

The impact of COVID-19 on adult cardiac surgery

COVID-19'un erişkin kalp cerrahisi üzerine etkisi

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ABSTRACT

Background: This study aims to evaluate the impact of the novel coronavirus disease 2019 (COVID-19) pandemic on cardiac surgery in a single cardiac surgery center in Lithuania.

Methods: Between November 2018 and March 2021, the data of male COVID-19-negative patients (n=81; mean age: 65.5±8.5 years; range, 46 to 87 years) operated during the pandemic were compared with the data of male COVID-19-positive patients operated during the same period (n=14; mean age: 65.2±10.6 years). The number of patients, demographic and perioperative data were compared between the patients operated during the pandemic (2020/2021 years; pandemic group) and the pre-pandemic period (2018/2019 years; control group).

Results: A statistically significant difference between the COVID-19-positive and COVID-19-negative patients was found in terms of the frequency of wound infection (n=3, 21.4% vs. n=12, 14.8%; p=0.013), re-sternotomy due to bleeding (n=2, 14.3% vs. n=0, 0%; p=0.018), and duration of hospitalization after surgery (26.4±20.4 days vs. 15.3±8.9 days; p=0.008). Comparing data of patients who had surgery before and during the pandemic, a significant decrease in the number of cardiac operations (166 vs. 95) was observed. There was significantly increased body mass index (p=0.01) and incidence of diabetes mellitus type 2 (p=0.021) in the pandemic group.

Conclusion: Despite a significantly higher rate of complications in patients infected with COVID-19, planned cardiac surgery with the utilization of adequate protective measures during quarantine is still a better option than a complete cessation of elective cardiac surgery.

Keywords: Cardiac surgery, COVID-19 pandemic, mortality.

ÖZ

Amaç: Bu çalışmada Litvanya'daki bir kalp cerrahisi merkezinde yeni koronavirüs hastalığı 2019 (COVID-19) pandemisinin kalp cerrahisi üzerindeki etkisi araştırıldı.

Çalışma planı: Kasım 2018 - Mart 2021 tarihleri arasında, pandemi sırasında ameliyat edilen erkek COVID-19 negatif hastaların verileri (n=81; ort. yaş: 65.5±8.5 yıl; dağılım, 46-87 yıl), aynı dönemde ameliyat edilen erkek COVID-19 pozitif hastaların verileri (n=14; ort. yaş: 65.2±10.6 yıl) ile karşılaştırıldı. Ayrıca pandemi öncesi (2018/2019; kontrol grubu) ve sırasında (2020/2021; pandemi grubu) ameliyat edilen hasta sayısı demografik ve perioperatif veriler karşılaştırıldı.

Bulgular: COVID-19 pozitif ve COVID-19 negatif hastalar arasında yara enfeksiyonu (n=3, %21.4'e kıyasla n=12, %14.8; p=0.013), kanamaya bağlı re-sternotomi (n=2, %14.3'e kıyasla n=0, %0; p=0.018) ve ameliyat sonrası hastanede yatış süresi (26.4±20.4 güne kıyasla 15.3±8.9 gün; p=0.008) açısından istatistiksel olarak anlamlı bir fark vardı. Pandemi öncesi ve sırasında ameliyat edilen hastaların verileri karşılaştırıldığında, kalp ameliyatlarının sayısında anlamlı bir düşüş gözlemlendi (166'ya kıyasla 95). Pandemi grubunda vücut kitle indeksi (p=0.01) ve diyabet mellitus tip 2 (p=0.021) insidansı açısından anlamlı bir artış izlendi.

Sonuç: COVID-19 ile enfekte olan hastalarda anlamlı düzeyde artmış komplikasyon oranına rağmen, karantina sırasında yeterli koruyucu önlemler kullanılarak planlanan kalp ameliyatı, elektif kalp ameliyatının tamamen durdurulmasından daha iyi bir seçenektir.

Anahtar sözcükler: Kalp cerrahisi, COVID-19, mortalite.

