

Airway fires during surgery: Management and prevention

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Abstract

Airway fires pose a serious risk to surgical patients. Fires during surgery have been reported for many years with flammable anesthetic agents being the main culprits in the past. Association of airway fires with laser surgery is well-recognized, but there are reports of endotracheal tube fires ignited by electrocautery during pharyngeal surgery or tracheostomy or both. This uncommon complication has potentially grave consequences. While airway fires are relatively uncommon occurrences, they are very serious and can often be fatal. Success in preventing such events requires a thorough understanding of the components leading to a fire (fuel, oxidizer, and ignition source), as well as good communication between all members present to appropriately manage the fire and ensure patient safety. We present a case of fire in the airway during routine adenotonsillectomy. We will review the causes, preventive measures, and brief management for airway fires.

Key words: Airway fires, head and neck surgery, operating room fires

Introduction

The incidence of operating room fires has decreased over the past 100 years as less flammable anesthetic agents are being used. However, it still remains a constant threat to patient safety. Estimates suggest there are approximately 700 fires each year with more than 500 cases that are unreported or near misses. Airway fires are more common in head/neck and ENT procedures including, but not limited to, tracheostomy, adenotonsillectomy, skin surgery, cataract or other eye surgery, and burr whole surgery.^[1]

It has been reported recently that approximately 650 surgical fires are reported in US hospitals each year, and another three to four times as many are “near misses” or unreported events. Fires have been reported during tracheostomy, adenotonsillectomy, and skin surgery of the head and neck.^[2]

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Case Report

An 8-year-old boy (American Society of Anesthesiologists [ASA 1]), weighing 25 kg, was scheduled for routine adenotonsillectomy. Anesthesia was induced by inhalation of 8% sevoflurane in 100% oxygen at 6l/min. An intravenous access was secured, and Fentanyl 25 µg was given. Airway was secured with 5.5 mm non-cuffed preformed endotracheal tube (ETT). A big leak around the ETT in oropharynx was noticed. Anesthesia was then continued with 5.5 mm ETT with a throat pack around the ETT.

Patient was breathing spontaneously a mixture of oxygen and nitrous oxide (50:50) at 3 l/min each. Intramuscular pethidine 25 mg was administered after 10 min of induction.

Operation was uneventful but at the end of adenotonsillectomy, a small bleeder from the base of right tonsil was noticed. Electrocautry (Bipolar, Bovie-400SR[®]) was used to stop the bleeder. Suddenly a spark occurred causing the ETT to catch fire. Surgeon did not panic on seeing fire inside oral cavity and sprayed normal saline on the fire and removed the burning ETT [Figure 1].

The anesthetist reintubated the patient after suctioning the oropharynx. Patient was breathing spontaneously all the time and maintained SpO₂ above 96%. Patient was given salbutamol nebulizer through the ETT and dexamethasone 4 mg intravenously before extubation. Patient was monitored in high dependency unit overnight; he made a good recovery without any complications and discharged the next day.

Discussion

Electrosurgical units or lasers are used routinely to coagulate and cut tissue; this presents particular risks during airway surgeries. Oxygen and nitrous oxide mixture are commonly used to ventilate and anesthetize patients, respectively. These gases are highly combustible and require a low level of energy (e.g., current, heat, friction) to ignite. These gases are present below tracheal tube cuff in the airway and may leak around the cuff into the oropharynx creating an oxygen rich environment. This oxygen rich environment may lower the temperatures at which certain materials burn (e.g., tracheal tube) than at room air.^[2]

Flammable substances present in the airway during airway surgeries include tracheal tubes, catheters, and surgical sponges. Tissue heated by an ignition source may turn to gas, especially from fatty tissue, which will burn if mixed with sufficient oxygen.^[3]

When polyvinylchloride ETT were subjected to ignition tests, using electrocautery in various oxygen concentrations, it was noticed that at 52% oxygen and cautery current at 25-W the ETT could not be ignited.^[4] On the contrary, if the oxygen concentration was increased moving the ETT away from the cautery it still allowed ignition of tube.

