the ICU, without inotropic support, were as follows: BP, 146/92 mm Hg; heart rate, 95 beats/min; central venous pressure, 18 mm Hg; pulmonary arterial pressure, 35/17 mm Hg; pulmonary capillary wedge pressure, 11 mm Hg; and cardiac output, 10.0 L/min.

*S. aureus* was isolated from the intraoperative abscess collection, while the pericardium showed fibrous scarring with mixed acute and chronic inflammation on microscopy. Dilute povidone-iodine mediastinal irrigation was continued for 5 days. The patient was discharged on postoperative day 7 and completed a 6-week course of IV vancomycin at home. TTE prior to discharge showed no pericardial effusion, normal right ventricle size with normal free wall excursion, and normal left ventricle function. At follow-up about a year and a half later, the patient remains free of symptoms, with resolution of his ascites.

**COMMENTS**

Although bacterial pericarditis in the absence of prior cardiac surgery is typically diffuse in nature, there appears to be an atypical form of presentation, a localized mass associated with *S. aureus*, as demonstrated in this case report and in an earlier report by Suzuki et al.1

This characteristics of *S. aureus* may be related to its peculiar microbiological characteristics of causing localized tissue destruction with abscess formation, compared with streptococcus, for instance, which secrete a lytic enzyme that allows a more widespread infection. Moreover, in ESRD patients, *S. aureus* is the most common pathogen associated with hemodialysis access as result of compromised granulocyte number and function due to sequestration in a small vessels during hemodialysis and impairment of granulocyte locomotion, phagocytoses, and intracellular killing due to azotemia.2

To our knowledge, this patient represents the second reported case in the English-language literature presenting with an encapsulated intrapericardial abscess, causing embarrassment of right heart function consistent with pericardial tamponade and without systemic manifestation of sepsis.

Our preoperative diagnosis included a pericardial/thyroid cyst or cystic tumor, displacing the heart and compromising cardiac function. A walled-off abscess was not entertained in the absence of systemic signs of infection, although the WBC count showed borderline elevation. Had a localized abscess been suspected preoperatively, a CT-guided or echo-guided needle drainage would have been attempted to relieve the pressure on the heart and to improve hemodynamics prior to a definitive drainage. Surgical drainage and pericardiectomy of the thickened pericardium could have been accomplished electively, as opposed to emergently, as in this case.

Increased awareness among clinicians of this atypical presentation of *S. aureus* pericarditis and a high index of suspicion are required to make the correct diagnosis. A thorough history, physical examination, and ancillary studies should elucidate the correct diagnosis. A remote history of *S. aureus* septicemia in a patient presenting with signs of right heart failure and enlarged cardiac silhouette on chest radiograph should raise the suspicion of this entity in the differential diagnosis, which can then be confirmed by TTE and chest CT scan if still in doubt.

In addition to antibiotics, treatment should include some drainage method, which can be accomplished by needle drainage under echocardiographic or CT guidance in early cases. For more chronic cases with a thickened pericardium, surgical drainage with pericardiectomy should be performed to prevent development of effusive constrictive pericarditis.4

The approach could be either a subxiphoid, thoracotomy, or median sternotomy incision. We prefer a median sternotomy, as this allows a wider pericardiectomy and also placement of irrigation catheters from above and below for postoperative dilute povidone-iodine or antibiotic irrigation.

In an autopsy review from Johns Hopkins between from 1945 to 1975, purulent pericarditis was established antemortem in only 10 of 55 patients (18%), indicating its elusive nature.2

In the current era with modern diagnostic capabilities, availability of broad-spectrum antibiotics, and improved anesthetic and surgical techniques, most cases should be diagnosed antemortem, with good prognosis following early diagnosis and aggressive management.

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**Tension Pneumothorax and Contralateral Presumed Pneumothorax From Endobronchial Intubation via Cricothyroidotomy**

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Cricothyroidotomy can be a life-saving procedure for the “can’t intubate, can’t ventilate” patient who has upper-airway obstruction. The procedure is usually fast and easy to do; however, complications have been reported. We report two cases in which cricothyroidotomy with an endotracheal tube led to unrecognized endobronchial intubation, ipsilateral tension pneumothorax, contralateral presumed pneumothorax, and unnecessary emergency surgery. Additionally, these led to the triad of hypotension, hypoxemia, and, probably, elevated intracranial pressure, which
can worsen cerebral injury. We discuss methods to avoid these complications.

