Indonesian Journal of Global Health Research
Volume 5 Number 4, November 2023
e-ISSN 2715-1972; p-ISSN 2714-9749
http://jurnal.globalhealthsciencegroup.com/index.php/IJGHR

THE IMPACT OF COVID-19 INFECTION HISTORY ON OXYGEN SATURATION IN ELECTIVE SURGERY PATIENTS

Irwadi*, Yenni Elfira, Fatimah
Vocational Faculty, Universitas Baiturrahmah, Jl. Raya By Pass KM 15 Aie Pacah, Padang City, West Sumatra 25158, Indonesia
*irwadi@staff.unbrah.ac.id

ABSTRACT

Coronavirus Disease (COVID-19) infection can cause complications in the respiratory system including oxygen saturation, this condition can affect the condition of post-surgery patients. In patients who will undergo surgery, optimal oxygen saturation is very important in maintaining hemodynamic stability and success in anesthesia and patient recovery. The purpose of this study was to determine the impact of a history of COVID-19 infection on oxygen saturation in elective surgical patients. The design of this study was an observational analytical study with a cross-sectional approach. The sample size was 76 people consisting of 38 groups with a history of COVID-19 and 38 groups with a history of COVID-19. The sampling method used a purposive sampling technique with respondent criteria that had been determined according to the inclusion and exclusion criteria. The results of the Independent Sample t-test showed a significant difference in decreased oxygen saturation in patients with a history of COVID-19 compared to patients without a history of COVID-19 with the results ($p < \alpha = 0.05$). It can be concluded that a history of COVID-19 infection has an impact on decreased oxygen saturation in elective surgical patients. These findings suggest the importance of careful preoperative evaluation and more intensive oxygenation monitoring in patients with a history of COVID-19 infection to minimize the risk of intraoperative and postoperative complications.

Keywords: history of COVID-19; oxygen saturation ; respiratory infection; surgery

First Received	Revised	Accepted
10 September 2023	14 September 2023	30 September 2023

Final Proof Received	Published
04 November 2023	28 November 2023

How to cite (in APA style)
Irwadi, I., Elfira, Y., & Fatimah, F. (2023). The Impact of COVID-19 Infection History on Oxygen Saturation in Elective Surgery Patients. Indonesian Journal of Global Health Research, 5(4), 1059-1068. https://doi.org/10.37287/ijghr.v5i4.4783.

INTRODUCTION

Coronavirus Disease (COVID-19) infection caused by the SARS-CoV-2 virus has a negative impact on global health, including in the perioperative period (Rabadan, 2021). COVID-19 causes complications in the respiratory system, such as pneumonia, acute respiratory distress syndrome (ARDS), and hypoxemia which are very risky for patients who will undergo surgery (Pfortmueller et al., 2021). One of the main problems that arises is decreased oxygen saturation, which plays an important role in maintaining hemodynamic stability during surgical procedures. Low oxygen saturation in surgical patients can affect tissue oxygenation and lead to various intraoperative and postoperative complications (Argenzian et al., 2020). Patients with a history of COVID-19 infection in the lungs can experience damage due to excessive inflammation and fibrosis and significantly interfere with decreased gas exchange in the lungs. This condition causes inadequate maintenance of normal oxygen saturation during the operation, especially patients who have a history of previous respiratory disorders (Camporota et al., 2022). Studies have shown that patients suffering from COVID-19 are more likely to experience severe hypoxemia while under general anesthesia (Wiersinga et al., 2020).

With a history of COVID-19 infection in patients that causes inflammatory disorders in the lungs, it can also cause vascular dysfunction and microthrombosis which can interfere with tissue perfusion and oxygen absorption in cellular cells (Nicosia et al., 2021). In patients undergoing surgery, the risk of these complications increases, especially in invasive procedures and long surgical durations (Dorken-Gallastegi et al., 2023). Therefore, oxygen saturation should be closely monitored in surgical patients with a history of COVID-19 to prevent complications such as organ ischemia, heart failure, and other hemodynamic disorders (Song et al., 2023). The hyperinflammatory condition that occurs due to COVID-19 causes an increase in the need for oxygen in the tissue. This condition has an impact on increasing the workload of the lungs which are already disturbed, thereby increasing the possibility of hypoxemia in patients during surgery (Silva et al., 2023). Several studies have reported that patients who undergo surgery after recovering from COVID-19 tend to require longer mechanical ventilation and more complex intensive care to keep their oxygen saturation stable (Zunyou Wu, 2020).