A review of the data from the closed claims project database, which contains summary data on malpractice claims from 35 different liability carriers revealed burn injuries continue to occur primarily from cautery, warming devices and airway fires.^[5] In the same database, the claims for burns caused by cautery fires increased from 11% to 44% during 1994-2003, with the majority being on the face or in the airway during plastic surgery.

An estimated 550-650 surgical fires occur in the United States each year, according to the Food and Drug



Figure 1: Burnt endotracheal tube, the burned area coincides with oropharynx

Administration, some causing serious injury, disfigurement and more rarely, death.^[6]

In our patient, we believe that the leak around the non-cuffed ETT raised oxygen concentration in the oropharynx. This along with the use of electrocautery was responsible for this fire in oropharynx. There was no extension of the fire down the larynx to trachea and lungs, which would be devastating.

Cuffed ETTs offer many advantages. The cuff of ETT serves as a barrier to prevent oxygen leaking out from the trachea and accumulating around the operative site. The use of cuffed ETT should be strongly recommended along with checking the integrity of cuff before use. Careful use of electrocautery is recommended in these cases, especially if non-cuffed ETT is used.

There is debate on immediate extubation versus maintaining the ETT during an airway fire. Immediate extubation during any airway fire is appropriate from general ASA guideline as it may continue thermal injury. In patients with difficult airways maintaining, the ETT should be considered assessing the risk benefits on an individual basis.

The inspired oxygen concentration should be <50% while maintaining patient's oxygen saturation within normal range, especially in the procedures involving electrocautery close to ETT.^[7,8]

If long, insulated electrosurgical electrode probes are needed to prevent mouth burns during procedures such as tonsillectomies, commercially available insulated probes should be used. Red rubber catheters or other materials should not be used to sheathe the probes. The heat from the active electrode may ignite the rubber even in the air.^[9]

Scavenging around the surgical site with separate suction and use of wet gauze or sponges when operating in the oropharynx, to catch leaking O₂ and nitrous oxide may decrease the concentration in the oropharynx.

Laryngeal mask airway use has been suggested instead of ETT in adenotonsillectomies to decrease chances of airway fires, but there is debate about the safety of laryngeal mask regarding the possibility of aspiration.^[10]

Recently, Ho *et al.* reported that flooding the surgical field with carbon dioxide prevented fires during tracheostomy in pigs.^[11] This is an interesting finding that needs to be evaluated further in humans.

An updated report by the ASA task force on operating room (OR) fires was approved as guidelines for the prevention and management of operating room fires on October 17, 2012.^[12] Major recommendations in latest ASA guidelines for the prevention and management of operating room fires include relevant education of all anesthesiologists for fire safety specifically for OR fires. ASA guidelines for laser procedures recommend that a laser resistant tracheal tube should be used. The tracheal cuff of the laser tube should be filled with saline and colored with an indicator dye such as methylene blue.

For the management of airway fire, measures should be taken to extinguish the airway fire such as disconnecting the oxygen supply (with or without extubation, depending upon the anesthetic assessment on control of airway), saline wash and removing the cautery from the site of fire. The cornerstones of therapy for smoke inhalation injury are maintaining oxygenation, ventilation and stabilization of hemodynamic status.^[13] Inhaled bronchodilators help reduce bronchospasm, and humidification can relieve excessive airway drying or mucous plugging. Antibiotics and corticosteroids do not influence survival rates and should not be routinely administered to smoke inhalation patients. Bronchoscopy with protected brushings and washings may be required in severe cases.

Conclusion

As with any potential hazard, awareness is the first step to prevention. Before each surgical case, the OR team should determine if a case is at high risk for surgical fires. If a high-risk situation exists, the team should decide on a plan and roles for preventing and managing a fire. Communication between nursing staff, anesthesiologist and surgeon is critical. The most important thing to do in the case of a surgical fire is to eliminate the fire and protect the patient. When a surgical fire occurs, halt the procedure, remove whatever is on fire, and immediately cut the oxygen. Airway fires are significant risk in the OR, but with awareness and preventive measures, they can be easily avoided.

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