Thoracotomy for Tracheal Disruption After Traumatic Intubation: A Case Report

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Tracheal dissection is an uncommon complication of endotracheal intubation. A large source of morbidity and mortality in anesthesia is associated with airway issues. Several airway complications can be avoided or minimized by proper technique and vigilance. Emergency thoracotomy surgery is required in patients who suffer lower tracheal trauma. A tracheal tear poses additional challenges to traditional airway management, demanding vigilant planning and collaboration among the entire operative team.

This case report details the airway management strategies employed during an emergent thoracotomy for a patient who suffered tracheal perforation during endotracheal intubation. A discussion of airway anatomy, airway considerations, intubation complications, and one-lung ventilation techniques is provided. Airway management techniques for one-lung ventilation are highly variable, requiring an extensive knowledge of equipment, clinical implications, and technical challenges. It is important for clinicians to be skilled in the use of several airway devices and to be prepared for any unexpected situation such as the case being presented.

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Blunt or penetrating forces can interrupt the structural continuity of the airway. Performing tracheal intubation is associated with risks, including upper and lower airway trauma. Tracheal perforation is an uncommon complication of endotracheal intubation. The trachea is part of the lower airway that extends from the bottom of the cricoid cartilage to the carinal bifurcation. The trachea has c-shaped cartilages that give the anterior trachea support. The posterior trachea is devoid of structural support, which allows space for the esophagus during swallowing. The posterior tracheal wall is an area of the airway that is very susceptible to injury during placement of an endotracheal tube (ETT). Complications of endotracheal intubation have been linked to factors such as multiple intubation attempts, inexperienced clinician, protruding stylet, inappropriate tube diameter, excessive coughing, and abrupt movement of the patient. Many authors suggest that correct use of a stylet involves insertion to a point just proximal to the Murphy’s eye with removal as the ETT passes through the vocal cords toward the proper tracheal position. Airway injuries caused by improper airway management or accidental trauma are manifested by difficulty breathing, inadequate oxygenation, bloody sputum, discomfort behind the sternum, air around the heart or lungs, and subcutaneous air in the chest or neck.

The time between airway disruption and its discovery ranges from minutes to several days. Bronchoscopy is used to diagnose a tracheal tear, determine severity and extent of the tear, and identify the best treatment. Direct laryngoscopy to secure the airway of a patient with a sub-glottic lesion should not be the technique of choice because of the possibility of passing the ETT into the mediastinum or causing complete airway dissection. Fiberoptic bronchoscopic endotracheal intubation is the preferred choice because this facilitates direct visualization of the ETT distal to the tracheal dissection. Positive pressure ventilation may influence the severity of the tracheal dissection, so maintenance of spontaneous ventilation until a definitive airway is established beyond the defect is imperative. A distal tear that involves the trachea and thoracic vascular structures may necessitate the use of cardiopulmonary bypass for treatment and correction.

One-lung ventilation is often necessary to repair tracheal tears, and equipment used for lung separation may include a single-lumen ETT with a moveable bronchial blocker incorporated into a second lumen (Univent, Fuji Systems Corp, Tokyo, Japan), a double-lumen tube, or a single-lumen tube with an endobronchial blocker. A patient who is medically stable with only a small tear or with an artificial airway that can bridge the defect may simply need antibiotic coverage and medical follow-up. Conservative therapy has been used successfully without the development of tracheal stenosis or mediastinitis. However, surgery is necessary for patients who have an unstable cardiopulmonary system, have a tear greater than 4 cm in length, or cannot maintain spontaneous ventilation. Patients with a tracheal disruption near the carina require surgery through a right-sided thoracotomy incision.

Case Summary
A 72-year-old woman arrived via ambulance at the emergency room after having a witnessed seizure. She arrived...
with electrocardiographic, noninvasive blood pressure and pulse oximetry monitors. She was receiving oxygen through a non-rebreather mask. The patient's medical history consisted of epilepsy and hypertension. The patient's surgical history consisted of a laparoscopic cholecystectomy without any complications. Presenting data included the following: weight, 62 kg; height, 162.6 cm; Glasgow coma scale, 11; heart rate, 133/min; blood pressure, 210/115 mm Hg; respiratory rate, 14/min; and pulse oximetry, 92%. The patient received 40 mg of labetalol and 1 g of fosphenytoin (Cerebyx) in the emergency department. The patient had generalized weakness, slurred speech, and disorientation. The patient's complete blood cell count, blood chemistry panel, and coagulation profile were all within normal limits. An arterial blood gas analysis revealed pH, 6.97; partial pressure of arterial carbon dioxide (PaCO₂), 102.7 mm Hg; partial pressure of arterial oxygen (PaO₂), 266 mm Hg; bicarbonate level, 23.1 mmol/L; and base excess, −10.5 mmol/L.

