Maneuvers To Relieve The Endotracheal Tube Obstruction Caused By The Bevel Orifice Abutting The Trachea In The Prone Position

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Abstract

Endotracheal obstruction can be life threatening complication and immediate intervention is needed. Evaluation and maneuvers to relieve the obstruction can be difficult if this occurs in a patient positioned prone. We report a case intraoperative airway obstruction caused by the abutting of the endotracheal tube orifice against the tracheal wall in the prone position. We describe the steps performed in evaluating and recognizing the cause of endotracheal tube obstruction in our patient as management of this complication. These simple maneuvers uncommonly used can also be employed in intensive care units in patients with long term ventilator support in prone position.

Introduction

Acute endotracheal tube (ETT) obstruction is a potentially life-threatening situation and rapid recognition and intervention is essential [1]. We report a case of partial ETT obstruction caused by the abutting of the ETT orifice against the tracheal wall in the prone position during a posterior spinal fusion surgery. We describe the steps performed in evaluating the cause of ETT obstruction in our patient as well as simple maneuvers to relieve the obstruction. The same maneuvers can be used in intensive care units (ICU) in patients with long term ventilator support in prone position.

Case Report

A 15-year-old male, weighing 62 kilograms with a history of idiopathic scoliosis and Cobb’s angle of 65 degrees was scheduled to undergo posterior spinal fusion under general anesthesia. His vital signs included a heart rate of 80 beats/minute, blood pressure of 112/68 mmHg, oxygen saturation of 100% on room air and a temperature of 36.8°C. Past medical history did not reveal any co-morbidity except occasional seasonal allergies, for which he was treated with oral antihistamines. The rest of the physical exam was within normal limits. An 18 G intravenous catheter was inserted in preoperative holding area and intravenous diazepam 10 mg was given for anxiolysis. In the operating room, standard ASA monitors were applied and anesthesia was induced with intravenous fentanyl 200 mcg and propofol 150 mg. Cisatracurium 12 mg was administered intravenously to facilitate tracheal intubation. Cisatracurium was chosen for its intermediate duration of action to avoid any interference with intraoperative motor-evoked potential monitoring. A standard left-beveled 6.5 mm internal diameter high volume low pressure cuffed Mallinckrodt® ETT with a Murphy eye (Mallinckrodt Medical, St. Louis, MO, USA) was easily placed under direct laryngoscopy with a grade 1 view of the airway. Proper placement of ETT was confirmed by equal bilateral breath sounds and positive end tidal carbon dioxide (ETCO2). The ETT cuff was inflated to maintain an audible leak at 20 cm of H2O and the ETT secured at 22 cm at the lips. The lungs were mechanically ventilated with a tidal volume of 600 ml, a respiratory rate of 8 cycles/min and inspired oxygen at 50% with a peak inspiratory pressure of 18-20 cm H2O. Anesthesia was maintained with a mixture of nitrous oxide (50 vol. %), isoflurane (0.48 vol. %) and continuous infusion of propofol 100 mcg/kg/min and remifentanil 0.1 mcg/kg/min. After induction of anesthesia, 20 G right radial arterial and 7 F double lumen right internal jugular central venous catheters were placed using sterile techniques. A pre-operative chest radiograph confirmed proper position of the central line and showed the ETT in the mid-trachea position. The patient was then positioned prone with his head in a foam headrest and surgery commenced. Over the next few minutes, there was a gradual increase in the peak inspiratory pressures (PIP) to 38 cm of H2O and increase in end tidal carbon dioxide (ETCO2) to 45 mmHg without a decrease in the oxygen saturation. There was limited chest expansion, but no coughing or bucking on ETT. The position of the ETT at the lips was unchanged. Auscultation of the lungs revealed bilaterally diminished breath sounds but no wheezing. Visual inspection of the anesthetic circuit or the ETT did not show any kinking and
manual ventilation confirmed increased airway resistance and poor lung compliance. A 14 F suction catheter was passed through the lumen of the ETT to check the patency and aspirate any secretions. No secretions or any mucous plug could be suctioned from the ETT lumen; however the catheter could not be passed beyond the tip of the ETT. Deflating the cuff to rule out cuff herniation did not relieve the airway obstruction.

A fiberoptic bronchoscope (FOB) was then passed the ETT lumen. The FOB showed the ETT orifice abutting the left tracheal wall, thereby causing partial respiratory obstruction. The ETT cuff was hyperinflated to move the ETT away from the trachea wall. After hyperinflation of the cuff, the peak inspiratory pressures dropped down to 20 cm of H2O. It was easier to manually ventilate the patient and the lung compliance improved dramatically. On repeating FOB it was easy to negotiate into the trachea and the ETT tip was approximately 2 cm proximal to the carina. Re-examination of the chest x-ray showed the ETT orifice was not abutting the lateral tracheal wall although it was in the close proximity to it. The remainder of the surgery was uneventful. The patient’s trachea was successfully extubated at the end of the procedure in the operating room and the patient was transported to the intensive care unit for post-operative recovery. The patient was discharged home without any complications after five days.

