Cardiac arrest due to an unexpected inability to ventilate in a tracheostomy patient suggesting the need for a routine anesthesia checklist and an anesthesia relevant emergency pathway for tracheostomy management: a case report

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Background: Up to 30% of patients worldwide have a significant complication related to their tracheostomy. We report a case of a 'cannot ventilate' event resulting in cardiac arrest due to an unexpected airway occlusion in a patient with a pre-existing brain injury The following case report is unique as the patient had developed a mucus plug that turned into a crystal following a coronavirus disease 19 (COVID-19) infection.

Case Description: The patient was a young adult who suffered a traumatic brain injury from a motor vehicle collision. He presented for elective cystoscopy to treat recurrent urinary tract infections. During induction of anesthesia, the patient became agitated, desaturated, and ventilation became impossible. With chest compressions underway the tracheostomy was removed, and the patient was quickly and successfully orally intubated using a video-laryngoscope. Subsequent inspection of the tracheostomy tube revealed a mucus plug in the distal portion which had hardened into a rock-like appearance. The inner cannula was also missing. Follow-up revealed that the patient recently had a COVID-19 infection and because of this received less frequent suctioning of his tracheostomy tube.

Conclusions: Reviewing the literature, we recognized that there has been no case report documenting a mucus plug that turned into a stone. Reviewing guidelines for handling tracheostomy emergencies, we recognize that there are no anesthesia specific guidelines in the USA. We also recognize that there are no established checklists for patients with tracheostomy undergoing surgery. We therefore recommend establishing a routine checklist and anesthesia specific guideline for emergencies that follows every patient with a tracheostomy undergoing surgery.

Keywords: Tracheostomy; mucus-plug; coronavirus disease 19 (COVID-19); cannot ventilate; case report

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Introduction

Background

Up to 30% of patients worldwide may have a significant complication related to their tracheostomy (1,2). A wide variety of tracheostomy tubes exist, and this can complicate airway management, particularly in an emergency. Common features include an inflatable cuff and an inner cannula, which can be removed (I) for cleaning to minimize risk of blockage, or (II) during an emergency (3). Tracheostomy complications include but are not limited to hemorrhage, aspiration, pneumothorax, blockage, tube displacement or

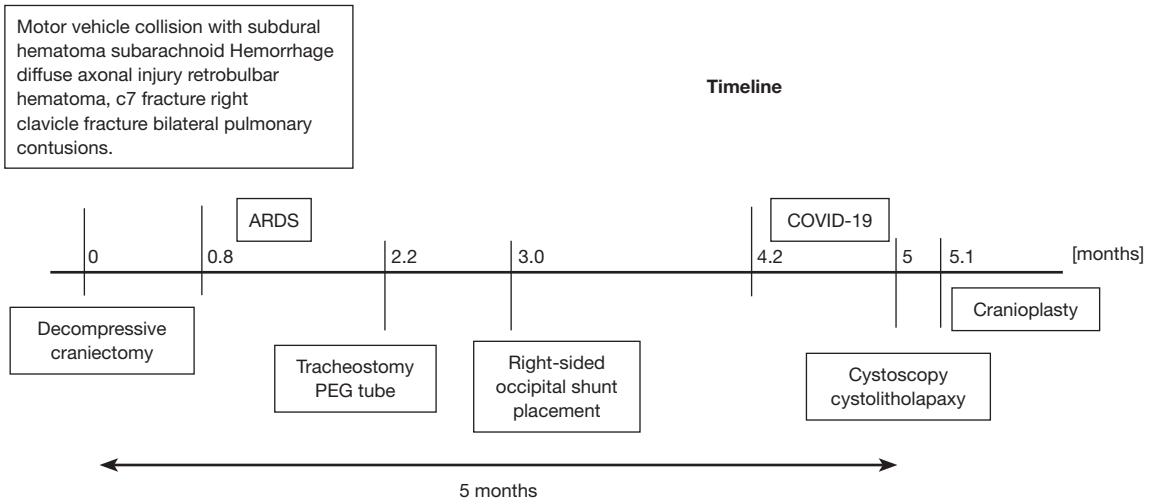

Figure 1 Timeline. ARDS, acute respiratory distress syndrome; PEG, percutaneous endoscopic gastrostomy; COVID-19, coronavirus disease 19.

tracheal stenosis. The Royal College of Anaesthetists 4th National Audit Project found that most tracheostomy-related critical incidents are related to displacement of the tracheostomy tube (4). Following the audit, the National Tracheostomy Safety Project developed guidelines to aid in the recognition and management of tracheostomy-related emergencies (5).

