International Journal of
BioScience and Applications

ISSN : 2619-8363
Volume 3, Number 3, September 2021
https://doi.org/10.22662/IJBSA.2021.3.3.006

Emergency surgery in COVID-19 confirmed patients in hospitals without a negative-pressure operating room

Cheol-Hyeong Lee[1], A Ram Doo[2], Ji-Seon Son[2], Sang-Kyi Lee[2], Yeon-dong Kim[1, 3]*

[1]Department of Anesthesiology and Pain Medicine, Wonkwang University School of Medicine, Wonkwang University Hospital, Iksan, Korea
[2]Department of Anesthesiology and Pain Medicine, Jeonbuk National University Medical School and Hospital, Jeonju, Korea
[3]Jesaeng-Euise Clinical Anatomy Center, Wonkwang University School of Medicine, Iksan, Korea

Abstract

Background: Confirmed coronavirus disease 2019 (COVID-19) patients sometimes require emergency surgery, but protecting healthcare workers and other patients from infection is a high priority. This report describes two cases where surgeries were performed in a hospital without a negative-pressure operating room.

Case: Two patients diagnosed with COVID-19 required emergency surgery in a negative-pressure isolation room. Two operating rooms were designated an operating room and an anteroom, and the central air conditioning system was turned off. The disinfection exhaust fan of the operating room was used to create a negative-pressure environment (−1.0 Pa).

Conclusions: Performing surgery on COVID-19 patients remains challenging in hospitals not specialized for infection. It is necessary to share experiences between hospitals, and changing the pressure inside the operating room from positive to negative pressure with a simple maneuver is a good option for protection.

.

Index Terms

COVID-19, Patient Isolators, Emergent surgery, General anesthesia, Pandemic

---

Corresponding author : Yeon-Dong Kim
kydpain@hanmail.net

• Manuscript received July 15, 2021.
• Revised August 10, 2021 ; Accepted September 1, 2021.
• Date of publication September 30, 2021

I. INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic has now lasted over a year and a half. Thus, many tertiary hospitals in Korea have exclusive intensive care units (ICUs) and wards for COVID-19 confirmed or suspected patients. These are operated under negative pressure following strict regulations. The negative-pressure room is advantageous for preventing the spread of contamination by only allowing the flow of air to enter the room from the outside by creating a pressure difference between the room and the outside [1,2]. In Korea, per the relevant 2018 law, negative-pressure isolation wards are mandatory in certain sized hospitals, and most COVID-19 patients receive treatment under quarantine. However, what if these patients require surgery? Although a negative-pressure room seems to be essential for surgery, few hospitals are currently equipped with negative-pressure operating rooms nationwide, and even these are not being operated properly due to the lack of demand.

Per the Guidelines for Surgery of Confirmed or Suspected COVID-19 Patients published by the Korean Society of Infectious Diseases and the Korea Medical Association Task Force Expert Committee, using a negative-pressure operating room or an operating room equipped with a negative-pressure device is recommended [3]. Moreover, according to the Coronavirus Infectious Disease-19 response guidelines for hospitals published by the Central Disease Control Headquarters and Central Disaster Management Headquarters, in principle, the aerosol generation procedure should be performed in a negative-pressure isolation room equipped with a high-efficiency particulate air (HEPA) filter [4]. If this is not possible, the aerosol generation procedure should be conducted in a space independent of the entire air conditioning system with good external ventilation. In addition, several experts suggest that negative-pressure operating rooms are ideal for reducing the risk of the spread of infection [5, 6].

We present two cases of inevitable yet successful surgeries performed on confirmed COVID-19 patients in a hospital without a negative-pressure operating room. We find it beneficial to share how the operating room environmental setting, patient transfer, anesthesia, and surgery should be performed following the principles of isolation and protection for the safety of medical staff and other patients.

II. CASE

CASE 1

An 81-year-old woman was admitted to the hospital emergency room due to left neck swelling and fever. The initial severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) screening test performed in the emergency room was negative. Para-pharyngeal abscess and resulting sepsis were diagnosed, and an emergency incision and drainage with tracheostomy were performed. Meanwhile, a patient who visited the emergency room at the same time tested positive for COVID-19. Therefore, our patient was classified as a suspected COVID-19 patient. The subsequent retest was positive, and the patient was transferred to the exclusive COVID-19 ICU.