Received: February 09, 2022 Accepted: September 08, 2022 Published online: October 31, 2022

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Cite this article as:

Venckus V, Budrikis A, Kazlauskaitė M, Kemesyte K, Jakuska P, Rumbinaite E, et al. The impact of COVID-19 on adult cardiac surgery. Turk Gogus Kalp Dama 2022;30(4):495-502

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The severe acute respiratory syndrome-coronavirus 2 (SARS-CoV-2) outbreak, which was first reported in Wuhan, China in December 2019, has had an enormous worldwide impact.^[1] In 2020 March, the World Health Organization (WHO) declared novel coronavirus disease 2019 (COVID-19) as a global pandemic.^[2] Until the beginning of September 2021, the laboratories-confirmed cases in Lithuania increased to 292,274 and 4,607 deaths were recorded which main cause was this virus.^[3]

Due to the COVID-19 pandemic, an emergency was declared in Lithuania in March 2020, which disrupted the work of the entire healthcare system, reduced the number of planned surgeries, and no exception was the activity in cardiac surgery departments. Similar to all over the world, many heart disease sectors were transformed into COVID-19 departments.^[4] This affected the treatment of patients in need of cardiac surgery due to suggestions to delay all elective procedures and focus only on more urgent ones.^[5] Most patients waiting for heart surgery were elderly, with chronic lung or heart disease, diabetes, arterial hypertension, or obesity. Therefore, this group of individuals were advised to observe special security during a pandemic, as infection before or after surgery would have been particularly dangerous for them.^[6] Also, COVID-19 was associated with respiratory distress, which could significantly increase postoperative patient mortality in complex cardiac surgeries with cardiopulmonary bypass (CPB).^[7]

There are limited data about the COVID-19 effect on the survival of patients after cardiac surgery. In addition, there are no precise recommendations for a cardiac surgical patient's treatment after postoperative COVID-19 diagnosis.

In the present study, we aimed to compare data of COVID-19-positive and COVID-19-negative patients postoperatively operated during the pandemic and to evaluate the impact of pandemic on cardiac surgery patients by comparing the same time periods before and during the pandemic.

PATIENTS AND METHODS

This retrospective study was conducted at Hospital of Lithuanian University of Health Sciences Kaunas Clinics, Department of Cardiac Surgery between November 2018 and March 2021. The data of postoperatively negative male COVID-19 patients (n=81; mean age: 65.5±8.5 years; range, 46 to 87 years) operated during the pandemic were compared with the data of postoperatively positive male COVID-19 patients operated during the same period (n=14; mean

age: 65.2±10.6 years). The clinical course of patients who were COVID-19 positive postoperatively was also evaluated. The number of patients, demographic and perioperative data were compared between patients operated during the pandemic from November 6th, 2020 to February 25th, 2021 (2020/2021 years; pandemic group) and the pre-pandemic period from November 6th, 2018 to February 25th, 2019 (2018/2019 years; control group). Coronary artery bypass grafting (CABG), heart valve and complex (CABG + heart valve) surgeries were performed in these patients. Inclusion criteria were male sex, CABG, valvular and complex operations performed during the selected period. Our study did not involve women, as there were no females infected with COVID-19 during that period. There were no age restrictions in this study. Pre-, peri-, and postoperative patient data, including complications were evaluated.

Quarantine

Under quarantine conditions, various cardiac operations were performed in our hospital. Before a hospitalization, patients were screened for COVID-19. Body temperature, clinical symptoms, and previous contact with those infected with the virus were assessed. For the detection of the SARS-CoV-2 virus, nasopharyngeal samples were taken, and viral ribonucleic acid (RNA) was detected using real-time polymerase chain reaction (PCR). Patients were isolated in special wards, until test results were received. In addition, 72 h before surgical treatment, the PCR test was repeated: in case of a negative result, the patient was operated. After transfer to the department, the patient was PCR-tested with a nasopharyngeal swab every seven days and 48 h before discharge. If the virus infection was detected before surgery, the patient was observed and re-consulted for postponement of cardiac surgery. Healthcare workers and patients always wore protective equipment and relatives were not allowed to visit their family members, except patients who were younger than 14 years old or patients with extremely severe conditions.

All staff were tested according to the procedure established by the Ministry of Health of Lithuania: after contact with the infected person, the staff were re-tested. In case of a positive test result, staff were required to isolate themselves and observe their health condition on an outpatient basis.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 23.0 software (IBM Corp., Armonk, NY, USA). Continuous data were expressed in mean ± standard deviation (SD), while categorical

data were expressed in number and frequency. The differences were checked using the t-test and the Mann-Whitney-Wilcoxon criterion. Differences in categorical variables were checked using the chi-square or the Fisher exact test. A *p* value of <0.05 was considered statistically significant.