The main mechanism causing decreased oxygen saturation in surgical patients infected with COVID-19 is due to lung parenchymal damage and disruption of the vascular endothelium, as well as systemic effects of an excessive inflammatory response (Swenson & Swenson, 2021). This condition can be exacerbated by the effects of anesthesia where the work of anesthetic drugs can suppress the respiratory response and affect the slow recovery of postoperative oxygen saturation (Sewell et al., 2021). Decreased oxygen saturation after surgery in patients with a history of COVID-19 can lead to the need for prolonged ventilation, and cause patients to be hospitalized in the ICU, have a long recovery, and are at higher risk of death (Bhangu et al., 2020). Therefore, it is very important for health workers to carry out early identification and close monitoring of oxygen saturation in patients undergoing surgery with a history of COVID-19, especially during intraoperative patients, to reduce these risks (Grasselli et al., 2020). Patients with COVID-19 infection usually also have comorbid diseases such as hypertension, diabetes, and chronic obstructive pulmonary disease (COPD) which will worsen the decrease in oxygen saturation (Olloquequi, 2020). Patients who have comorbidities tend to experience decreased ability to adapt to surgical stress such as impaired tissue oxygenation, thereby increasing the risk of perioperative complications .(Cao, 2020)

Research conducted by Argandykov et al., (2023) showed that patients with COVID-19 infection who underwent surgery had a higher mortality rate compared to patients without COVID-19. The same thing was shown by the study by Laigaard et al., (2022) explaining the importance of monitoring oxygen saturation (SpO2) before and after surgery in patients with a history of COVID-19, the results of the study showed lower oxygen saturation before surgery (94.8% ± 2.1) in patients with a history of COVID-19 while the group without COVID-19 (97.2% ± 1.4) and the results after surgery, SpO_2 of patients with a history of COVID-19 decreased to 92.5% ± 2.4, while in the control group it remained relatively high at 95.8% ± 1.8. These results prove that patients with a history of COVID-19 are at high risk of hypoxemia compared to patients without a history of COVID-19. Low oxygen saturation can cause hypoxia and risk multiple organ failure and poor postoperative outcomes (Vallamkondu et al., 2020). Prolonged hypoxemia can result in ischemia in vital organs such as the kidneys, heart, liver, and brain due to insufficient oxygen supply, leading to Multiple Organ Dysfunction Syndrome (MODS) or failure (Liang et al., 2020). Patients with low postoperative oxygen saturation are at higher risk of MODS due to pre-existing respiratory problems and potential damage from initial COVID-19 infection (Grasselli et al., 2020). Therefore, proper perioperative management of surgical patients with COVID-19 is essential to minimize complications and improve prognosis (El-Boghdadly et al., 2020). Conducting appropriate monitoring and intervention strategies is very effective in optimizing oxygen saturation in surgical patients with a history of COVID-19 by using supplemental oxygenation, mechanical ventilation support, and intensive hemodynamic monitoring to prevent intraoperative hypoxemia (McEnery et al., 2020). In addition, a more careful approach in the selection of anesthetic techniques and perioperative fluid management should be considered to reduce the risk of complications (Lei et al., 2020). This study aims to determine the impact of a history of COVID-19 infection on oxygen saturation in elective surgical patients, and to provide insights to develop appropriate interventions for patients undergoing surgery.