Discussion

ETT obstruction in an intubated patient is a dreaded complication and is not uncommon. Evaluation and management may become more difficult if the patient is in prone position. The ETT obstruction can present as high peak inspiratory pressures (PIP), and / or as steadily increasing ETCO2 with or without decrease in oxygen saturation [2, 3]. Various causes of the ETT obstruction have been described, including mucous plugs foreign bodies blood clot, “biting down” on the ETT, external compression on the tube, endobronchial intubation, cuff herniation and defective ETT [3-10]. Rarely obstruction of the ETT may occur when the distal beveled orifice of the ETT abuts the tracheal wall. Brasch et al. in their anatomic studies with infant cadaver showed that ETT orifice can abut lateral or posterior tracheal wall depending on the head position and ETT orientation [11]. The obstruction of the tube orifice by the tracheal wall is more likely to occur if the infant’s neck is fully flexed, the ETT tip is relatively high or when infant’s head is positioned on one side [11-12]. This position of the ETT can be seen on radiograph, but clinically may not be immediately evident. Alterations in the ETT position also occur in adults with head or neck movement or change in the body position [13]. Steen et al described a case with fatal outcome of complete acute respiratory obstruction due to the ETT abutting the tracheal wall [14]. Han et al described the case of adult patient in whom the ETT became obstructed during flexion of neck for the craniotomy procedure. FOB revealed that the distal bevel of the endotracheal tube had come into contact with the tracheal wall causing partial obstruction [15]. Abutting of the endotracheal tube against the tracheal wall can also be a cause of ETT obstruction in prone ICU patients who are on long term ventilator support.

The prone positioning of the patients like in our case creates extra challenges to evaluate and treat different causes of ETT obstruction, which are otherwise easily recognized and treated in supine patients. In our particular case, we postulate that positioning the patient in prone position for the surgery may have caused the ETT orifice to abut the lateral tracheal wall leading to partial respiratory obstruction and increased PIP [11-13, 15]. Deflation of the ETT cuff may have caused the ETT orifice to further abut the tracheal wall (Illustration 1). Hyperinflation of the ETT cuff pushed the ETT orifice away from the tracheal mucosa, hence relieving the partial obstruction (Illustration 2). In the event of obstruction of main orifice of ETT, the Murphy eye provided an alternate route for ventilation and prevented complete respiratory obstruction. We considered pulling the ETT back a couple of centimeters or changing the direction of the bevel of the ETT by rotating the ETT 90°, but both these maneuvers are not easily accomplished with the patient in the prone position with an open back wound. In conclusion, our case illustrated three interesting management issues. The first issue consisted of a partial airway obstruction secondary to the ETT orifice abutting against the lateral tracheal wall and manifested by gradual increase in ETCO2 values and peak airway pressures. Even an appropriately placed endotracheal tube may get obstructed due to the left sided bevel. The ability to ventilate through the Murphy eye prevented complete airway obstruction and potential catastrophe [15, 16]. Hyperinflation of the ETT cuff moved the ETT away from the lateral tracheal wall and relieved the obstruction. Secondly, FOB has a role in early assessment of an adverse respiratory event in an intubated patient. Jarreau et al described an acoustic reflection method to detect positional airway obstruction due to the ETT abutting the tracheal wall in neonates [12]. Radiograph may
also be helpful in identifying the problem, however these methods are time consuming and not easily accomplished in the prone position [11]. Thirdly, ETT with small internal diameter and especially those without Murphy eye are more likely to obstruct in this manner and create airway emergencies [15, 16]. It thus remains vital to use ETT with Murphy eye to allow ventilation of the lung when the bevel of the endotracheal tube is occluded. The use of the cuffed ETT should be considered in the pediatric population in the prone position in order to avoid the above-mentioned complication. One maneuver which we could have attempted after FOB evaluation in this patient was to rotate the ETT 90° after the cuff deflation in an attempt to move the bevel away from the tracheal wall [17].

Hosking et al have proposed a practical algorithm for the management of airway obstruction [18]. We suggest that hyperinflation of the ETT cuff for a short period of time, followed by reevaluation by a FOB (to prevent tracheal mucosal injury) and the maneuver to rotate the ETT to move the bevel away from the tracheal wall (after cuff deflation) are incorporated in the algorithm of the steps taken for airway obstruction in an intubated patient.

References

Illustrations

Illustration 1

Endotracheal tube with deflated cuff, abutting the trachea
Illustration 2

Endotracheal tube with inflated cuff. Note the tube orifice moving away from the tracheal wall.
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