Tracheostomal Fire During an Elective Tracheostomy

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Some surgeries, a tracheostomy and oral surgeries in particular, have a higher risk of fire. Often it can occur when leaking flammable gas contacts an ignition heat source. Fire during a tracheostomy can sometimes be seen to produce different degrees of insult to the patient. The essential components of a fire, i.e., the fuel source, ignition, and an oxidizer, can be avoided or blocked in order to prevent fires from occurring. Herein, we discuss a fire during a tracheotomy, and ways to avoid its occurrence, and how to stop once it gets started. This case demonstrates 2 important points regarding tracheostomies. First, extreme caution should be exercised when cautery is used in an approximately 100% oxygen gaseous condition, and second, immediate extubation is not absolutely necessary if a fire breaks out during a tracheostomy. The procedures which can be taken when facing this type of emergency are also considered and discussed. *(Chang Gung Med J 2005;28:186-90)*

Key words: tracheostomy, fire.

Fire induced by electrosurgery in the operating room is a uncommon occurrence, and severe sequelae may occur if not properly managed. The 3 main components of a fire are the fuel source, ignition (usually a spark from an electrosurgical unit), and an oxidizer.[1-11] The operating room is an environment often filled with rich oxygen and other flammable gases used for anesthesiology and surgical purposes. The oxygen and other flammable gases can come in contact with the heat of an ignition source. When other flammable materials (including gases and surgical items) come in contact, combustion and an explosive fire can occur. Some surgical procedures, including a tracheotomy and oral surgery, present higher risks of fire.[2-5] Fire is often an issue when combustible air leaks from an endotracheal tube into the oral cavity or trachea. Herein we report a case of fire induced by electrosurgery while performing a tracheotomy in a patient with prolonged intubation. We discuss proper management when faced with this situation. Preventive measures are also discussed.

CASE REPORT

A 48-year-old woman was hospitalized in May 1997 under the impression of pneumonia, hypertension, and uremia. While in the ordinary ward, she received aggressive treatment for pneumonia, hemodialysis for end-stage renal disease, strict blood pressure control, and a blood transfusion to correct her severe anemia. However, her condition deteriorated with development of sepsis and adult respiratory distress syndrome. Ventilation by a mechanical respirator was used through an in situ 7.0-mm internal-diameter polyvinyl chloride endotracheal tube (ETT) in the intense care unit for 2 weeks, and unsuccessful weaning was attempted. She was then

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scheduled for an elective tracheotomy. Before surgery, general anesthesia was induced with 50 mg intravenous lidocaine, 150 μg fentanyl, 40 mg atracurium, and 120 mg propofol. The anesthesia was maintained with 50% oxygen, 50% air, and kind of anesthetic gas inhalation. The patient was in the supine position with her neck hyperextended. At about 1 or 2 cm below the cricoid cartilage, a vertical incision was made about 4 to 6 cm in length. The incision was continued via electrocautery to the level of the strap muscles. Subsequently, the second to fourth tracheal rings were exposed, and a #11-blade knife was then used to cut a window out of the trachea. After entering the trachea, a vessel overlying the trachea was coagulated to achieve hemostasis. A roaring sound was heard, followed by fire emerging from the tracheal window. We immediately covered the site with moist gauze pads, and the anesthesiologist disconnected the oxygen delivery. The fire was extinguished within seconds. The polyvinyl chloride ETT was not removed until reestablishment of the airway could be confirmed. Once there was no evidence of fire in the airway, the ETT was removed. A #6 double-lumen Shiely tube with an inflated cuff was put in place and secured. The subsequent direct flexible laryngoscopic and bronchoscopic examinations were performed and revealed no evidence of burn injury to the upper or lower airway. Only the mucosa of the anterior trachea surrounding the tracheostomy window was erythematous and charred. After examination of the ETT, it was determined that the cuff with the tip was burned with charred extraluminal areas (Fig. 1). During and after the accident, the patient's vital signs remained relatively stable. The estimated blood loss during surgery was 50 ml. The entire procedure was finished within 20 min. In the recovery room, she received 50 mg of meperidine for pain relief and nifedipine using for lowering high blood plessure up to 190/110 mmHg. Also, prophylactic steroids were given. Mechanical ventilation with positive pressure was administered, with the tidal volume, inspiratory force, and respiratory rate all within normal ranges. A postsurgical chest X-ray revealed that the tracheal tube was still in place with no significant changes compared with preoperative films, such as pneumothorax or deterioration. After a 2-h stay in the recovery room, the patient fully *recovered* and was transferred to the surgical intense care unit.

