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Case Report

# Tracheal Rupture After Emergent Endotracheal Intubation

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**Abstract**

Tracheal rupture after endotracheal intubation is a rare but serious complication. Its causes remain unclear but many physicians believe that weakness of the membranous trachea in patients with chronic illness is a leading factor. We present three patients who developed membranous tracheal rupture after emergent endotracheal intubation. Based on our experience and a review of the relevant literature, we emphasize selection of a correctly sized endotracheal tube to minimize the risk of rupture. Use of a smaller endotracheal tube in the emergent setting, especially for patients at potential risk of rupture due to steroid use or chronic illness, is highly recommended. (*Tzu Chi Med J* 2008;20(3):227–231)

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## 1. Introduction

Tracheal rupture is most commonly associated with blunt or penetrating trauma to the neck and chest, and can be life-threatening. Tracheal rupture may occur as a complication of endotracheal intubation, often when there is an emergent need for airway management (1). Recognition of major iatrogenic tracheal rupture is often delayed, possibly as a result of its rare incidence in both adults and children (2). Although multiple aspects of physician technique and patient anatomy have been discussed as risk factors, the etiology of tracheal injury following intubation remains uncertain. Furthermore, there is no clear consensus regarding management with either surgical or nonsurgical care (1–3). We report our experience with three patients who had tracheal rupture as a complication of intubation and consider key risk factors for this iatrogenic injury.

## 2. Case reports

### 2.1. Case 1

An 84-year-old woman (height, 150 cm; weight, 48.7 kg), with a history of controlled hypertension, was hospitalized for sudden-onset cardiovascular collapse with respiratory failure. On admission, her physical condition was grossly normal except for a level of consciousness down to E2V1M4. She had coarse breath sounds and rales in both lung fields. Use of accessory muscles was prominent and arterial blood gas showed an oxygen saturation of only 78%. Emergent intubation was performed smoothly with a 7.0-mm styleted endotracheal tube (ETT). The follow-up chest X-ray showed that the tip of the ETT was positioned on the carina; the tube was repositioned to 20 cm (Table 1). A diagnosis of unstable angina with pulmonary edema was made shortly after intubation.

**Table 1 — Patient characteristics**

| Case | Age (yr) | Weight (kg) | Height (cm) | Endo (mm) | Initial intubation (cm) | Fixed (cm) | Chronic illness | Daily medication | Emergent intubation |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 84 | 48.7 | 150 | 7.0 | 22 | 20 | CHF | Anti-HT agents | Yes |
| 2 | 77 | 44.7 | 150 | 7.5 | 21 | 19 | COPD | Steroid | Yes |
| 3 | 87 | 35 | 144 | 7.0 | 22 | 20 | Uremia | Anti-HT agents | Yes |

CHF = congestive heart failure; HT = hypertension; COPD = chronic obstructive pulmonary disease.

