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Anesthetic and surgical management of tracheostomy in a patient with COVID-19

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ABSTRACT

Objective: The ongoing pandemic coronavirus disease-2019 (COVID-19) infection causes severe respiratory dysfunction and has become an emergent issue for worldwide healthcare. Since COVID-19 spreads through contact and droplet infection routes, careful attention to infection control and surgical management is important to prevent cross-contamination of patients and medical staff. Tracheostomy is an effective method to treat severe respiratory dysfunction with prolonged respiratory management and should be performed as a high-risk procedure

Method: The anesthetic and surgical considerations in this case involved difficult goals of the patient safety and the management of infection among health care workers. Our surgical procedure was developed based on the previous experiences of severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV).

Results: We described the management procedures for tracheostomy in a patient with COVID-19, including the anesthesia preparation, surgical procedures, required medical supplies (a N95 mask or powered air purifying respirator, goggles, face shield, cap, double gloves, and a water-resistant disposable gown), and appropriate consultation with an infection prevention team.

Conclusion: Appropriate contact, airborne precautions, and sufficient use of muscle relaxants are essential for performing tracheostomy in a patient with COVID-19.

1. Introduction

Ever since a cluster of patients with pneumonia of an unknown cause was linked to a seafood wholesale market in Wuhan, China in December 2019, an outbreak of the novel coronavirus (severe acute respiratory syndrome coronavirus 2; SARS-CoV-2) has led to a pandemic of coronavirus disease 2019 (COVID-19) [1]. After the World Health Organization (WHO) upgraded the status of the outbreak from epidemic to pandemic on March 11, 2020, the number of patients with COVID-19 has rapidly increased in many countries worldwide. Patients with severe COVID-19 are likely to be considered for tracheal intubation and mechanical ventilation to support potential recovery from the illness, and in 4–5% of such patients, invasive mechanical ventilation is required [2,3].

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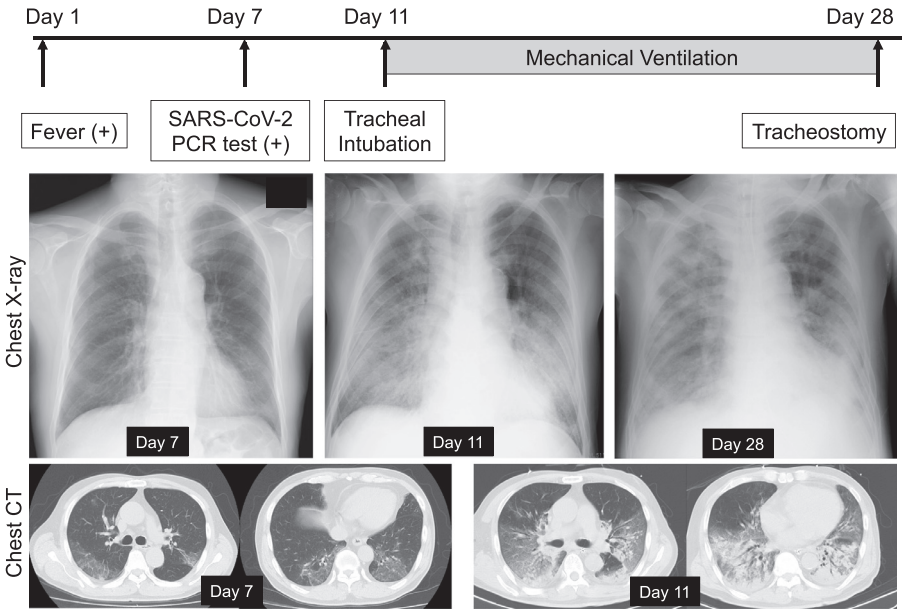

Fig. 1. Clinical history and chest images of X-ray and computed tomography.

To avoid in-hospital infection with COVID-19 among healthcare workers, appropriate and strict infection prevention is essential, particularly in aerosol-generating medical procedures such as tracheal intubation, bronchoscopy, cardiopulmonary resuscitation, and tracheostomy [4]. When performing tracheostomy in a patient with COVID-19, meticulous attention should be paid to the details of anesthetic and surgical management of the tracheostomy to minimize cross-contamination and occupational infection among healthcare workers in the hospital. Here, we report our experience with anesthetic and surgical management in a patient with COVID-19 who underwent tracheostomy.