Because of a decrease in sensorium, periods of apnea with desaturations after seizure, and hypercapnia, the emergency room physician chose to intubate the patient. A rapid sequence intubation was performed with propofol and succinylcholine. During placement of the 7.0-gauge ETT, the physician described a grade 2 laryngoscopic view. According to the emergency room physician, the ETT was advanced with a properly positioned stylet, and the stylet was withdrawn after advancing the ETT a few centimeters past the glottic opening. The physician stated that he experienced moderate resistance during advancement of the ETT. The presence of exhaled carbon dioxide and bilateral breath sounds confirmed tracheal placement. A propofol infusion was used to sedate the patient during mechanical ventilation. A chest radiograph revealed the ETT tip deviated 180 degrees and was directed superiorly within the trachea (Figure 1). Subcutaneous emphysema was noted by the radiologist in the supraclavicular region of the chest. The emergency room physician repositioned the ETT and confirmed midtracheal position with a chest radiograph. Before transfer from the emergency department to the computed tomography (CT) suite, the patient's vital signs were as follows: blood pressure, 125/75 mm Hg; heart rate, 80/min; controlled respiratory rate, 14/min; pulse oximetry, 99%. The patient was taken to radiology for a CT scan of the neck and chest, which revealed a tracheal perforation, involving the posterior wall approximately 3.5 to 4 cm superior to the carina (Figure 2).

The patient was transferred to the medical intensive care unit while the cardiothoracic surgical and anesthesia team were consulted. The patient was placed on mechanical ventilation using assisted control mode with the following settings: fraction of inspired oxygen (FiO₂), 100%; tidal volume, 450 mL; respiratory rate, 14/min; and positive end-expiratory pressure, 5 cm H₂O. An arterial blood gas specimen was obtained and analysis revealed pH, 7.358; PaCO₂, 41 mm Hg; PaO₂, 351 mm Hg; bicarbonate level, 22.6 mmol/L; and base excess, −2.6 mmol/L. The surgical team decided to take the patient immediately to the operating room for surgical repair of the 8-cm tear in the membranous portion of the posterior trachea.

The patient was taken to the operating room, transferred safely to the operating table with the safety strap securely fastened, and extremities were padded. All standard monitors were applied. Breath sounds were checked to verify tube position before placing the patient on the ventilator. Initial ventilator settings were as follows: FiO₂, 100%; tidal volume, 450 mL; and respiratory rate, 14/min. Isoflurane was titrated to maintain anesthesia, and 10 mg of vecuronium was given to provide neuromuscular relaxation. The propofol infusion was discontinued. The patient's hemodynamic status was stable. Two large-bore intravenous catheters and a left radial arterial line were placed. One gram of cefazolin was given to provide antibiotic coverage. Although the patient had an ETT in place, discussions regarding the best way to provide surgical exposure and facilitate one-lung ventilation ensued. Severe crepitus in the upper aspect of the chest and the neck distorted anatomical landmarks, making surgical airway placement difficult if necessary. A double-lumen tube was discussed but decided against because of postoperative ventilatory considerations. The decision was made to use a bronchial blocker with a larger tube. The 7.0-gauge ETT was removed under direct laryngoscopy, and an 8.5-gauge ETT was inserted through the glottic opening. A fiberoptic bronchoscope was used to facilitate placement of the ETT past the defect. The cuff was inflated, and mechanical ventilation was initiated with the following settings: FiO₂, 100%; tidal volume, 650 mL; and respiratory rate, 10/min. The fiberoptic bronchoscope was then used to visualize place-
ment of a bronchial blocker into the right main-stem bronchus. The bronchial blocker cuff was deflated during positioning. The patient was then turned and positioned in the left lateral decubitus position. The fiberoptic bronchoscope was used to adjust and verify the position of the ETT and bronchial blocker.

With the use of the bronchial blocker, the nondependent lung was collapsed to allow the surgeon direct visualization of the trachea through the right-sided thoracotomy incision. The surgeon noted that the cuff of the ETT was partially overlying the defect. There was not sufficient distance past the dissection to advance the ETT without causing a main-stem bronchus intubation. Tube positioning options were discussed between the surgeon and anesthesia team. At the surgeon’s request, the bronchial blocker was removed and the ETT was advanced into the left main-stem bronchus with the guidance of the fiberoptic bronchoscope. One-lung ventilation was resumed and the surgery progressed. The pulse oximeter reading stayed above 93% throughout one-lung ventilation.

The surgeon used primary closure with interrupted sutures instead of a bovine pericardial patch tracheoplasty because the patient’s trachea was relatively large. The ETT was repositioned above the repaired segment of the trachea. With the cuff down, ventilation was performed with a peak inspiratory pressure of 30 cm H₂O to ensure that no leaks were present. The surgeon requested that suctioning be avoided, the ETT cuff remain deflated, and peak airway pressures be maintained between 14 and 16 cm H₂O. The patient was placed on volume control ventilation with the following settings: Fio₂, 100%; tidal volume, 450 mL; and respiratory rate, 14/min. Peak airway pressures remained in the desired range. The surgeon placed a right-sided chest tube and closed the incision. The patient’s vital signs stayed very stable throughout the procedure, and the patient was transferred to the intensive care unit.