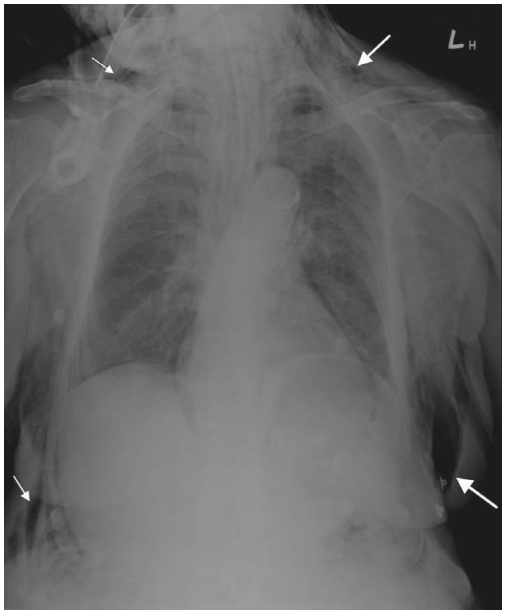

**Fig. 1 — X-ray shows subcutaneous emphysema involving the chest and neck.**

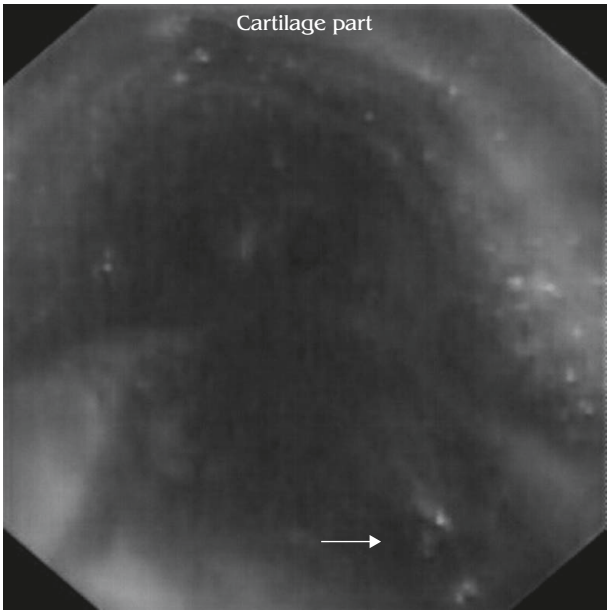


**Fig. 2 — Bronchoscopy reveals a rupture over the membranous portion of the mid-trachea that is slowly oozing (arrow).**

When her condition worsened, the patient was admitted to the intensive care unit (ICU) and treated with morphine/nitroglycerin/furosemide. Although the bilateral pulmonary edema improved, extensive subcutaneous emphysema around the chest and neck developed (Fig. 1). Airway injury was highly suspected. Physicians tried weaning and extubation the following morning but fresh hemoptysis was noted and the patient was re-intubated that night. Bronchoscopy revealed a slightly oozing perforation on the right lateral aspect of the membranous mid-trachea, 3–4 cm above the carina (Fig. 2), with diffuse fresh blood scattered bilaterally. On the second day, fever, atrial fibrillation and hypertension were recorded. Secondary infection due to tracheal rupture developed and progressed to shock. On the third day, a chest surgeon performed emergent surgical repair of the tracheal rupture and the patient was transferred to surgical intensive care. Three days after surgery, the ETT was removed successfully. She was discharged on the sixth postoperative day.

### *2.2. Case 2*

A 77-year-old woman (height, 150 cm; weight, 44.7 kg), with several years' history of severe chronic obstructive pulmonary disease managed with home nebulizers and intermittent oral steroids, presented with dyspnea and respiratory failure. In the emergency department, consciousness was E3V3M6. She was in respiratory distress with 30 breaths per minute; shallow breathing, bilateral wheezing and rales were noted. Her extremities were cyanotic and arterial blood gas showed oxygen saturation was 75%. She was intubated smoothly with a 7.5-mm styleted ETT for mechanical ventilation. A chest X-ray was performed and showed that the tip of the ETT was located just on the carina. The tube was then pulled back by 2 cm and repositioned to 19 cm (Table 1). Obvious and progressive subcutaneous emphysema around the face, neck, abdomen and legs was noted 2 hours later (Fig. 3). Bronchoscopy showed tracheal rupture of the right membrane cartilage junction of the lower trachea,

