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Anesthetic Management of Pulmonary Metastatectomy in a Patient Infected with Novel Corona Virus SARS-CoV-2

Mohammed J. Al-Naabi,[1] *Madan M. Maddali,[1] Karima R.S. Al Aliyani,[2] Ahmed Al-Balushi[3]

Departments of [1]Cardiac Anesthesia and [3]Cardiothoracic Surgery, National Heart Center, Royal Hospital, Muscat, Oman; [2]Anesthesia Residency Training Program, Oman Medical Specialty Board, Muscat, Oman.

**Corresponding Author's e-mail: madanmaddali@gmail.com*

Abstract

Prioritization of individual patients for thoracic surgeries gained importance during the current severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic to ensure optimal utilization of resources. We report the successful anesthesia management of an urgent pulmonary metastasectomy in an elderly patient despite him testing positive for real-time reverse transcription–polymerase chain reaction [rRT-PCR] on two occasions. The rationale behind acceptance of the case for surgery and the precautions taken for reducing aerosol generation during the various stages of anesthesia are highlighted.

Keywords: COVID-19; SARS-CoV-2; Coronavirus Infections; One-Lung Ventilation; Personal Protective Equipment; Aerosols; Thoracic Surgical Procedures

Introduction

The emergence of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic provisionally named as the coronavirus disease 2019 (COVID-19), has resulted in the prioritizing of individual patients for thoracic surgeries in order to conserve resources.[1] Droplets, contact, and natural aerosols cause the spread of SARS-CoV-2. Thoracic anesthesia for thoracic surgical procedures in patients infected with COVID-19 gain special attention as many inherent procedures involved are a major source of aerosol generation and may contribute to the speared of the virus. This case report describes the successful anesthesia management of an elderly patient who tested positive twice for real-time reverse transcription–polymerase chain reaction [rRT-PCR] and needed a pulmonary metastasectomy as a semi-emergency. The report highlights the rationale behind the decision for surgery and the precautions taken for reducing aerosol generation during the various stages of anesthesia. To the best of the authors' knowledge, this is probably the first case report from this country describing the practical aspects of anesthetic management of a thoracic surgical procedure in a patient with COVID-19.

Case report

A 76-year-old-man presented to the authors institution with bilateral pulmonary metastasis one year after having surgical excision of an adenocarcinoma of the sigmoid colon [pT4aN1b]. The 18F-fluorocholine positron emission tomography/computed tomography (FCH-PET/CT) imaging revealed an interval progression of the pulmonary metastases [Figure-1].

A left lung metastasectomy as a semi-emergency was planned as the metastatic nodule in the left lower lobe was rapidly increasing in size and was in close proximity to the pulmonary artery. The pandemic was at its peak and a preoperative rRT-PCR test as a screening investigation was done despite the patient being asymptomatic. Surgery was deferred as SARS-CoV-2 RNA was detected. After 4 weeks, the patient's rRT-PCR test was still positive. However, it was decided to proceed with the surgery as the cycle threshold [Ct] value was 43 above the cut off value of 34.[2,3] The cross-linked D-Dimer assay XDP value was normal [0.1mg/L, normal range; <0.5mg/L]. A quantitative Covid-19 antibody test [Anti -SARS-COV-2 S] done 1 day before surgery was negative

[<0.400 IU/mL]. The cardiopulmonary reserve assessed by 6-minute walk test was acceptable [500 meters]. The room air arterial blood gas analysis results were within the normal range [pH: 7.4; pCO_2: 40 mm Hg; pO_2: 88 mm Hg; oxygen saturation: 96%; HCO3:24 mmol/L, Na+:138 mmol/L, K+: 4.2 mmol/L lactate: 1mmol/L] as were the vital parameters [blood pressure: 140/88 mmHg, heart rate: 78/min]. He could hold his breath for more than 10 seconds and he was using an incentive spirometer regularly. The chest X-Ray displayed multiple nodular opacities related to the underlying malignancy. There were no ground glass opacities or evidence of consolidation suggestive of a COVID-19 involvement of the lungs [Figure-2].

