history of neck tilt to the right side for 3 months with features of raised intracranial pressure as evidenced by a history of vomiting, lethargy, and irritability, for 2 months along with recurrent upper respiratory tract infections. His magnetic resonance imaging of the brain revealed a large intra axial mass lesion measuring $4.5 \times 6 \times 5.6$ cm in the posterior fossa arising from the fourth ventricle, causing obstructive hydrocephalus. He was posted for a midline suboccipital craniotomy and decompression of the tumor in the prone position.

In the operating room, standard American Society of Anesthesiologists-recommended monitoring, such as electrocardiography, noninvasive blood pressure, and pulse oximetry, was initiated. As the patient did not have intravenous access in situ, inhalation induction was done with 8% sevoflurane with 6 L/min of 100% oxygen, and a 20-gauge peripheral intravenous access was secured. Intravenous fentanyl (14 µg) and vecuronium (1 mg) were administered to facilitate endotracheal intubation. A 4.0-sized (ID mm)

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Microcuff endotracheal tube (ETT) was inserted, and after confirming the optimal position, ETT was secured. There was an audible leak after the ETT insertion, and hence cuff was inflated with 2 mL of air. After the cuff inflation, the cuff pressure was checked with the help of a cuff pressure manometer and pressure was maintained at 15 cm H_2O.

Anesthesia was maintained with sevoflurane with a MAC of 1.0 with an oxygen and air mixture of 1:1 ratio and fentanyl infusion of 10 µg/h. After securing an ultrasound-guided 5.5 Fr right-sided internal jugular vein central venous access and a 22 gauge right radial arterial access for invasive blood pressure monitoring, the patient was turned prone after ensuring all the precautions for the prone positioning. A midline suboccipital craniotomy was performed with the head fixed on a Mayfield clamp with the neck flexion of around 60 degree from the midline with two finger breadths between the chin and the sternum. The procedure lasted for 6 hours with a blood loss of 300 mL which was replaced with blood components in a 1:1 ratio. In addition, there was a significant brainstem handling as evidenced by two episodes of transient bradycardia, which reverted after cessation of the surgical stimulus. After completion of the surgery, the child was turned supine and an oral suctioning was performed. The child was shifted to the intensive care unit (ICU) for further management. In ICU, he was kept on Synchronized Intermittent Mandatory Ventilation with settings of FiO_2 of 50%, tidal volume of 50 mL, respiratory rate of 25/min, and pressure support of 12. A sudden increase in peak airway pressure from 14 to 30 mm Hg was noted after 1 hour of ventilation, triggering the ventilatory alarms. There was a drop in oxygen saturation from 100 to 65% and significant bradycardia of up to 20 bpm from a baseline of 120 bpm, during which 100% FiO_2 and Inj Atropine 0.2 mg were given. A checklist was initiated to rule out the potential causes of raised airway pressure, including screening for any kink in the tube or circuit, tube bite, and inadequate sedation. An attempt at endotracheal suction with a 10 Fr suction catheter was made and the catheter could not be negotiated, following which 8 size (2.7 mm) infant feeding tube was tried which also could not be passed due to a probable blocked ETT. The Microcuff tube was immediately changed to a 4.0-sized uncuffed ETT, following which the airway pressures normalized and vitals returned to baseline. On examination of the Microcuff tube, we found a white mucous plug inside the tube, which had led to the symptomatic tube obstruction. The absence of the Murphy's eye in the Microcuff tube had led to sudden respiratory distress. The child was then extubated after evaluating for the presence of cough and gag reflexes. The rest of the postoperative period was uneventful, and the patient was discharged home on the seventh postoperative day.

Discussion

Uncuffed ETT has conventionally been preferred in children to avoid trauma to the subglottic region. However, it has various disadvantages, the main being the multiple attempts at tracheal intubation for choosing the appropriate ETT size, unreliable monitoring of ventilatory parameters, inability to use low flow, higher incidence of air pollution, and an increase in the risk of aspiration.[1] The typical cuffed ETT is not used in infants due to the risk of airway mucosal injury leading to subglottic stenosis. Besides, the poor design can lead to the risk of cuff placement at the vocal cord level if used according to the appropriate age formula resulting in cord injury and edema.[2] Also, there is no clear consensus on an adequate safe limit of cuff pressure in pediatric patients. Various Microcuff tubes (Microcuff Pediatric Tracheal Tube, Microcuff GmbH, Weinheim, Germany and Microcuff PET; Kimberly Clark, Health Care, Atlanta, Georgia, United States) have been specially designed to overcome these problems.[1,3] Microcuff ETT provides an adequate sealing with its ultrathin polyurethane cuff, which is placed more distally below the subglottic area. The more distal placement of the cuff resulted in eliminating Murphy's eye from these designs.[4] The Murphy's eye functions as a vent during the occlusion of the distal opening of ETT. A large multicentric trial has proved the advantage of using these ETTS, which reliably seal the airway without increasing the incidence of postoperative stridor.[5] This makes the Microcuff tube an attractive option for neurosurgical patients. Most of these patients are at high risk of aspiration in the perioperative period due to the high incidence of lower cranial nerve deficit, especially in those undergoing posterior fossa surgeries.

Additionally, this subset of patients undergo long surgeries in various positions such as prone and lateral and have prolonged ICU stay. Therefore, accurate monitoring of ventilatory parameters is desirable in these patients. Furthermore, it is pertinent to avoid multiple intubation attempts and ETT changes, as this could further increase the intracranial pressure. However, in this case, using a Microcuff tube proved to be hazardous as it led to severe hypoxia, probably due to the absence of the indispensable Murphy's eye. This was followed by the parasympathetic surge resulting in bradycardia which is commonly encountered as a response to hypoxia in infants. As evidenced in the literature, airway obstruction is detrimental in the neurosurgical population. In addition to respiratory embarrassment, it also leads to increases in intracranial pressure and secondary neurological injury. The overall incidence of partial tube obstruction is 10 to 20% with total occlusion occurring in 4% of patients, which is more commonly associated with smaller ETTs with an internal diameter of $\leq$4.0 mm.[6] To date, symptomatic tube obstruction with a Microcuff tube has been reported very sparsely.[6] A recent study has also disfavored the use of the Microcuff tubes by demonstrating that the proximal end of the cuff is near the cricoid cartilage, potentially increasing the cuff-induced mucosal pressure injury at the cricoid outlet, which is the narrowest area in the pediatric population.[7] These changes can be even more harmful when the head is manipulated,[8] which is common in neurosurgical patients as the head is often maneuvered to facilitate optimum surgical access before the skeletal fixation.

The postoperative tube blockade is not uncommon among pediatric patients, however, it can become more deleterious in absence of Murphy's eye. The overall occurrence of distal ETT obstruction is not affected by the presence of Murphy's eye, but it rather enables ventilation during the distal obstruction event.[6] With the help of this report, we wish to draw our colleagues' attention to the possibility of this serious complication of either partial or complete tube obstruction with the use of a Microcuff tube. Though the Microcuff tube looks appealing and is marketed as being a safer alternative, it can prove to be detrimental, especially when used for long duration surgery.

Conflict of Interest
None declared.

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