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Outcomes of cardiac surgeries following COVID-19 infection

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Abstract--Background: Worldwide, cardiac surgery has been significantly impacted by the COVID-19 pandemic infection. In the event of respiratory tract involvement, COVID-19 may be fatal and may serve as a significant contraindication to surgery. Our objective was to investigate the safety and outcomes of patients who underwent cardiac surgeries subsequent to their COVID-19 infection. **Methods:** This retrospective observational study was carried out on 22 patients undergoing elective or urgent open-heart surgery following COVID-19 infection. **Results:** 9 patients (40.91%) were extubated within 24 hours of surgery, 6 patients (27.27%) were extubated on the first postoperative day, and 3 patients (13.64%) were extubated on the second postoperative day. Regarding the postoperative complications, 6 (27.27%) patients required NIV with a mean \pm SD of duration 6 ± 2.37 days (range 3-9 days), and 5 (22.73%) developed respiratory failure, 2 (9.09%) developed heart failure, 1 (4.55%) patient experienced AKI on pre-existing CKD, and 1 (4.55%) patient developed dilated cardiomyopathy was presenting with CAD + VHD. 3 (13.64%) patients needed inotropes, one of them developed dilated

cardiomyopathy and the other two developed heart failure. The mortality incidence was 3 (13.64%), one of them presented with dyspnea with consolidation and died due to respiratory failure while the other two patients were no COVID-19 related deaths but due to heart failure in both. **Conclusions:** Cardiac surgery can be safely performed on preoperative COVID-19 patients after the recovery period, particularly in asymptomatic and mild infection.

Keywords---COVID-19, Cardiac Surgery, Euroscore II, Triple Vessel Disease, CABG.

Introduction

On January 30, 2020, the World Health Organization (WHO) announced that SARS-CoV-2 (COVID-19) was a public health emergency of international concern. The prognosis for patients with underlying cardiovascular disease is particularly bleak, as there were nearly 34,000 fatalities worldwide by the end of March 2020 [1].

Nevertheless, the exact effects on individuals who were undergoing cardiovascular disease surgery were unknown. In spite of the limited sample size ($n < 35$), the initial surgical investigations on COVID-19 concluded that there was a significant mortality risk associated with surgery in individuals with the disease [2, 3] and that surgery might accelerate disease progression in those incubating COVID-19 [2]. This investigation was designed to evaluate the safety and health outcomes of patients who underwent cardiac surgeries subsequent to their COVID-19 infection.

Patients and Methods:

This retrospective observational study was carried out on 22 patients undergoing elective or urgent open-heart surgery after COVID-19 infection from August 2020 to August 2021.

Inclusion criteria:

- Age more than 18 years.
- Both genders.
- Positive COVID-19 via polymerase chain reaction (PCR).
- Patients undergoing elective or urgent open-heart surgery.

Exclusion criteria:

- Age under 18 years.
- Negative COVID-19 via polymerase chain reaction (PCR).

Patients who were diagnosed with COVID-19 infection via positive swab test prior to surgery were identified from our hospital's COVID database. Their cases were reviewed after each patient provided informed written consent. The patients in our cohort were all non-vaccinated. Data were retrospectively collected and evaluated

from patients' medical records. In order to accumulate further information, telephone interviews were implemented.

Statistical Analysis

A statistical analysis was conducted using SPSS v26 (IBM Inc., Armonk, NY, USA). Quantitative data, such as age, were displayed as the mean and standard deviation (or SD). Qualitative data (e.g., sex) were presented as percentages (%) and numbers.

Results

The age of the studied patients ranged from 36 to 72 years with a mean \pm SD of 51.5 ± 9.54 years. There were 14 (63.64%) males and 8 (36.36%) females. Regarding the comorbidities, HTN is the most prevalent comorbidity (54.55%), followed by DM 36.36% and CKD 31.82%. The majority of patients (90.91%) had NYHA Class I-II while Only 2 patients (9.09%) had NYHA Class III-IV. Regarding angina severity (CCS Class), 13.64% of patients had CCS I-II angina, 45.45% of patients had CCS III-IV angina, and 40.91% of patients report no angina, indicating cases where cardiac issues are present but without significant ischemic symptoms (**Table 1**).

