Loss of the airway during tracheostomy: rescue oxygenation and re-establishment of the airway

[La perte du contrôle des voies aériennes pendant la trachéotomie: l'oxygénation de secours et le rétablissement de la ventilation]

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Purpose: To describe loss of the airway during tracheostomy and suggest a method for re-establishment of the airway and providing rescue oxygenation.

Clinical features: A 22-yr-old female diagnosed with encephalomyelopathy was admitted to the intensive care unit with a progressively deteriorating level of consciousness and respiratory failure requiring intubation and ventilation. Several weeks later, an elective tracheostomy was performed under anesthesia. The surgeon made an anterior tracheal wall incision and inserted a cuffed #6 Shiley tracheostomy tube. No end-tidal CO_2 was detected and the patient could not be ventilated. After another failed attempt at insertion of a second tracheostomy tube, the diagnosis was made of a false passage within the trachea. The Shiley tracheostomy tube was removed and a #6 regular endotracheal tube was introduced in the trachea through the tracheostomy incision. The patient now could be ventilated with difficulty and low readings of end-tidal CO_2 were noted. Despite all efforts to further ventilate the patient, the arterial oxygen saturation never recovered, resulting in cardiac arrest.

Conclusion: To restore a lost airway during tracheostomy, we recommend that a jet ventilation airway exchange catheter (JVAE) be inserted in the endotracheal tube through a bronchoscope port attachment prior to surgical entry into the trachea. The JVAE will also ensure continued ability to oxygenate the patient.

Objectif : *Décrire la perte du contrôle des voies aériennes pendant une trachéotomie et suggérer une méthode pour le rétablissement de la ventilation et l'apport d'oxygène de secours.*

Éléments cliniques : *Une femme de 22 ans, atteinte d'encéphalomyélopathie, a été admise à l'unité des soins intensifs. Son état présentait une détérioration progressive du niveau de conscience et une insuffisance respiratoire nécessitant l'intubation et la ventilation. Quelques semaines plus tard, une trachéotomie non urgente a été réalisée sous anesthésie. Le chirurgien a pratiqué une incision à la paroi antérieure de la trachée et inséré une canule de trachéotomie à ballonnet no 6 de Shiley. Le CO_2 de fin d'expiration n'a pas été détecté et la ventilation était impossible. L'essai d'une seconde canule de trachéotomie ayant échoué, on a conclu à une insertion paratrachéale de la canule. On a remplacé la canule de Shiley par une canule endotrachéale régulière no 6, introduite dans l'incision trachéale. On pouvait maintenant ventiler, mais avec peine et on a enregistré de faibles relevés de CO_2 de fin d'expiration. Malgré tous les efforts supplémentaires fournis pour restaurer la ventilation, la saturation en oxygène du sang artériel n'est jamais revenue à la normale, le tout amenant à un arrêt cardiaque.*

Conclusion : *Pour rétablir le contrôle des voies aériennes, nous recommandons l'utilisation d'une sonde d'échange permettant la ventilation en jet à haute fréquence (VJHF). Cette sonde devrait glisser par l'ouverture d'un connecteur (utilisé pour les bronchoscopies flexibles) dans une canule endotrachéale et serait mise ne place avant l'introduction chirurgicale dans la trachée. La sonde d'échange (VJHF) maintiendra la capacité d'oxygéner le patient en tout temps.*

ELECTIVE tracheostomy is a common procedure for long-term airway management of intensive care unit patients. A drastic complication that rarely occurs is intraoperative death due to loss of the airway during insertion of the tracheostomy tube. This report describes such a case and suggests a possible method for re-establishment of the airway and providing rescue oxygenation.

Case report

A 22-yr-old (94 kg, 162 cm) Caucasian female was diagnosed with progressive encephalomyelopathy of unknown origin. Her past medical history included

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controlled moderate asthma. In the medical-surgical intensive care unit (MSICU), her glasgow coma scale (GCS) deteriorated to 7 requiring intubation and ventilation. Computed tomography (CT)-scan and magnetic resonance imaging (MRI) studies showed multiple non-specific lesions in the pons, medulla, corpus striatum and basal ganglia. Empiric therapy included acyclovir for a possible herpes simplex infection and immunoglobulin for a demyelinating syndrome. Over three weeks in the MSICU, she was hemodynamically stable and her GCS improved to 9–10. She was easily ventilated with pressure support of 15 cm H_2O thus generating tidal volumes of 350–400 mL at a rate of 18–26 breaths·min^{-1}. Because of her dependence on ventilatory support and to protect her airway from possible aspiration, an elective tracheostomy was scheduled.