Rationale and knowledge gap

In this case report, we present an unexpected airway complication in a brain-injured patient with an established tracheostomy. We were unable to find any case reports in the literature describing a similar scenario, and we were also unable to find a previous report of a tracheostomy mucus plug crystallizing into an impassable stone. The only similar case report described a mucus plug that was distal to the tracheostomy tube, and prevented suctioning but still permitted passage of a suction catheter (6).

Objective

We will discuss the unusual underlying cause in relation to established guidelines, differentials, and treatment options for patients who present to the operating room (OR) with an existing tracheostomy tube. We present this case in accordance with the CARE reporting checklist (available at https://atm.amegroups.com/article/view/10.21037/atm-23-1834/rc).

Highlight box

Key findings

- We present a cannot ventilate with cardiac arrest scenario despite following current tracheostomy guidelines.
- As underlying problem, we found a stone like mucus plug in a tracheostomy tube following a coronavirus disease 19 (COVID-19) infection.

What is known and what is new?

- It is known that up to 30% of patients worldwide have a significant complication related to their tracheostomy.
- What is new is that a mucus plug in a tracheostomy had turned into a stone following a COVID-19 infection.

What is the implication, and what should change now?

- We recommend establishing a routine checklist and anesthesia specific guideline for emergencies that follows every patient with a tracheostomy undergoing surgery.

Case presentation

The patient was a young adult male with no comorbidities, 84 kg [body mass index (BMI) 23.9 kg/m^2], who suffered a traumatic brain injury after a motor vehicle collision and ejection 5 months prior to this reported event (see *Figure 1* for timeline of events). All care he received at that time was outside of our institution, and therefore the specifics of his hospitalization are based solely on the limited records we received after his transfer. The patient was thrown 40 feet

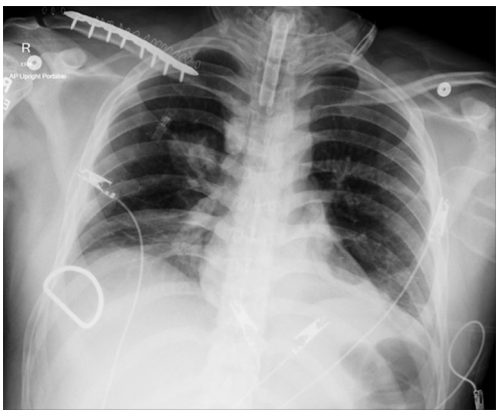

Figure 2 Chest X-ray after tracheostomy. Tracheostomy tube in place. No airway abnormalities. No acute osseous abnormalities. Right clavicular fixation hardware in place.

from the vehicle, which resulted in extensive head trauma. He first had a decompressive craniectomy for his subdural and subarachnoid hematomas. In addition to his intracranial bleeds, he presented with diffuse axonal injury, retrobulbar hematoma, a C7 fracture, a right clavicular fracture and bilateral lung contusions. After his craniotomy, he underwent open reduction and internal fixation of the right clavicle, and lateral canthotomy to evacuate the retrobulbar hematoma. Later, he suffered from a methicillin-resistant staphylococcus aureus (MRSA) and klebsiella ventilator-associated pneumonia with acute respiratory distress syndrome shortly after admission. After his acute recovery, he remained ventilator dependent, and required surgical tracheostomy placement (see *Figure 2* for X-ray). Following surgical tracheostomy without complications, the patient had a cuffed Shiley™ Flexible Adult Tracheostomy (Medtronic, Minneapolis, MN, USA) 7.5 mm I.D. (inner diameter) with disposable inner cannula. Complicating his course, he later developed communicating hydrocephalus for which he was then transferred to our institution a month later for a right-sided occipital shunt placement. Shortly after his surgery, he developed another pneumonia. This time it was a methicillin-sensitive staphylococcus aureus (MSSA) and pseudomonas pneumonia, and 2 months later he endured coronavirus disease 19 (COVID-19) pneumonia. This, along with several recurrent urinary tract infections (UTIs), prevented a planned cranioplasty. He eventually recovered from COVID-19, and he was later deemed appropriate to be brought to the ORs for an elective cystoscopy and cystolitholapaxy to address his recurrent UTIs. Prior to his arrival in the OR, the patient was noted to be at his baseline vegetative state with a Glasgow coma score of 7 for eye opening and unresponsive to commands. While at our institution the patient had no abnormal lab values. There were no obvious concerns regarding the procedure or anesthesia.

