CASE REPORT

An unusual cause of difficulty in ventilation; a defective endotracheal tube connector

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ABSTRACT

We present a case of an unexpected difficulty in ventilation following intubation for mastectomy. Difficulty in ventilation during GA was due to manufacturing defect of the endotracheal tube. Ventilation difficulty due to tube defects are rare, moreover it might be hard to detect this kind of a defect with routine evaluation. However, if the defect is not detected it would may cause catastrophic results. In our case the problem was carefully evaluated and solved uneventfully after following an algorithm.

Key words: Airway obstruction; Intubation; Trachea; Intubation, Intratracheal; Equipment Failure; Catheter Obstruction; Equipment Failure Analysis

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INTRODUCTION

The differential diagnosis of difficulty in ventilation during general anesthesia (GA) includes problems with the endotracheal tube (ETT), respiratory circuit, the ventilator, as well as various problems related to the patient. Hyperactive airway and secretion are the most common causes related to the patient, whereas the main causes related to respiratory circuit are kinking and/or malpositioning of the ETT or the lines. Problems related to the ventilator have been rarely reported since they can be solved during preoperative tests and eliminated easily. There are mechanical obstruction reports in the literature due to all causes.[1-3]

It is important to establish an early diagnosis and fast management of the condition before it affects the patient. Moreover, in the differential diagnosis structural defects due to manufacturing processes should also be ruled out besides more common etiological causes. We report a case of partial obstruction due to a structural defect of the connector of an ETT.

CASE REPORT

A 42 year-old female with an American Society of Anesthesiologist (ASA) physical status I presented for elective mastectomy. Her medical history was unremarkable. Just before induction, the anesthesia machine (Julian, Draeger, Germany) was tested for leakage also all other preanesthetic checks were completed including the cuff of the ETT.

Following standard monitoring and preoxygenation, anesthesia was induced with intravenous (IV) propofol 2 mg/kg, remifentanil infusion 0.5 μg/kg/min and rocuronium 0.6 mg/kg. After uneventful facial mask ventilation the patient was intubated with a 7.5mm ID single lumen ETT. The manual ventilation was resistant, bilateral breath sounds were present and equal but decreased by auscultation. When the ventilator was connected, the end-tidal carbon dioxide ($EtCO_2$) was 40-45 mmHg, and with 30 cmH_2O peak airway pressure only 200-300 ml gas could be delivered to the patient. The place and level of the ETT was checked with direct laryngoscopy, and the tube was then repositioned to 18 cm to be at the level of lip corner. However, the auscultation findings didn't change besides wheezing could be heard. The respiratory circuit with the ETT connector *on it* was disconnected to aspirate the patient. No secretion was detected. All

the circuits were checked and no abnormality or kinking was present.

Severe bronchospasm was suspected and inj. prednisolone 100 mg bolus and aminophylline 250 mg infusion were administered. The patient was hemodynamically stable and SpO_2 was above 96% on 100% oxygen. The anesthesia machine was reconnected. However, the adequate minute volume could only be achieved with a frequency of 20 breaths/min although the peak airway pressure was too high.

Following a few breaths the high airway pressure alarm (>40 cmH_2O) was blinking and the $EtCO_2$ was as high as 50 mmHg, besides the achieved tidal volume was about 180-200 ml only. She was than disconnected from the machine and bag ventilation was started with 100% oxygen via a reservoir bag connected to a portable oxygen cylinder. Still high airway resistance was felt upon manual ventilation. And on auscultating breath sounds could hardly be heard. Meanwhile, a pilot balloon was connected to respiratory circuit in order to check the ventilator and mechanical ventilation started. A normal tidal volume could be reached with normal pressures. Patient's SpO_2 steadily decreased to 90%, and we decided to re-aspirate the patient. The reservoir bag was disconnected, and the suction catheter was tried to pass through the tube with the connector *attached*. However, it couldn't be advanced through the connector. When the connector was inspected carefully, we observed that it was covered with a plastic membrane and there was only a tiny orifice where it should be completely open (Figure 1). The tube connector was replaced with another one, ventilation started smoothly and the operation was performed uneventfully.

Figure 1: Transparent plastic membrane at the opening of the ETT connector with an orifice with a diameter of 2 mm

DISCUSSION

The cause of mechanical obstruction in our case was the connector of the ETT that was partially sealed with a transparent plastic membrane with a tiny hole on it. This was a structural defect occurred during manufacturing, which went undetected till intubation.

During GA, mechanical problems due to all ventilation system including ETT,[2] respiratory circuit,[3] all connectors,[4] ventilator or pulmonary system can be observed and these conditions can result in severe damages.[5] Obstructions in the ventilation system can cause barotraumas as described by McEwan et al.[6] or bilateral tension pneumothorax as reported by Smith et al.[7] but also temporary desaturation, brain damage and death can occur due to failure or delay in solving the problem. Preoperative control and testing of the anesthesia circuits and the anesthesia machine is important to prevent the occurrence of such conditions.

A review of the literature reveals case reports of breathing system obstructions either partial[3] or complete.[2,4,8]The difficulty in the ventilation of the patient and decrease in the breath sounds reminded us a mechanical obstruction. First we tried to eliminate the patient-related reasons. Following confirmation of the ETT's position by direct laryngoscopy, in the first attempt of endotracheal aspiration, the circuit was disconnected with the ETT connector attached to the circuit, thus unfortunate missing of the defect. It was than confirmed that the tube was correctly placed and there was no secretion or kinking resulting in obstruction. The partial obstruction due to the small hole at the end of the closed connector caused bronchospasm like symptoms with high airway pressures, decrease in breathing sounds and wheezing, that's why the later diagnosis was acute bronchospasm or rigidity due to opioid administration or an existing hyperactive airway and management was according to this diagnosis. However, the findings and ventilation didn't improve, so we re-checked all the anesthesia circuit and the ventilator systematically which ended in the right diagnosis of the obstruction without any harm to patient. This incident was reported to the manufacturing company with the

tube's lot number.

Hosking et al.[9] described an algorithm to diagnose perioperative airway obstruction to find a cause in ventilator,ETT, respiratory circuit or the patient related causes. The presented case of unexpected manufacturing defect of the ETT connector could not be noticed during routine controls and checking before GA. Before induction of anesthesia although whole anesthesia circuit, cuff of the ETT were checked, anesthesia machine was tested for leakage as a part of routine check, the defected connector wasn't noticed. Similarly, Campbell et al.[10] failed to detect a structural defect at a double-lumen ETT by a routine check, the authors recommended verifying patency of lumens of the endobronchial or tracheal tubes with a suction catheter before using it in a patient during routine checks.

Similar structural endotracheal tube defects due to manufacturing process have been reported but not very frequently.[11] As an anesthesiologist we should keep in mind that mechanical obstructions due to single-use endotracheal tubes could still be observed despite the fact that they are manufactured and packed with recent high technology standards.

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Author contribution: All authors shared in the management of the case, and preparation of this case report.

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