**Discussion**

Airway management skills are essential to the practice of anesthesia. Proper airway management entails knowledge of airway structures, experience in airway assessment, and competent use of multiple airway devices. A major contributor to anesthetic morbidity and mortality involves improper airway management. Several authors categorize complications of intubation by problems related to laryngoscopy and intubation, adverse events while the patient has an ETT, and troubles after removal of the ETT.

Several airway complications can be avoided or mini-
mized by proper technique and vigilance. One of the most frequent complications of ETT placement is dental injury. Along with proper intubation technique, dental injury can be minimized by placing a protective barrier over the teeth and by avoidance of contact and leverage on the upper teeth.9,10 Dental protection devices reduce the amount of horizontal and axial forces applied to the teeth, with minimal affect on laryngeal view.10 The preoperative interview should include questions about removable hardware and loose teeth in addition to a visual inspection.

Another complication of intubation concerns misplacement or migration of the ETT into the esophagus or bronchus. Direct visualization of the ETT passing through the vocal cords is ideal but not always possible. Endotracheal tube position should be verified by end-tidal carbon dioxide and bilateral breath sounds. The distance of ETT insertion should be noted on the record and checked intermittently. The ETT should be secured appropriately and the head position should be maintained to avoid displacement. Head extension can lead to withdrawal of the ETT, and flexion can lead to advancement of the ETT.9 Endotracheal tube position should be verified after every position change.

Tracheal stenosis is an intubation complication that has many contributing factors, some of which are modifiable. The advent of ET Ts with cuffs that have a large volume with less pressure has decreased the incidence of postintubation tracheal narrowing; however, other factors contribute to the continued occurrence. The size of the ETT should be tailored to the specific patient. A cuff pressure should not exceed 30 cm H2O. Movement of the ETT should be minimized, and when the ETT position needs to be changed, the cuff should be deflated before the move.12

Other complications of intubation include aspiration of stomach contents, accidental extubation, vocal cord paralysis, esophageal rupture, laryngospasm, laryngitis, and ETT obstruction.9,11 The incidence of adverse events related to endotracheal intubation is small and should not affect the verdict to intubate a patient.9 Although it is important to know the possible complications and ways to minimize the chance of occurrence, it is also critical to be able recognize and treat any complication that may arise.

Tracheal disruption caused by accidental trauma or complicated intubation can require emergency surgery. When providing anesthesia care for a patient with a tracheal disruption, a thorough preoperative assessment is essential to planning and preparing for the emergent case. It is important to assess the patient’s ventilatory status, vital signs, airway characteristics, radiographic images, and arterial blood gas results along with the standard preoperative assessment. This information will help in devising a plan for airway management. The anesthesia provider should have available a variety of airway supplies and equipment, the “difficult airway cart,” and the fiberoptic bronchoscope. It is very important to plan ahead, but the anesthesia provider should be flexible and ready to adapt if the situation requires alterations. It is crucial to maintain communication with the surgeon to adequately preserve the patient’s airway.

Preparation for one-lung ventilation is required in the anesthesia management for tracheal disruption. The earliest technique for one-lung ventilation was developed in 1931. This technique involved placement of an endobronchial tube into the main bronchus of the lung that was intended to be ventilated.13 Two basic concepts provided a framework for the basis of all one-lung ventilation techniques. The first and most popular technique uses an ETT that has 2 lumens. The endobronchial lumen is inserted into the main-stem bronchi, while the endotracheal lumen opens into the trachea. The double-lumen tube can isolate either lung depending on the need for surgical exposure. The other lung isolation technique uses a device that blocks the main bronchus of one lung so that the other lung can be selectively ventilated.14 Two types of endobronchial blockers are commonly available: a single-lumen ETT with bronchial blocker and a Univent ETT. There are several advantages and disadvantages to each technique used for lung isolation. The decision to use a bronchial blocker during this case was based on the necessity to provide mechanical ventilation postoperatively while minimizing the amount of airway manipulation.

Bauer et al15 compared bronchial blockers and double-lumen tubes for one-lung ventilation during thoracoscopy, illustrating the advantages and disadvantages of these techniques. Bronchial blockers were positioned inappropriately more often than were double-lumen tubes. Bronchial blockers are easier to place in the right bronchus than the left bronchus because of the difference in the angulations of the main bronchi dividing from the trachea. Time required for proper placement of a one-lung ventilation device was shortest with a double-lumen tube, followed by the right bronchial blocker and then the left bronchial blocker. Surgeons rated the quality of lung deflation among the different devices and decided that double-lumen tubes and left bronchial blockers were far superior to right bronchial blockers in isolating the chosen lung.

Conclusions
Airway management is an essential skill for anesthesia providers to master. The anesthesia provider should have a comprehensive knowledge of intubation complications, techniques to minimize the risks, and treatment modalities should a complication occur. This case study presents a situation that could have been avoided. The emergency department physician may have been able to minimize the trauma by removing the stylet earlier or by stopping the advancement of the ETT when resistance
was felt. A thorough airway assessment, careful planning, and proper technique may minimize the chance of complications resulting from endotracheal intubation.

REFERENCES

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