METHOD

This study used an analytical observational design with a cross-sectional approach. by observing oxygen saturation in surgical patients who had a history of COVID-19 infection and comparing them with surgical patients without a history of COVID-19 infection during the operation period. The population in this study was patient visit data in September 2022 at the Siti Khadijah Islamic Hospital in Palembang, as many as 105 people who underwent elective surgery. The research sample was taken using a purposive sampling technique consisting of 38 groups with a history of COVID-19 infection and 38 groups without a history of COVID-19 infection, both with and without a history of COVID-19 infection. Data analysis used to see the difference in oxygen saturation (SpO2) in these two groups before and after using the Independent Sample t-test. The first research procedure was respondents who had been determined according to the inclusion criteria, namely surgical patients undergoing general anesthesia, aged 18-65 years, patients with a history of COVID-19. While the exclusion criteria were patients with severe respiratory or cardiovascular disorders before surgery. Patients who were uncooperative or refused to participate in the study. Data were collected using an observation sheet that had been tested for validity and reliability, obtaining a Cronbach alpha (0.865). This study has a letter of passing the ethical test from the ethics and health research commission of Dr. M. Djamil Padang Hospital with No. 71/KEPK/2021.

RESULTS

Table 1.
Frequency Distribution of Respondent Characteristics Age, and Gender (n=76)

Characteristics Respondents	Tampa History COVID-19 (n=38)		History COVID-19 (n=38)		Homogeneity Test (P value)
	f	%	*f*	%	
Age					
Young Adults (18-40 Years)	32	84.2	34	89.5	0.434
Older Adults (> 40 Years)	6	15.8	4	10.5	
Gender					
Woman	35	92.1	37	97.4	0.477
Man	3	7.9	1	2.6	

Table 1. The number of respondents in this study was 76 people. The characteristics of the respondents showed that the age of the respondents in the group with no history of COVID-19 was 32 (84.2%) young adults, 35 (92.1%) female. While the characteristics of the respondents in the group with a history of COVID-19 were 34 (89.5%) young adults, 37 (97.4%) female. Based on the homogeneity test on the age and gender variables, it shows that the p value> 0.05 means that the research data in both the group with no history of COVID-19 and the group with a history of COVID-19 have almost the same characteristics (homogeneous).

Table 2.
Comparison of Oxygen Saturation Before and After in Two Groups with and without a History of COVID-19 (n=76)

Variables	N	Mean	Δ	SD	*P Value*
No COVID-19 History					
SPO2 Before Operation	38	96.50	-0.8	2.00	0.000
SPO2 After Surgery	38	95.80		2.50	
History of COVID-19					
SPO2 Before Operation	38	94.30	-2.0	3.20	0.000
SPO2 After Surgery	38	92.30		4.50	

Table 2. Differences in oxygen saturation (SpO2) were found in the group without a history of COVID-19 before (96.50% ± 2.0) after surgery (95.80%± 2.50)with the difference in the decrease obtained-0.8% with a p value of 0.000. Meanwhile, in the group with a history of COVID-19 SpO2 before surgery (94.30% ± 3.20) and after surgery (92.30% ± 4.50) dwith the difference in the decrease obtained-2.0% with a p value of 0.000. From the results of the Independent Sample t-test, there was a comparison between the two groups showing a significant difference in post-operative oxygen saturation between patients with and without a history of COVID-19 infection, with a p-value = 0.000. Patients with a history of COVID-19 infection tend to experience a greater decrease in oxygen saturation after surgery compared to patients without a history of infection.

DISCUSSION

Based on the results of the study, it showed that in the group without a history of COVID-19 before (96.50% ± 2.0) after surgery (95.80% ± 2.50) with a difference in the decrease obtained -0.8% with a p value of 0.000. While in the group with a history of COVID-19 SpO2 before surgery (94.30% ± 3.20) and after surgery (92.30% ± 4.50) with a difference in the decrease obtained -2.0% with a p value of 0.000. From the results of the Independent Sample t-test, there was a comparison between the two groups which showed a significant difference in post-operative oxygen saturation between patients with and without a history of COVID-19 infection, with a p-value = 0.000. It can be seen that patients with a history of COVID-19 infection tend to experience a greater decrease in oxygen saturation after surgery compared to patients who do not have a history of infection. The results of this study are also in line with research conducted by Laigaard et al., (2022) explaining that the results of the study showed lower oxygen saturation before surgery (94.8% ± 2.1) in patients with a history of COVID-19 while the group without COVID-19 (97.2% ± 1.4) and the results after surgery, SpO_2 of patients with a history of COVID-19 decreased to 92.5% ± 2.4, while in the control group it remained relatively high at 95.8% ± 1.8. These results prove that those at high risk of hypoxemia are patients with a history of COVID-19 compared to patients without a history of COVID-19.

