Clinical Research

Comparison of Mechanical Ventilation Lengths and Outcomes After a Cardiac Surgery in Patients with and Without a Covid-19 History

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ABSTRACT

Objective: There are several reasons for prolonged mechanical ventilation after open-heart surgery. Covid-19 has been linked to several lung-related complications. It is, therefore, important to discuss Covid-19's role in prolonged mechanical ventilation in accordance with the literature. This study aimed to compare the mechanical ventilation lengths of stay after cardiac surgery in patients with and without a history of Covid-19 and evaluate its effect on postoperative outcomes.
Material and Method: The study was designed as a prospective observational study. A total of 70 patients, 35 with a Covid-19 history, and 35 without, were included in the study. Researchers observed the patients in the postoperative intensive care unit and filled out patient information forms.
Results: Although the length of ventilation was longer in patients with a history of Covid-19, there was no significant difference between the groups ($p > 0.05$). The median values of the length of spontaneous ventilation mode in patients with a history of Covid-19 were significantly higher ($p < 0.05$). The ventilation length of those with a Covid-19 history and previous cardiac surgery history was significantly longer ($p < 0.05$).
Conclusion: According to the results of this study, Covid-19 may affect mechanical ventilator weaning time and postoperative outcomes after cardiac surgery.

Keywords: *Covid-19, Cardiac Surgery, Ventilation Length, Prolonged Mechanical Ventilation.*

ÖZ

Covid-19 Geçmişi Olan ve Olmayan Hastalarda Kalp Cerrahisi Sonrası Mekanik Ventilasyon Süreleri ve Sonuçlarının Karşılaştırılması

Amaç: Açık kalp ameliyatı sonrası mekanik ventilasyonun uzun sürmesinin çeşitli nedenleri vardır. Covid-19 akciğerle ilgili çeşitli komplikasyonlarla ilişkilendirilmiştir. Bu nedenle Covid-19'un uzamış mekanik ventilasyondaki rolünün literatür doğrultusunda tartışılması önemlidir. Bu çalışmada, Covid-19 öyküsü olan ve olmayan hastalarda kalp ameliyatı sonrası mekanik ventilasyonda kalış sürelerinin karşılaştırılması ve bunun ameliyat sonrası sonuçlara etkisinin değerlendirilmesi amaçlandı.
Gereç ve Yöntem: Çalışma prospektif gözlemsel bir çalışma olarak tasarlandı. Çalışmaya 35'i Covid-19 öyküsü olan, 35'i olmayan toplam 70 hasta dahil edildi. Araştırmacılar, ameliyat sonrası yoğun bakım ünitesindeki hastaları gözlemledi ve hasta bilgi formlarını doldurdu.
Bulgular: Covid-19 öyküsü olan hastalarda ventilasyon süresi daha uzun olmasına rağmen gruplar arasında anlamlı fark yoktu ($p > 0,05$). Spontan ventilasyon modu uzunluğunun medyan değerleri, Covid-19 öyküsü olan hastalarda anlamlı derecede yüksekti ($p < 0,05$). Covid-19 öyküsü olan ve daha önce kalp ameliyatı geçirenlerin ventilasyon süresi anlamlı olarak daha uzundu ($p < 0,05$).
Sonuç: Bu çalışmanın sonuçlarına göre Covid-19, kalp cerrahisi sonrası mekanik ventilatörden ayrılma süresini ve ameliyat sonrası sonuçları etkileyebilir.

Anahtar Sözcükler: *Covid-19, Kalp Cerrahisi, Ventilasyon Süresi, Uzamış Mekanik Ventilasyon.*

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Mechanical ventilation (MV) support, used to maintain respiratory function in patients following cardiovascular surgery, is often weaned within the first 24 hours. However, conditions such as comorbidities and intraoperative and/or postoperative problems may necessitate prolonged MV (1). Prolonged mechanical ventilation (PMV) is observed in 3-22% of adult

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ptients following cardiac surgery and is linked to morbidity and death (2, 3).

Covid-19 is an infectious disease caused by the SARS-CoV-2 virus, leading to severe acute respiratory distress syndrome (4). Covid-19 infection can lead to variety of complications, including pulmonary issues such as acute respiratory distress syndrome, pulmonary fibrosis, pulmonary hypertension, pulmonary embolism, and pneumothorax (5). SARS-CoV-2-induced damage to the lungs results in decreased capillary permeability and leakage. One consequence of this pulmonary leakage is pulmonary edema, which impairs gas exchange and respiratory function. This condition intensifies respiratory drive, prompting patients to breathe deeply and rapidly, causing rises and shifts in pleural pressure and inadvertently harming the lungs (6). Covid-19 patients with respiratory failure often require long-term MV support (7).

