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Case Report

Electric Scalpel Induced Combustion of the Endotracheal Tube During Tracheostomy - Case Report

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Abstract: The electric scalpel operates on high values of electric current and tension, which leads to spark formation, exposing the staff to risks. Combustion depends on three elements: fuel, oxidant and ignition. The fuel is represented by the endotracheal tube (ET), composed by a material named polyvinyl chloride (PVC). The oxidant is represented by the oxygen. The ignition occurs when the electric scalpel, laser or diathermic loop are activated. The anesthesiologist plays a crucial role in the prevention and management of crises in the operating room.

Keywords: Combustion, Tracheostomy, Electric Scalpel, Anesthesia

1. Introduction

The electric scalpel operates on high values of electric current and tension, which promotes spark formation and electromagnetic interference, exposing both the staff and the patient to risks (electric shock, burns, explosions and cardiac arrest). Combustion depends on three elements: fuel, oxidant and ignition. The fuel is represented by the endotracheal tube (ET), composed by a material named polyvinyl chloride (PVC). The oxidant is represented by the oxygen. The ignition occurs when the electric scalpel, laser or diathermic loop are activated. Thus, the anesthesiologist must be familiar with some concepts which will guide the electrocautery operation, in order to prevent accidents and manage crises in the operating room (OR). The objective of this article is to report a case of endotracheal tube combustion during a tracheostomy and, through a review of the literature, to discuss strategies to minimize accidents involving fires in the (OR) [1-4].

2. Case Report

A fourty-five-year old female patient, BMI: 21,5 kg/m², with systemic hypertension, undergoing right pneumonectomy due to pulmonary tuberculosis sequelae, besides chronic cor pulmonale. She was hospitalized for the treatment of severe community acquired pneumonia, which evolved with respiratory failure and the need for orotracheal intubation on the admission day. Transfered to intensive care unit (ICU) with severe sepsis. Intravenous (IV) antibiotherapy initiated with Meropenem and Vancomycin, in addition to support therapy, with an improvement in the clinical status. The tracheostomy was scheduled 22 days later. The patient was admitted to the OR with central venous access in the right subclavian vein. After multiparametric monitoring, the subject received fractionated intravenous doses of midazolam and fentanyl and was attached to mechanical ventilation, in PCV, with sevoflurane 1.5% and gas mixture (oxygen/air), with inspired oxygen concentration at 50%. Local anesthesia with lidocaine at 1% + 20 mL ropivacaine 0.5% carried out by the surgeon. The surgical staff asked to deflate the endotracheal tube cuff, in order to access the trachea. Upon trachea incision with the electric scalpel, there was combustion of the tube (Figure 1) and flame blow-off through the tracheostomy. At this moment, there was a transitory decrease in the oxygen saturation (from

98% to 89%), which was later restored. The flames were dampened with wet compresses and the endotracheal tube was, then, removed to allow the passage of a tracheostomy cannula 8mm, with patency of the airways. Corticotherapy initiated with 10 mg dexamethasone IV. The patient was transferred to the (ICU), with Richmond Agitation Sedation Scale (RASS-2) sedated with skin burn around the tracheostomy ostium. (Figure 2) Patient submitted to bronchoscopy at 6 and 48 hours following the event which revealed edema and hyperemia of the trachea mucosa with paresis of the right vocal fold. The patient showed good clinical evolution, with a normal videolaryngoscopy before being discharged.

Figure 1. *Endotracheal tube (SOLIDOR® 7.0) after combustion in the cuff area.*

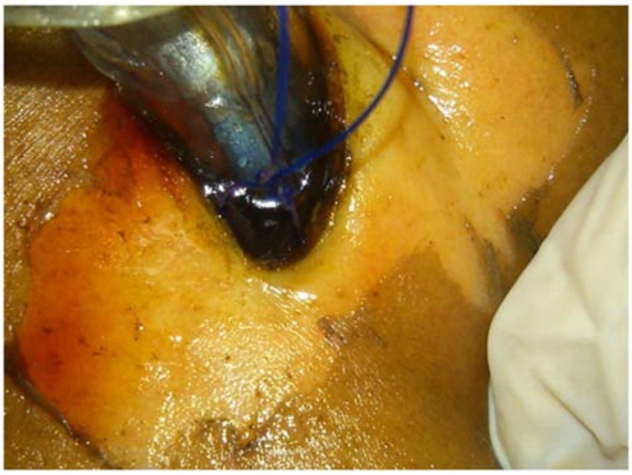

Figure 2. *Skin burn around the tracheostomy ostium.*

3. Discussion

Historically, accidents in the operating room involving fire were rather frequent due to the use of flammable volatile anesthetics such as ether. It is estimated that there are 550-650 events of fire in the operating room, in the United States, every year, according to the Food and Drug Administration, some leading to serious injury, disfigurement and, more rarely, death [5]. The indexes for burns caused by cauterization fire have increased from 11% to 44% between 1994-2003, most of which were facial and airways events. Around 25 cases of airway burns during tracheostomy were reported in the USA, some of which with significant morbi-mortality [6].