After obtaining an informed consent for the surgical procedure, the patient was shifted to the operation room. All personnel involved, donned personal protective equipment [PPE]. The positive- pressure system and air conditioning in the operating room was turned off. After preoxygenation with oxygen through a tight-fitting face mask for 3 mins, general anesthesia was administered under standard ASA monitoring. Patients' trachea was intubated with a 37 Fr double lumen tube [DLT] with the help of a video laryngoscope. The DLT was positioned and the placement was confirmed by fiberoptic bronchoscopy [FOB] with the patient being apneic. The tracheal and bronchial cuffs of the DLT were inflated immediately to avoid leakage of aerosol. High-efficiency particulate air (HEPA) filters were applied between the disposable anesthesia face mask and the breathing circuit, on the inspiratory and expiratory limbs of the breathing circuit, between the DLT catheter mount and the breathing circuit and on the bronchial lumen of the DLT that would be in communication with the operative non-dependent lung adding up to a total of 5 HEPA filters.

A pressure-controlled mode of mechanical ventilation was initiated with a fraction of inspired oxygen [FiO_2] of 0.7 and a positive end expiratory pressure [PEEP] of 5 cm H_2O. Pressure limit was adjusted to achieve 6ml/kg/min tidal volume monitoring the end tidal carbon dioxide [$EtCO_2$]. General anesthesia was maintained with infusions of dexmedetomidine [0.6 mcg/kg/hr], cisatracurium, fentanyl and sevoflurane [0.6 to 1 MAC]. One lung ventilation was achieved without any episode of hypoxemia. Left parenchymal sparing metastasectomy with anatomical segmentectomy was performed and 6 metastatic masses were removed. On completion of the procedure, aspiration of secretions was performed via a closed system from the non-dependent of the lung, followed by an alveolar recruitment maneuver of the collapsed lung and initiation of both lung ventilation. The wound was closed in layers and the surgery lasted about 95 minutes.

One intercostal drain was inserted that was connected to an Argyle™ Thora-Seal™ III chest drain system [Cardinal, Ireland]. Synchronized intermittent mandatory ventilation [SIMV] mode was initiated on return of spontaneous breathing. This was changed to pressure support mode [10 cm H_2O] and the neuromuscular blockade was reversed. Cough reflex was inhibited with dexmedetomidine infusion and a bolus of lidocaine injection[1mg/kg]. All anesthetic agents were stopped once surgical dressing was completed. 100% FiO_2 was administered for 2 minutes and the patient's trachea was extubated. Oxygen was administered through nasal prongs and a surgical face mask was applied to the patients face. An arterial blood gas analysis was done [pH:7.39, $PaCO_2$: 37mm Hg, PO_2: 90 mmHg, oxygen saturation:99% HCO_3:22 mmol/L, Na^+:136 mmol/L, K^+: 3.2 mmol/L, lactate:1.9 mmol/L]. After confirmation of uncompromised spontaneous breathing, the patient was transferred to intensive care unit. The intercostal drain was removed after 48 hours postoperatively and the patient was discharged home on the 7th day after surgery. The patient flow diagram shows the stages of management of the patient as well as the zones in the operating room [Figure-3].

A computerized tomography done during the 3-month follow-up reported diffuse bronchial wall thickening with patent central tracheobronchial tree. There was mild para-septal emphysema with bi-apical scarring. The left apical region displayed cicatrization and atelectasis. Informed patient consent as well as institutional ethical committee approval was obtained to publish this report.

Discussion

This report describes the successful anesthetic management of an elderly patient who had a positive rRT-PCR test and needed urgent pulmonary metastasectomy. The recommendation for timing the surgery in patients with SARS-CoV-2 infection has changed recently. At the time the current patient was operated on, the recommendation was that once SARS-CoV-2 infection was diagnosed, surgery was to be postponed for at least 7-14 days from the end of symptoms and that too with a negative swab result.[4,5] The recent evidence suggests that the surgery should be delayed by 7 weeks.[6]

However, a positive rRT- PCR assay result alone may not be as important as the Ct value. The Ct threshold value is the number of amplification cycles needed to yield a positive fluorescent signal in a rRT-PCR and is a surrogate marker for the viral load. Ct levels are inversely proportional to the amount of target nucleic acid in the sample. At the time of surgery for the current patient data suggested 34 cycles as the cutoff value for deciding on SARS-CoV-2 infectivity.[2] A patient may not be infectious if Ct values are ≥35.[3]

