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Unusual Rare Complete Transection of Polyvinylchloride Endotracheal Tube in Intensive Care Unit During Sedation Vacation with Spontaneous Breathing Trial.

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ABSTRACT

The polyvinyl chloride endotracheal tubes (PVC ETT) are the standard safe protective airway devices applied in intensive care unit practices to associate with a mechanical ventilator to maintain respiratory function and airway patency. While this transparent PVC ETT is semi-rigid at room temperature, but relatively becomes more flexible as it warms to the body core temperature and carries a high risk of perforation or even complete transection during sedation vacation and spontaneous breathing trial (SBT) for possible extubation. However, this manuscript reported an unusual, rare case of PVC ETT transected in two pieces due to the patient's short interval of repetitive strong bites and whose distal portion was trapped in the large airways. To overcome this fatal, life-threatening condition, we removed the transected PVC ETT.

KEYWORDS: Endotracheal Tube (ETT), Polyvinyl Chloride Endotracheal Tube (PVC, ETT), Glasgow Coma Scale (GCS), Spontaneous Breathing Trial (SBT).

INTRODUCTION

The endotracheal tube (ETT) is the standard safe protective airway device placed in the nasal or orotracheal airways, associated with the mechanical ventilator to provide controlled or intermittent mandatory breath or reverse life-threatening cardiorespiratory events or maintaining respiratory function during general anesthesia. (1) Generally, ETT is made of polyvinyl chloride (PVC), silicon, rubber, and Teflon materials. The common ETT used in the current medical practice is the polyvinyl chloride endotracheal tube (PVC ETT- single use). This PVC ETT is available in many types, including oral or nasal, cuffed or uncuffed, transparent, reinforced tubes, and double-lumen endobronchial tubes. The transparent PVC ETT is semirigid at room temperature but relatively

flexible as it warms to the body core temperature. (2) We can also visualize breath fogs of both inspiratory and expiratory cycles, exhalation condensation around PVC ETT walls, secretions, and other foreign materials within the tube. In addition, spiral embedded PVC ETT or reinforced tubes or armor tubes have circled metal coils that are less likely to get kinked and used in some clinical settings, particularly during neurosurgery (brain and spinal) maxillofacial surgery and patients who require a prone position during surgery. (3) However, many studies limited to the case reports described a significant complication such as obstruction caused by nitrous oxide (N2O- bubble formation across the tube walls), tube bites, tight ETT tie, tube kinking, patient biting, obstruction of the lumen by blood or foreign body, bronchospasm, hemothorax, tension pneumothorax or equipment malfunction. Specifically, A tube bite could result in deformity of the spiral embedded wires with irreversible obstruction and even transection of the tubes due to inadequate anesthesia or during recovery from anesthesia [4]. Likewise, a significant complication such as obstruction, foreign bodies, and tube bites can happen in PVC ETT in ICU due to inadequate sedation or recovery from a sedation agent for possible extubation during a spontaneous breathing trial (SBT). Herein we present a 34 years female RTA polytrauma mechanically ventilated patients in ICU with PVC ETT resulting in complete transection of PVC ETT due to repetitive patient bite during a spontaneous breathing trial (SBT). To our knowledge, this is the first case of complete transection of PVC ETT in two pieces, and the distal part of the dissected tube lodged in the patient airway (trachea) during the trial of SBT in ICU stay. We describe our challenges and safety measures applied in retrieving the transected PVC ETT inpatient airway. Furthermore, in this report, we strongly suggest altering the standard mechanical ventilation alarm limits based on the patient's minute ventilation during the trial of SBT for possible extubation. Thereby, uneventful situations like reintubation, reestablishment of sedative agents, and further complications are avoided for the patient for possible extubation.

