Review Article

Obesity, Obstructive Sleep Apnea, and Noninvasive Ventilation: Perioperative Consideration during the COVID-19 Outbreak

Abhishek Singh[1], Avishek Roy[1], Punnet Khanna[2]

1. Department of Anesthesiology, Pain Medicine and Critical Care, All India Institute of Medical Sciences, New Delhi, India
2. Department of Anaesthesiology, Pain Medicine and critical care, All India Institute of Medical Sciences, New Delhi, India

Corresponding Author:
Abhishek Singh, M.D; Senior Resident, Department of anesthesiology, pain medicine and critical care, All India Institute of Medical Sciences, New Delhi; India
E-mail: bikunrs77@gmail.com

Abstract

The Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) pandemic has affected nearly 3.4 million people worldwide. People with comorbidities like chronic obstructive pulmonary disease, diabetes, hypertension, and coronary artery disease are at high risk of suffering from the most severe form of the disease. Various studies around the world have reported Obesity as one of the most common comorbidities associated with a high mortality rate. Noninvasive ventilation like continuous positive airway pressure (CPAP) and bi-level positive airway pressure (BPAP) help in the perioperative management of these patients under normal circumstances but during COVID -19 pandemic they should be used with caution considering their aerosol generation potential. In this article, we will review the effect of morbid obesity and obstructive sleep apnea on perioperative outcomes and measures need to be taken that will benefit both patients as well as a healthcare provider.

Keywords: Covid-19 pandemic, Obesity, Obstructive sleep apnea, Noninvasive ventilation

Please cite this article as: Singh A, Roy A, Khanna P. Obesity, Obstructive Sleep Apnea, and Noninvasive Ventilation: Perioperative Consideration during COVID-19 Outbreak. J Cell Mol Anesth. 2020;5(3):185-9.

Introduction

Currently, Covid-19 has been officially declared as a pandemic by the WHO (1). Now it has spread to more than 185 countries with 36 million confirmed cases and 1 million death (2). It has placed us in sustained demand for healthcare infrastructure and essential community resources. Such demands have led to the development of a situation where we need to judiciously allocate our healthcare resources, equipment, and manpower for a better outcome. This pandemic has created a dual problem concerning perioperative care. First, a lot of uncertainty has arisen regarding the management of patients who are at increased risk for perioperative morbidity and mortality and second is the protection of our frontline health care personnel.

COVID-19 and obstructive sleep apnea (OSA)

Zhou, *et al*, in their study concluded that hypertension, pulmonary disease, diabetes mellitus, cardiovascular disease, and advanced age are the main risk factor for mortality in COVID-19. (3) Pazarlı, *et al*, observed that the common risk factor for mortality due to COVID-19 was also the risk factor for the development of the

OSA. (4) Guan WJ et al in his study of 1099 patients with laboratory-confirmed Covid-19 from 552 hospitals from china found that all those patients who were admitted to intensive care unit mechanically ventilated or died had higher rates of comorbidities like chronic obstructive pulmonary disease (COPD), diabetes, hypertension, and coronary artery disease (5). Arentz, *et al,* showed that OSA was present in 28% of the 21 patients who were admitted to their intensive care with COVID-19. (6) Memsoudis et al. demonstrated that out of sixty patients admitted to ICU, 8.3 % had OSA while among the non-ICU patients, 6.3 % were suffering from OSA. (7) Data from the COVID-19 outbreak in Italy showed a similar pattern with male gender, morbid obesity, and age over 60 had higher mortality. (8) It is interesting to note that the above demographics have a high probability of being associated with coexisting OSA.

The pathophysiological manifestation of longstanding obstructive sleep apnea with recurrent intermittent hypoxemia has been linked with a higher incidence of cardiac arrhythmia and sudden cardiac death (9-11). This existing low-grade inflammatory state may aggravate the inflammation associated with COVID -19 leading to the development of sepsis and Acute Respiratory Distress Syndrome (ARDS). Morbid obesity causes significant changes in respiratory mechanics. It is associated with a reduction in total lung capacity, vital capacity, and functional residual capacity along with increased airway resistance (12). They are at risk of developing atelectasis which is increased by sedative premedication, supine position, and mechanical ventilation. One important clinical manifestation associated with these patients is obesity hypoventilation syndrome (OHS) which is characterized by the combination of sleep-disordered breathing with chronic awake hypercapnia ($PaCO2 \geq 45$ mm Hg) and obesity. The patients with OHS are at an enhanced risk of developing life-threatening complications if they get infected with COVID-19.