Viral droplets are the principal cause of speared of COVID-19 infection.[4] Many anesthetic procedures result in aerosol generation of viral particles that may pose a risk for the medical team taking care of a COVID-19 patients. Stress on minimizing aerosol generation during the various stages of anesthesia is the primary difference in anesthetizing a non-COVID patient for thoracic surgery compared to those who are infected with COVID-19. The European Association of Cardiothoracic Anaesthesiology Thoracic Subspecialty Committee recently published recommendations for the management of thoracic anesthesia patients with suspected or confirmed COVID-19 infection.[4] The recommendations lay emphasis on achieving successful airway management without compromising the health of the treating team. Guidelines are also available for triaging patients with thoracic malignancies based on the trajectory and the impact of COVID-19 cases on each institution.[1] Notwithstanding a rapidly escalating COVID-19 trajectory with many hospital admissions and resources constraint, the current patient underwent early surgery.

During preoperative evaluation of suspected COVID-19 patients, rRT-PCR testing and when its unavailable, chest computed tomography needs to be done.[5] There might be COVID-19–related blood test anomalies like elevated values of C-reactive protein, erythrocyte sedimentation rate, and D-dimer levels.[5] COVID-19 patients may exhibit chest radiography abnormalities as well.[5] The current patient tested positive for rRT-PCR on two occasions with a Ct of >35 the second time. As the metastatic lesions were rapidly increasing in size with the possibility of infiltration into pulmonary vasculature, a decision to operate was made.

Tracheal intubation is to be performed electively using rapid sequence induction with complete neuromuscular paralysis after preoxygenation in an “isolated” negative pressure room with >12 air changes/minute.[4] In the current patient, as a negative pressure operating room was not available, the tracheal intubation was done in an operating room after switching off the positive pressure with the doors closed.

The operating room area was separated into red, white and yellow zone.[4] In the red zone i.e., the operating room, there were 2 staff donned with full PPE during the tracheal intubation that was performed by a senior anesthesiologist with the assistance of a nurse. The yellow zone was the induction room that was attached to the operating room and separated by a glass partition where an anesthesiologist with full donned PPE was available in case of need for help as suggested by Şentürk and colleagues.[4] An observer from the institutional infection control team was present in the white zone that was outside the dedicated operating room where the surgery was to take place. The PPE donned by the team comprised of hair covers, two N95 face masks each, face shield, long sleeve fluid-resistant gown, double gloves and overshoes as prescribed.[4] According to the European Guidelines, lung separation with a bronchial blocker may be the preferred mode in COVID patients undergoing thoracic surgery.[4] This technique mandates the use of an FOB guidance.

Simultaneously, many other international societies recommend consideration of DLTs in lieu of bronchial blockers for patients who do not have a known or suspected difficult airway with the placement of an antiviral filter on the open nonventilated lumen of the DLT.[7,8] A DLT may be positioned without the help of FOB guidance based on auscultation and may be a better choice of lung isolation in COVID-19 infected patients.

In the current patient an initial attempt was made to place a DLT without the help of FOB guidance. As this initial attempt failed, it necessitated the need for FOB for accurate placement of the DLT during the second attempt. This was done maintaining the patient apneic. The management guidelines suggested by Şentürk M and colleagues for the conduct of one lung ventilation in patients with COVID-19 were adopted by the authors in the current patient.[4] The placement of HEPA filters in the anesthesia circuit, management of ventilation parameters, alveolar recruitment techniques prior to resumption of both lung ventilation after achieving one lung ventilation, use of closed system for aspiration of secretions, cough suppression at the time of tracheal extubation etc. were in accordance with these guidelines.[4] Nasal prongs for oxygen supplementation were inserted in the patient with the application of a surgical face mask over the prongs. Observation of the patient during the immediate post extubation period was done in the operating room and once the anesthesiologist was convinced of the cardio-pulmonary stability of the patient, the patient was shifted to an isolation room in the intensive care unit for further management.

Attention was paid towards possibility of virus transmission via the chest drainage unit. Following the metastatectomy, no air leak was detected during the process of recruitment and expansion of the lung that was operated on. The intercostal drain was connected to a chest drain unit that was a closed system that and had three chambers: a collection chamber for pleural fluid/ chest drain output; a water-seal chamber that acted as a one-way valve; and a suction control chamber set to negative pressure of 5 cmH_2O. The outlet port of the 3rd chamber was connected to the wall mounted suction to scavenge the exhaust, from any ongoing air leak or air displaced by pleural drainage in the operating room and in the intensive care unit. During transport to the intensive care unit the outlet port was kept sealed. In order to curb any possibility of disease transmission, some authors suggested attachment of a HEPA filter to the port of the drainage system that is open to the environment.[9]

Based on prior experience of management of patients during the MERS-CoV outbreak and the available literature, guidelines for anesthesia management of thoracic surgery in patients with suspected/confirmed COVID-19 were recently published by the Saudi Anesthesia Society.[10] These guidelines addressed the general regulations, organization, preparations and lung isolation/separation in different types of patients during COVID-19 outbreak.[10] Many of these were adopted in the current patient management.