CASE REPORT

A 34-year-old female, a medically free polytrauma victim, was rescued at our hospital. On arrival, the patient Glasgow coma scale (GCS) was 7, agitated with severe respiratory distress using accessory muscles. Her vitals are blood pressure 149/83 mmHg, heart rate 133/min, respiratory rate 38 breaths/min, temperature 37 °C, and oxygen saturation of 86% on room air. Initial arterial blood gas (ABG) revealed ph:7.39, pCO_2:37mmhg, pO2:57mmhg, HCO_3:20.2mmol/L. On examination, profuse oropharyngeal bleeding and several abrasions on the face, thorax, and right femur fracture were seen. On auscultation, significant bilateral breath sounds. Anteroposterior chest X-ray revealed bilateral increased Broncho vascular markings and hyperinflated lungs, and electrocardiogram (ECG) showed sinus tachycardia. The patient was intubated for airway protection. In a resuscitation room, O_2 15 L/min via a non breathing mask was administered. Although oxygen saturation rose to 93%-95%, there was no significant improvement in her GCS and agitation. Therefore, the patient has been electively intubated with an Endotracheal tube [ETT] size of 7.5-mm internal diameter at level 22cm and connected to a mechanical ventilator under a mode of Synchronized intermittent mandatory pressure support ventilation (SIMV-PS) with a FiO_2 of 0.8, Respiratory rate 18 breath/min, Tidal volume 420ml, I:E 1.2, Pressure support 7 cmh_20 and a PEEP of 8 cmh_2O. Sedation was maintained with fentanyl 150 mcg/hr and propofol 50 mg/hr infusion in synchrony with the mechanical ventilator. Post intubation arterial blood gas (ABG) analysis was within the normal range. Her initial blood biochemistry was within normal limits. Nasal swab for COVID-19 and sputum for cultures collected. Immediate post-intubation X-ray confirmed the proper placement of the ETT. A computed tomography (CT) scan of the brain revealed bilateral brain contusions with less severity. A mild right lung contusion, grade 2 spleen injury, and bilateral eye ecchymosis with edema. After 60 min of arrival, written consent was obtained and transferred to the intensive care unit (ICU) for close observation. The patient was stabilized hemodynamically. On day 1, the patient was mobilized to the operation room for surgical fixation of the right femur, fracture sustained during the RTA, fixation of

the right femur was uneventful, and she was stable throughout the surgery. The patient was not extubated at the end of the surgery, considering the RTA history of brain contusions and a possible postoperative edematous airway related to right lung contusion. Hence,the patient remained intubated and transferred to the intensive care unit (ICU) for overnight nursing care under sedation and ventilation. On day 2, patient hemodynamics improved very well, ABG was satisfactory. FiO_2 was weaned to 0.4 %, and the peep was weaned to 5cmh_20. Satisfactory chest X-rays and sedation have been withheld for daily wean screening, resulting in spontaneous breaths and good neuromuscular function. Hence, a spontaneous breathing trial was initiated to assess the neurological and respiratory lung dynamics status for possible extubation. The patient was switched to the spontaneous breathing mode of continuous positive airway pressure (CPAP) trial using a CPAP level equal to the previous positive end-expiratory pressure (PEEP) level such as peep 5cmH20 with a low level of pressure support of 7cmh_20, and PVC ETT cuff pressure was maintained at 26 mmhg. After 30 minutes of the SBT trial, the patient was reassessed. patient Measured values during the first 30 minutes were satisfactory, VE: 14–17L/min, Peak airway pressure: 12 cmh_2O, RR: 24 –26 breaths/min, VT 480–530 mL, Adequate oxygenation pO_2; 88 mmHg on FiO_2 less than 0.4, PEEP: 5 cmh_2O; pO_2/FiO_2: 252, HR less than 120 beats/min, stable blood pressure, no vasopressors, Afebrile (temperature 37.5°C), Adequate GCS 11 with adequate cough. In addition, the patient met criteria for successful SBT such as positive cuff leak test, Respiratory rate < 30 breaths/minute, Heart rate < 130 /minute, Arterial oxygen saturation >94%, PaO_2> 70 mmHg with FiO_2<0.4, Blood pressure, no signs of respiratory excursion or use of accessory muscles. We believed ventilator liberation could be possible. However, patient GCS was 11, Richmond agitation scale -1 (agitated, biting the ETT intermittently), and decided to extend Trial SBT to the next 30 minutes and not longer than 120 minutes. Therefore, we instructed the patient's assigned nurse to place the oral airways and restrain the patient's hands. Unfortunately, the patient could not tolerate the oral airway becoming more agitated because it induced the patient nauseating. Therefore, the oral airway has been removed, and at the duration of the 50^{th} minute of SBT, the assigned ICU nurse informed us about the complete transection of PVC ETT (Figure 1) and part of the transected PVC ETT still intact in the patient airway. The team rushed to the patient's bedside witnessed that the proximal part of PVC ETT was along with a swivel connector connected to the ventilator and the distal PVC ETT still in the patient airway, and the patient was breathing through the distal portion of the ETT. Although the patient was agitated, she was comfortable with the remaining transected PVC ETT in the trachea without any respiratory distress. This critical incidence did not lead to hypoxia, cyanosis, or any life-threatening events, and oxygen saturation constantly remained above 96%, as measured by pulse oximetry. The respiratory therapist deflated the endotracheal cuff balloon, cautiously, removed the remaining complete cut of PVC ETT from the patient airway, and hooked a facemask of 8 LPM of oxygen. The patient becomes calm. No post-extubation stridor was seen. However, reintubation was prepared at the bedside if needed. Post extubation ABG after 30 minutes was within normal limits. After 2 hours of extubation, patient GCS started to improve. At the 4th hour of post-extubation, her GCS was 15/15 with stable hemodynamics, and she was alert and consciously oriented. Her repeated ABG was satisfactory, and she shifted to the floor on the same day for nursing care and postoperative rehabilitation.

