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# Complications associated with the use of the Esophageal-Tracheal Combitube

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**Purpose:** To report four cases of subcutaneous emphysema, pneumomediastinum and pneumoperitoneum associated with the use of the Esophageal-Tracheal Combitube® (ETC) during prehospital management of cardiac arrest.

**Clinical features:** Between September 1994 and April 1996, 1139 patients were resuscitated with the ETC and the semiautomated external defibrillator as part of the CPR protocol for prehospital management of cardiac arrest by basic emergency medical technicians. Eight of these patients presented with subcutaneous emphysema. Four of them, declared dead after arrival in the emergency room (ER), had autopsy studies. In two, autopsy revealed large (6 and 6.5 cm respectively) longitudinal transparietal lacerations of the anterior wall of the oesophagus. Multiple superficial lacerations of the oesophagus were also present in another patient, while no lesion of the airway or the oesophagus was found in the last patient.

**Conclusion:** These cases suggest that subcutaneous emphysema, pneumomediastinum and pneumoperitoneum might be complications associated with the use of the ETC. At least in two cases, oesophageal laceration appears to be the mechanism by which these complications occurred.

**Objectif :** Rapporter quatre cas d'emphys eme sous-cutan e, de pneumothorax et de pneumop eritoine associ es   l'usage du Combitube® durant la r eanimation pr e-hospitali ere de l'arr et cardiaque.

**Aspects cliniques :** Entre septembre 1994 et avril 1996, 1139 patients ont  t  r eanim es en utilisant le Combitube® et un d efibrillateur externe semi-automatique dans le cadre d'un protocole de RCR pour la prise en charge des arr ets cardiaques par des techniciens m edicaux d'urgence ayant une formation de base. Huit de ces patients ont pr esent e de l'emphys eme sous-cutan e. Quatre d'entre eux, d ec ed es apr es leur arriv ee   la salle d'urgence, eurent des autopsies. Chez deux, l'autopsie a montr e d'importantes lac erations longitudinales transpari etales (6 et 6,5 cm respectivement) de la paroi ant erieure de l'oesophage. Des lac erations superficielles multiples  taient aussi pr esentes chez le troisi eme patient, alors qu'aucune l esion ni des voies a eriennes ni de l'oesophage ne fut retrouv ee chez le dernier patient.

**Conclusion :** Ces cas sugg erent une association entre l'emphys eme sous-cutan e, le pneumo-m ediastin et le pneumop eritoine comme complications de l'utilisation du Combitube®. Au moins chez deux patients, des lac erations oesophagiennes semblent  tre le m ecanisme de ces complications.

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**E**VEN if tracheal intubation remains the method of choice to manage the airway, alternatives are available. One recent device, designed by Frass, Frenzer and Zahler, is the Esophageal-Tracheal Combitube (ETC) (Kendall Sheridan Catheter corp., Argyle, New-York, USA) (Figure 1).<sup>1</sup> It is used mainly in two situations: the management of a difficult airway in a cannot-ventilate-cannot-intubate situation and for cardiopulmonary resuscitation (CPR) in a prehospital setting.<sup>2-4</sup> The main characteristic of the ETC is its design allowing blind insertion with minimal training. No serious complications have been described with the ETC.

In September 1994, the Regional Health Board for the Québec City area (Canada) introduced the ETC in the CPR algorithm for management of cardiac arrests in the prehospital setting. This algorithm mandates the use of the ETC as an initial step for airway management and lung ventilation, combined with the use of the semiautomated external defibrillator (SAED). Cardiopulmonary resuscitation is conducted by basic emergency medical technicians (EMT). Each case of CPR is recorded live on an audio tape and a written report is made by the EMTs. These data are kept on file.

After one of the authors (DV) witnessed one case of severe subcutaneous emphysema during CPR conducted using this algorithm, the CPR files were reviewed. All the files of CPR performed between September 1994 and April 1996 (1139 cases) were reviewed. Eight cases of subcutaneous emphysema were identified. In four of these, an autopsy study had been done. The EMT written reports, audio recordings, autopsy reports and coroner's investigation reports of these four cases were reviewed and the findings are presented.

