

# Esophageal misplacement of a single-lumen tube after its exchange for a double-lumen tube despite the use of an airway-exchange catheter

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## ABSTRACT

An airway-exchange catheter (AEC) can increase the safety of exchanges of endotracheal tubes (ETTs); however, the procedure is associated with potential risks. We describe a case of esophageal misplacement of a single-lumen ETT after switching from a double-lumen tube, despite the use of an AEC as a guidewire. To avoid this, physicians should consider the insertion depth and maintenance depth of the AEC and should verify its position before changing ETTs and should perform, if possible, with simultaneous visualization of the glottis with direct or video laryngoscopy during the exchange. Additionally, the new ETT position should be confirmed by auscultation, end-tidal carbon dioxide, and portable chest X-ray.

**Key words:** Airway extubation, esophagus, intratracheal, intubation

## INTRODUCTION

Anesthesiologists are frequently required to replace an endotracheal tube (ETT) for various reasons, including a cuff leak, a tube laceration, or a tube occlusion. With this procedure, there is a significant risk of losing control of the airway. Chest surgery using a double-lumen tube (DLT) is one situation in which an AEC is useful. DLTs are routinely used to isolate the lungs for surgery, but changing from a DLT to a single-lumen tube peri or postoperatively can be difficult.<sup>[1]</sup> An airway-exchange catheter (AEC) is a long, hollow, slightly rigid catheter of small diameter which is inserted through an *in situ* ETT before tracheal extubation, and can be a useful tool for exchanging the ETT.<sup>[2,3]</sup> After the ETT is withdrawn over the AEC, the AEC serves as a stylet for repeated intubation. Although changing an ETT using an AEC has been described as a simple and relatively safe procedure,<sup>[4]</sup> it can be associated with life-threatening complications. We present a case of esophageal misplacement of a

single-lumen ETT after its exchange for a DLT despite the use of an AEC.

## CASE REPORT

A 22-year-old male victim of a traffic accident presented with dyspnea, and was diagnosed with right hemothorax and pneumothorax. He was intubated and chest tube drainage (CTD) was performed, after which he was transferred to our emergency room (ER) for further evaluation and management. On arrival, he had decreased mental status, and his initial vital signs were as follows: Blood pressure (BP): 80/50 mmHg, heart rate (HR): 124 beats/minute, respiratory rate (RR): 28 breaths/minute, oxygen saturation: 90%, and arterial blood gas analysis (ABGA) values of pH: 7.28, PaCO<sub>2</sub>: 31, PaO<sub>2</sub>: 60 mmHg, HCO<sub>3</sub>: 14.6 mEq/dL, and Hb: 10.9 g/dL. The patient was placed on mechanical ventilation (continuous mandatory ventilation (CMV) mode, fraction of inspired oxygen (FiO<sub>2</sub>): 100, tidal volume: 500 mL, respiratory rate: 15/minute, positive end-expiratory pressure (PEEP): 5 mmHg), and a central catheter and arterial catheter were inserted into the right subclavian vein and left femoral artery, respectively. Chest X-ray showed right pulmonary hemorrhage [Figure 1], and computed tomography (CT) revealed a 9 cm radiopacity in the right upper hemithorax which suggested hematoma (hemothorax) as well as minor pneumothorax.

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Soon after undergoing CT, the patient stopped responding to mechanical ventilation. At that time, ABGA showed pH: 7.03, PaCO<sub>2</sub>: 42, PaO<sub>2</sub>: 43 mmHg, HCO<sub>3</sub>: 10.8 mEq/dL, oxygen saturation: 58%, and Hb: 7 g/dL. The patient was transferred to the angiography room for extracorporeal membrane oxygenation (ECMO), where a 21 Fr venous cannula (DLP<sup>®</sup>, Medtronic Inc., Minneapolis, MN, USA) was inserted into the right atrium and a 24 Fr venous cannula (RMI<sup>®</sup>, Edward's Life Science LLC, Irvine, CA, USA) was inserted into the inferior vena cava via both femoral veins using the Seldinger technique, and venous ECMO was begun at 4 L/minute.

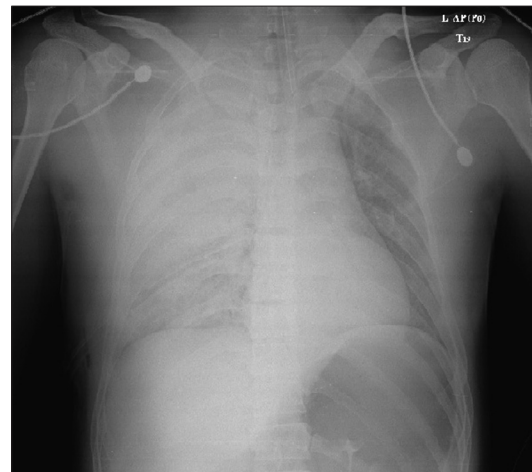
Next, the patient was transferred to the operating room, where general anesthesia was induced with a bolus of rocuronium 50 mg for muscle relaxation. Then, a 37 Fr left DLT was inserted following removal of the single-lumen tube, and the correct position of the DLT was confirmed by fiberoptic bronchoscopy, both before and after positioning in the lateral decubitus position. A right anterolateral thoracotomy via the fifth intercostal space was performed, which revealed 3 L of blood in the extrapleural space as well as a blood clot due to a right subclavian artery injury. The blood and blood clot were removed and the damaged subclavian artery was repaired. During the surgery, which lasted approximately two hours, five pints of packed red cells were transfused. At the end of the operation, the DLT needed to be exchanged for a single-lumen tube. Using the AEC as a guidewire, a 12 F, 80 cm AEC with a flexible tip (MEITI, VBM, Germany) was inserted 25 cm from the lip through the DLT, which we then tried to remove over the AEC. The DLT was removed stiffly, and the AEC remained *in situ* 25 cm from the lip following its removal. Subsequent intubation was performed through the AEC using a 7.5 Fr single-lumen tube. The tube was inserted smoothly, and fixed at 22 cm. We assumed that the ETT had been placed correctly into the trachea, although its position was not confirmed by auscultation or end-tidal carbon dioxide. Then, the patient was transferred to the intensive care unit (ICU) with Ambu bagging under ECMO. Immediately after arrival in the ICU, portable chest X-ray revealed esophageal misplacement of the ETT [Figure 2]. The patient was successfully reintubated using laryngoscopy, then extubated a week later. The ECMO was stopped 10 days later.