Due to the lack of direct evidence that supports OSA as one of the risk factors for severe COVID-19 infection, we will have to extrapolate data from ARDS to make a definite conclusion. Karnatovskaia LV et al in 2014 has shown that obesity was an independent risk factor for the development of ARDS in hospitalized patients (13). Memtsoudis, *et al,* in his retrospective analysis of 6 million cases has notified that sleep apnea was associated with an increased risk of developing ARDS in patients after noncardiac surgery (14) but Zhi, *et al,* in his meta-analysis supported the "obesity paradox" in the respiratory system and found that though obesity was the important risk factor for the development of ARDS these patients have improved survival than patients with normal BMI (15). Nowbar, *et al,* reported that OHS was common in morbidly obese patients admitted for medical service and was associated with adverse outcomes but the risk was reduced in patients being treated by noninvasive ventilation (16).

Handling Airway in COVID-19 OSA patients

Securing the airway in COVID-19 patients is itself challenging and the presence of OSA makes airway management even more complicated as OSA is a known predictor of difficult bag-mask ventilation and intubation. Reduction in FRC in morbidly obese patients makes them susceptible to desaturation during airway management. Desaturation warrants immediate intervention by anesthetists in the form of bag-mask ventilation, ventilation by inserting LMA or front of neck accesses by cricothyroidotomy. All these interventions are highly aerosol-generating putting anesthetists at risk for transmission of infection. Another challenging task is the weaning of COVID-19 patients with coexisting OSA. They are at higher risk of weaning failure and prolonged mechanical ventilation due to upper air obstruction, underlying hypoxemia, and coexisting lung injury. Hence early tracheostomy may aid in weaning these patients from mechanical ventilation. Noninvasive ventilation may help in weaning these patients under normal circumstances but during the COVID-19 pandemic, they should be used with caution considering their aerosol generation potential.

Is it safe to use noninvasive ventilation?

Patients suffering from COVID-19 develop rapid hypoxemic respiratory failure and most clinical guidelines around the world recommend early intubation in a controlled setting than doing crash intubation after trial of NIV (17,18). Patient selection plays an important role during NIV use. Routine use of

NIV on every patient may lead to delay in diagnosis of respiratory decompensation resulting in urgent invasive airway intervention. Recent studies on the use of NIV has reported increased failure and conversion to invasive ventilation in patients diagnosed with moderate to severe ARDS while in patients with mild hypoxemia, NIV can be tried with close monitoring of the patient and timely conversion to invasive mechanical ventilation if there is no improvement or deterioration in the clinical condition.

One important concern is the risk of an aerosol generation which depends on oxygen flow rate, duration of use, patient's cooperation, and fitting of the interface with the patient. The high oxygen flow rate, leaking mask along with coughing can significantly increase aerosol generation. CPAP of 5-10 cm H2O may lead to aerosol generation up to 332 mm depending on different manufacturers (19). With increasing inspiratory pressures, BiPAP leads to significant aerosol generation, and at constant expiratory pressures of 4 cm H2O, increasing inspiratory pressures from 10 cm to 18 cm H2O increases aerosol spread from 0.65 meters to 0.85 meters. A whisper swivel adapter, a one-way valve to prevent rebreathing can further increase aerosol spread beyond 1 meter (20). In comparison to oral/nasal masks, the use of a helmet for NIV can curtail aerosol spread but unfortunately, they are not widely available and are more costly than a standard face mask (21).

Perioperative implications of OSA during COVID-19

Ana et al. in their study concluded that all those patients who were classified as screening OSA (S-OSA) had similar rates of acute respiratory events than already diagnosed OSA (D-OSA) patients but the S-OSA group had increased postoperative respiratory interventions, 30 days all-cause mortality and hospital use. These poor postoperative outcomes in S-OSA patients reflect inappropriate management and lack of proper awareness of S-OSA patients after PACU discharge (22). Devraj, *et al,* concluded that unrecognized OSA is common in preoperative patients and is independently associated with postoperative complications (23). Chan, *et al,* also concluded that among at-risk adults undergoing major noncardiac surgery, unrecognized severe OSA was significantly associated with increased risk of 30-day postoperative cardiovascular complications (24). The latest guidelines from the Society for Anesthesia and Sleep Medicine recommend using the CPAP throughout the perioperative period (25). Its use has led to a significant reduction in postoperative pulmonary complications in OSA patients. But using NIV in suspected or confirmed COVID patients is complicated by the risk of transmission of the disease to a healthcare provider. Hence it the responsibility of anesthetists taking care of such patients to analyze the risk and benefit associated with NIV use and use it judiciously.