After the transfer, while maintaining supportive care, a tracheoesophageal fistula occurred in the mid-trachea due to the prolonged tracheostomy tube placement, requiring surgery to repair the tracheoesophageal fistula (Figure 1A). Our hospital did not have a separate negative-pressure operating room, and it was difficult to transfer to other hospitals considering the patient's current systemic condition, including respiratory distress (Figure 1B). Therefore, the surgery was scheduled in the operating room of our hospital after discussion with the Department of Infection Control, Thoracic Surgery, and Anesthesiology. For easy control and isolation, the surgery was planned in Room 20 of D-rosette on Saturday morning. Our hospital does not plan regular surgeries on Saturdays and Sundays, ensuring sufficient ventilation time after surgery. The operating rooms of our hospital are composed of A-, B-, C-, and D-rosettes, and the D-rosette operates a separate air conditioning system. Room 19, connected to Room 20, was designated as the anteroom.

First, we requested that the central air conditioning system be turned off in both rooms. After confirming that the air conditioning system was off, a separate disinfection exhaust fan in the operating room was used to exhaust the air inside the operating room. As a result, only exhaust went through the exhaust fan without supply air. The inside of the operating room was not under positive pressure, so the air inside the operating room did not escape elsewhere (e.g., the corridor or the adjacent operating room), only to the designated passage. The differential pressure displayed on the differential pressure gauge (DS Mecasys, Seoul, Korea) inside the operating room was –1.0 Pa (Figure 2A), and the differential pressure measured with a portable differential pressure manometer (Kimocorea, Seoul, Korea) was approximately –0.9 Pa (Figure 2B). Items other than disposables were covered with vinyl to prevent exposure to aerosols (Figure 3A), and two heat and moisture exchange (HME) filters were connected to the corrugate tube (Figure 3B).

The surgical team included the minimum number of medical staff: one thoracic surgeon, one anesthesiologist, two surgical assistants, and three nurses. All medical staff dressed in Level D personal protective equipment (PPE) on third floor, separate from the operating room (on the second floor), including two pairs of gloves, ono N95 mask, and a powered air-purifying respirator (PAPR). After completing all preparations, the patient was transported to the operating room through the designated passage, which included a separated elevator with a negative-pressure cart, by transport personnel wearing Level D PPE. The patient was placed on a surgical table, the corrugate tube was promptly connected to the tracheostomy tube, and the invasive arterial blood pressure, pulse oximeter, and electrocardiogram were monitored. The patient was in a near-alert state with spontaneous breathing through tracheostomy and in both thoracostomy states due to both types of pneumothorax. The initial vital signs were blood pressure of 167/75 mm Hg, heart rate of 91 beats/min, respiratory rate of 20 breaths/min, and peripheral oxygen saturation of 100 %. Total intravenous anesthesia was induced using propofol and remifentanil target-controlled infusion. Fistula suture closure was performed on the esophageal and tracheal sides over 90 min after anesthetic induction. After surgery, the patient was transferred back to the exclusive COVID-19 ICU under sedation with a negative-pressure cart. Next, the waste was safely disposed of following the regulations, and the operating room and anteroom were subjected to forced circulation for eight hours through an air conditioning system and not used for 48 hours after.

CASE 2

A 69-year-old man was diagnosed with COVID-19 pneumonia and was undergoing supportive treatment in our exclusive COVID-19 ward. On the third day of hospitalization, the patient fell and complained of lower sensory and motor deterioration (motor grade 2). Magnetic resonance imaging indicated spinal cord compression with compressive myelopathy, requiring emergency surgery (anterior cervical discectomy and fusion at level C5/6) (Figure 4). Since it was a weekday, the surgery was scheduled in room 20 of the D-rosette after all regular surgeries were complete. The air conditioning was controlled as in Case 1, and all items, excluding the disposables, were protected with vinyl as much as possible. All participating medical and transport staff members were equipped with Level D PPE and PAPR.

The patient was transported while wearing a KF94 mask with a negative-pressure cart, and the initial vitality was stable. Once the KF94 mask was removed for anesthetic induction, the facial mask connected to the circuit was fitted to minimize aerosol discharge. Anesthesia was induced using propofol, remifentanil, and sevoflurane, and endotracheal intubation was performed quickly using a video laryngoscope. The operation lasted approximately 70 minutes and was terminated without any specific events. Since the cough reflex induced by endotracheal extubation can spread the virus, the patient was transferred to an exclusive COVID-19 ICU equipped with a negative-pressure isolation room for endotracheal extubation. The elective surgery scheduled for the next day in the same operating room was canceled and performed elsewhere, and the operating room was not used for 24 hours.

Fig. 1. A preoperative computed tomography (A) and chest anterior-posterior image (B).

Fig. 2. The instrument panel (A) and portable differential pressure manometer (B) used in the surgery.