The postoperative management of ventilator dependence is multifactorial. Patients' characteristics, habits, diseases, and the complexity of the surgical procedure can all impact lung function following cardiac surgery, influencing the length of postoperative MV support (8). A study found a statistically significant difference between short and long MV lengths in Covid-19 patients, with those experiencing shorter MV having shorter intensive care and hospital stay (7). Additionally, preoperative patient characteristics such as hypertension, COPD, chronic kidney disease, and previous endocarditis may also be predictive of delayed extubation (2). Nevertheless, early extubation not only promotes early patient mobilization but has also been associated with shorter durations of intensive care and hospital stays; for instance, a study reported that patients who were extubated early (within <24 hours) demonstrated reduced time in intensive care and shorter hospital stays (8,9). Considering the impact of Covid-19 on lung functions, evaluating the duration of MV application in Covid-19 patients after cardiac surgery and understanding the factors affecting length and postoperative outcomes will contribute valuable insights to the literature.

MATERIAL AND METHOD

Study design and participants

The study was conducted as a prospective observational investigation involving patients who underwent open-heart surgery and were admitted to the cardiovascular surgery intensive care unit between September and December 2022.

A study was referenced to determine sample size (10). The sample size was calculated by power analysis method (G*Power 3.1) using difference between two independent means. Accordingly, with 95% power analysis and 0.05% margin of error, a total of 34 patients, 17 with a history of Covid-19 and 17 without. Our study was to be completed with 70 individuals, with 35 having a Covid-19 history and 35 without. The inclusion criteria for patients were being over 18 years old, being able to communicate, having a planned surgery, and accepting to participate in the study voluntarily. Exclusion criteria were refusing to participate in the study, having received an intra-aortic balloon and extracorporeal membrane oxygenation therapy, undergoing an urgent surgery, and having post-operative unconsciousness.

Data collection tools

The Patient Information Form was used to collect demographic characteristics (age, gender, educational status, etc.), clinical status (comorbidity, Covid-19 history, vaccination, previous surgery, etc.), and post-operative data (on-pump time, ventilation time, intensive care unit stay, mobilization time, etc.).

Data collection

The patients were visited by the researchers at the clinics where they were hospitalized one day before the operation. The aim of the study was explained, and their Covid-19 background was assessed. The first 35 patients with and without a Covid-19 history who were scheduled to have surgery were included in the research. As of the start of the study, if a patient could not be recruited from either group, the next patient from both groups was excluded and the process was repeated with the subsequent patients. For example, if the tenth patient with a Covid-19 history was not included in the study, the tenth patient without a Covid-19 history was also excluded, and the study proceeded with the eleventh patients. When the first 35 patients with a Covid-19 history and the first 35 patients without a Covid-19 history agreed to participate in the study, they were monitored in the cardiovascular surgery intensive care unit. The researchers recorded the responses to the questions.

Ethics

Ethics committee approval was obtained from Trabzon Kanuni Training and Research Hospital (Decision no: 12/09/2022-2022/49). Institutional permission was obtained from hospital. Written informed consent was received from the patients who agreed to participate in the study. Patients were informed that they could leave the study at any time.

Statistical analysis

The Kolmogorov-Smirnov test was used to examine the suitability of the data for normal distribution. Percentages, mean, and standard deviation were used in the evaluation of descriptive data. The chi-square test was used to compare the Covid and non-Covid groups with categorical independent variables (Covid vaccination status, previous surgery, smoking, alcohol, etc.), and Mann Whitney U and correlation test were used to compare continuous variables (on-pump time during operation, ventilation time, spontaneous ventilation, etc.) for those not normally distributed.

RESULTS

Most of the patients were male in both groups. The mean age was similar in both groups (Table 1).

