CASE 9–2014

Supracarinal Tracheal Tear After Atraumatic Endotracheal Intubation: Anesthetic Considerations for Surgical Repair

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IATROGENIC TRACHEAL TEARS are rare but very serious complications of tracheal intubation. Because an unknown fraction of postintubation tracheal injuries are undiagnosed, misdiagnosed, or underreported, the actual incidence and outcomes of such injuries are unknown. The incidence of reported cases is approximately 1 in every 20,000 intubation attempts,[1] but postmortem studies suggest the actual incidence may be as high as 15% of emergency intubations.[2] When discovered, tracheal tears typically are managed conservatively, although larger tracheal tears generally require surgical intervention after diagnosis by fiberoptic bronchoscopy. The authors report on the anesthetic and surgical management of a large tracheal tear close to the carina in a young female patient and discuss airway management recommendations for such injuries.

CASE PRESENTATION*

A 27-year-old Caucasian female with a history of migraines and intractable seizure disorder presented for a left craniotomy and an implantation of subdural grid and depth electrodes to localize the site of her seizures. She and her husband had expressed a desire to have children, and this procedure was meant to facilitate weaning her off of potentially fetotoxic seizure medications.

An uneventful anesthesia induction with 150 mg of propofol, 50 mg of lidocaine, and 50 μg fentanyl was followed by a single atraumatic attempt at direct laryngoscopy with a grade-1 view. The patient was intubated with a 7.0 endotracheal tube (ETT) that was taped at 22 cm at the lips before the surgeon attached the Mayfield frame to the head in the magnetic resonance imaging suite. After the required images were obtained, the intubated patient was transported to the operating room (OR) and sedated with propofol (100 μg/kg/min) for the second part of the procedure, a left craniotomy, implantation of subdural grid with the use of stealth navigation, and stereotactic implantation of right and left depth electrodes, to localize the epileptogenic focus. The patient was extubated and transported to the postanesthesia care unit after the uneventful procedure. On postoperative day 2, she was rushed to the OR for an emergency craniotomy to evacuate an epidural hematoma. Her reintubation with a styletted 7.0 ETT was atraumatic with a grade-1 view on laryngoscopy. Shortly after the procedure started, the patient spontaneously desaturated into the low 80s and was ventilated manually back to an SpO_2 of 100%. A second episode of desaturation occurred an hour and 25 minutes into the case, prompting an arterial blood gas (ABG) analysis, which revealed a PaO_2 of 49.3 mmHg. A repeat ABG 30 minutes after the desaturation episode was normal (PaO_2 of 370 mmHg). Thirty-two minutes after the second set of ABG results was obtained, a third episode of spontaneous desaturation (89%) reverted to 100% with little intervention. The authors observed that the ETT had migrated down into the right main bronchus and left breath sounds were diminished. The tube was readjusted and pulled back from 24 cm and retaped at 22 cm at the lip.

Because of the unexplained desaturations in the OR, the anesthesia and surgical teams agreed that the patient should remain intubated. Axial and coronal views on computed tomography angiography, which were obtained to rule out a pulmonary embolus, instead revealed a small pneumomediastinum (Figs 1 and 2), prompting an urgent cardiothoracic consult and return to the OR for exploration.

PaO_2 was 54.7 mmHg on arrival in the OR. Standard monitors were attached and adequate anesthesia was ensured. The surgeon then evaluated the entire trachea under fiberoptic guidance through the existing ETT and discovered a 6-cm tear that was 2 cm from the carina (Figs 3 and 4). The surgeon decided to approach the repair through a right thoracotomy. Because of the airway trauma and proximity of the injury to the carina, the authors isolated the left lung by advancing the ETT into the left main bronchus under bronchoscopic guidance. The patient was placed on ventilator support with a tidal volume of 400 mL. Peak and plateau airway pressures were 22 and 21 cmH_2O, respectively, and SpO_2 was 100%. A desaturation episode (SpO_2 of 65%) an hour into the case could not be explained by the tube position because it was distal to the lesion. Fiberoptic bronchoscopy revealed further migration of the ETT past the left bronchial bifurcation. The ETT was, therefore, repositioned distal to the carina but proximal to the left bronchial bifurcation, also under fiberoptic guidance. Oxygenation improved significantly, and the patient was placed in a left lateral decubitus position for a 6-hour right open thoracotomy.

The tracheal defect was found to be just beneath the ETT cuff (Fig 5), with only a thin membrane separating the cuff from the tracheal lumen. Once the defect was opened, the ETT and deflated cuff clearly could be seen just entering the left mainstem bronchus (Fig 6). The tube was advanced further to repair the site. Intraoperative management included intermittent manual ventilation for adequate oxygenation.

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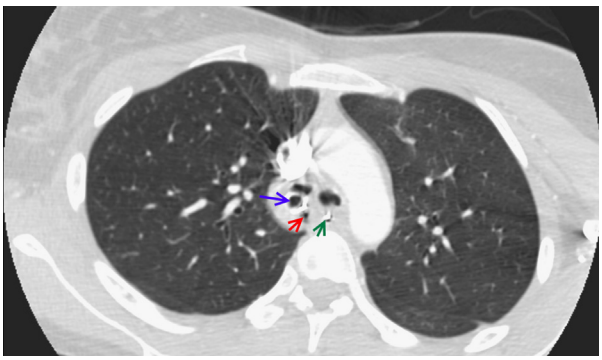

Fig 1. Axial view of chest computed tomography. A pneumomediastinum from the tracheal tear (red arrow), endotracheal tube in right mainstem bronchus (blue arrow), and enteric tube in esophagus (green arrow) can be seen. (Color version of figure is available online.)