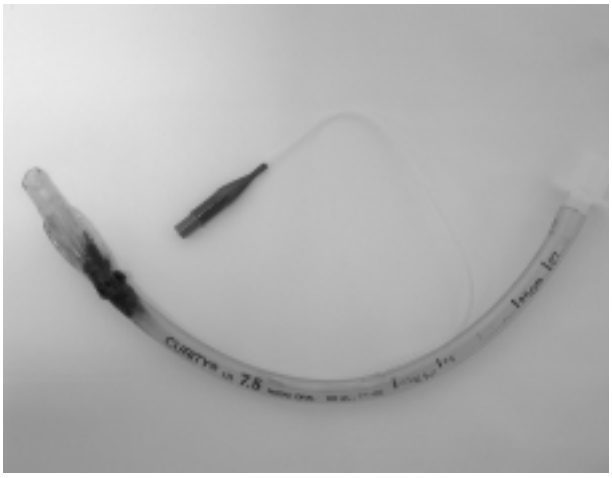

Fig. 1 Photograph of a burned endotracheal tube. The charred area is about 3 cm in length and 5 cm from the tip of the tube.

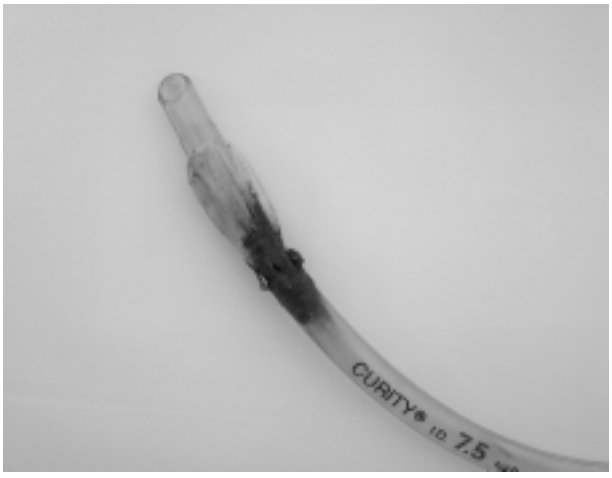

Fig. 2 Nearing picture of the charred area, the cuff with part of tube were burned through.

Postoperatively, antibiotics were administered. She received prophylactic steroids for 5 days to prevent inflammatory changes induced by the intensive burns. There were no signs of necrosis or infection over the stoma wound 1 week after surgery. During very close observation over 3 days, no significant respiratory distress or changes were noted. The patient was transferred to a respiratory care unit for further treatment. The patient was in follow-up for 6 months, and against advice, was discharged after a downhill turn in her pulmonary condition and sepsis. The burn injuries did not cause clinically irreversible

insult to the patient, although superficial damage was described initially.

DISCUSSION

A review of the literature revealed that there is controversy in the management of a fire during a tracheostomy-whether removal of the ETT is prudent.[4-7,10,11] Some authors claimed removal would further introduce thermal and chemical hazards to the lower airway. However, a patient receiving a tracheotomy often has anatomical difficulty with intubation or has the sequela of an edematous airway secondary to prolonged intubation and limited pulmonary reserves. Securing the airway is important. In our experience, removal of the ETT is dangerous, because reestablishing the airway may be difficult unless re-intubation of the oral ETT or a tracheostomy is immediately performed. Avoiding the risk of airway loss may be the key.

By addressing the 3 main components making up a fire (a fuel source, ignition, and an oxidizer), the risks of fire can be decreased. This requires close cooperation among the anesthesiologist, surgeons, and other members involved in the procedure. The anesthesiologist should be prepared to immediately turn off the oxidizer providing oxygen or anesthetic gas (nitrous oxide is flammable), ensuring the safety of the airway.[1,2,6,8] The management team should be informed of the potential dangers and consequences of a fire, including possible thermal injury from inhalation, bronchospasms, and burn injuries. During the procedure, the surgeon should be prepared to stop electrocautery procedure and thus to cease ignition. Quick removal of any possible fuel source, including gauze is also important. Being prepared to perform suction of the flammable air and using wet drapes to cover the site of a fire are important in reducing injury to the patient. Irrigation with water can be performed after the fire has been put out, since the fire may persist and extend to other areas. Afterwards, the tracheotomy should be established as soon as possible. After putting out the fire, the extent of the damage due to the fire should be investigated, including inspection of the entire airway route, using a flexible scope, laryngoscope, or bronchoscope. A chest X-ray is necessary immediately after in order to determine the pulmonary condition. In the possible situation of thermal injury due to inhalation, pneumothorax may occur. Close monitoring of the patient's condition is advised, as it may rapidly deteriorate in the intensive care unit, although most damage is superficial. In past reviews and in our own experience, steroids and antibiotics should be administered, but dosages depend on the situation.[3,4,6,7]

It is important to think of preventive measures before such an accident occurs. While incising the trachea, the anesthesia oxygen concentration should be lowered to 50% or below. The surgeon should use a knife or scissors instead of an electrocautery unit to incise the trachea.[3,4,7] Afterwards, use of an electrocautery unit for hemostasis without oxygen delivery is safer. Inserting a Shiely endotracheal tube and inflating the cuff to ensure that flammable gases will not come in contact with the spark of the electrocautery unit, and saving the hemostasis procedure for last are the keys. We believe that when using a knife to incise the trachea with a ruptured cuff and electrocautery to coagulate the bleeding vessels in an emergency while oxygen is being delivered in a high concentration, there is still a chance that fire can also occur in such a case.