## DISCUSSION

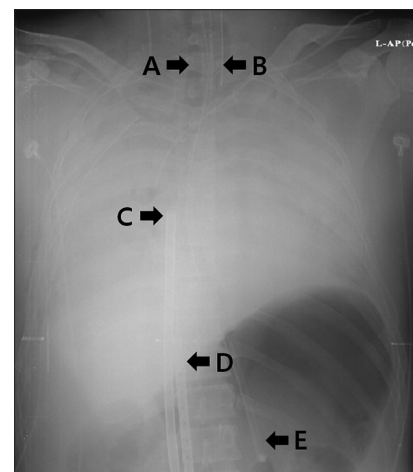
AEC can be used as a stylet when exchanging an ETT and allows jet ventilation as well as monitoring of end-tidal carbon dioxide during the exchange.<sup>[3,5]</sup> Although the procedure is known to be safe and relatively easy to perform without advanced training, it has the potential for life-threatening complications. Reported complications

include an inability to secure the airway, tracheal or bronchial mucosal tears, or pneumothorax. In one case, a 2 cm tear of the membranous trachea developed after changing from a single-lumen tube to a DLT using an AEC.<sup>[6]</sup> In another case report, a patient developed pneumothorax after the use of an AEC to exchange a malfunctioning ETT, even though jet ventilation was not used.<sup>[7]</sup> The authors postulated that the pneumothorax could have been related to the manipulation of the AEC to a more distal position. Many of the complications associated with the AEC result from excessively deep placement of these catheters.<sup>[5]</sup> Leeson<sup>[8]</sup> recommends the use of a marker (such as a Sharpie<sup>®</sup>) to color a segment of the AEC 20 to 25 cm from the tip to prevent overly deep placement. When the marked zone is at the lip, the AEC is 20 to 25 cm from the lip.

In the present case, a single-lumen ETT was misplaced into the esophagus after exchange with a DLT despite



**Figure 1:** Chest radiograph showing right pulmonary hemorrhage



**Figure 2:** Chest radiograph showing the trachea (arrow A), an endotracheal tube in the esophagus (arrow B), a 21 Fr venous cannula inserted into the right atrium (arrow C), a 24 Fr venous cannula inserted into the inferior vena cava (arrow D), and a Levin tube in the stomach (arrow E)

the use of an AEC. The AEC was likely pulled out above the vocal cord along with the DLT during removal of the DLT over the AEC, and at this point, the AEC was pushed into the esophagus. Intubation was then performed through the AEC, and as a result, the single-lumen tube was placed in the esophagus. This case demonstrated that the appropriate depth of the AEC should be completely maintained during ETT exchange, especially when a tube with small internal diameter, such as that used in children or a DLT for single-lung ventilation, is exchanged using an AEC. The marking technique can facilitate maintenance of the position of the AEC when changing from a DLT to a single-lumen tube.<sup>[8]</sup> Additionally, another important point of this case report is that a tube exchange with an AEC should be performed, if possible, with simultaneous visualization of the glottis with direct or video laryngoscopy. This would have avoided this complication.

Misplacement of an AEC in the esophagus can have catastrophic results. Fetterman *et al.*<sup>[9]</sup> reported a case of gastric perforation secondary to inadvertent esophageal placement of an AEC. They recommended that an AEC be treated as an ETT, and its placement should never be assumed to be correct until objective findings support that conclusion. Unfortunately, the physicians in the case we report here assumed that the AEC was correctly placed, and neither auscultation nor end-tidal carbon dioxide were checked; thus esophageal misplacement of ETT was revealed only by a chest X-ray in the ICU. The consequences for our patient could have been gastric perforation secondary to an inadvertent esophageal intubation if an L-tube had not been used, or he could have developed hypoxia and desaturation if ECMO were not applied.

One study reported that a Cook<sup>®</sup> AEC and a bronchoscope adapter could verify the position of an AEC as well as an ETT by monitoring end-tidal carbon dioxide.<sup>[10]</sup> Of course, it is important that placement of the AEC be confirmed before subsequent intubation; however, many hospitals do not possess such helpful tools. Thus, verification of ETT position by auscultation, end-tidal carbon dioxide, and portable chest X-ray is essential; moreover, the position of the AEC must be checked prior to subsequent intubation.

## CONCLUSION

An AEC can be used to increase the safety of ETT exchange, but the potential risks include tracheal or bronchial injury, pneumothorax, and esophageal misplacement of the AEC or ETT. To avoid these, physicians should consider the insertion and maintenance depths of the AEC and should verify its position before exchange, and should perform, if possible, with simultaneous visualization of the glottis with direct or video laryngoscopy during the exchange. Additionally, the placement of the second ETT should be confirmed by basic methods such as auscultation, end-tidal carbon dioxide, and portable chest X-ray, after exchange.

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