Conclusions

In conclusion, case selection for thoracic surgeries during the current pandemic must be based on multidisciplinary discussion and the timing of surgery may be dictated by the patients underlying pathology. The perioperative anesthetic management poses an important challenge as many events that are necessary for the conduct of anesthesia in these patients are a major source of aerosol generation and may contribute to spread of infection. Therefore, the primary objective of the conduct of thoracic anesthesia in COVID-19 patients is to minimize aerosol generation at all stages.

Authors' Contribution

MMM conceptualized the work and was involved in acquisition of the images and drafted the manuscript. MJN, MMM, KRSA and AB were involved in the interpretation of the data. MJN was responsible for the provision of the anesthesia details. AB was responsible for the provision of the operation data. KRSA collected the data. All authors approved the final version of the manuscript.

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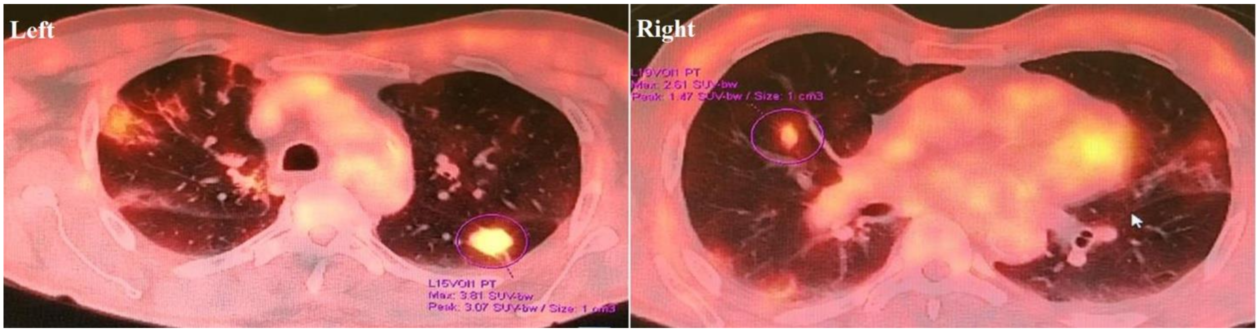

Figure 1: 18F-fluorocholine positron emission tomography/computed tomography (FCH-PET/CT) imaging displaying metastatic nodules in the left and right lungs

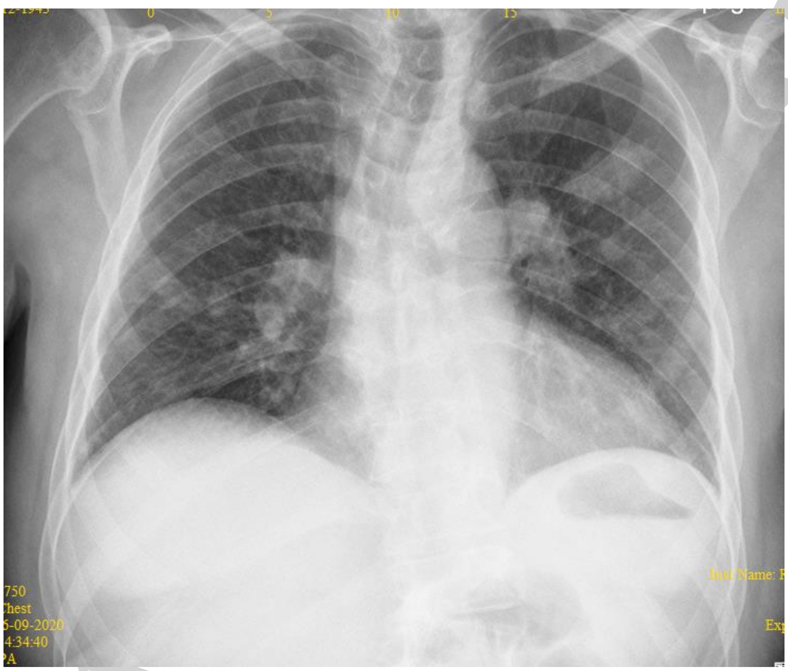

Figure 2: Chest radiograph the anteroposterior view displaying the lung fields with no signs of opacities or consolidation suggestive of COVID-19 infection of the lungs