The amount of oxygen that should be delivered has been discussed in the literature. In 1996, Brechthelsbauer et al. described the policy of their hospital,[1,2,6] where they allowed the oxygen concentration in the endotracheal tube to reach 40% in order to maintain the patient's oxygen saturation at a level acceptable to the anesthesiologist, usually at 93% to 94%. If a higher oxygen concentration is needed, electrocautery should be turned off. The oxygen should be completely turned off during an operation requiring electrocautery. Also, increased sedation may be required, as more oxygen is required, and thus there is a greater risk of fire. In 1990, Bailey et al. suggested that inflating the ETT cuff with water or saline instead of air before entering the trachea and using a bipolar electrocautery unit is safer than a unipolar unit at low voltages.[3,8]

In conclusion, preventing the outbreak of a fire or maintaining an outbreak requires attention to the 3 main components: an ignition source, e.g., an electrocautery unit inducing a spark; an oxidizer, e.g., a high concentration of oxygen or nitrous oxide; and a fuel source, e.g., extinguishing the fire with ETT or gauze. If a fire occurs, quick separation of the main elements described above and securing the airway are important for the patient's safety. Completing the

tracheotomy as quickly as possible is also important. Finally, inspecting and investigating the extent of the injury to the patient are prudent. Patients should be treated for thermal inhalation injury. However, note that past reviews of serious tracheotomy fires reported no extensive burn injuries. Administering steroids, antibiotics, and positive mechanical ventilation provid adequate treatment.

REFERENCES

1. Brechtelsbauer PB, Carroll WR, Baker S. Intraoperative fire with electrocautery. Otolaryngol Head Neck Surg 1996;114:328-31.
2. Simpson JI, Wolf GL. Endotracheal tube fire ignited by pharyngeal electrocautery. Anesthesiology 1986;65:76-7.
3. Lim HJ, Miller GM, Rainbird A. Airway fire during elective tracheostomy. Anaesth Intensive Care 1997;25:150-2.
4. Awan MS, Ahmed I. Endotracheal tube fire during tracheostomy: a case report. Ear Nose Throat J 2002;81:90-2.
5. Chee WK, Benumof JL. Airway fire during tracheostomy: extubation may be contraindicated. Anesthesiology 1998;89:1576-8.
6. Le Clair J, Gartner S, Halma G.. Endotracheal tube cuff ignited by electrocautery during tracheostomy. AANA J 1990;58:259-61.
7. Aly A, McIlwain M, Duncavage JA. Electrosurgery-induced endotracheal tube ignition during tracheotomy. Ann Otol Rhinol Laryngol 1991;100:31-3.
8. Bailey MK, Bromley HR, Allison JG, Conroy JM, Krzyzaniak W. Electrocautery-induced airway fire during tracheostomy. Anesth Analg 1990;71:702-4.
9. Bowdle TA, Glenn M, Colston H, Eisele D. Fire following use of electrocautery during emergency percutaneous transtracheal ventilation. Anesthesiology 1987;66:697-8.
10. Wolf GL, Sidebotham GW. Endotracheal tube fire: comments on the advisability of not extubating. Anesthesiology 1999;91:888-9.
11. Ng JM, Hartigan PM. Airway fire during tracheostomy: should we extubate? Anesthesiology 2003;98:1303.

進行選擇性氣管切開術時發生氣管切口起火燃燒

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部分手術，如氣管切開術及口腔內手術，會引發起火燃燒的高危險性。原因通常是易燃性氣體洩漏而接觸到發熱物所引起的。而在氣管切開術中所引起的燒灼，對病人造成不同程度的傷害。因此我們可以經由防止起火物、易燃物、和氧氣等物質的接觸，進而抑制燃燒發生。病例中詳述在氣管切開術中，如何能避免及阻止氣管切口燃燒起火的發生。我們在術中使用百分之一百的氧氣是需要謹慎的，若發生氣管切口起火燃燒後，立即的氣管內管拔除，並不一定是需要的。在本病例中也將討論當面對此種緊急情況的處置過程。(長庚醫誌 2005;28:186-90)

關鍵字：氣管切開術，起火燃燒。

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