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Endotracheal Tube Fire Ignited by Pharyngeal Electrocautery

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Electrocautery is frequently used for procedures involving the oral cavity, upper respiratory tract, and upper alimentary tract, such as tonsillectomy,[1] laryngectomy, adenoidectomy, and gingivectomy. The danger of electrocautery with regard to fire is well known. We report a case of combustion of an endotracheal tube secondary to intraoral pharyngeal electrocautery.

REPORT OF A CASE

A 4-yr-old boy was admitted for elective adenoidectomy and tonsillectomy. His past medical history was negative except for recurrent tonsillitis, the last episode having occurred 3 to 4 weeks prior to surgery. Past surgical history included repair of an inguinal hernia 2 months before, under general anesthesia, without complications. The patient was taking no medications and had no allergies. He weighed 17 kg and his physical examination was normal except for large, opposed tonsils touching at the midline. Preoperative blood chemistry, complete blood count, prothrombin time, plasma thromboplastin time, and urinalysis were normal. Atropine, 0.3 mg im, was given 1 h prior to surgery.

Intraoperative monitors included an oxygen analyzer, left chest precordial stethoscope, blood pressure cuff, electrocardiogram, and rectal temperature probe. Anesthesia was provided using a Bain Circuit. A warming blanket was used to maintain normal temperature.

Anesthesia was induced by inhalation of O_2, N_2O, and halothane and was uneventful. An iv infusion was then started. The trachea was atraumatically intubated with a 4.5 mm ID polyvinylchloride (PVC) endotracheal tube. Lubricant was not used on the endotracheal tube. Breath sounds were equal bilaterally in all four quadrants. The endotracheal tube was fixed with the aid of a Davis-Crow mouth gag.[1] Endotracheal tube position was again confirmed by equal breath sounds bilaterally. The eyes were protected with tape. The patient breathed N_2O 3 l/min, O_2 3 l/min, and 1% halothane, by controlled ventilation. A moderate retrograde leak of gases was noted around the tube at the larynx.

The surgeons performed the adenoidectomy and right tonsillectomy without incident then began to use a suction electrocautery to control the bleeding in the right tonsillar fossa. The electrocautery was set at 35-watts coagulation in the "spray" mode. After approximately 30 s of cautery, a fire erupted in the pharynx that "blow-torched" toward the lips. Breath sounds were immediately lost and increased airway pressure was noted. The fire was extinguished with saline, the pharynx was suctioned, and the endotracheal tube was immediately removed. The tube was noted to be melted and charred externally for 2 cm, midway between the distal tip and the adaptor, and fused for 1 cm at that point with 100% occlusion. From the point of fusion distally, the tube was blackened internally. The trachea was immediately reintubated with a 5.0 mm ID PVC, uncuffed, endotracheal tube. With a fractional inspired O_2 concentration (FI_{O_2}) of 0.99 and 1% halothane, pH_a was 7.43, Pa_{CO_2} 28 mmHg, and Pa_{O_2} 575 mmHg. On direct examination the mucosa of the posterior tongue, uvula, and hypopharynx were noted to be erythematous and charred. Rigid bronchoscopy using a 4.0 mm × 30 cm bronchoscope was performed. The cords were not burned, but were edematous. The mucosa of the anterior trachea, carina, and left mainstem bronchus was erythematous and charred in some areas. This was probably caused by a "blow-torching" of the fire downward. The burns were mostly anterior and not circumferential. After bronchoscopy, the trachea was reintubated orally with a 5.0 mm ID PVC, uncuffed, endotracheal tube under direct vision. Breath sounds were again equal and clear bilaterally. The patient was given dexamethasone 2 mg iv.

After the patient was determined to be stable, the oral endotracheal tube was replaced with 4.5 mm ID PVC nasotracheal tube with the help of Magill forceps. The left tonsil was left intact and emergence was without incident. The trachea remained intubated, breathing via a T-piece with 5 l O_2, while he was transferred to the recovery room. Tidal volume, inspiratory force, and respiratory rate were all normal. Chest roentgenogram was normal. After an uneventful 2-h stay in the recovery room, the patient was transferred to the pediatric intensive care unit.