Fig. 3. The operating room before the start of surgery (A) and the heat and moisture exchanger filters used in the surgery (B).

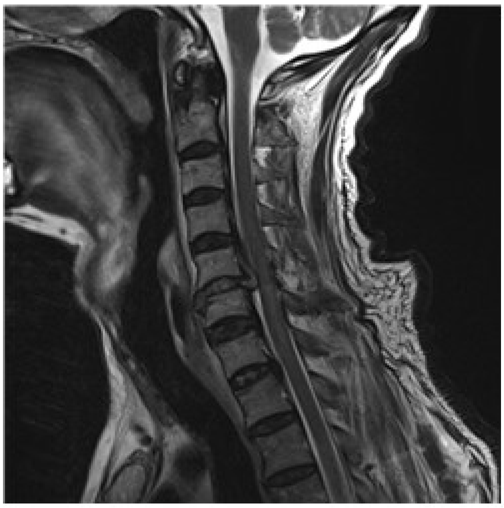

Fig. 4. The patient's cervical magnetic resonance image.

Ⅲ. DISCUSSION

SARS-CoV-2 mainly infects by airborne transmission. The respiratory fluid particle size excreted by people during exhalation varies, and even very small droplets are small enough to travel tens of meters and float in the air for hours [7,8]. SARS-CoV-2 has also been detected on the surface of hard objects, such as plastic and stainless steel, for 72 h to 9 days [8,9]. The estimated basic reproduction number of COVID-19 is 3.38 ± 1.40, ranging from 1.90 to 6.49 [9]. The operating room and the operating room corridor are spaces where many people come and go throughout the day. A positive pressure is maintained inside the operating room to prevent pathogens, such as bacteria or viruses from outside. Therefore, if the virus spreads inside the operating room, everyone sharing the common corridor is very easily exposed.

Fundamental to these cases is ensuring the safety of the medical staff performing the emergency surgery and the other patients without a negative-pressure operating room. Thus, controlling the air conditioning system was the most important. A central air-conditioning system circulates air throughout the operating room for air purification and cooling. We designated two operating rooms as the main COVID-19 operating room and anteroom and blocked the air coming in through the supply fan on the ceiling, allowing the air to go out only through the four exhaust fans at the bottom of the wall. The air passing through the exhaust fan passed through the HEPA filter and exited the roof of the building. To this end, the central air conditioning was off, and the disinfection exhaust fan, directly controlled in the operating room, was activated. After a few minutes, the differential pressure between the operating room and the operating room corridor became –1.0 Pa. This is significant because the differential pressure in the operating room can change from positive to negative with a simple maneuver, although it does not meet the criteria for a negative-pressure isolation area (–2.5 Pa) presented by the US Centers for Disease Control and Prevention [1].

Surgery was performed after the end of the regular surgical working day or on weekends, without other surgeries, using the operating room that was spatially farthest from the other operating rooms. A dressing room was set up at the entrance to the operating room, and staff from the Infection Control Department instructed how to appropriately wear the PPE and PAPR and blocked non-participants from entering. As the air conditioning system was off in the operating room, it was impossible to cool, so PAPR was essential for the medical staff to facilitate easier breathing over a long period. All medical staff entered and exited through the anteroom, where they were allowed to remove the contaminated PPE and PAPR. Non-disposable anesthesia and monitor devices, syringe pumps, and warmers were wrapped in vinyl as much as possible and manipulated over vinyl to minimize exposure to infectious agents. HME filters were also installed on the expiratory and the common limbs of the corrugate tube to protect the anesthetic machine from the patient's breathing. The patient moved through the designated route, including the designated elevator with the negative-pressure cart connected to the HEPA filter while wearing a KF94 mask, and the transport staff also wore Level D. Before anesthetic induction, the tracheal tube was connected to the closed-circuit, or the mask was sealed as quickly as possible to minimize the aerosol exposure to the air through the patient's breathing.

After surgery, endotracheal extubation was not performed in the operating room but rather in the COVID-19 ICU, equipped with a negative-pressure room. The air conditioning was controlled to ensure sufficient circulation, and the operating rooms were not used for at least 24 hours after. The anesthetic machine operated free ventilation to remove any remaining aerosol for several hours. All products that came into contact with the patient (e.g., the corrugate tube, facial mask, bag valve mask, laryngoscope bladder, and temperature probe) were used as disposables and immediately discarded.