Decreased oxygen saturation in surgical patients infected with COVID-19 is caused by damage to the lung parenchyma and disruption of the vascular endothelium, as well as systemic effects of an excessive inflammatory response (Swenson & Swenson, 2021). The lung parenchyma consists of alveoli and tissues that function in exchanging oxygen and carbon dioxide, the disruption of its function is caused by SARS-CoV-2 attacking alveolar epithelial cells, especially those expressing the Angiotensin Converting Enzyme (ACE2) receptor (Wiersinga et al., 2020). COVID-19 infection causes disruption of ACE2 function which can cause narrowing of blood vessels and increased blood pressure due to the inability of the angiotensin 2 enzyme to become angiotensin 1-7 so that patients experience vasodilation resulting in decreased blood pressure, and impaired oxygenation and can worsen inflammation, increase the risk of thromboembolism, and cause organ dysfunction and if the infection is not controlled it will become Acute Respiratory Distress Syndrome (ARDS) (Beyerstedt et al., 2021).

Uncontrolled infection in COVID-19 patients can develop into Acute Respiratory Distress Syndrome (ARDS) where the alveoli of the small air sacs in the lungs fill with fluid due to inflammation. This event will reduce lung elasticity and the lungs' ability to take in oxygen and cause acute respiratory failure (Tzotzos et al., 2020). If the lungs experience ongoing damage due to inflammation, it can cause scar tissue or fibrosis, and result in decreased function and damage to the lung parenchyma (Fan et al., 2020). As a result of damage to the patient's lung parenchyma, the lungs' ability to oxygenate the blood is disrupted, causing hypoxemia where oxygen levels are low in the blood (Stergaard, 2021). In patients undergoing surgery, hypoxemia is at high risk because vital organs, such as the brain and heart, may not receive enough oxygen (Fan et al., 2020). Patients with a history of COVID-19 and lung damage are very important in the provision of preoperative, intraoperative, and postoperative oxygen and the use of mechanical ventilation or non-invasive oxygen therapy to maintain oxygen saturation stability during surgical procedures (Marini & Gattinoni, 2020).

The decrease in oxygen saturation in patients with a history of COVID-19 will also be exacerbated by the effects of anesthesia where the action of anesthetic drugs can suppress the respiratory response and affect the slow recovery of oxygen saturation after surgery (Sewell et al., 2021). Decreased oxygen saturation after surgery in patients with a history of COVID-19 can cause the need for prolonged ventilation, and cause patients to be hospitalized in the ICU, have a long recovery, and have a higher risk of death (Bhangu et al., 2020). Administration of anesthesia, especially general anesthesia techniques, can suppress respiratory drive and reduce lung volume, leading to atelectasis and ventilation-perfusion mismatch. This effect is more pronounced in patients who have a history of previous lung infections, such as patients recovering from COVID-19 infection, making them susceptible to intraoperative and postoperative hypoxemia (Ong et al., 2020). Anesthetic drugs that affect breathing include propofol, thiopental, etomidate, sevoflurane, fentanyl, ketamine midazolam, rocuronium and vecuronium (Ong et al., 2020). General anesthesia can cause respiratory depression by reducing the speed and depth of breathing. This is because the effect of the anesthetic drug will disrupt the respiratory center in the brain, thereby reducing the body's response to increased carbon dioxide levels. Patients with a history of lung damage due to COVID-19 tend to be more sensitive to respiratory depression, which worsening hypoxemia (Hoyler et al., 2021).