Postoperatively, the patient received prophylactic antibiotics and steroids. Follow-up chest roentgenogram and arterial blood gases remained normal. On the second postoperative day the patient was returned to the operating room for a second bronchoscopy, performed under general anesthesia. At that time, the burns in the trachea, carina, and left mainstem bronchus were resolving. There was no residual edema. The burns on the tongue, uvula, and pharynx persisted but were improved. The trachea was extubated. Arterial blood gases and chest roentgenogram remained normal. The patient did not have stridor or speech impairment. The steroids were discontinued slowly, and he was discharged on the fifth postoperative day.

DISCUSSION

While endotracheal tube fires ignited by lasers have been reported, the only previous case of an electrosurgically ignited PVC endotracheal tube fire was reported by Rita and Seleny,[2] who reported ignition of an endotracheal tube during the use of a urethral resectoscope for laryngeal surgery. Although the resectoscope uses electrosurgical cutting, it is not set for "spray" coagulation. Quite the contrary, the aim is for precision cutting and the energy is concentrated onto a very small area. Ours

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is the first reported case of an endotracheal tube fire ignited by "spray"-type coagulation cautery.

Three factors are necessary to create our complication: 1) a carbon source or fuel (PVC endotracheal tube); 2) an oxidant (N_2O/O_2 environment caused by a retrograde gas leak); and 3) an ignition source (electrocautery). In attempting to change the carbon source, most authors recommend using red rubber or silicone tubes for laser surgery,[3-5] avoiding PVC tubes. PVC tubes are more easily ignited by laser, and, once ignited, produce a more intense and uncontrollable flame.[4] This may be secondary to the release of vinyl chloride gas, which is itself highly flammable.

In attempting to change the oxidant, studies have shown that the N_2O/O_2 combination may support combustion better than 100% O_2.[6] Only when decreasing the O_2 below 30% in N_2 was there a difference in the flammability of endotracheal tubes.[7,8] Although studies have been done with respect to lasers,[3,5] no controlled study has been performed to determine the effect of varying these factors with electrocautery as the ignition source.

Perhaps when using intraoral or pharyngeal electrocautery, especially when set on "spray," we should consider using cuffed endotracheal tubes, even in children. This would leave an atmosphere of air in the mouth and pharynx. Perhaps we should avoid the use of electrocautery in close proximity to PVC endotracheal tubes.

In summary, we report a case of a pharyngeal electrocautery-ignited endotracheal tube fire. For laser surgery, using red rubber or silicone tubes and less than 30% O_2 in N_2 in the inspired gas is beneficial. It is not clear whether these data are applicable to electrocautery-ignited endotracheal tube fires.

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Massive Air Embolism during Cesarean Section

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Air embolism may occur during any surgical procedure in which the operative field is above the level of the heart.[1-3] That such a catastrophe has complicated pregnancy or the puerperium has been confirmed almost exclusively at post mortem examinations.[4-9] In particular, venous air embolism during cesarean section has a high incidence of mortality,[5,6,10,11] with a devastating morbidity should the patient survive.[12] Rapid, accurate diagnosis is essential for the successful therapy of this life-threatening complication. We describe a case of significant air embolism during cesarean section that was diagnosed intraoperatively by an acute decrease in the end-tidal CO_2 tension and by aspiration of air from the central venous circulation.

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Report of a Case

A 28-yr-old, 92-kg, G_4 P_3 Ab_0 patient at term gestation arrived at the labor suite with massive vaginal hemorrhage. Her pregnancy had been noteworthy for numerous hospital admissions due to vaginal bleeding from a complete placenta previa. Her past medical history revealed a 8- to 10-yr history of intermittent wheezing self-treated