RESULTS

Postoperative data comparison of Coronavirus-positive and -negative patients

The COVID-19-positive group and the COVID-19-negative groups were similar regarding their baseline characteristics and previous medical history. However, compared to COVID-19 positive group, a higher rate of arterial hypertension was found in the COVID-19 negative group (78.6% vs. 97.5%, *p*=0.003). Although there was no statistically significant difference, a higher percentage of smokers was spotted in the

COVID-19-positive group (35.7% vs. 14.8%). In the COVID-19-positive group, a statistically significant number of patients required re-sternotomy due to bleeding. With prolonged treatment due to COVID-19 disease, a higher number of bed days after surgery was observed in the COVID-19-positive group (mean 26.4±20.4 days) (Table 1).

Characteristics and course of the disease in COVID-19-positive patients

Most of the patients were treated with antibiotics. Six patients received specific antiviral treatment. Asymptomatic patients received standard postoperative treatment and their condition was closely observed. Three patients were readmitted to the intensive care unit (ICU) and two patients required reintubation due to COVID-19 infection. Among symptomatic patients, the most common one was fever. Samplings before and after the COVID-19-positivity showed decreased

Table 1. Data comparison of postoperatively COVID-19-positive and -negative patients

	COVID-19 positive (n=14)			COVID-19 negative (n=81)			<i>p</i>
	n	%	Mean±SD	n	%	Mean±SD	
Before surgery							
Age (year)			67±7.7			65.5±8.5	0.409
Body mass index (kg/m ²)			29.2±5.4			30.3±5.3	0.515
Diabetes mellitus type 2 (insulin-dependent)	5	35.7		27	33.3		0.862
Arterial hypertension	11	78.6		79	97.5		0.003
Smoking	5	35.7		12	14.8		0.060
Chronic atrial fibrillation	5	35.7		19	23.5		0.330
Bed days before surgery			4±2.8			4.5±4.5	0.597
Postoperative period:							
Glomerular filtration rate (after surgery)			68±31.8			78.5±23.4	0.792
Creatinine (mmol/L) (after surgery)			118.3±61			96.5±58.4	0.579
Blood transfusions (after surgery)	5	35.7		23	28.4		0.579
Resternotomy due to bleeding	2	14.3		0			0.018
Number of bed days after surgery			26.4±20.4			15.3±8.9	0.008
Total number of bed days			30.5±21.1			19.8±10.5	0.198
Pleural puncture (thoracocentesis)	3	21.4		21	25.9		0.721
Pneumonia	4	28.6		10	12.3		0.114
Superficial wound infection	3	21.4		12	14.8		0.013
Deep wound infection	2	14.3		1	1.2		0.010
Paroxysmal atrial fibrillation (I48.0)	6	42.9		22	27.2		0.234
Death	1	7.1		2	2.5		0.356

SD: Standard deviation; Total bed days: Number of bed days during all stay in hospital.

hemoglobin and increased C-reactive protein (CRP), lactate dehydrogenase, and D-dimer levels (Table 2). Only one patient with comorbidities died in that group. This patient became infected 48 days after surgery, although the average time before diagnosing COVID-19 in other patients with this virus was 11 days after surgery. Mediastinitis with sternal wound infection was diagnosed for this patient before COVID-19 infection. His COVID-19 course was complicated with pneumonia and acute respiratory failure.

Comparison of patients operated before and during the pandemic

The number of patients decreased by double during the pandemic in the same time period: 166 heart surgeries were performed during a 3.5-month period in 2018/2019 years (control group) and only 95 in 2020/2021 (pandemic group) years during the same period. The baseline characteristics of the patients in both groups were similar. However, compared to

Table 2. COVID-19-positive patients' laboratory findings, symptoms, and treatment

	n	%	Mean±SD
COVID-19 positive patients data			
Time after surgery to COVID-19 diagnosis (days)			13
Amount of time between the last date of laboratory samplings and COVID-19 diagnosis (days)			1.21
White blood cells (×10 ⁹ /L)			7.9±3.2
Neutrophils (%)			67.2±10.1
CRP (mg/L)			91.1±54.5
Hemoglobin (g/L)			103.2±10.6
Symptoms after COVID-19 positive diagnosis:			
Dry cough	3	21.4	
Fever >37.5°C	9	64.3	
Need for oxygen therapy	6	40	
Dyspnea	4	28.6	
No symptoms	5	35.7	
Readmission to ICU	3	21.4	
Reintubation after readmission to ICU	2	14.3	
After COVID-19 positive diagnosis			
Average time of laboratory sampling after COVID-19 diagnosis (days)			8.75
Ferritin (µg/L)			311.1±345.9
Lactate dehydrogenase (U/L)			350.1±146.8
D-dimer (mg/L)			3±1.4
White blood cells (×10 ⁹ /L)			7±1.8
Platelets (×10 ⁹ /L)			348.1±152
Hemoglobin (g/L)			103.6±8.7
CRP (mg/L)			53.9±54.7
Chest computed tomography	4	28.6	
Treatment:			
Remdesivir	6	42.9	
Dexamethasone	5	35.7	
Antibiotics	9	64.3	
Donor plasma with antibodies	1	7.1	

SD: Standard deviation; CRP: C-reactive protein; ICU: Intensive care unit.