The explanation above is in line with research conducted by Navas-Blanco & Dudaryk, (2020) stating that patients with a history of COVID-19 can experience decreased lung function and impaired diffusion capacity. This residual effect can worsen the respiratory depression effect of anesthesia, thereby increasing the risk of perioperative hypoxemia (Navas-Blanco & Dudaryk, 2020). And also supported by research conducted by Argandykov et al., (2023) showing that patients with COVID-19 infection undergoing surgery have a higher mortality rate compared to patients without COVID-19. Low oxygen saturation can cause hypoxia and the risk of multiple organ failure and poor postoperative outcomes (Vallamkondu et al., 2020). Prolonged hypoxemia can cause ischemia in vital organs such as the kidneys, heart, liver, and brain due to insufficient oxygen supply, causing Multiple Organ Dysfunction Syndrome (MODS) or failure (Liang et al., 2020). Patients with low postoperative oxygen saturation are at higher risk of developing MODS due to pre-existing respiratory problems and potential damage from the initial COVID-19 infection (Grasselli et al., 2020). Therefore, appropriate perioperative management of surgical patients with COVID-19 is essential to minimize complications and improve prognosis (El-Boghdadly et al., 2020). Conducting appropriate monitoring and intervention strategies is very effective in optimizing oxygen saturation in surgical patients with a history of COVID-19 by using supplemental oxygenation, mechanical ventilation support, and intensive hemodynamic monitoring to prevent intraoperative hypoxemia (McEnery et al., 2020).

Factors that cause decreased SpO2 in surgical patients include age, which is an important factor affecting oxygen saturation in surgical patients with a history of COVID-19 with an older age range tending to have different responses to COVID-19 virus infection, where as a person gets older, there will be degenerative lung function and oxygenation capacity which has the potential to cause hypoxemia (Parohan et al., 2021). Judging from the results of the study, it was found that of the two age groups of respondents in the group without a history of COVID-19, 32 (84.2%) were young adults, and those with a history of COVID-19 were young adults, 37 (97.4%) were female. In addition, gender factors also affect oxygen saturation in COVID-19 patients where men are more susceptible to COVID-19 infection and often experience more severe symptoms than women. This is due to differences in the immune system and hormonal factors where the role of the hormone estrogen in women can increase the immune response to viral infections. Estrogen has also been reported to have a protective effect on the lungs, which contributes to lower rates of respiratory complications in women than men (Jin et al., 2020). Men with a history of COVID-19 tend to experience a more significant decrease in oxygen saturation than women due to differences in hormones and lifestyle so that patients with a history of respiratory tract infections recover faster. In addition, habits such as smoking can also worsen lung function and cause decreased oxygen saturation. This can be seen from the results of the study, it was found that most of the respondents in both groups were female, where the group without a history of COVID-19 was 35 (92.1%) female, while in the group with a history of COVID-19, 37 (97.4%) were female.

COVID-19 infection causes damage to the lungs, especially the alveoli, resulting in impaired gas exchange and can cause hypoxemia. Patients with a history of COVID-19 may experience decreased lung function and impaired diffusion capacity. This condition can also be exacerbated by the effects of anesthesia where the work of anesthetic drugs can suppress the respiratory response and affect the slow recovery of postoperative oxygen saturation. Awareness of this impact emphasizes health workers for the importance of conducting an initial assessment in preanesthesia, better monitoring and management strategies for patients with a history of COVID-19 with close monitoring of oxygen saturation, careful management of anesthesia, and comprehensive preoperative evaluation can help minimize the risk of hypoxemia and improve postoperative patient recovery.

CONCLUSION

Patients with a history of COVID-19 infection can affect significant changes in postoperative oxygen saturation (SpO2) compared to uninfected patients, this is due to lung damage due to infection that interferes with effective gas exchange. The results obtained in patients with a history of COVID-19 infection showed a significant decrease in SpO2 after surgery. The results of this study provide direction for further research to develop and discuss the problem of respiratory disorders caused by infection, both hemodynamic stability and perioperative risks in intra and postoperatively.

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