Risk reduction during NIV use

COVID-19 pandemic has created an increased demand for healthcare infrastructure and workforce. The time has come now that we should develop strategy and technique to provide maximum benefit to the patient while simultaneously reducing the risk to the healthcare professionals. For OSA patients undergoing surgery, it will be beneficial if we use regional anesthesia whenever possible as it will avoid high aerosol-generating medical procedures like intubation, suction, and bag-mask ventilation. Regional anesthesia will also result in reduced opioid consumption thereby reducing postoperative respiratory complications and exacerbation of clinical manifestation of OSA. But for patients suffering from a severe form of OSA, undergoing surgery under general anesthesia or receiving intraoperative opioids should be managed postoperatively in a monitored bed with continuous pulse oximetry along with capnography if available so that any postoperative complications like hypoxemia and hypoventilation can be recognized early.

Finally, we recommend the following measures to prevent and control the spread of hospital infection during NIV use

1. The patient should be kept in a negative pressure isolation room with at least 12 air exchanges per hour.
2. Non vented mask should be used to avoid the spread of aerosol
3. Breathing circuits should be used with exhalation port High-efficiency particulate (HEPA) filters.
4. For patients with thick airway secretion, consider using dual circuit NIV as heating and humidification can be done at one end while virus filter can be installed at another end.

5. The distance between beds should be at least 1 meter
6. The number of medical staff and other personnel entering the ward should be minimum
7. Replace the air filter of the non-invasive ventilator on time as moisture from exhaled gas can increase resistance to flow.
8. Appropriate use of sedative and analgesic drugs (such as dexmedetomidine, sufentanil, etc.) to reduce respiratory drive, asynchrony, and agitation of the patient
9. Selection of mask should be from least aerosol-generating to highest ie Helmet>full face mask> tight-fitting oronasal mask>nasal mask.
10. The face mask should be fitted snugly before turning on the ventilator and the ventilator should be stopped first before removing the mask
11. All healthcare professionals should wear PPE, N95 mask, goggles, face shield, and gloves before entering the room.
12. Reduce the pressure during suction to as low as possible preferably below 10 cm of H_2O.
13. Medical staff should be monitored regularly for symptoms of the infection.

Conclusion

Before the COVID-19 outbreak, NIV has been successfully used for the management of patients with varying degrees of OSA. But the recent outbreak of COVID-19 has resulted in several limitations regarding their use in patients with OSA. First, as morbidly obese patients with COVID infection decompensate rapidly and NIV may mask the detection of deterioration of the clinical condition of these patients. Second, aerosol generation poses a serious threat of transmission of infection to medical staff and healthcare professionals. Sometimes patient requires urgent intubation due to NIV failure which may expose the healthcare provider if they not wearing adequate personal protection equipment. Third, Facial anomalies, airway obstruction, absent protective airway reflexes, nausea and vomiting, confusion, agitation, unstable hemodynamics, and severe hypoxia are major limitations for using NIV . Hence balanced decisions should be taken based on the clinical profile of patients and risk of viral transmission depending upon the availability of type of NIV, patient profile and infection prevention infrastructure in the hospital.

Acknowledgment

None

Conflicts of Interest

The authors declare that there are no conflicts of interest.

References

1. https://www.who.int/news-room/detail/27-04-2020-who-timeline---covid-19
2. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200504-covid-19-sitrep-105.pdf?sfvrsn=4cdda8af_2
3. Zhou F, Yu T, Du R, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet. 2020; 395 (10229):1054–1062.
4. Pazarlı AC, Ekiz T, Ilik F. Coronavirus disease 2019 and obstructive sleep apnea syndrome. Sleep Breath. 2020;1. Online ahead of print
5. Guan WJ, Ni ZY, Hu Y, et al. Clinical Characteristics of Coronavirus Disease 2019 in China. N Engl J Med. 2020;382(18):1708-20.
6. Arentz M, Yim E, Klaff L, Lokhandwala S, Riedo FX, Chong M, et al. Characteristics and outcomes of 21 critically ill patients with COVID-19 in Washington State. JAMA. 2020;323(16):1612-4.
7. Memtsoudis SG, Ivascu NS, Pryor KO, Goldstein PA. Obesity as a risk factor for poor outcome in COVID-19-induced lung injury: the potential role of undiagnosed obstructive sleep apnoea. Br J Anaesth. 2020;125(2):e262-e263.
8. Sorbello M, El-Boghdadly K, Di Giacinto I, Cataldo R, Esposito C, Falcetta S, et al. The Italian coronavirus disease 2019 outbreak: recommendations from clinical practice. Anaesthesia. 2020;75(6):724-32.
9. Kerns ES, Kim ED, Meoni LA, Sozio SM, Jaar BG, Estrella MM, et al. Obstructive Sleep Apnea Increases Sudden Cardiac Death in Incident Hemodialysis Patients. Am J Nephrol. 2018;48(2):147-56.
10. Shamsuzzaman AS, Somers VK, Knilans TK, Ackerman MJ, Wang Y, Amin RS. Obstructive Sleep Apnea in Patients with Congenital Long QT Syndrome: Implications for Increased Risk of Sudden Cardiac Death. Sleep. 2015;38(7):1113-9.
11. Patel N, Donahue C, Shenoy A, Patel A, El-Sherif N. Obstructive sleep apnea and arrhythmia: A systemic review. Int J Cardiol. 2017;228:967-70.
12. McCallister JW, Adkins EJ, O'Brien JM, Jr. Obesity and acute lung injury. Clin Chest Med. 2009;30(3):495-508, viii.
13. Karnatovskaia LV, Lee AS, Bender SP, Talmor D, Festic E. Obstructive sleep apnea, obesity, and the development of acute respiratory distress syndrome. J Clin Sleep Med. 2014;10(6):657-62.