In Korea, during the Middle East Respiratory Syndrome (MERS) outbreak in 2015, group infection through domestic medical institutions strengthened facility standards. In particular, the law was amended, so general hospitals with more than 300 beds were required to have negative-pressure isolation rooms. With the COVID-19 pandemic, hospitals are expanding the number of negative-pressure rooms and infection protection equipment. However, compared to negative-pressure isolation wards, negative-pressure operating rooms are very rare, except for in a few designated hospitals in Korea, owing to very low demand and a high cost. In most surgeries, blood and body fluids are exposed, and during endotracheal intubation and extubation performed under general anesthesia, aerosols in the lungs are easily spread into the air [11]. Specifically, the aerosol amount emitted increases significantly when coughing due to the cough reflex during extubation [12].

The recommendation is to postpone or reschedule elective surgery for COVID-19 confirmed or suspected patients based on priority [13,14] and consider transferring patients who need emergency surgery to a hospital with a negative-pressure operating room. However, hospitals with negative-pressure operating rooms are very rare, and it is practically difficult to transport all surgeries required during hospitalization to other hospitals. There is a lack of clear guidelines on this scenario, and there are heterogeneity and gaps in each recommendation, such as for preoperative preparation or anesthesia [15]. For this reason, when such a situation occurs, most hospitals follow their own regulations or respond according to the circumstances.

Ⅳ. CONCLUSION

This case report allows us to share our experiences, which can serve as a reference for the safety of the patients requiring emergency surgery and the medical staff performing them. This report also describes and suggests turning the operating room ventilation into negative pressure using a simple maneuver when surgery is unavoidable in patients with highly infectious aerosol disease as a safety option for the medical staff.

REFERENCES

[1] Chinn RY, Sehulster L. (2003). Guidelines for environmental infection control in health-care facilities; recommendations of CDC and Healthcare Infection Control Practices Advisory Committee (HICPAC).

[2] Al-Benna, S. (2021). Negative pressure rooms and COVID-19. *Journal of Perioperative Practice, 31*(1-2), 18-23.

[3] Lee JS, Yum HK, Si HJ, Han SH, Park SY, Peck KR, Eom JS. (2020). Guidelines for surgery of confirmed or suspected COVID-19 patients. *Infection & chemotherapy, 52*(3), 453.

[4] Central Disease Control Headquarters and Central Disaster Management Headquarters. Coronavirus Infectious Disease-19 response guidelines – for hospital.

[5] Coccolini, F, Perrone G, Chiarugi M, Di Marzo F, Ansaloni L, Scandroglio I, Catena F. (2020). Surgery in COVID-19 patients: operational directives. *World Journal of Emergency Surgery, 15*(1), 1-7.

[6] Peng PW, Ho PL, Hota SS. (2020). Outbreak of a new coronavirus: what anaesthetists should know. *British journal of anaesthesia, 124*(5), 497-501.

[7] Morawska L, Cao J. (2020). Airborne transmission of SARS-CoV-2: The world should face the reality. *Environment international, 139*, 105730.

[8] Van Doremalen N, Bushmaker T, Morris DH, Holbrook MG, Gamble A, Williamson BN, Munster VJ. (2020). Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. *New England journal of medicine, 382*(16), 1564-1567.

[9] Kampf G, Todt D, Pfaender S, Steinmann E. (2020). Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. *Journal of hospital infection, 104*(3), 246-251.
[10] Alimohamadi Y, Taghdir M, Sepandi M. (2020). Estimate of the basic reproduction number for COVID-19: a systematic review and meta-analysis. *Journal of Preventive Medicine and Public Health, 53*(3), 151
[11] Kim HJ, Ko JS, Kim TY. (2020). Recommendations for anesthesia in patients suspected of COVID-19 Coronavirus infection. *Korean journal of anesthesiology, 73*(2), 89-91
[12] Brown J, Gregson FKA, Shrimpton A, Cook TM, Bzdek BR, Reid JP, Pickering AE. (2021). A quantitative evaluation of aerosol generation during tracheal intubation and extubation. *Anaesthesia, 76*(2), 174-181.
[13] The American College of Surgeons. COVID-19: Recommendations for Management of Elective Surgical Procedures 2020 [updated 2020 Mar 13]. *American college of surgeons.*
[14] Moletta L, Pierobon ES, Capovilla G, Costantini M., Salvador R, Merigliano S, Valmasoni M. (2020). International guidelines and recommendations for surgery during Covid-19 pandemic: a systematic review. *International Journal of Surgery, 79*, 180-188.
[15] Ong S, Lim WY, Ong J, Kam P. (2020). Anesthesia guidelines for COVID-19 patients: a narrative review and appraisal. *Korean journal of anesthesiology, 73*(6), 486.