The patient was brought to the OR and noted to be spontaneously breathing through the tracheostomy. Of note, at that time, the tracheostomy cuff was not inflated. He was then connected to the anesthesia ventilator circuit. Upon inflation of the tracheostomy cuff, the patient started coughing. Sevoflurane was administered through the circuit; however, spontaneous ventilation or assisted ventilation proved to be ineffective. The patient appeared agitated while the measured oxygen saturation decreased to ~70s% with peak pressures measuring 29 cmH_2O. In order to remove a potential mucus plug in the tracheostomy tube, suctioning of the tracheostomy was attempted without successful return of mucus or improvement in ventilation. The oxygen saturation continued to decrease to 64%, and the patient became bradycardic. Anesthesia was deepened using propofol, and the patient was paralyzed with succinylcholine. Eventually, the patient developed profound hypotension then pulselessness and chest compressions were initiated. At this point, the decision was made to perform an oral endotracheal intubation, bypassing the tracheostomy tube. Video laryngoscopy revealed a grade IIa view, and the tracheostomy tube was removed to advance the endotracheal tube from above. Following intubation of the trachea, end-tidal CO_2 and ventilation were confirmed, and peak pressures decreased to 15 cmH_2O. The patient was noted to have a successful return of spontaneous circulation (ROSC) and his heart rate normalized. Chest compressions were discontinued when a blood pressure of 200/110 mmHg was observed.

Visualization of the tracheostomy tube after removal from the patient showed a mucus plug in the distal portion that had hardened into a "rock-like" appearance. The inner canula was also found to be missing. A subsequent root cause analysis which included discussion with the family revealed that due to a COVID-19 infection, suctioning of the tracheostomy tube had not been performed as regularly, thus eventually resulting in a crystalized mucus formation. Postoperatively, the patient returned to his baseline and was able to be discharged from the hospital to a long-term care facility.

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki

Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this case report and accompanying image. A copy of the written consent is available for review by the editorial office of this journal.

Discussion

Key findings

Greater than 100,000 tracheostomies are performed annually in the United States and complications are relatively common (7). Anesthesiologists are considered "airway experts", and as such are often called to emergencies involving a tracheostomy. Nevertheless, the exact details of published guidelines can be difficult to remember during an emergency and anecdotally we find relatively few clinicians, even anesthesiologists who are familiar with tracheostomy management guidelines. Frequently the expectation is that patients with an existing tracheostomy will be a straightforward case, especially if an established tracheostomy tube with an inflatable cuff is present. When coming to the OR these patients are often simply connected to the circuit and a volatile anesthetic is administered until the patient reaches an adequate depth of anesthesia to perform the surgical procedure. Eventually, anesthesia may be supplemented with narcotics and muscle relaxants as needed. However, in our case, the patient started coughing when the cuff was inflated. This is not unusual as the inflated cuff irritates the tracheal mucosa which is sensed as pain. Believing the root cause to be pain, the team believed deepening the anesthetic would solve the problem. However, ventilation continued to be impossible, and at this point, either severe bronchospasm or a mucus plug was suspected. Administering a small amount of intravenous epinephrine and attempts to suction mucus or a mucus plug were unsuccessful. When later reviewing elements of the case, it was found that the provider who attempted to suction may not have realized that the plastic catheter was not advancing down the tracheostomy tube, highlighting that the pressure of emergencies makes even simple things difficult.

Explanations of findings

Current tracheostomy emergency guidelines emphasize the need to evaluate the tracheostomy tube for patency if ventilation is impossible. Reflecting this need, a key question in the guidelines is: "Can you pass a suction catheter?". However, in our case the provider believed they were able to successfully pass a suction catheter and assumed that the tracheostomy was patent. At this point continuation of ABCDE (Airway, Breathing, Circulation, Disability, Environment) assessment is recommended based on the current guidelines. We indeed followed this concept, performing chest compressions and further assessing the airway. As we assumed that something was wrong with the tracheostomy tube, the decision was ultimately made to orally intubate from above which resolved the problem. However, since we believed that we in fact had initially passed a suction tube, we also were afraid that we could simply lose the airway as the tracheostomy tube could have created a false lumen which would have prevented us to from intubating from above or reinserting the tracheostomy tube. Nevertheless, reintubation from above resolved the issue, the patient recovered instantly, and the elective cystoscopy was successfully performed. Following a cranioplasty the patient was discharged to a nursing facility without any further sequelae.

Comparison with similar case reports

We were unable to find any case reports in the literature describing a similar scenario, and we were also unable to find a previous report of a tracheostomy mucus plug crystallizing into an impassable stone. The only similar case report described a mucus plug that was distal to the tracheostomy tube, and prevented suctioning but still permitted passage of a suction catheter (6). Interestingly, discussing the problem with the family revealed that the development of such a mucus plug might have been caused by COVID-19 pneumonia during the pandemic. Due to fear of COVID-19, suctioning was performed less regularly than it would have without such a devastating infection. This also resulted in a missing inner cannula. In fact, one of the functions of the inner cannula is to avoid an accumulation of mucous plugs or other obstructions.