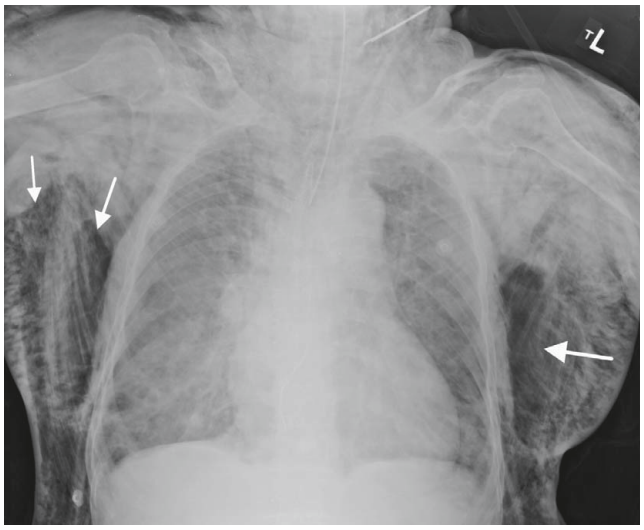

**Fig. 3 — X-ray shows extensive subcutaneous emphysema that has developed after tracheal rupture.**

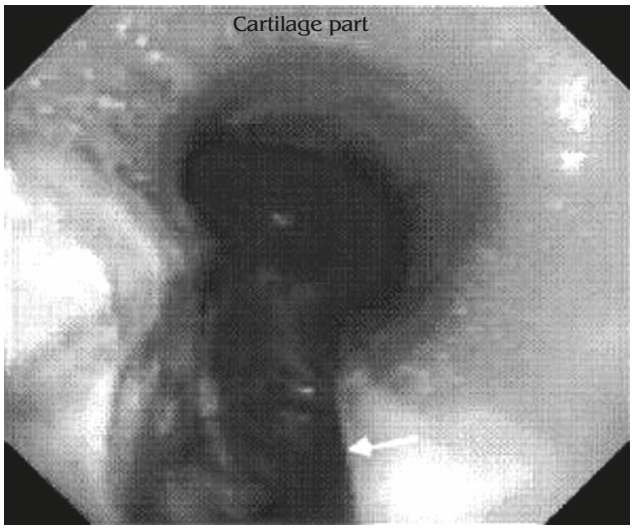


**Fig. 4 — Bronchoscopy reveals a 5-cm laceration at the membrane cartilage junction, 1 cm above the carina.**

1 cm above the carina (Fig. 4). A chest surgeon thought the deep V-shaped rupture would not heal spontaneously, so surgical repair was performed. Intraoperatively, the surgeon discovered 30 mL of turbid pleural effusion and a 5-cm full-thickness rupture. The area was cleaned and drained of fluid, and the rupture was sutured. Postoperatively, the patient was kept sedated with midazolam due to severe intraoperative air leakage, and cefepime hydrochloride and chest tube drainage were used. Bronchoscopy tracked the rupture; by the 13$^{th}$ postoperative day it had healed, and the patient was extubated and weaned. Progressive dyspnea and diffuse wheezing led to re-intubation that night. On the 14$^{th}$ day, the chest tube was removed. On the 16$^{th}$ day, the patient was transferred to a medical ward for treatment of pneumonia and weaning from the ventilator.

### *2.3. Case 3*

An 87-year-old woman (height, 144 cm; weight, 35 kg) was transferred to our hospital for emergent hemodialysis after sudden deterioration with known chronic renal failure and severe metabolic acidosis. She presented with dyspnea, altered mental status, unstable hemodynamics and respiratory failure. Atrial fibrillation with rapid ventricular response and poor left ventricular contractility was documented with cardiac echo studies in the emergency room, and doctors supported adequate left ventricular function with inotropic agents. Initial management was endotracheal intubation using a 7.0-mm styleted ETT smoothly placed at 23 cm. After the chest X-ray showed that the tip was too deep, it was repositioned to 20 cm

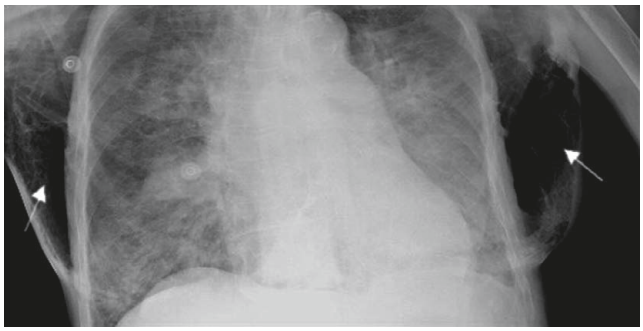

**Fig. 5 — X-ray shows massive subcutaneous emphysema.**

(Table 1) and she was referred to the ICU for further treatment. Next morning, slight emphysema was found around the neck and chest (Fig. 5). ICU staff suspected airway injury possibly caused by misuse of the stylet during intubation. Bronchoscopy showed a 4-cm rupture in the mid-trachea (Fig. 6). Due to the patient's age and the high risks of surgical repair, the patient's family refused surgical treatment. The patient's tracheal rupture healed spontaneously and uneventfully. When she required two successive inductions of general anesthesia for arteriovenous shunt revision, we used a 6.0-mm ETT uneventfully.