Table 1. *Distribution of Demographic Characteristics of Patients with and without a Covid-19 History (n =70).*

Demographic Characteristics		Patients with a Covid-19 History (n =35)	Patients without a Covid-19 History (n =35)
Gender	Male	34 (%97.1)	28 (%80)
Age		62.2±9.00	62.9±9.9
Marital Status	Married	35 (%100)	33 (%94.3)
Education Level	Literate	3 (%8.6)	9 (%25.7)
	Primary school	24 (%68.6)	15 (%42.9)
	High school	3 (%8.6)	7 (%20)
	University and above	5 (%14.3)	4 (%11.4)

Among the participants, 65.7% and 68.6% of those with and without a Covid-19 history had hypertension (HT), respectively. Data revealed that 91.4% of those with a Covid-19 history and 97.1% of those without a Covid-19 history had no history of respiratory tract infection. It was observed that 62.9% and 57.1 % of those with and without a Covid-19 history were non-smokers, respectively, and 97.1% and 94.3% of those with and without a Covid-19 history got vaccinated, respectively. Most patients in both groups underwent coronary artery bypass graft (CABG) surgery (Table 2).

Table 2. *Distribution of Clinical Characteristics of Patients with and without a Covid-19 History (n=70).*

Clinical Characteristics		Patients with a Covid-19 History (n =35)	Patients without a Covid-19 History (n =35)
Hypertension	Yes	23 (%65.7)	24 (%68.6)
Diabetes mellitus	No	22 (%62.9)	26 (%74.3)
Hyperlipidemia	No	24 (%68.6)	31 (%88.6)
Chronic obstructive pulmonary disease	No	32 (%91.4)	33 (%94.3)
Chronic renal failure	No	35 (%100)	34 (%97.1)
Respiratory tract infection	No	32 (%91.4)	34 (%97.1)
Smoking	No	22 (%62.9)	20 (%57.1)
Alcohol	No	32 (%91.4)	34 (%97.1)
Covid-19 vaccination	Yes	34 (%97.1)	33 (%94.3)
Sinovac (n =21)	1 dose	1 (%4.8)	1 (%4.8)
	2 doses	10 (%47.6)	16 (%76.2)
	3 doses	8 (%38.1)	2 (%5.7)
	4 doses	2 (%9.5)	2 (%5.7)
BioNTech (n =26)	1 dose	3 (%11.5)	5 (%14.3)
	2 doses	10 (%38.5)	15 (%55.6)
	3 doses	13 (%50)	7 (%25.9)
Previous surgery	No	18 (%51.4)	21 (%60)
Current surgery	CABG	30 (%85.7)	27 (%77.1)
	AVR		2 (%5.7)
	MVR	2 (%5.7)	4 (%11.4)
	Bentall		2 (%5.7)
	CABG+MVR	1 (%2.9)	
	CABG+AVR	2 (%5.7)	

The median length of ventilation was 485 (415-535) minutes in patients with a Covid-19 history and 480 (390-580) minutes in the other group, and there was no statistically significant difference between the groups (p >0.05). The duration of spontaneous ventilation mode in patients with a Covid-19 history was 75 (55-110) minutes, which was significantly lower (p <0.05). A statistically significant difference was observed in the lengths of ventilation in patients with a Covid-19 history based on their previous surgery status (p <0.05) (Table 3).

Table 3. *Comparison of Postop Data of Patients with and without a Covid-19 History (n =70).*

Postop Data	Patients with a Covid-19 History (n =35))	Patients without a Covid-19 History (n =35)	p
On-pump time (min)	133 (103-170)	124 (98-158)	p =0.481
Spontaneous ventilation mode duration (min)*	100 (70-140)	75 (55-110)	**p =0.025**
Ventilation duration (min)**	485 (415-535)	480 (390-580)	p =0.832
Intensive care hospitalization (day)	2 (2-2)	2 (2-3)	p =0.229
Hospital discharge (day)	6 (5-7)	7 (6-10)	p =0.187
Mobilization (days)	1 (1-2)	1 (1-2)	p =0.219

**Physiological pressure, normal spontaneous mode,*

***SIMV+SPONT+CMV mode.*

Ventilation was longer in patients with a history of both surgery and Covid-19. There was a positive correlation between ventilation length of patients with a Covid-19 history, and the length of intensive care hospitalization, as well as hospital discharge (r =0.399, p =0.018; r =0.362, p =0.033, respectively) (Table 4).