In the operating room, the patient was placed on a regular operating room table and a senior ENT surgeon was scrubbed with a senior ENT resident to perform the procedure. Anesthesia was induced with fentanyl (2 μg·kg^{-1}), midazolam (0.02 mg·kg^{-1}) and propofol (0.5 mg·kg^{-1}). The lungs were easily ventilated (tidal volume 700 mL, respiratory frequency 8, I:E 1:2 and positive end-expiratory pressure (PEEP) 5 cm H_2O). Her peak inspiratory pressure was 32 cm H_2O. Anesthesia was maintained with N_2O/O_2 (V/V) and isoflurane (0.5 %). Oxygen saturation was 99% and end-tidal CO_2 was kept at 38–40 mmHg.

The surgeon made an anterior tracheal wall incision, the endotracheal tube was retracted cephalad by the anesthesiologist and its tip was visualized at the upper border of the tracheal incision. The surgeon noted that the mucosa was quite reddened and edematous. A #6 Shiley tracheostomy tube was inserted and the cuff was inflated. However, no end-tidal CO_2 waveform was shown on the capnograph and the end-tidal CO_2 reading was zero. Moreover, the patient could not be adequately ventilated because of very high airway pressures (>60 cm H_2O). A quick check of the anesthesia circuit, the end-tidal sampling tubing and the anesthesia machine revealed no obstructions or leaks. Furthermore, any possibility of obstruction or malfunction of the tracheostomy tube was ruled out by replacing the tracheostomy tube with another #6 Shiley. However, this did not improve ventilation which was then performed using 100% O_2. The capnograph did not record any end-tidal CO_2. Auscultation of the chest revealed bilateral, very distant, crackly breath sounds. A diagnosis of a false passage within the trachea was made.

The surgeon then removed the Shiley tube and directly inserted a #6 regular endotracheal tube in the trachea through the tracheal incision. Such manoeuver was preferred to orotracheal intubation because at this point the surgeon had direct access to the tracheal lumen allowing him to insert the tracheal tube under vision in the trachea rather than blindly reinserting the orotracheal tube. The latter "blind" manoeuver might have led to insertion of the orotracheal tube in a false passage, probably by stripping the already inflamed and damaged tracheal mucosa. The patient now could be ventilated with difficulty, low readings of end-tidal CO_2 (16–18 mmHg) were noted on the capnograph and auscultation of the chest revealed bilateral wheezing and diminished breath sounds. Oxygen saturation was progressively decreasing to less than 80% despite the administration of 100% O_2. Salbutamol was given via the endotracheal tube. A diagnosis of pneumothorax was entertained due to the high airway pressures. A portable chest *x-ray* showed a right pneumothorax and evidence of subcutaneous emphysema. A right chest tube was inserted. A left chest tube was placed also, because of continuing difficulty in ventilating the patient.

A fibreoptic bronchoscope was used to confirm the tube position in the trachea however, blood-tinged secretions obscured the view. Suctioning showed fair amounts of frothy blood tinged mucous. Despite multiple salbutamol administrations, repeated verification of the endotracheal tube position and an unsuccessful attempt at jet ventilation, the patient's oxygen saturation never recovered, resulting in cardiac arrest. Cardiopulmonary resuscitation was initiated. Nonetheless, the patient did not regain cardiorespiratory function and showed signs of midbrain damage after 60 min of resuscitation.