2. Case report

The patient was a 74-year-old man with a body weight of 65 kg and had no overseas travel history and no contact with COVID-19 patients. He was a hepatitis B carrier and had hypertension, bronchial asthma, and was not under a medical treatment. He experienced slight fever on Day 1 and was admitted to a nearby hospital on Day 4 with prolonged high fever (> 39 °C) and shortness of breath. The Hemoglobin A1c (HbA1c) test revealed poorly controlled diabetes with a value of 9.4%. The PCR test for SARS-CoV-2 was positive, and he was diagnosed with COVID-19 on Day 7. He received intensive drug treatment, including ciclesonide, lopinavir/ritonavir and systemic corticosteroids, as well as respiratory care. Despite these treatments, his respiratory condition deteriorated, and he underwent tracheal intubation (23 cm deep from the mouth) for mechanical ventilation on Day 11. After his transfer to our hospital on Day 12, favipiravir was added to the drug regimen to improve the general condition. However, the patient's condition did not improve despite these intensive treatments. Because of the prolonged tracheal intubation, a tracheostomy was performed after consultation with the anesthesiologists, medical staff in the intensive care unit (ICU), and the infection prevention and control team. Surgical tracheostomy was performed on Day 28 in a negative-pressure airborne infection isolation room in our ICU. Fig. 1 shows the patient's clinical course and chest radiological findings before tracheostomy was performed. After the tracheostomy, his respiratory condition improved by Day 35, and thus he was considered for transfer to the other hospital.

The surgical team consisted of experienced personnel (two otolaryngologists, one anesthesiologist, and one critical care nurse) to minimize operating time and avoid self-contamination. All surgical staff used personal protective equipment (PPE), such as wearing a N95 mask or clean space HALO® (powered air purifying respirator: PAPR, Fig. 2a), goggles, face shield, cap, double gloves, and a water-resistant disposable gown (Fig. 2b, c).

2.1. Surgical tracheostomy

2.1.1. Anesthesia preparation

To prevent aerosol generation of COVID-19 if the cuff would be ruptured by surgical intervention, we examined the chest radiograph before performing the tracheostomy and confirmed that the intubation tube would be inserted up to 27 cm deep from the mouth. After intravenous injection of 70 mg rocuronium for muscle relaxation, 5 mg midazolam for sedation, and 100–200 mg fentanyl for pain control, mechanical ventilation was discontinued, and chest movement was confirmed to stop by the anesthesiologist. Thereafter, the intubation tube was inserted up to 27 cm deep from the mouth, and mechanical ventilation was immediately reinstated. Finally, chest movement was confirmed without listening to the patient's chest using a stethoscope. During tracheostomy, 0.2 mg/kg of rocuronium was added every half hour to prevent patient movement and coughing.

Fig. 2. Typical PPE during tracheostomy in a patient with COVID-19 a: powered air-purifying respirator, b: Clinical care nurse with PPE who assisted the tracheostomy outside the surgical field, c: Tracheostomy performed by two otolaryngologists and one anesthesiologist. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

2.1.2. Surgical procedures

Before the tracheostomy, all members inside and outside the isolation room confirmed that the equipment and surgical devices were ready to use. By administering local anesthesia around the neck region, surgical tracheotomy was performed by two otolaryngologists. Before opening the trachea, we confirmed that muscle relaxant action and oxygenation were sufficient for the subsequent surgical procedures. The ventilator was turned off immediately before tracheal incision to avoid aerosol generation of blood or tracheal secretions. A scalpel was used to incise the trachea to reduce the risk of airway fire, and the trachea was opened between the second and third trachea rings. After the trachea was opened, any electrosurgical device was not used to avoid the aerosolization of viral particles. While observing the intubation tube directly inside the trachea, otolaryngologists asked the anesthesiologist to pull out the intubation tube up to the level of the arytenoid cartilage. Immediately, the tracheostomy tube was placed into the trachea and was temporally sutured with the trachea to avoid accidental extraction. After the anesthesiologist carefully examined the connection between the ventilator and tracheostomy tube, mechanical ventilation was restarted. We confirmed the chest movement with regularity. After removing the intubation tube from the mouth, we fixed the tracheal tube to the neck skin. Postoperative radiography showed that the cannula was placed at the appropriate position of the neck by all team members. The procedure, from gowning to de-gowning, took 75 min. Most importantly, the PPE was taken off by a non-contact person to avoid self-contamination and exposure to surrounding people.

3. Discussion

The most important aspect for the management of infection with the novel coronavirus is to prevent in-hospital infection among health care workers. A previous report of 138 patients diagnosed with COVID-19 in China demonstrated that 43% of the patients were infected in the hospital [1]. Moreover, invasive surgical procedures, such as tracheal intubation, non-invasive positive pressure ventilation, tracheostomy, and bronchoscopy, have been reported to be strongly associated with an increased risk of infection of severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV) [5,6]. To the best of our knowledge, no previous study has reported about tracheostomy in a patient with COVID-19. We described the management procedures for tracheostomy in a patient with COVID-19, including the surgical and anesthetic process, required medical supplies, and appropriate consultation with an infection prevention team. Our detailed experience of the tracheostomy in a patient with COVID-19 is shown in Table 1. Although there is a lack of clear evidence for the management of SARS-CoV-2, anesthesia and surgical techniques are thought to be essential to prevent virus exposure and contamination to the self and other medical staff based on the results of previous studies on SARS or MERS [7,8]. Accordingly, careful attention should be paid to invasive medical procedures, and strict PPE is critical for infection prevention among healthcare workers while conducting surgical procedures in patients with COVID-19.