Table 3. Overall characteristics of patients and their perioperative data comparing (control) and (pandemic) groups

	2018/19 years (control) group (n=166)			2020/21 years (pandemic) group (n=95)			p
	n	%	Mean±SD	n	%	Mean±SD	
Before surgery							
Age (year)			65.17±10.6			65.5±8.5	0.762
Body mass index (kg/m ²)			28.1±4.7			30.3±5.3	0.001
Diabetes mellitus type 2 (insulin-dependent)	33	19.9		27	33.3		0.021
COPD	15	9		3	3.7		0.130
Smoking	27	16.4		12	14.8		0.755
Chronic atrial fibrillation	30	18.2		19	23.5		0.330
Bed days before surgery			6±5.4			4.5±4.5	0.017
Perioperative period							
Urgent surgery	7	4.2		7	8.6		0.158
Elective surgery	149	89.8		71	87		0.619
Emergency surgery	10	6		3	3.7		0.443
CABG	97	58.4		50	61.7		0.620
CABG + valve surgery	35	21.1		16	19.8		0.808
Valve surgery	30	18.1		15	18.5		0.932
Cardiac arrest time (min)			56.7±24.2			60±27.9	0.351

SD: Standard deviation; COPD: Chronic obstructive pulmonary disease; CABG: Coronary artery bypass grafting.

the 2018/2019 years (control group), patients in the 2020/2021 years (pandemic group) were found to have a higher rate of type 2 diabetes mellitus and higher body mass index (BMI) (Table 3). No statistically significant difference in the duration of surgery, CPB, and cardioplegia time was observed between the two groups in the perioperative period (Table 3).

DISCUSSION

To prevent COVID-19 outbreaks in hospitals, the units had particularly stricter staff and patient screening. The United Kingdom (UK) paid particular attention to the followings: all patients were tested for COVID-19 before surgery, staff used personal protective equipment, the floors, where infected and non-infected patients were treated, were separated, and staff rotation was as infrequent as possible to reduce the likelihood of virus transmission.^[8] Similar measures were applied in Lithuanian hospitals, as well. However, although the hospital departments strictly adhered to the National Public Health Center (NPHC) instructions and recommendations (i.e., temperature measurements, epidemiological verification, personal

protective equipment), the spread of the virus could not be completely prevented. The COVID-19 infections among staff and patients after surgeries were recorded in the cardiac surgery unit of our hospital.

Although several studies have demonstrated that the incidence of COVID-19 infection may be associated with diabetes, higher European System for Cardiac Operative Risk Evaluation (EuroSCORE II), higher preoperative serum creatinine levels,^[9] BMI^[10] and age,^[11] there were no statistically significant differences in our study comparing COVID-19 infected and non-infected patients.

Furthermore, our study involved only men, as there were no females infected with COVID-19 during the study period. As reported in the literature, there is no significant difference in the proportion of males and females with confirmed COVID-19 diagnosis.^[12] The lack of female patients in our study can be explained by the fact that women accounted for a smaller proportion of cardiac surgical patients, and probably as they were more obligated to adhere to anti-pandemic requirements. Another possible cause

is the spread of the virus in the postoperative wards, which are different for men and women.

As the preoperative data of patients with and without COVID-19 who underwent surgery in 2020/2021 was similar, it can be concluded that patients became infected with COVID-19 regardless of their health condition and comorbidities. A higher percentage of smokers in the COVID-19-positive group can be related to the increased contamination due to repetitive hand interactions with the mouth during smoking process and higher number of contacts without wearing a mask. Also, smoking can change angiotensin-converting enzyme 2 (ACE-2) gene expression and cause immune system weakening.^[13] In the COVID-19-positive group, a statistically significant number of patients required re-sternotomy due to bleeding. Other studies have shown that the most likely pathophysiological mechanism causing bleeding after surgery is CPB-related inflammatory reaction. The CPB may exacerbate the harmful effect of COVID-19 on the coagulation system. Therefore, cardiac surgery patients with postoperative COVID-19 appear to be more susceptible to postoperative bleeding requiring surgical revision.^[14] Increased bleeding in the COVID-19-positive group may have led to a higher rate of wound infections. On the other hand, comparing the rate of complications in both groups, similar results were obtained.