After the repair, the ETT was pulled back under fiberoptic guidance to a site proximal to the repair to avoid ETT balloon compression of the repair. When the defect was tested with Valsalva of up to 30 cmH_2O, no leak was visible. The patient then was placed on pressure control ventilation with a peak pressure of 25 cm H_2O, respiratory rate of 16 breaths/minute, and F_IO_2 of 100%. At the end of the procedure, the patient was extubated awake in the OR and transferred to the intensive care unit in stable condition. The defect was intact on postoperative day 19 (Fig 7).

DISCUSSION

Iatrogenic tracheal injuries are rare but potentially life threatening. The incidence of reported cases is approximately 1 in every 20,000 intubation attempts,[1] or 0.005%, although certain postmortem studies suggest an incidence as high as 15% in cases involving emergency intubation.[2] In an analysis of American Society of Anesthesiologists (ASA) closed claims data (1961-1996), 6% of claims were due to airway injury. Factors associated with claims for pharyngoesophageal perforation included difficult intubation, age older than 60 years, and female gender. Nevertheless, 9 of 13 claims for tracheal perforation involved routine (nondifficult) tracheal intubation.[3]

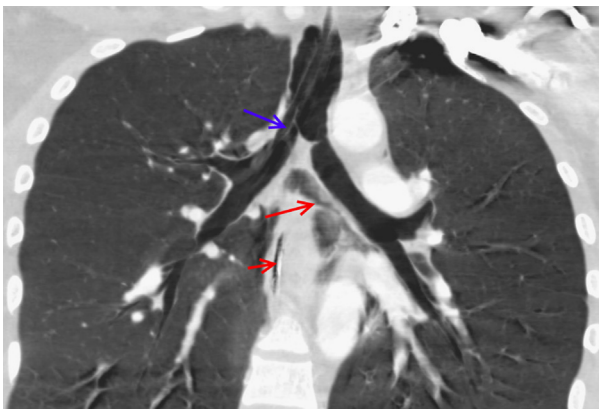

Fig 2. Coronal view of chest computed tomography. The tip of the endotracheal tube is in the right main bronchus (blue arrow) and air is in the mediastinum (red arrows). (Color version of figure is available online.)

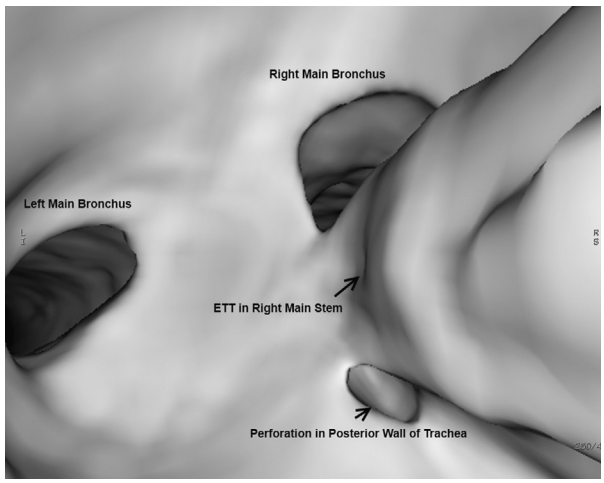

Fig 3. Virtual 3-D bronchoscopic image. The endotracheal tube is entering the right main bronchus, and the tear is in the posterior wall of the trachea. (Color version of figure is available online.)

The trachea is susceptible to injury whenever an ETT is placed. It is a cartilaginous (anterior two-thirds) and membranous (posterior third) tube extending from the lower part of the larynx at the level of the sixth cervical vertebra to the upper border of the fifth thoracic vertebra, where it divides into the two main bronchi. Made up of fibrous tissue and muscular fibers, the posterior third is the weakest part of the trachea and the location of most reported injuries.[4]

ETIOLOGY AND RISK FACTORS

The mechanism of tracheal injury remains unclear, but the most probable explanation is a direct laceration from the tip of an ETT when it is caught in a fold of a flaccid posterior tracheal membrane as the tube is being advanced. The vast majority of cases have been reported in shorter female patients.[5] The smaller airway of female patients is an injury risk factor. The upper limits of coronal and sagittal tracheal dimensions are 25 and 27 mm, respectively, in men, and about 4 mm smaller in both dimensions in women. The lower limit of normal for both dimensions is 13 mm in men and 10 mm in women. The tracheal diameter from side to side is 2 to 2.5 mm, always greater in males than females.[6]

Other important risk factors for tracheal injury include pathologic conditions such as tracheomalacia or stenosis, size and mobility of the ETT, and the skill level of the provider placing the ETT. Emergency intubations, unanticipated difficult airways resulting in repeated intubations,[7] duration of intubation, inappropriate use of a stylet, ETT cuff pressure, and surgeries involving the head and neck region are also predisposing factors. A prospective study reported a 4% incidence of tracheal stenosis for intubations lasting 5 to 10 days and up to 12% for intubations lasting 11 to 24 days.[8] Repeated intubations and prolonged contact of the tracheal mucosa with the ETT cuff are associated with inflammatory changes that make the trachea susceptible to injury. In an animal study, anesthetized neonatal piglets were randomized to 1 of 4 groups: Injured (reintubated every 0.5 hours), intratracheal pretreated (given intratracheal pretreatment of 1 mg of nebulized budesonide), intravenous