## Case reports

### Case 1

A 59-yr-old man, with a history of coronary artery disease (CAD) was found unconscious. Seven minutes after the 911 call, CPR was started, the ETC inserted and the SAED installed according to the algorithm. The EMTs reported having some difficulty inserting the ETC. One hundred forty ml of air were injected into the proximal balloon and 20 ml into the distal cuff. The oesophageal position was confirmed by the Oesophageal Detector Device (ODD)<sup>5</sup> and ventilation was initiated by the oesophageal lumen of the ETC. The patient presented progressive subcutaneous emphysema of the face, neck and thorax. Shortly after arrival in the emergency room (ER), CPR was stopped and the patient declared dead. An autopsy performed the following day, with the ETC removed, revealed multiple superficial oesophageal lac-

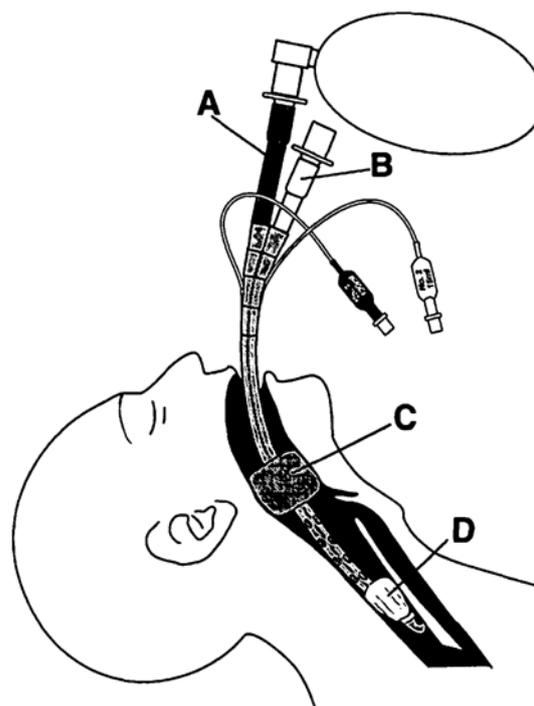


FIGURE 1 The Esophageal-Tracheal Combitube. A) the "oesophageal" lumen, B) the "tracheal" lumen, C) the proximal oropharyngeal balloon, D) the distal cuff. (see text for description).

erations and abdominal distention, but no source of air leak could be identified. A large amount of gastric material was also noted in the bronchi. The pathology report concluded that the probable cause of death was cardiac arrhythmia secondary to a left coronary thrombosis.

### Case 2

A 77-yr-old man lost consciousness during a meal. Using the same CPR algorithm, an ETC was inserted by the EMTs 12 min after loss of consciousness. At this time, the patient was in asystole according to the SAED. No problem was noted during the insertion of the ETC. One hundred forty ml of air were injected into the proximal balloon and 20 ml into the distal cuff. The oesophageal position was confirmed by the ODD and the oesophageal lumen was used for ventilation. The lungs were ventilated without difficulty but subcutaneous emphysema on the upper part of the body was suspected during transportation to the ER. The patient was declared dead soon after arrival at the hospital. A chest X-ray, done shortly after death, demonstrated the presence of air in the subcutaneous tissues, mediastinum, thorax and abdomen. Autopsy was performed the following day, with the ETC removed. The chest and abdomen were opened underwater. It revealed a

pneumomediastinum and a pneumoperitoneum but no lesion explaining these abnormalities or any source of air leak. The pharynx, larynx, oesophagus and trachea were normal. A small amount of gastric material was found in the main bronchi. The pathology report concluded that the probable cause of death was cardiac arrhythmia caused by a left coronary thrombosis.