Although a statistically higher mortality rate was found in similar studies carried out in other countries,^[9,15] there was no statistically significant difference in mortality between COVID-19-positive and COVID-19-negative patients in our study.

Moreover, the patient's condition and symptoms after cardiac surgery can be very similar to COVID-19 disease (temperature, shortness of breath). Blood sampling results such as an increase of lactate dehydrogenase, CRP, and D-dimer may help to suspect patients to be infected with virus.^[16] Our study also showed that patients who were infected with the virus had an increase in these laboratory sampling results. This finding suggests that there is a correlation between these blood samplings and COVID-19 infection. In case of suspicion, it would be wise to have a nasopharyngeal swab test immediately.

Evaluating the data of cardiac surgery patients operated in our hospital, the impact of COVID-19 on the number of surgeries was observed. Twice fewer patients in 2020/2021 underwent surgery compared

to the same period before the pandemic, due to quarantine restrictions and decreased medical support availability due to COVID-19 virus. Decreased number of surgeries due to the pandemic was also observed in other countries. In the UK and Israel, all planned surgeries were canceled, only emergency and urgent cardiac surgeries were performed.^[8,15] There are no exact data in the literature on what happened to those patients who did not have planned heart surgery, but negative effects of delayed operations are described in the literature.^[17,18] Despite quarantine restrictions, a relatively large amount of elective surgery was performed in our hospital. However, all patients were selected and surgeries were performed only in case of patient's worsening state. In the current study, we examined what happened to patients operated during the pandemic and whether it was safe to do so.

General characteristics and perioperative data did not significantly differ between the control and pandemic groups, and similar results were obtained in other studies.^[15,17] However, the slower pace of life showed a statistically significant increase in patients' BMI during quarantine ($p=0.001$), and more patients from the pandemic group had type 2 diabetes mellitus, which may have contributed to a longer duration of hospitalization.

Although at the time of writing this report, around 70% of the country's population have been vaccinated, face protection and special clothing sets are used in the departments in case of contact with a potentially infected person or confirmed case. We believe that this and the other measures listed above reduce the number of COVID-19 infections in the hospital setting. Other authors have also reported similar findings.^[19] Quarantine restrictions lead to longer patients waiting lists for elective and emergency cardiac and thoracic surgeries. While preparing for surgical interventions, special attention should be paid to the care of elderly patients with cardiovascular disorders. Thus, decisions regarding the surgical treatment of patients must be made by a multidisciplinary team consisting of cardiovascular and thoracic surgeons, as well as experts in vaccination, geriatrics, pulmonology, and virology.^[20]

The main limitation to this study is that the sample size of the COVID-19-positive group is small ($n=14$); however, this relatively small sample size also indicates that the protective measures used were quite effective.

The main strength of this study is that the control group data were used to assess the effect of the

pandemic, which is lacking in many other similar studies. It should also be considered an advantage to provide data, when the clinic has not stopped elective cardiac surgery, as in many cardiac surgery clinics in other countries. In addition, we were able to analyze pre-vaccination data. We do not consider the findings to be less relevant, as some patients still refuse vaccination and some vaccinated or relapsed individuals develop COVID-19 again.

In conclusion, although postoperative mortality did not differ between COVID-19-positive and COVID-19-negative groups, hospitalization for COVID-19-positive patients lasted longer. They were also more likely to undergo re-sternotomy for bleeding with a higher incidence of wound infection. The number of cardiac surgery operations performed during the pandemic decreased by half in our hospital and COVID-19 was detected in some of our patients postoperatively despite protective measures. Planned cardiac surgery during the COVID-19 pandemic-caused quarantine seems to be better for the patient than a complete cessation of elective cardiac surgery, if adequate protective measures are taken.

Ethics Committee Approval: The study protocol was evaluated by the local Bioethics Council with permission (no. 2021.02.11 Nr. BEC-LSMU (R)-29). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Idea/Concept: A.B., L.J.; Design: V.V., A.B.; Control/supervision: A.B., P.J., E.R., L.J.; Data collection and/or processing: V.V., M.K., K.K.; Analysis and/or interpretation: V.V., A.B.; Literature review: V.V., M.K., K.K.; Writing the article: V.V., A.B., M.K., K. K.; Critical review: A.B., P.J., E.R., L.J.; References and fundings: V.V., A.B., M.K., K.K.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

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