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Key words: cricothyroidotomy; endotracheal intubation; endotracheal tube; mechanical ventilation; pneumothorax; presumed pneumothorax

Cricothyroidotomy can be a life-saving procedure for the “can’t intubate, can’t ventilate” patient who has upper-airway obstruction. An opening is made in the cricothyroid membrane, and a tracheostomy or endotracheal tube is inserted to permit oxygenation and ventilation. This procedure has been advocated as fast and easy, taking < 30 s with minimal equipment.1 While complications have been reported from cricothyroidotomy, they are rarely life threatening.2,3 In this report, we present two cases of emergency cricothyroidotomy, in which the patients suffered unrecognized endobronchial tube placements, left presumed pneumothorax, and delayed recognition of right pneumothorax, which led to hypotension, hypoxemia, and unnecessary surgery.

CASE REPORTS

Patient 1

A 16-year-old man was involved in a motor vehicle collision. He was transported to an outlying facility, where he was noted to be hypotensive and in respiratory distress. Because of an inability to intubate, a cricothyroidotomy was performed and an endotracheal tube (6.0-mm inner diameter) was inserted. Initially, breath sounds were equal bilaterally. After several minutes, the patient became difficult to ventilate manually, and breath sounds decreased on the left, so a chest tube was inserted without return of fluid or air. Ventilation remained difficult, and the patient became progressively hypotensive and then desaturated. The chest tube was replaced because of concerns that it was kinked, with only mild improvement in oxygen saturations, to approximately 70%. During transport, he received 5 L of crystalloid and 5 U of packed RBCs. There was no evidence of chest trauma on examination, and no attempt had been made to insert a central line. Because of persistent hypotension and a distended, firm abdomen, he was rushed to the operating room for exploratory laparotomy. On arrival in the operating room, the endotracheal tube was noted to be tied at 20 cm at the skin. It was withdrawn until resistance of the balloon could be felt at the site of cricothyroidotomy. Although breath sounds on the left improved, inspiratory pressures and hemodynamics failed to improve. Examination of the chest radiograph, taken earlier in the emergency department, showed a right mainstem bronchus intubation and a right tension pneumothorax (Fig 1). A che
tube was inserted into the right pleural space, and there was a rush of air and immediate improvement in peak inspiratory pressure, hemodynamics, and resolution of the distended abdomen. The exploratory laparotomy disclosed no abdominal trauma or hemorrhage. The patient’s condition continued to deteriorate, and he was pronounced dead of severe craniofacial injuries the next day.

Patient 2

A 16-year-old man was involved in a motor vehicle collision. Because of severe craniofacial injuries, the emergency medicine technicians performed a surgical cricothyroidotomy, inserting a 6.0 endotracheal tube. He had a left chest contusion. A left subclavian vein central line was inserted. Initially, he had equal bilateral breath sounds, but then breath sounds decreased on the left. A needle thoracostomy was performed in the left mid-clavicular line, with no rush of air or fluid, but only the return of “two to three bubbles.” A 32F chest tube was then placed in the left chest without return of air or fluid. On arrival in the emergency department, about 70 min after cricothyroidotomy, pulse oximetric saturation was 80% on a fraction of inspired oxygen of 1.0. Chest radiograph showed right pneumothorax, right clavicular fracture, left pulmonary density, and right endobronchial intubation. A right chest tube was inserted. Follow-up radiograph showed good expansion of the right lung and continued right endobronchial intubation. Diagnostic peritoneal lavage showed blood, and the patient went to the operating room. Intraoperatively, he remained hypoxic and hypotensive, with increased inspiratory airway pressures. The left chest did not expand with inspiration. Both chest tubes were replaced, with no improvement in left chest expansion. Left thoracotomy was performed, and a small lingula tear was sutured. Chest expansion did not improve. The cricothyroidotomy endotracheal tube was then removed, and the patient was intubated orally. Bronchoscopy was limited by blood in the airway, but did not show any injury. Exploratory laparotomy was completed with resection of a ruptured spleen. Postoperatively, the patient’s condition continued to deteriorate, and he was pronounced dead that night from severe cranial injuries.