### Case 3

A 70-yr-old woman, with a history of CAD, was found unconscious in her bed. It was impossible to determine the exact time of the cardiac arrest. Cardiopulmonary resuscitation protocol was initiated and the ETC inserted without difficulty 16 min after the EMTs had received the 911 call. The lungs could not be ventilated by either lumen of the ETC and a large amount of gastric juice was noted both in the ETC and in the patient's mouth. The ETC was removed, an oropharyngeal cannula inserted and mask ventilation initiated. About 90 sec later, a second ETC was also inserted without difficulty. One hundred forty ml and 40 ml of air were injected into the proximal balloon and into the distal cuff respectively. The oesophageal position was confirmed by the ODD and the oesophageal lumen was used for ventilation. Subcutaneous emphysema of the chest became apparent shortly after initiation of ventilation. The patient was declared dead after arrival in the ER. Less than three hours later, an autopsy study was performed with the second ETC still in place. It revealed massive subcutaneous emphysema of the head, neck, chest, right arm down to the wrist and left arm down to the elbow. The ETC was in the correct position in the oesophagus. The pharynx, larynx and trachea were normal. At 3.5 cm below the pharyngo-oesophageal junction, there was a 6 cm longitudinal, transparietal laceration of the anterior wall of the oesophagus (see Figure 2). The distal cuff of the ETC was protruding through the perforation. A superficial laceration was also found 1 cm laterally to the first one. The pathology report concluded that these lacerations had caused the air leak to the surrounding tissues. The probable cause of death was cardiac arrhythmia secondary to coronary atherosclerosis and acute pulmonary oedema.

### Case 4

An 80-yr-old woman presenting progressive dyspnea called 911. Fifteen minutes later, the EMTs arrived and found her conscious but in respiratory distress. Ventilation was assisted by mask while she was brought to the ambulance. Two minutes later, she lost consciousness and the cardiac monitor showed bradycardia. Since no pulse was palpable, the CPR protocol was started. When

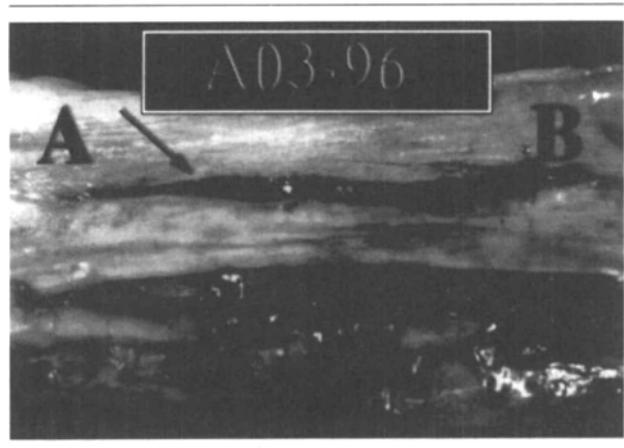


FIGURE 2 Transparietal laceration of the anterior wall of the oesophagus (arrow) found at autopsy in patient no.3. Cephalad end at left (A), caudal end at right (B).

the EMTs tried to insert the ETC, her dentures were displaced and pushed down into the pharynx, making insertion of the ETC difficult. After the dentures were pulled out, insertion of the ETC proceeded easily. The proximal balloon was inflated with 140 ml of air and the distal cuff with 20 ml. The oesophageal position was confirmed by the ODD and the lungs were ventilated through the oesophageal lumen. Ventilation rapidly became difficult and it was noted that the neck and face were progressively enlarging. The ETC was pulled out after deflation of both cuffs and at that time, oropharyngeal bleeding was noted. Then, ventilation was performed with a face mask and an Ambu bag during transportation to the ER. Nine minutes after the initial bradycardia, the patient developed asystole. The patient was declared dead upon arrival at the ER and CPR was stopped. The autopsy study revealed the presence of subcutaneous emphysema of the head, neck and chest. The trachea and larynx were normal. A 6.5 cm laceration of the posterior wall of the pharynx and a 6 cm longitudinal transparietal laceration of the anterior wall of the oesophagus were found. The pathology report concluded that the probable cause of death was cardiac arrhythmia secondary to a left coronary thrombosis and acute pulmonary oedema.

### Discussion

Since 1987, the usefulness of the ETC has been reported in many clinical settings. In elective surgical patients under general anaesthesia, the ETC has been shown to be comparable with the endotracheal tube for oxygenation and alveolar ventilation.<sup>6</sup> Similar results have been found with intensive care patients, for a ventilatory period up to eight hours.<sup>7</sup> In addition, the ETC was evaluated for CPR in an hospital setting; two studies have shown equivalent

efficacy of the ETC and the endotracheal tube.<sup>8-9</sup> A more recent study has evaluated the ETC during prehospital CPR managed by paramedics.<sup>3</sup> In 35 of the 52 patients (69%), the ETC was properly inserted and its position (tracheal or oesophageal) correctly determined in all cases. Besides superficial lacerations of the oesophagus no case of subcutaneous emphysema or other serious complications have been reported.<sup>1</sup> However, oesophageal and gastric lacerations have been reported with the oesophageal obturator airway, a device which has similarities to the ETC.<sup>1,10-12</sup>