The mean EuroSCORE II of 4.82 ± 1.62 . The mean EF of $41.14 \pm 11.15\%$. Regarding cardiac diagnosis, the most common diagnosis is triple vessel disease (45.45%), 22.73% of patients had CAD + VHD, 13.64% of patients had VHD, 9.09% had infective endocarditis, and 9.09% of cases had ascending aortic aneurysm (**Table 1**).

Table 1: Baseline characteristics

	n=22
Age (years)	51.5 \pm 9.54
Sex	
Male	14 (63.64%)
Female	8 (36.36%)
HTN	12 (54.55%)
DM	8 (36.36%)
CKD	7 (31.82%)
NYHA class	
I-II	20 (90.91%)
III-IV	2 (9.09%)
Angina	
No	9 (40.91%)
CCS I-II	3 (13.64%)
CCS III-IV	10 (45.45%)
Euroscore II	4.82 \pm 1.62
EF (%)	41.14 \pm 11.15
Cardiac diagnosis	
Triple vessel disease	10 (45.45%)
VHD	3 (13.64%)

CAD + VHD	5 (22.73%)
CAD + Ascending aortic aneurysm	2 (9.09%)
Infective endocarditis	2 (9.09%)

Data are presented as mean \pm SD or number (percentage %), HTN: hypertension, DM: diabetes mellitus, CKD: chronic kidney disease, NYHA: New York Heart Association, CCS: Canadian Cardiovascular Society, EF: ejection fraction, VHD: valvular heart disease, CAD: coronary artery disease. Most patients (72.73%) were asymptomatic, with only 9.09% experiencing dyspnea and 18.18% with fever. Chest X-ray was normal in 72.73%, but 27.27% showed consolidation (**Table 2**).

Table 2: COVID-19 examination

	n=22
COVID-19 presentation	
Asymptomatic	16 (72.73%)
Fever	4 (18.18%)
Dyspnea	2 (9.09%)
Chest X-Ray	
Normal	16 (72.73%)
Consolidation	6 (27.27%)

Data are presented as number (percentage %).

The average time from COVID-19 diagnosis to surgery was 36.68 ± 14.59 days. Urgent surgeries (72.73%) were more common than elective (27.27%). CABG (54.55%) was the most performed procedure, with a significant number requiring combined surgeries (CABG + valve replacement 22.73%) while 2 (9.09%) patients underwent only valve replacement, another 2 (9.09%) patients underwent aortic surgeries, and only one patient underwent Redo valve replacement. The mean \pm SD CPB time was 117.23 ± 34.97 min and cross-clamp time was 94.86 ± 34.99 min (**Table 3**).

Table 3: Surgery related data

	n=22
Duration from COVID diagnosis to surgery (days)	36.68 ± 14.59
Surgery urgency	
Urgent	16 (72.73%)
Elective	6 (27.27%)
Surgery	
Isolated CABG	12 (54.55%)
Valve replacement	2 (9.09%)
CABG + valve replacement	5 (22.73%)
Aortic surgery	2 (9.09%)
Redo valve replacement	1 (4.55%)
CPB time (min)	117.23 ± 34.97
Cross-Clamp time (min)	94.86 ± 34.99