SARS-CoV-2 is thought to spread through contact and droplet infection. Practice of droplet and contact precautions would be appropriate to decrease the infection risk during medical care of patients with COVID-19. Current WHO guidelines recommend that the prevention methods for contact and droplet infection should be added to standard precaution, and stricter prevention is needed if aerosol exposure is suspected [9]. Similarly, the Centers for Disease Control and Prevention (CDCs) also recommend these prevention methods as the prevention of airborne infection is necessary at any given

Table 1
Tracheostomy protocol in a suspect or probable COVID-19 patient.

Anesthesia Preparation
1. Confirm chest X-ray to check tube cuff position
2. Increase FiO2 on the ventilator
3. Inject drugs for muscle relaxation and sedation
4. Suction secretions and turn off the ventilator
5. Insert the intubation tube deeper to avoid the ruputure of the tube cuff
6. Turn on the ventilator and examine chest movement*
Surgical Procedures
1. Set a position for tracheostomy
2. Administer local anesthesia
3. Incise the skin and reach the trachea
4. Assess the status of muscle relaxant action and oxygenation before opening the trachea
5. Suction secretions and turn off the ventilator
6. Attach the closed suction system for tracheostomy tube
7. Incise the trachea with a scalpel and check the intubation tube
8. Pull out the intubation tube up to the level of the arytenoid cartilage
9. Place the tracheostomy tube in the trachea
10. Check the connection between the ventilator and tracheostomy tube
11. Turn on the ventilator and examine chest movement*
12. Remove the intubation tube with careful attention
13. Fix the tracheostomy tube to the neck skin
14. Examine the chest X-ray to confirm tube cuff position
15. Remove personal protective equipment by non-contact person

* Auscultation is not recommended.

time [10]. We performed the tracheostomy with a gown, N95 mask, double gloves, eye shield, and boots to avoid exposing the medical staff. Further, PAPRs were used for medical staff members who were at a high-risk for the viral infection. During tracheostomy, surgical procedures should be considered to prevent aerosolization of viral particles in a negative pressure isolation room in ICU. Surgeons should check the surgical field to avoid post-operative bleeding from wound bed before incising the trachea using a scalpel. Once the trachea is opened, an electrosurgical device should not be used to avoid aerosolization of viral particles. Notably, sufficient use of muscle relaxants is key to prevent patient movement and coughing, resulting in a considerable benefit for the containment policy for COVID-2019 [11]. Although strict precaution requires additional cost, labor, and time to perform surgical procedures, we should understand the importance of infection prevention and perform the necessary medical procedures to avoid aerosol generation.

The optimal timing of tracheotomy in critically ill patients remains controversial [12]. Previous reports of the SARS pandemic showed that the timing from tracheal intubation to the tracheostomy ranged from14 days-25 days [7,8]. Considering an unstable general condition, early tracheostomy (within 10 days) should be avoided in these novel coronavirus patients with an acute respiratory failure [13]. To decide whether a tracheostomy should be performed, repeated careful considerations by the infection prevention team in the hospital are required. It is recommended that tracheostomy should be performed in patients with COVID-19 only when deemed absolutely necessary, and otolaryngologists encounter and have to deal with this difficult situation directly. Thus, we should know the surgical risks and appropriate management of tracheostomy for both the patients and healthcare team involved. During the SARS outbreak in 2003, 43 operative procedures, including 15 surgical tracheostomies, were performed on SARS-related patients in Singapore. Interestingly, there was no transmission of SARS within the operating room complex, in which staff personal protection, patient risk categorization, and reorganization of operating room workflow processes were thoroughly implemented [14]. Similarly, reliable use of PPE (particularly an N95 mask) significantly reduced the risk of infection among critical care nurses during the SARS epidemic [15]. Therefore, we do not overemphasize the risk of medical procedures in patients who really need intensive treatment for recovery from illness. Depending on the medical resources in each hospital, region, and country, a tracheostomy should be performed with appropriate contact precautions (i.e., double gloves, gown, and eyewear) and airborne precautions (i.e., PAPRs or masks with filter efficiency of greater than or equal to 95%) for the personal protection of staff during the ongoing COVID-19 pandemic.

4. Conclusion

Appropriate contact, airborne precautions, and sufficient use of muscle relaxants are essential for performing tracheostomy in a patient with COVID-19.

Declaration of Competing Interest

The authors have no financial conflicts of interest to declare.

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Ethical Statement

The study was performed in accordance with the Helsinki Declaration of 1975 and its amendments, and the laws and regulations of the Japan. Written informed consent was obtained from the patients.

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