DISCUSSION

The ETT removal and mechanical ventilation discontinuation can be accomplished through the process of gradual or abrupt weaning. The word gradual implies the term "gradual weaning" (spontaneous awakening trial) is the gradual decrease of sedation and gradual reduction in the rate of intermittent mandatory ventilation before starting unassisted breathing, which accounts for nearly 40% of the duration of invasive ventilation. (5) whereas abrupt implies a term "liberation" (spontaneous breathing trial) removing sedation and ventilator support, which accounts for approximately 75% successful liberation of mechanically ventilated patients of those respiratory failure has been either resolved or recovering. However, in today's ICU setting, liberation (SBT) of ventilatory support likely better serves the

critically ill population rather than the gradual withdrawal of sedation and ventilator support, and it is not only unnecessary but potentially harmful. Everyday spontaneous breathing trials (SBTs) are the quickest way to ascertain the safe liberation of ventilatory support. In these settings, after the abrupt removal of sedation, our patient passed all SBT criteria of the international consensus conference recommendations in 2005 for ventilator weaning and SBT trials.(7); commonly, an intensivist executes any one of the three approaches of SBT: Trial of T-pieces with desired oxygen liters per minute administered through a T-piece attached to an endotracheal tube, trial of continuous positive airway pressure (CPAP) using the same positive end-expiratory pressure (PEEP) level of the former mode of ventilation and invasive ventilation with a low level of pressure support (5-8 cmH2O). However, none of these SBT approaches are superior to each other, respectively (8,9). In contrast, LadeiraMagdaline T et al. stated that pressure support ventilation is superior to T-piece in the symmetry of successful SBT trials. Recent guidelines recommended applying 5–8 cm H2O inspiratory pressure rather than T-piece or CPAP (10). These guidelines explained that administering the SBT with inspiratory pressure was more likely to be successful of 84.6% vs. 76.7%; risk ratio [RR] of 1.11, 95% confidence interval [CI] 1.02–1.18) ended in a higher rate of extubation success of 75.4% vs. 68.9%; RR 1.09, 95% CI 1.02–1.18 and was associated with lower ICU mortality of 8.6% vs. 11.6%; RR 0.74, 95% CI 0.45–1.24. Likewise, we commenced the SBT trial with a low level of pressure support 5-7cmh20. Individual prospective multicenter randomized trials of 526 patients noticed similar spontaneous breathing trials of 30 and 120 minutes with successful extubation. (11) According to the collective task force in 2001 recommendation, we closely monitored the initial minutes of SBT. It seems advantageous and predictive when the duration of the SBT assessment increased to greater than 20–30 minutes (12) and our measured values after 30 minutes SBT trial from the ventilator screen were satisfactory, and Richmond Agitation Sedation Scale (RASS) was + 1. Hence, we decided to continue for the next 30 minutes and not longer than 120 minutes to reach Richmond Agitation Sedation Scale (RASS) 0 for possible extubation as recommended by Several SBT guidelines to assess readiness for ventilator weaning (13). To our knowledge, this is the first case in which a PVC ETT is completely transected in two pieces, and the distal part of a transected PVC ETT lodged in the patient airway (trachea) during the trial of SBT in ICU. In this case, Life-threatening transected PVC ETT incidence was most likely to happen during the SBT trial due to repetitive short intervals of strong bites rather than single bite cuts. Moreover, it might be due to the sedation's withdrawal effect, which is similar to the statement of Andreas Duma et al. (14). Generally, these ETT bites are managed by placing tube guards while the patient is on mechanical ventilation with sedation. Shepherd J stated in his report that during surgical procedures in the prone position, endotracheal tube perforation could not be prevented by bite blocks. (15) Despite this, we maintained the correct placement of the oral airway, did not displacing the tongue into the hypopharynx, resulting in airway obstruction. Due to the presence of gag and cough reflex on GCS 10, an oral airway with spontaneous breath trial with off-sedation resulted in retching, nausea, and avoiding further unwanted complications; the oropharyngeal airway was removed. (16)