Data are presented as mean \pm SD or number (percentage %), CABG: coronary artery bypass graft surgery, CPB: cardiopulmonary bypass. 9 (40.91%) patients were extubated within 24 hours of surgery, 6 (27.27%) were extubated on day 1 postoperatively, and 3 (13.64%) were extubated on postoperative day 2. Regarding the postoperative complications, 6 (27.27%) patients required NIV with a mean \pm SD of duration 6 ± 2.37 days (range 3-9 days), and 5 (22.73%) developed respiratory failure, 2 (9.09%) developed heart failure, 1 (4.55%) patient experienced AKI on pre-existing CKD, and 1 (4.55%) patient developed dilated cardiomyopathy was presenting with CAD + VHD. 3 (13.64%) patients needed inotropes, one of them developed dilated cardiomyopathy and the other two developed heart failure. The mean \pm SD of ICU stay was 4.82 ± 2.82 days and hospital stay was 11.41 ± 6.7 days. The mortality incidence was 3 (13.64%), one of them presented with dyspnea with consolidation and died due to respiratory failure while the other two patients were no COVID-19 related deaths but due to heart failure in both, one of them presented with triple vessel disease and underwent CABG + valve replacement while the other presented with VHD and underwent Redo valve replacement with both having, at presentation, asymptomatic COVID-19 (**Table 4**).

Table 4: Postoperative outcomes

	n=22
Time to extubation	
< 1 day	9 (40.91%)
1 day	6 (27.27%)
\geq 2 days	3 (13.64%)
Complications	
NIV	6 (27.27%)
Respiratory failure	5 (22.73%)
Heart Failure	2 (9.09%)
AKI	1 (4.55%)
Dilated cardiomyopathy	1 (4.55%)
Ventilation time (days)	6 ± 2.37
Need for inotropes	3 (13.64%)
Length of hospital stay (days)	11.41 ± 6.7
Length of ICU stay (days)	4.82 ± 2.82
Mortality	3 (13.64%)

Data are presented as mean \pm SD or number (percentage %), NIV: non-invasive ventilation, AKI: acute kidney injury, ICU: intensive care unit.

Discussion

Worldwide, cardiac surgery has been significantly impacted by the COVID-19 pandemic infection [4]. Cardiovascular surgery centers were converted into COVID-19 facilities in significant quantities. A significant decrease in the number of surgical cases has been observed as a result [5]. Due to the involvement of the respiratory tract, COVID-19 may be fatal and may serve as a significant contraindication to surgery, unless emergent severe conditions (e.g., acute aortic dissection) occur [6].

Most of our patients (72.73%) were asymptomatic, with only 9.09% experiencing dyspnea and 18.18% with fever. Chest X-ray was normal in 72.73%, but 27.27% showed consolidation. The average time from COVID-19 diagnosis to surgery was 36.68 ± 14.59 days.

Our findings were in line with Sanders et al. [7] In the study, 53 (7.0%) of the 755 individuals were found to have Covid-19. Comparing individuals with and without Covid-19, those with Covid-19 had a significantly prolonged postoperative stay (11 days vs. 6 days) and a significantly higher mortality rate (24.5% vs. 3.5%). Preoperative Covid-19 diagnoses demonstrated comparable recovery rates to those of non-Covid-19 patients. Nevertheless, our hospital stay was lengthier than theirs following the operation. This variance may be attributed to the fact that our patients had a higher Euroscore II than their cohort. In our study, 9 (40.91%) patients were extubated within 24 hours of surgery, 6 (27.27%) were extubated on day 1 postoperatively, and 3 (13.64%) were extubated on postoperative day 2. Regarding the postoperative complications, 6 (27.27%) patients required NIV with a mean \pm SD of duration 6 ± 2.37 days (range 3-9 days), and 5 (22.73%) developed respiratory failure, 2 (9.09%) developed heart failure, 1 (4.55%) patient experienced AKI on pre-existing CKD, and 1 (4.55%) patient developed dilated cardiomyopathy was presenting with CAD + VHD. 3 (13.64%) patients needed inotropes, one of them developed dilated cardiomyopathy and the other two developed heart failure. The mean \pm SD of ICU stay was 4.82 ± 2.82 days and hospital stay was 11.41 ± 6.7 days. The mortality incidence was 3 (13.64%), one of them presented with dyspnea with consolidation and died due to respiratory failure while the other two patients were no COVID-19 related deaths but due to heart failure in both, one of them presented with triple vessel disease and underwent CABG + valve replacement while the other presented with VHD and underwent Redo valve replacement with both having, at presentation, asymptomatic COVID-19.