The Combitube® kit includes the ETC itself, a 140 ml syringe to inflate the proximal balloon and a 20 ml syringe to inflate the distal cuff. The ETC is a double lumen tube with an oesophageal and a tracheal lumen (Figure 1). The oesophageal lumen has proximal perforations and a blind distal end. The tracheal lumen has an open distal end similar to a standard endotracheal tube. A large volume proximal oropharyngeal balloon is used to seal the oropharyngeal area. A smaller distal cuff, is used to seal the distal part of either the oesophagus or the trachea depending on the final position of the ETC. Insertion of the ETC is usually done blindly.<sup>13</sup> The manufacturer recommends introducing the ETC in the patient's mouth and pushing it down until the printed marks on the tube are aligned with the incisor teeth. Then, the oropharyngeal balloon should be filled with 100 ml air and the distal cuff with 5 to 15 ml. The tracheal or oesophageal position of the tube is determined by a ventilation test. Ventilation of the lungs can be accomplished in either position. First, the ventilatory bag is connected to the oesophageal lumen and ventilation is attempted. Presence of breath sounds during lung auscultation and absence of gastric insufflation confirm the oesophageal position of the ETC, thus ventilation can be continued through the oesophageal lumen. Otherwise, ventilation is done through the tracheal lumen and the tracheal position of the ETC is confirmed by auscultation of the lungs. In the CPR algorithm used for the four cases reported, the oesophageal position of the ETC was also determined by performing a test with the ODD before initiating ventilation of the lungs.<sup>5</sup> Briefly, when applying a negative pressure to the tracheal lumen using a 60 ml syringe with a 15 mm adaptor, free aspiration of air indicates the tracheal position of the ETC. If the ETC is in the oesophagus, aspiration of air is impossible.<sup>5,14</sup>

The four cases reported here involved different teams of EMTs and had in common CPR conducted according to the same algorithm using the ETC complicated by subcutaneous emphysema. The autopsy studies of cases #3 and #4 demonstrated severe oesophageal wounds that explain the presence of air outside the airway. These transparietal lacerations of the

anterior wall of the oesophagus can easily allow the passage of air into the mediastinum, the thorax, the peritoneum and subcutaneous tissues. In cases #1 and #2, no anatomical abnormality was found to explain the presence of air outside the airway. In these last two cases, the lesion might have been too small to be identified by the pathologist or subcutaneous emphysema might have been produced by another mechanism.

Although highly suspicious, a cause-and-effect relationship between oesophageal laceration and the ETC is difficult to prove in the cases reported here. However, different hypothesis, not mutually exclusive, can be proposed to explain the complications observed. First the ETC is a large and stiff tube with an anterior curvature, a design that might cause injuries. The lacerations observed on the anterior wall of the oesophagus make direct trauma caused by the ETC a strong possibility. Second, the technique of blind insertion without visualisation of the passage of the ETC into the pharynx and the proximal oesophageal opening may also promote injuries. Third, in all cases, and especially in case #3, the distal cuff of the ETC was inflated to a volume higher than that recommended by the manufacturer. Fourth, oesophageal injury may be related to the chest compression during CPR with the ETC in place. Finally, subcutaneous emphysema is a well known complication of positive pressure ventilation, and might not be related to the use of the ETC.

The exact incidence of this complication with the use of the ETC is unknown. Eight cases of subcutaneous emphysema were retrieved from the 1139 cases reviewed. However, the methodology used may underestimate the problem. The ETC remains a useful tool for prehospital cardiac arrest management and, in some regions, it is also used for prehospital management of trauma patients. According to the autopsy reports, the subcutaneous emphysema and the oesophageal lacerations were not a factor in the death of the patients presented here. However, the possibility of this complication should be kept in mind since an oesophageal laceration is a very serious complication. Further studies would be helpful to define better the incidence and the pathophysiology of this complication.

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