14. Memtsoudis S, Liu SS, Ma Y, Chiu YL, Walz JM, Gaber-Baylis LK, et al. Perioperative pulmonary outcomes in patients with sleep apnea after noncardiac surgery. Anesth Analg. 2011;112(1):113-21.
15. Zhi G, Xin W, Ying W, Guohong X, Shuying L. "Obesity Paradox" in Acute Respiratory Distress Syndrome: Asystematic Review and Meta-Analysis. PLoS One. 2016;11(9):e0163677.
16. Nowbar S, Burkart KM, Gonzales R, Fedorowicz A, Gozansky WS, Gaudio JC, et al. Obesity-associated hypoventilation in hospitalized patients: prevalence, effects, and outcome. Am J Med. 2004;116(1):1-7.
17. Giwa AL, Desai A, Duca A. Novel 2019 coronavirus SARS-CoV-2 (COVID-19): an overview for emergency clinicians. Pediatr Emerg Med Pract. 2020;17(5):1-24.
18. Patel A, Jernigan DB. Initial Public Health Response and Interim Clinical Guidance for the 2019 Novel Coronavirus Outbreak - United States, December 31, 2019-February 4, 2020. MMWR Morb Mortal Wkly Rep. 2020;69(5):140-6
19. Hui DS, Chow BK, Lo T, Tsang OTY, Ko FW, Ng SS, et al. Exhaled air dispersion during high-flow nasal cannula therapy versus CPAP via different masks. Eur Respir J. 2019;53(4).
20. Simonds AK, Hanak A, Chatwin M, Morrell M, Hall A, Parker KH, et al. Evaluation of droplet dispersion during non-invasive ventilation, oxygen therapy, nebuliser treatment and chest physiotherapy in clinical practice: implications for management of pandemic influenza and other airborne infections. Health Technol Assess. 2010;14(46):131-72.
21. Patel BK, Wolfe KS, Pohlman AS, Hall JB, Kress JP. Effect of noninvasive ventilation delivered by helmet vs face mask on the rate of endotracheal intubation in patients with acute respiratory distress syndrome: a randomized clinical trial. JAMA;315(22):2435-41.
22. Fernandez-Bustamante A, Bartels K, Clavijo C, Scott BK, Kacmar R, Bullard K, et al. Preoperatively Screened Obstructive Sleep Apnea Is Associated With Worse Postoperative Outcomes Than Previously Diagnosed Obstructive Sleep Apnea. Anesth Analg. 2017;125(2):593-602.
23. Devaraj U, Rajagopala S, Kumar A, Ramachandran P, Devereaux PJ, D'Souza GA. Undiagnosed Obstructive Sleep Apnea and Postoperative Outcomes: A Prospective Observational Study. Respiration. 2017;94(1):18-25.
24. Chan MTV, Wang CY, Seet E, Tam S, Lai HY, Chew EFF, et al. Association of Unrecognized Obstructive Sleep Apnea With Postoperative Cardiovascular Events in Patients Undergoing Major Noncardiac Surgery. JAMA. 2019;321(18):1788-98.
25. Chung F, Memtsoudis SG, Ramachandran SK, Nagappa M, Opperer M, Cozowicz C, et al. Society of Anesthesia and Sleep Medicine Guidelines on Preoperative Screening and Assessment of Adult Patients With Obstructive Sleep Apnea. Anesth Analg. 2016;123(2):452-73.