DISCUSSION

In the severely injured trauma patient, appropriate aggressive airway management is essential. Early control...
of the airway to ensure oxygenation, ventilation, and protection against aspiration is paramount. In situations such as “cannot intubate, cannot ventilate,” severe lower facial trauma, with distortion and no visualiziation of the airway, and where nasotracheal or orotracheal intubation is impossible or contraindicated, cricothyrotomy is a rapid and effective method to control the airway. Although cricothyrotomy may be performed rapidly (< 30 s),1 complications do occur (6.8 to 40%).2–7 Well-known complications include local hemorrhage, cartilage fracture, through-and-through puncture, injury to adjacent structures, infection, subcutaneous and mediastinal emphysema, aspiration, extratracheal tube placement, vocal cord damage, laryngeal edema, esophageal or tracheal laceration, cardiac dysrythmias, and cardiac arrest.6 Delayed complications include laryngeal or subglottic stenosis (up to 2.6%), globus sensation, persistent stoma, and voice change.5–7 We present here a previously undescribed complication: intubation of the right mainstem bronchus, with ipsilateral pneumothorax and contralateral presumed pneumothorax.

Both patients had similar symptoms at presentation. They were victims of multiple trauma with severe craniofacial injuries. The emergency personnel considered a cricothyroidotomy necessary for airway management. Both patients had endotracheal tubes inserted via the cricothyroidotomy into the right mainstem bronchus, or even into the bronchus intermedius, with resultant decreased breath sounds on the left, which was interpreted as indicating a pneumothorax. Both patients then had left chest tubes inserted, without return of air or improvement in left chest expansion and breath sounds, followed by late discovery of a right pneumothorax and of insertion of a right chest tube. Additionally, the first patient had an unnecessary exploratory laparotomy because of hypotension and the caudal displacement of the diaphragm due to right-sided tension pneumothorax. The second patient had an unnecessary left thoracotomy because of persistent absence of signs of left-sided ventilation, which was actually due to persistently unrecognized right mainstem bronchus intubation.

Volumes intended for two lungs but delivered to only one can lead to barotrauma and pneumothorax. Under tension, a pneumothorax impedes venous (including jugular) return and leads to low cardiac output. If pulmonary shunt is present from the collapsed or atelectatic left lung, the low mixed venous PO₂ from low cardiac output will cause arterial hypoxemia. Both patients exhibited hypoxemia, hypotension, and signs of low cardiac output. They probably also had elevated jugular venous pressure from impeding of venous return, which would cause an elevated intracranial pressure. Cerebral perfusion pressure is the driving force for perfusion and brain oxygenation and is calculated as the difference between arterial BP and intracranial pressure. Hypoxemia, hypotension, and elevated intracranial pressure form a triad that should be avoided in trauma patients. Although in these two patients, the severity of the craniocerebral injuries precluded survival, other patients who might have less severe cranial injuries could be harmed by this trial.

Cricothyroidotomy is an important procedural skill for emergency personnel. However the procedure is usually done with very little time for preparation. If the tracheotomy tube is not readily available, it may be necessary to use an endotracheal tube. However, the endotracheal tube is long enough to extend into the right lower lobe. Thus, if it is used, it is crucial to insert the endotracheal tube only until the cuff disappears from view—no farther—in the cricothyroidotomy opening. This is well before any depth numbers are printed on the endotracheal tube. Advancing the endotracheal tube until the point where numbers mark the depth of insertion risks endobronchial intubation, as happened in both these cases. Breath sounds must be assessed immediately after tube insertion and periodically thereafter. If at any time breath sounds become decreased or lost, the position of the endotracheal tube must be confirmed before assuming that the patient has suffered a hemothorax or pneumothorax.

If a tracheotomy tube is not available and an endotracheal tube must be utilized, the physician should use tape to form a large cuff around the endotracheal tube, approximately 2 to 3 cm above the balloon. (The endotracheal tube should not be shortened until tracheobronchial injury has been excluded.) When an endotracheal tube is used through a cricothyrotomy site, the tube should be inserted only until the balloon just disappears from sight. The tape cuff then helps prevent caudal migration of the tube.

In summary, we present two cases of cricothyroidotomy leading to right mainstem intubation, ipsilateral pneumothorax, contralateral presumed pneumothorax, and unnecessary exploratory surgeries.

References