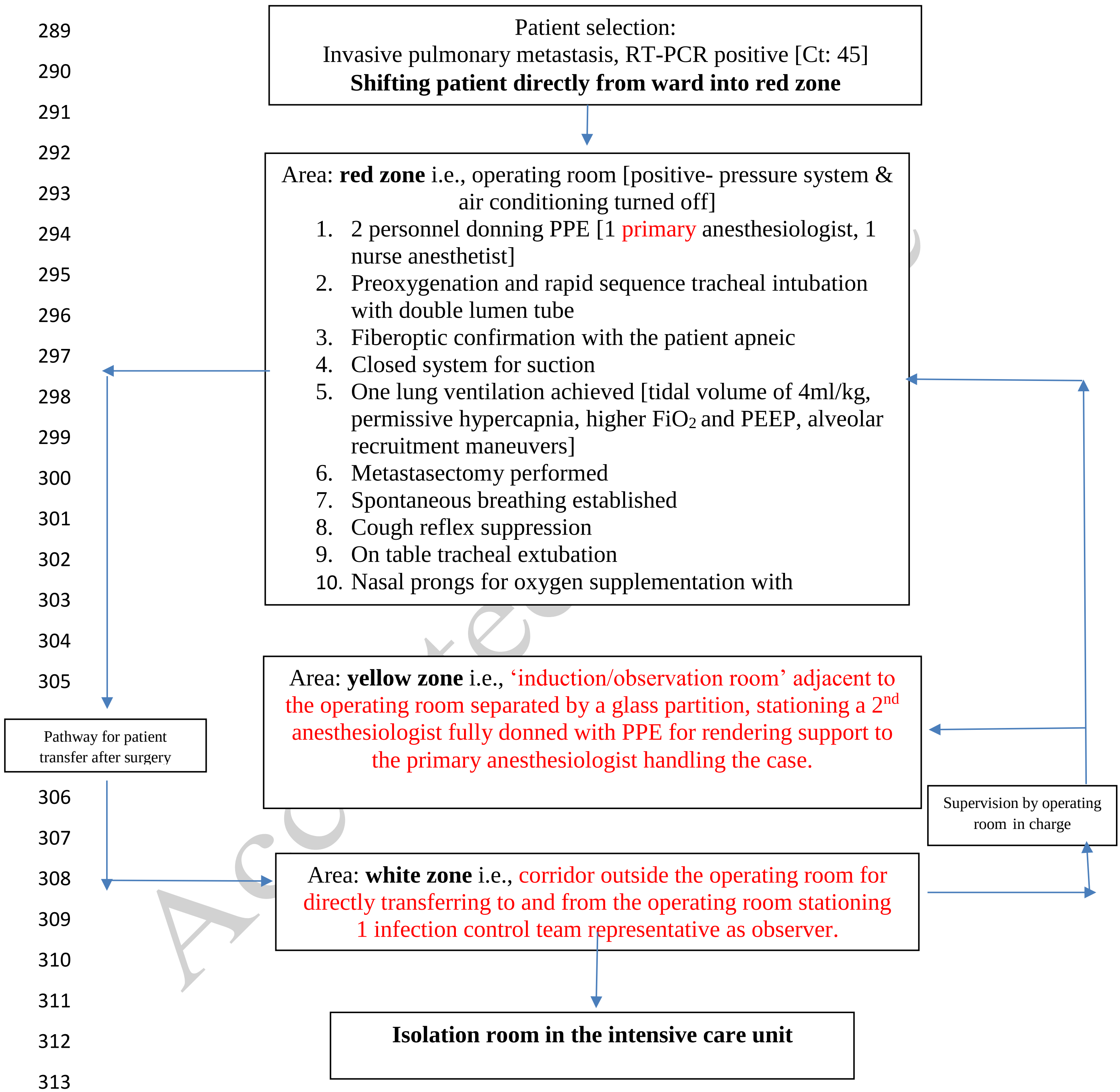

Figure 3: The patient flow diagram showing the stages of patient management and the zones in the operating room.