## 3. Discussion

Tracheal ruptures are commonly associated with direct trauma to the neck and thorax. In these three cases, there was no evidence of direct trauma above the trunk from medical history and physical examination. With this in mind, it seems most likely that the

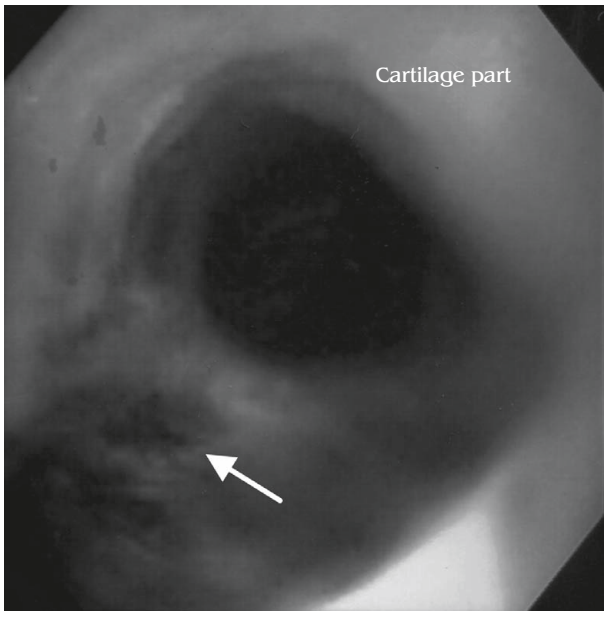


**Fig. 6 — Bronchoscopy reveals a 4-cm rupture in the mid-trachea.**

tracheal injuries occurred during intubation. Due to the rarity of this complication, there are no adequate prospective studies to evaluate its true incidence. Descriptions of possible etiological factors are based on a number of case reports [1,2].

Our cases have seven clear similarities: all three women were over 65 year of age and were small in stature; they had serious chronic illnesses (congestive heart failure, chronic obstructive pulmonary disease and uremia, respectively) and may have gradually developed fragile tracheal tissue; they all needed emergent endotracheal intubation because of respiratory failure; their tubes were repositioned after initial placement (pulled back by 2 cm, with repositioning to 20 cm, 19 cm and 20 cm respectively); all patients developed clinical subcutaneous emphysema over the neck and chest within 2–6 hours of intubation; the three patients were intubated by three different emergency physicians with the same training background; when tracheal rupture was suspected, the diagnosis was immediately confirmed by flexible bronchoscopy.

Considering our cases and the published literature, we propose that several iatrogenic factors may be related to tracheal rupture. There appear to be four equipment factors. First is the use of double-lumen, larger tubes [1,4,5]. In addition, over-inflation of the cuff can result in mechanical disruption or mucosal necrosis after prolonged intubation. The third possible factor is inadequacy of the stylet, with inadequate care of the hard tip causing a rupture [1]. The use of a stylet may be routine in controlling the direction of an ETT in the emergency room but the ETT cannot be reshaped after it has passed the vocal cords. Under these circumstances, the styleted ETT impinges on the trachea wall. Finally, the tube can become dislocated when the patient moves. There are also four factors related to the patient: old age combined with female gender, weakness of the membranous trachea, chronic obstructive pulmonary disease and chronic steroid use [6].