Table 4. *Comparison of Ventilation Duration of Patients with and without a Covid-19 History with Some Variables (n =70).*

Characteristics		Ventilation duration		
		Patients with a Covid-19 History (n =35))	Patients without a Covid-19 History (n =35)	p
Hypertension	Yes	510 (435-540)	487 (386-637)	p =0.725
	No	417.5(348-493)	420 (405-480)	p =0.695
Diabetes mellitus	Yes	505 (430-660)	495 (427-615)	p =0.845
	No	475 (366-520)	432 (381-561)	p =0.942
Smoking	Yes	470 (325-525)	465 (385-520)	p =0.928
	No	502 (418-543)	480 (393-656)	p =0.860
Previous surgery (cardiac or non-cardiac)	Yes	515 (455-622)	447 (345-501)	**p =0.036**
	No	430 (337-502)	480 (420-637)	p =0.099
On-pump time (min)		p =0.603 r =0.091	p =0.629 r =-0.085	
Intensive care hospitalization (days)		**p =0.018** r =0.399	p =0.768 r =0.052	
Hospital discharge (days)		**p =0.033** r =0.362	p =0.263 r =0.194	
Mobilization (days)		p =0.694 r =-0.069	p =0.053 r =0.330	

DISCUSSION

Prolonged MV, also known as delayed extubation, is a significant complication. Prolonged MV may be associated with longer intensive care and hospital stay, increased mortality, reduced quality of life, and significant economic burden (2, 11). In this study, it was found that Covid-19 history had no statistically significant effect on the length of ventilation after cardiac surgery. However, the ventilation in patients with a history of Covid-19 was slightly longer.

Reports in the literature have presented varied findings regarding the impact of a Covid-19 history on the

lengths of ventilation and intensive care. Todi and Ghosh found no statistically significant difference in hospitalization time between those with and without a history of Covid-19, whereas El Moheb et al. reported statistically significant longer hospital stays for those with a history of Covid-19 (10, 12). In our study, there was no significant difference between patients with and without a Covid-19 history in terms of length of ventilation, intensive care, and hospitalization. However, there was a positive correlation between lengths of ventilation, intensive care, and hospital discharge time in patients with a Covid-19 history. Along with the results of our study, it is shown in the literature that when the ventilation period is prolonged, intensive care, and hospital discharge time may be extended. Therefore, it is thought that prolonged ventilation may indirectly contribute to extended intensive care and hospital discharge times in the context of Covid-19.

The study also explored the relationship between the length of cardiopulmonary bypass (CPB), spontaneous ventilation mode, previous surgery status, and ventilation. Although the length of CPB has been recognized as a risk factor for delayed extubation in previous research (2, 8, 11), our study found no significant difference between the groups regarding the length of CPB. However, patients with a history of Covid-19 were found to have longer CPB. Likewise, Sankar et al., found that a history of previous surgery was associated with prolonged MV. Surgical variables such as previous cardiac surgery and length of cardiopulmonary bypass, patient factors like critical preoperative condition, impaired left ventricular function, renal failure, and pulmonary hypertension, have been identified as risk factors for prolonged MV (11).

Limitations

This study has several limitations. Firstly, data collection was conducted in a single center, limiting the generalizability of the findings to a broader population. Additionally, the study had a relatively low sample size, which may impact the statistical power and reliability of the results. Furthermore, the Covid-19 history was obtained through self-reporting by of the patients, and individuals with silent Covid-19 (asymptomatic cases) could not be identified. The absence of symptomless cases might influence the comprehensive understanding of the impact of Covid-19 on the outcomes measured in the study. Moreover, the duration elapsed since the patients' Covid-19 infection could potentially influence the study results, and this factor was not explicitly addressed in the analysis. This study was mainly conducted to evaluate the extent to which Covid-19 disease affects MV weaning time when prolonged MV is already a significant complication after open heart surgery. Since prolonged MV might be induced by a variety of preoperative, intraoperative, and/or postoperative factors, the results are difficult to generalize. Therefore, further research is required to support the results of this research.

Conclusion

In conclusion, the adverse effects of covid-19 disease on lung function may contribute prolonged ventilation after cardiac surgery. The length of ventilation may also be affected by factors such as previous operation status (cardiac or non-cardiac) and the length of cardiopulmonary bypass. Consequently, while prolonged ventilation already may result in prolonged mobilization time, intensive care unit stay, hospital discharge time, and overall recovery time in the postoperative period, covid-19 may contribute to the prolongation of this process even more. This underscores the need for heightened awareness and specialized management strategies in cardiac surgery patients with a history of COVID-19 to optimize postoperative outcomes and enhance patient recovery.

Disclosure

The authors report no conflicts of interest in this work.

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