Discussion

Increased tracheal mucosal swelling and increased tissue friability are major risk factors for creation of a false passage during tracheostomy.[1,2] Such risk factors existed in our case. Excessive mucosal swelling occurred due to patient agitation, prolonged intubation and generalized edema. In addition, chronic corticosteroid therapy lead to increased tissue friability. A plan is needed to approach the problem of a false passage once it occurs because, if the tracheal mucosa has been stripped during surgical entry into the trachea, the lumen might not be identified, resulting in an airway emergency. Previous reports described methods to minimize the risk of a false passage during percutaneous tracheostomy and during replacement of dislodged tracheostomy tubes. These suggestions included the use of a fibreoptic bronchoscope[3] and a nasogastric tube[4] respectively. However, in the present report, we suggest a method for re-establishment of

the airway and providing rescue oxygenation during tracheostomy. Our suggested approach is to insert a jet ventilation/airway exchange (JVAE) catheter through the endotracheal tube prior to surgical entry into the trachea through a bronchoscope port attachment to allow for a tight seal around the catheter (Figure). The JVAE catheter will restore the airway in the case of a false passage during tracheostomy tube insertion and will ensure continued oxygenation until the airway is permanently secured by the surgical team. The JVAE catheter located above the carina can minimize the risk of losing the airway during tracheostomy because the catheter can guide the surgeon to the distal tracheal lumen should the mucosa become separated from the tracheal wall. Moreover, the JVAE catheter can act as a stylet for reintubation of the distal trachea and can ensure continued oxygenation/ventilation of the lungs. The latter manoeuver could be achieved by connecting the catheter to a Laerdel bag or a jet ventilation device.[5,6] In adults, we recommend the use of a lubricated size 14F JVAE catheter for such purposes. Size 14F catheters will be easily introduced in endotracheal tubes up to size #6.5. In our experience with several cases it was not difficult to insert the JVAE catheter into the endotracheal tube prior to tracheal incision or to remove the JVAE catheter after the insertion of the tracheostomy tube. We also found that fresh gas flow leaks occurring at the bronchoscope adapter port can be sealed with tightly applied bone wax around the JVAE catheter hence preventing ventilation failure.

When a JVAE catheter is not introduced in the endotracheal tube during tracheostomy, we suggest the following measures in the event of loss of the airway:

a) reintroduction of the endotracheal tube from the proximal trachea distally past the tracheostomy incision or orotracheal insertion of a rigid bronchoscope.
b) insertion of a large bore *iv* catheter into the tracheal lumen in the sternal notch, distal to the tracheostomy opening, for connection to a jet ventilation device.
c) when all access to the trachea in the neck is impossible, a sternotomy followed by carinal/mainstem bronchus transtracheal jet ventilation or endotracheal/endobronchial endotracheal tube insertion.
d) if oxygen cannot be delivered into the lungs, emergency cardiopulmonary bypass if available.

Conclusion

Tracheal disruptions or false passages can occur during tracheostomies.[7] The anesthesiologist and the surgeon must be prepared to act promptly to prevent hypoxic brain damage or death. To re-establish the airway if lost during tracheostomy, we recommend that a jet ventilation airway exchange catheter be inserted in the endotracheal tube through a bronchoscope port attachment prior to surgical entry into the trachea (Figure). Such a catheter could also be used for rescue oxygenation of the lungs until the surgical team secures the airway.

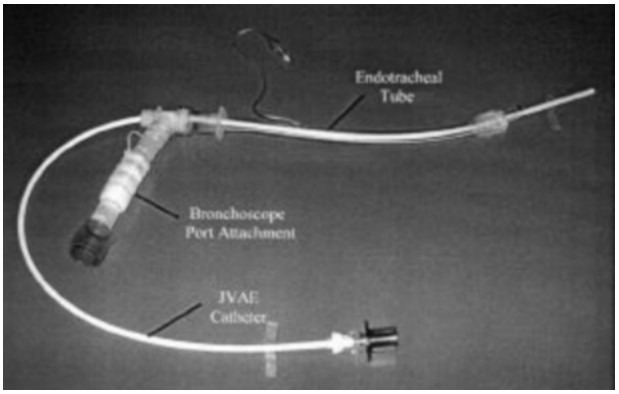

FIGURE Equipment suggested to prevent loss of the airway and to ensure continued oxygenation during tracheostomy procedures. Jet ventilation airway/exchange (JVAE) catheter is passed through an endotratracheal tube *in situ* through a bronchoscope port attachment prior to the tracheal incision. The JVAE catheter should be passed beyond the tip of the endotracheal tube. The JVAE catheter can act as a guide for inserting the tracheostomy tube or for reintroducing the endotracheal tube, thus preventing loss of the airway. The proximal end of the JVAE catheter can be attached to a 15 mm adapter (as in figure) or to a Luer lock connector for continued oxygenation using a Laerdel bag or a jet ventilation device respectively.

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