Previous reports have noted that the most common site of intubation-related rupture is the middle to lower third of the membranous trachea, parallel to its longitudinal axis [7]. The high incidence in elderly women raises the possibility that a small trachea, especially when tissue elasticity has been lost with aging, is a risk factor [1–4,7–13]. Our patients were all short in stature, and their particularly small tracheas probably increased their risk of rupture with intubation. As tracheal fragility is not clinically apparent, a significant number of tracheal ruptures can occur during intubations that appear to be performed without difficulty. Corticosteroid use and chronic medical illness are also contributing factors to tracheal rupture. In the past year, emergency cardiac care guidelines have suggested the use of an ETT with a 7.0-mm internal diameter for adult females, an 8.0-mm diameter for adult males and an 8.0–9.0-mm diameter for asthma patients in order to prevent airway resistance [14]. However, these suggestions may not be suitable for patients with several risk factors, such as old age, short stature and chronic steroid use, especially in an emergency situation [15]. Most of the present studies investigate how to predict an appropriate ETT size for children [16]. Little research has involved investigation related to adults. Previous articles have reported the use of a 7.0-mm or 7.5-mm tube for high-risk adult patients with small stature during emergent tracheal intubation that have led to many instances of tracheal rupture. Much research on adult tracheal rupture after intubation has ignored the risk factor of body stature and tube selection.

The causes of tracheal rupture are easily blamed on patient factors rather than improper tracheal tube selection. The same patients might have a higher vulnerability to high-pressure cuff inflation due to fragility of the membranous portion of the trachea. Case 3 suffered from a 7.0-mm ETT-induced tracheal rupture at the first tracheal intubation. She received two successive smooth inductions of general anesthesia when a 6.0-mm ETT was used during her arteriovenous shunt operation. This indicates that insertion of larger tubes also increases the risk of tracheal rupture [5,10]. We hypothesize that the cause of her tracheal rupture was secondary to the use of a relatively over-sized tube rather than a true gender predilection. Putting everything together, we believe that intubation-related tracheal rupture is most likely to occur when a disproportionately large ETT is used

for a patient with a small, potentially fragile trachea who is receiving emergent tracheal intubation.

The metal stylet is important in intubation but it can also be a major cause of iatrogenic tracheal rupture. If the tip of the stylet protrudes from the end of the ETT during intubation, the risk of rupture increases [2]. We prefer not to routinely use the stylet. What if difficulty during intubation occurs in cases where a stylet is not used? We recommend removing the stylet after the tip of the ETT has passed the vocal cords in order to reduce tube stiffness. Cases of tracheal rupture caused by the stylet are usually deep and long [10,11], with development of serious complications such as mediastinitis or late tracheal stenosis [6,9].

The diagnosis of tracheal rupture should be suspected when subcutaneous emphysema develops in the soft tissue of the neck or trunk. Chest radiographs show subcutaneous emphysema and pneumomediastinum. As occurred with our cases, diagnosis is confirmed by flexible bronchoscopy. Computed tomography can reveal tracheal injury and can be useful for making decisions regarding treatment [8].

Surgical management and conservative management have both been championed as the treatment of choice for post-intubation tracheal rupture [3,12,13]. The decision depends largely on the extent of injury (e.g., length of tracheal rupture) and the patient's risks for surgery. Cases 1 and 2 had ruptures that were 3 cm and 4 cm long, respectively. In the literature, if complicated longitudinal ruptures were longer than 5 cm, it was suggested that surgical therapy was the better option [7]. On the other hand, conservative management can effectively prevent complications and maintain a patent airway for uneventful healing if the injury is less than 3 cm in length [7]. We believe that there is a gray zone between criteria for surgical versus nonsurgical treatment. Conservative treatment is definitely a valuable option for patients who have stable vital signs, easy ventilation, absence of respiratory distress and stable pneumomediastinum or subcutaneous emphysema [7,13].

In conclusion, selection of ETT size is very important, especially for women. Specifically, women of short stature (especially when elderly) should be intubated with a tube that has an inner diameter of less than 6.5 mm. Above all, even emergent intubation should be gentle. Multiple intubation attempts or lack of operator skill raises the risk of tracheal rupture.

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