Limitations

As this patient was bedridden, succinylcholine was in theory contraindicated (8). However, as some motor activity and low potassium prior to inducing had been noted, we decided to give succinylcholine. In theory, this can lead to hyperkalemic cardiac arrest. However, as intubation and re-oxygenation resolved the issue instantly combined with the

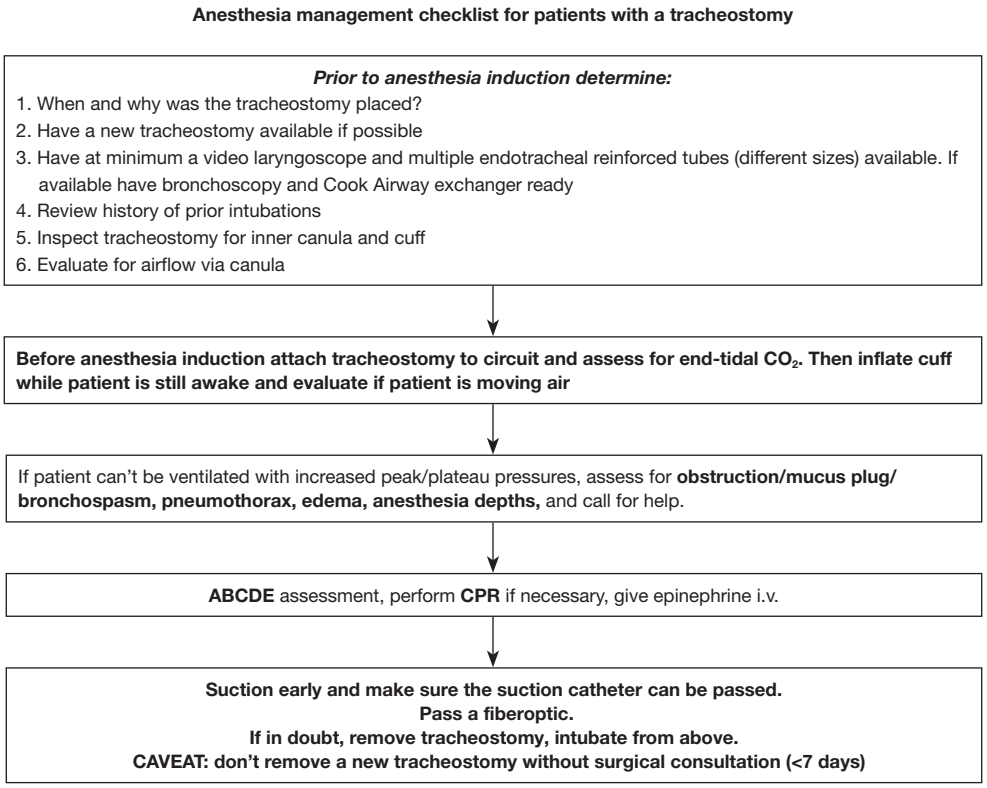

Figure 3 Proposed novel anesthesia checklist and guideline for emergency tracheostomy management. ABCDE, Airway, Breathing, Circulation, Disability, Exposure; CPR, cardiopulmonary resuscitation.

absence of hyperkalemia, this seems very unlikely.

Conclusions

Implications and actions needed

In summary, this case highlights the often-quoted phrase, "if in doubt, take it out", and reminds us of the importance of modifying the differential diagnosis based on response/non-response to specific therapeutic airway interventions. Based on the lack of an Anesthesia specific pathway for these scenarios, a proposed airway checklist and pathway has been designed and attached (*Figure 3*). We would like to emphasize though, that the concept "if in doubt, take it out" is somehow simplified and under certain circumstances this might not be the best approach. E.g., a tracheostomy that is younger than 7 days could be such a scenario: here, removing the tracheostomy tube might result in a complete loss of the airway and death (9). As this patient was transferred from a nursing facility it is important to follow the initial checks as outlined on our airway pathway. E.g., initial evaluation of the tracheostomy regarding inner cannula might have been able to prevent the events in the OR. Nevertheless, it highlights that checklists and improved understanding of tracheostomies are important for tracheostomy patients and should be used whenever patient care is transferred from one team to another.

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Footnote

Reporting Checklist: The authors have completed the CARE reporting checklist. Available at https://atm.amegroups.com/article/view/10.21037/atm-23-1834/rc

Peer Review File: Available at https://atm.amegroups.com/article/view/10.21037/atm-23-1834/prf

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this case report and accompanying image. A copy of the written consent is available for review by the editorial office of this journal.

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