

Needle Perforation of an Endotracheal Tube Cuff Pilot Line

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Abstract

A surgical needle will generally not penetrate an endotracheal tube (ETT) and intraoperative ETT cuff perforation is uncommon because the cuff, which is the weakest part of the tube, is placed in the subglottic trachea. We report a very rare case, in which an intraoperative airway air leak during maxillary advancement surgery was postoperatively confirmed to be due to ETT cuff deflation because of needle penetration of the cuff pilot line. We also measured the force required to penetrate the wall of the pilot line and the ETT wall, finding that the pilot line is vulnerable to a needle.

Keywords: Needle perforation; Cuff deflation; Cuff pilot line; Endotracheal tube cuff

Commentary

Complications such as pulmonary infection due to micro-aspiration of oropharyngeal secretions may be associated with insufficient inflation of the cuff of an endotracheal tube (ETT), even in patients undergoing short operations. Thus, we should seal the airway as tightly as possible with the cuff to prevent aspiration of pharyngeal contents into the trachea and enable positive pressure ventilation. Here we report a very rare case of intraoperative airway air leak during maxillary advancement surgery. Postoperatively, the cause was confirmed to be deflation of the ETT cuff due to needle perforation of the cuff pilot line.

A 19-year-old man (178 cm/64 kg) with cheilognathouranoschisis had undergone cheiloplasty, veloplasty, and iliac bone grafting to the alveolar cleft palate at the age of 6 months, 18 months and 14 years, respectively. He was scheduled for surgery to advance the maxilla and set back the mandible by sagittal split ramus osteotomy (Le-Fort I, SSRO, rigid fixation) to correct jaw deformity. His cardiac and laboratory examinations were within normal limits.

After the ETT cuff was checked for free flow of air, symmetry, and leaks, anesthesia was induced with intravenous propofol, fentanyl, and vecuronium. Nasal intubation was easily accomplished using a size 7.0 mm nasal ETT (Nasal preformed tracheal tube, Sheridan) with clear visualization of the vocal cords by direct laryngoscopy. Anesthesia was maintained with oxygen, air, isoflurane and remifentanyl.

After suturing the nasal cavity mucosa, the surgeon noticed bubbles of saliva in the patient's mouth, indicating the possibility of an air leak. However, we were unable to find an obvious air leak and peak inspiratory pressure was maintained, so the operation was continued. After completion of surgery, we searched for possible causes of an air leak inside the oral cavity before extubation and confirmed fresh hemorrhage into the pharynx within the operating field. The surgeon applied pressure using gauze, and the hemorrhage subsided after several minutes. Auscultation with a stethoscope revealed the presence of lung crackles, and a large quantity of blood and secretions were

aspirated through the ETT. Fortunately, his oxygen saturation (SpO₂) remained at over 98% with the fraction of inspired oxygen (FiO₂) being 1.0. At this point, we noticed that the pilot balloon was partially deflated. Therefore, the ETT cuff was re-inflated and the pressure was checked. While there was no obvious leak of air from the cuff, the pilot balloon became partially deflated again within a few minutes. Despite careful aspiration, fiberoptic revealed viscous secretions and blood in the ETT and the trachea. We suctioned the secretions three times along with frequent reflation of the pilot balloon. After confirming that there were no clinical signs of aspiration, extubation was completed uneventfully, approximately three hours after the initial detection of a possible air leak. Postoperatively, the patient was asymptomatic with no leukocytosis, fever, or other signs of infection, and a chest X-ray film was normal.

When the ETT was immersed in water for examination of the site of leakage, bubbling from the pilot line of the tube cuff was noted (Figure 1). After experiencing pilot line perforation, we measured the force required for the straight 20 mm gauge needle used in this patient to penetrate the ETT wall. The needle puncture force was measured at the cuff pilot line and tube wall using a Creep meter (RE2-3305 s, Yamaden, Tokyo, Japan) (Figures 2-4), which was operated at a crosshead speed of 1 mm/s at 25°C.



Figure 1: Detection of the air leak. Continuous bubbling from the cuff pilot line is seen after immersion in water.

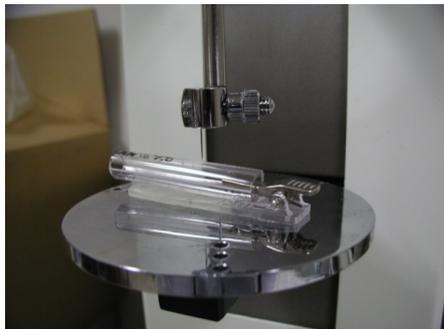


Figure 2: Creep meter.



Figure 3: Needle puncture at the tube wall.



Figure 4: Needle puncture at the cuff pilot line.

Results were compared by using the unpaired Student's t-test, which revealed a significant difference between the force required to penetrate the wall of the cuff pilot line and the wall of the ETT ($P \leq 0.001$). This indicated that the cuff pilot line is more vulnerable to needle injury than the main part of the ETT (Table 1).

	Tube wall (n=6)	Pilot line (n=6)
Force (Newtons)	6.15 ± 0.06	3.02 ± 0.29
Mean ± standard deviation (SD)		

Table 1: Needle punctures force.

Discussion

Many cases of ETT cuff perforation have been reported [1-3]. However, to our knowledge; this is the first report about perforation of the ETT cuff pilot line by a needle. It is generally considered that a surgical needle used with normal force will not penetrate an ETT (except a spiral tube). However, the ETT has a weakness, which is the thin wall of the cuff pilot line.

It is possible that the Sheridan tube became softer than usual at body temperature because it is made from thermoplastic. Also, the alveolar bone anatomy of this patient was abnormal because he had an alveolar cleft palate with iliac bone grafting, which may have led to problems when suturing near the ETT.

During an oral surgery operation, the exchanging the ETT by conventional manner can be technically difficult, risky, or even life-threatening. It is recommended that pharyngeal packing with soft gauze is used temporarily to limit the leaked volume. Inability to prevent the leak with gauze, the exchange can be performed using an ETT introducer as an intubating aid. The introducer is advanced through the old ETT into the trachea, the old ETT is withdrawn, and then the new ETT is gently threaded down into the trachea over the introducer [4].

In conclusion, we should remember that the pilot line of an ETT cuff is vulnerable to needle injury, which may cause cuff deflation during surgery.

References

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