Electrocautery-Induced Airway Fire During Tracheostomy

Melinda K. Bailey, MD, Howard R. Bromley, MD, John G. Allison, MD, Joanne M. Conroy, MD, and Walter Krzyzaniak, CRNA

Key Words: ELECTRICAL SYSTEMS, ELECTROCAUTERY—fires. EXPLOSIONS, FIRES—electrocautery.

Although most of the recent attention regarding airway fires has focused on the intraoperative use of the laser, it is important to remember that electrocautery may also serve as a source of ignition during surgery involving the airway and/or oropharyngeal cavity. This subject is mentioned in only a handful of isolated reports in the recent literature (1-3). The following is, we believe, the first case report of an electrocautery-induced fire occurring during an elective tracheostomy.

Case Report

The patient was a 33-yr-old woman with multiple medical problems including steroid-dependent nephritis, acute pancreatitis, and pneumonia complicated by the development of adult respiratory distress syndrome. After 2 wk of mechanical ventilation through an endotracheal tube that would be necessary for an indefinite period, she was brought to the operating room for elective tracheostomy.

Preoperative examination revealed an obese Cushinoid woman, awake and able to follow commands. Pulse rate was 108 beats/min, blood pressure 170/90 mm Hg, temperature 39°C, and respiratory rate 15 breaths/min with an intermittent mandatory ventilation rate of 10 breaths/min. Breath sounds were clear, but distant and not easily auscultated because of the patient's obesity and pulmonary abnormalities. Chest x-ray before surgery revealed bilateral pleural effusions and right lower lobe infiltration. Blood gas tensions included a Paco₂ of 37 mm Hg, PaO₂ of 83 mm Hg, and a pH of 7.40 during intermittent mandatory ventilation rate at a rate of 10 breaths/min with a tidal volume of 500 mL, positive end expiratory pressure of 10 cm H₂O, and an FiO₂ of 40%.

The patient was brought to the operating room, and anesthesia was induced with fentanyl and midazolam. Vecuronium was given for paralysis. Chest compliance was poor, and breath sounds remained diminished. The patient was given 100% oxygen with oxyhemoglobin saturation of 96%-98% by pulse oximetry. Blood gas tensions after induction were PaO₂ 323 mm Hg, Paco₂ 33 mm Hg, and pH 7.40. The neck was cleansed with povidone iodine, surgical drapes were put in place, and surgery was started. After the neck incision was made, an electrocautery device was used to secure hemostasis. After approximately 15 min, as the electrocautery device was being used, a loud pop was heard, followed by a fire in the surgical field. Moist towels were used to extinguish the flames, and the charred endotracheal tube was removed (Figures 1 and 2) and replaced with a #6.0 Shiley tracheostomy tube. The patient's vital signs remained stable throughout, including oxyhemoglobin saturation, which remained greater than 95% on the pulse oximeter. Flexible bronchoscopy and direct laryngoscopy revealed a thermal injury to the posterior midtrachea involving approximately a 3-cm area extending 50% around the tracheal circumference.

The patient tolerated the remainder of the procedure well and was taken back to the intensive care unit in stable condition. Postoperatively, a chest x-ray showed a large right-sided pneumothorax. (In retrospect the preoperative chest x-ray was also consistent with a pneumothorax, but only with a small one.) A chest tube was inserted and suction applied. The patient was followed closely over the next several weeks by both otolaryngologists and anesthesiologists. Bronchoscopy, performed periodically during this time, revealed the posterior tracheal wall to be...
healing without difficulty. Unfortunately, the patient continued with a long and protracted course, including development of hepatic failure and sepsis; she died 1 mo later.

The primary cause of death, determined at autopsy, was attributed to respiratory insufficiency as evidenced by lung abscesses with consolidation and multiple pulmonary emboli.

Discussion

Electrocautery is frequently employed during surgical tracheostomy, specifically in the "cutting mode" for separation of tissues and in the "coagulation mode" for control of bleeding. When used in such a fashion, electrocautery completes the triad required for production of an intraoperative fire, namely (a) a source of ignition (the electrocautery device); (b) a combustible material (the endotracheal tube); and (c) an oxidizing agent (oxygen and/or nitrous oxide) (1,2,4). Surgical tracheostomy, however, is not considered a procedure at high risk for the development of a fire because, theoretically, these three components do not come into contact with one another. This case should put that myth to rest. We believe that, in this instance, the cuff on the endotracheal tube was accidently ruptured by the electrocautery device, exposing the current to an atmosphere of virtually 100% oxygen, thereby leading to ignition of the endotracheal tube.

Prophylactic measures to avoid fires have been recommended during tracheostomies and should be used to guard against the risk of fire during routine tracheostomy. For example, reduction of the concentration of the oxidizing agent can be accomplished by dilution of oxygen with nitrogen (air) and/or helium, both of which reduce combustibility (5–7). (Nitrous oxide on the other hand, enhances combustion.) Next, the source of the ignition must be considered. Comparison of combustibility and resulting tracheal damage from laser-ignited tubes has shown polyvinyl chloride tubes to be more susceptible to ignition and production of tracheal damage than wrapped red rubber tubes in nitrous oxide–oxygen mixtures (8). Whether or not this applies to electrocautery-induced fires is unknown. Based on the available information, however, Shapiro and El-Baz state, “The use of N₂O and O₂ during anesthesia for intraoral, pharyngeal, or laryngotraheal procedures should be avoided completely in favor of air or air-oxygen mixture” (6). And finally, perhaps we should question the use of the electrocautery device at all for this type of procedure, i.e., tracheostomy. After experiencing a fire due to use of electrocautery occurring during transcervical ventilation for emergency tracheostomy, Bowdle et al. recommend that “electrocautery, especially for cutting, should be avoided if at all possible when the surgical field is immediately adjacent to the oxygen source” (1). Other authors stress the use of
bipolar, rather than unipolar, electrocautery, which would thereby minimize the amount of leakage current available (9).

In summary, we recommend the following precautions as a minimum for prevention of fire during elective tracheostomy:

1. Use of oxygen-air and/or helium mixtures to reduce combustibility, if the patient’s condition permits.
2. Sparing use of the electrocautery device, if any, at low levels of voltage, particularly as the trachea is exposed during the surgical resection.
3. Use of bipolar rather than unipolar electrocautery for prevention of current leakage.
4. Inflation of the endotracheal tube cuff with saline or water instead of air.

Is this overkill for a procedure such as a simple tracheostomy? Having been burned once, we think not.

References