In reviewing the studies of aspirated PVC ETT, we found only one case report detailed that ETT was cut at 22 cm, demonstrating the aspiration of 22 cm of PVC ETT had reached the carina, accessed the right bronchus, penetrated the tracheal wall, and entered into the mediastinum. (17) In similar cases, PVC ETT was cut at 22cm, but it was not aspirated below the vocal cords and still intact in the airway. Maybe this has been possible due to intact PVC ETT cuff pressure. Moreover, transection of PVC ETT was noted at a point when the ventilator exceeds more than 25 percent of the standard minute ventilation alarm limit. The Loss of minute ventilation and leakage is not displayed on the ventilator screen since leakage does not exceed the standard minute ventilation alarm limit during short repetitive bites. Therefore, we managed this critical incident of complete transection PVC ETT without inducing sedation and bag-mask ventilation to change the patient's ETT. However, we decided to remove the distal transected PVC ETT in the airway (trachea) because the patient maintained her ventilation and oxygenation through transected ETT with spo2 of 96% with good hemodynamic stability. Thereby not justifying the high-risk decision of

inducing sedation and changing the ETT.

Our case reflects a few possible mechanisms of complete transection of PVC ETT:

1. Sedation vacation and SBT caused the patient to consciously bite the tube into the perforation at first and then complete transection of PVC ETT by multiple short, strong bites.

2. The oral airway does not suit the patient while on SBT as it induces nausea and drooping of saliva.

3. Leakage does not exceed 25 percent of the standard minute ventilation alarm limit of the ventilator.

In addition, Health care staff's scarcity because of the COVID-19 pandemic. From this case experience, we strongly suggest few recommendations:

1. Minimize PVC ETT complications by altering the standard mechanical minute ventilation alarm limit based on patient minute ventilation while on SBT trial.

2. Proper bite blocks during SBT to be used if RASS are less than -1.

3. Daily assessment to determine readiness for extubation.

CONCLUSION

The medical faculty in the ICU should be aware that PVC ETT was developed to maintain airway patency, may not guarantee a secured airway during the SBT trial in ICU stay, and can obstruct the airways as a foreign body. When such complications befall, the aided procedure is to place the patient in a lateral or supine position and evaluate transected ETT patency in the airway with a 100% oxygen supply, if required extubate or re-intubate the patient with a smaller size tube. In addition, intensive physicians have to perform sedation monitoring with the RASS scale with recommended oral bites and alter the standard minute ventilation alarm limit based on their patient SBT minute ventilation.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

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Figure-1. Complete transection of polyvinyl chloride endotracheal tube (PVC ETT)