There is emerging evidence that COVID-19 patients who undergo surgery may be more susceptible to pneumonia and ARDS postoperatively, even if they are asymptomatic [2]. Patients who underwent surgery within six weeks of their COVID-19 diagnosis exhibited significantly higher adjusted 30-day postoperative pulmonary complication rates than those who did not have the covid-19 infection. After seven weeks, this risk will return to its original level [8]. The COVID Surg Collaborative advised against scheduling elective surgery within seven weeks of a COVID-19 infection diagnosis, unless the risk of postoperative morbidity/mortality associated with COVID-19 is significantly greater than the risk of deferring surgery. This recommendation was derived from a comprehensive multinational study that included over 100,000 patients across all surgical specialties [9].

Furthermore, Hirji et al. [10] The results of cardiac surgery for 155 patients with COVID-19 who were diagnosed before surgery and 52 patients who were diagnosed after surgery were evaluated in this study. There was no statistically significant difference between patients with COVID-19 who were diagnosed within 7 days of surgery and those who were diagnosed 30 days after surgery in terms of mortality (15.4% vs. 21.9%) or major morbidity (except for pneumonia: 28.8% vs. 46.6%). In order to reduce the likelihood of postoperative infection and its

complications, this guarantees that adults undergoing cardiac surgery are cared for on "COVID clean" pathways and wards.

The COVIDSurg Collaborative's previous research demonstrated that the mortality rate of all COVID-19 positive patients was reduced to pre-infection levels when surgery was postponed by ≥ 7 weeks following the diagnosis of SARS-CoV-2 [8]. Research indicates that the risk of mortality for a COVID-19 positive patient is elevated during surgery [8, 11].

Rescigno et al. [12] described the case of a 63-year-old patient who was referred for coronary artery bypass grafting. The patient passed away a few days after the surgery, and the cause of death was presumed to be severe postoperative complications. COVID-19 pneumonia. Fukuhara et al. [6] A patient with acute type A aortic dissection was presented, who was subsequently diagnosed with COVID-19 and passed away following the surgery.

It should be noted that the mortality rate in seroconverted cardiothoracic patients following surgery has been reported to be greater than 20% [2, 13, 14]. COVID-19 is known to cause long-term immune dysregulation, including lymphopenia, hyperinflammation, and endothelial dysfunction, which may increase the risk of complications after major surgeries like CABG. Patients recovering from COVID-19 may have prolonged inflammation, increased thrombotic risks, and impaired immune recovery, making them more vulnerable to post-surgical infections and complications [15]. When compared to historical control subjects, a recent literature review found that patients with myocardial infarction presented significantly later and had lower rates of primary percutaneous coronary intervention during the COVID-19 era [16].

The early inflammatory syndrome, often linked to cardiopulmonary bypass, may have a synergistic effect [17] As well as the recognized inflammatory response that is linked to COVID-19 [18]. The cytokine storm that exacerbated the cardiocirculatory, respiratory, and hematologic conditions of the patients, as a result of the two interconnected inflammatory stimuli, may have resulted in adverse outcomes. Cardiopulmonary bypass and COVID-19 both have harmful biological effects, which may explain why the worst outcomes were found so close together. Influenza and other seasonal viral respiratory infections can impact perioperative mortality and respiratory complications in cardiac surgery, according to recent large retrospective analyses [19].

Due to the small sample size and retrospective nature of our study, the majority of patients were asymptomatic or mildly infected with COVID-19. Consequently, the study did not include patients who were severely affected by the disease. Additionally, elective cases were employed due to severe hemodynamic and cardiac complications. Further comparison with a group of vaccinated individuals is needed to explore the effect of vaccine on cardiovascular disease patients and further research to examine the role of CT scans is advisable in selecting the surgical timing and minimize the postoperative pulmonary complications.

Conclusions

Cardiac surgery can be safely performed on preoperative COVID-19 patients after the recovery period, particularly in asymptomatic and mild infection.

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