The airway procedures using ignition sources and laser systems represent a relevant risk of fire, especially when high concentrations of oxygen are used. In such cases, the ideal scenario is to work with the lowest possible fraction of inspired oxygen (FiO2) able to keep adequate oxygen saturation. To date, no endotracheal tube assures absolute airway fire prevention. Oxygen is flammable at concentrations above 25% (flammability index: 0.263). Monopolar diathermy provides an energy source with a temperature peak of 910°C [7]. It has been discouraged when using the cutting mode during tracheostomy or the coagulation mode during secondary hemostasis [8]. The manufacturers do not recommend the use of diathermy in the presence of flammable anesthetic gases, explosive agents or endogenous gases [9]. Most of the authors recommend the use of bipolar diathermy, instead of the monopolar one, for tracheostomy [10-11].

Potential risk can be attributed to antiseptics [12]. Most of the preparations available contain some type of alcohol. Chlorhexidine with 70% alcohol has an ignition point at 900°C. In an environment with 100% oxygen, there is a drop at this point between 30ºC and 70ºC. The electrosurgical apparatus can reach high temperatures, generating enough heat to start combustion in practically all alcohol-based antiseptics, even when the concentration is 20% [13]. Vapor caused by evaporation of alcohol due to heat from the skin may facilitate combustion. The risk increases with the dispersion of the antiseptic of the surgical field, causing accumulation in regions such as hair, back, skin folds and margins of the surgical field. Special attention should be given to the drying time. Placing fields before complete drying can channel the vapors formed to the surgical site, favoring combustion [14]. The presence of hairs can delay the drying time of the antiseptics. The actual drying time may be longer than that described by the manufacturer in some products, and may reach five minutes [15]. Although many surgical centers have a sprinkler system, it is ineffective in most operating room incidents because sprinklers are rarely placed on the surgical table.

The fire in a surgical center usually results in the production of large amounts of smoke and toxic products due to the burning of synthetic materials. Combustion may produce carbon monoxide, ammonia, and cyanide. In addition to fire control techniques, measures and evacuation routes of the environment should be trained. It is important that everyone on the team is familiar with the location and use of extinguishers. These are classified into three types: Class A: used in solid fuels such as fabrics, plastics, paper and wood; Class B: used in flammable liquids and greases; and class C: used in energized materials. Many fire extinguishers are classified into 2 or 3 types of fire. Fire extinguishers may be pressurized water, carbon dioxide, foam and chemical powder. Water extinguishers should not be used on fuels and electrical equipment (B and C) for the risk of spreading flammable liquid and causing electrocution. Carbon dioxide fire extinguishers can be used for A, B and C type fires. However, the residue generated by its use can damage electrical appliances. They contain carbon dioxide under pressure in liquid form. The mechanism of action is to cool (expand) and eliminate the oxidant in the region, because it has a higher density than that of oxygen.

Foam extinguishers can be chemical or mechanical. Both act by quenching and cooling by the action of water, so they are useful in fires types A and B. They should not be used in Type C fires because of the risk of electric shock. Unlike the other extinguishers, they should be used in the inverted position, with the nozzle ejector at the bottom.

The chemical powder extinguishers are basically constituted by bicarbonate of sodium (95%) and act by suffocation. They are best suited for Type B fires. They do not work well on Type A fires, and although the powder is poorly conductive, they should be used with caution in Type C fires. Carbon dioxide extinguishers are the safest for use in the operating room, as it dissipates quickly and is non-toxic. Cooling of the extinguisher lever and handle limits the triggering time by the operator, minimizing the risk of thermal injury due to cooling. The water extinguisher may be an alternative to nuclear magnetic resonance rooms because of the possibility of being manufactured at low cost in non-magnetic material [16]. Surgeons, auxiliaries and technicians need knowledge about the composition of materials, the distance from the source of oxygen, the proper use of antiseptics and possible sources of ignition. The anesthesiologist plays a fundamental role in fire prevention in the operating room, recognizing possible sources of ignition and administering oxygen in a rational way, mainly in surgeries in the head and neck with open system of oxygen supply [17].

In the event of combustion during a procedure with handling of the airways, the oxygen supply must be discontinued in order to reduce inspired oxygen concentration temporarily, as well as the flow of inhalatory agents. The flames must be dampened with wet compresses and the procedure should continue in order to restore airways control as soon as possible [18]. There is a debate about immediate extubation versus maintaining the ET during an airway fire. Immediate extubation during any event of fire in the airways is a recommendation from the general ASA (*American Society of Anesthesia)* guidelines for the thermal lesion might continue. In patients in which the maintenance of the airway is difficult, each individual form must have its benefits and risks considered [19]. The cornerstone of therapy for injuries by smoke inhalation consists of oxygenation and ventilation maintenance as well as the stabilization of the hemodynamic status [20]. Inhalatory bronchodilators help reduce bronchospasm. The use of antibiotics and corticosteroids is still controversial and they shouldn't be administered in a routine basis. Bronchoscopy might be necessary for the monitoring and documentation of injuries and for harvesting material. Ho et al have reported that flooding the surgical field with carbon dioxide has avoided events of fire during swine tracheostomy. This is an interesting finding which should be analyzed in humans [21].

4. Conclusion

The events of fire in the operating room still represent a significant number among the accidents and present high morbidity. In the case of a high risk situation, the staff must decide on a plan and corresponding functions to prevent and manage fire. The communication among the nursing staff, anesthesiologist and surgeon is crucial. The most important action in the case of a fire event is to put out the fire and to protect the patient. When a surgical fire happens, stop the procedure, remove any flame objects and immediately cut oxygen supply.

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