

Adult Cardiac Surgery in the Time of the SARS-CoV-2 Virus: A Report of Eight Cases of Postoperative COVID-19 Infection

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ABSTRACT

Objective: While COVID-19 respiratory complications can lead to an acute respiratory distress syndrome, the impact of coronavirus disease in patients undergoing cardiac surgery procedures is unknown. The aim of this paper is to describe the baseline characteristics and outcomes of patients who tested positive early after cardiac surgery. We also present measures adopted targeting the new coronavirus pandemic in our department and the way we reorganized to resume the surgical activity in better conditions.

Case presentation: We experienced a crucial SARS-CoV-2 outbreak in our cardiovascular division during the peak of the pandemic in Tunisia with several patients tested positive for the new coronavirus. Here we present eight cases of COVID-19 positive patients on the postoperative course from February 22, 2021 to July 6, 2021. During this period, 148 patients underwent cardiac surgery at the department of Cardio-vascular Surgery of Abderrahmen Mami hospital. Among them, 8 patients were found positive for the SARS-CoV-2 virus after elective operations. The mean age of patients was 55 years (range from 36 to 65 years). Of the 8 patients, 5 were men and 3 were women. Four patients were operated on between February 28, 2021 and March 29, 2021 during the third wave of the pandemic. One had his operation on May 17, 2021 and 3 patients underwent cardiac surgery between June 12, 2021 and June 22, 2021 during the fourth wave of pandemic. The mean time from surgery to COVID-19 diagnosis was 4.62 days. Four patients died on the postoperative course. Twelve health care workers were also affected. Nine of them were moderately symptomatic for cough and mild dyspnea whereas the 3 others were asymptomatic.

Conclusion: The SARS-CoV-2 infection puts health services, including cardiac surgery units, under increasing pressure. Cardiac surgeons are faced with serious challenges induced by this novel virus and ensuing disease that leads to great uncertainty.

Keywords: Cardiac surgery; COVID-19; Post-operative

INTRODUCTION

The coronavirus disease 2019 has dramatically affected healthcare systems worldwide and severely impacted cardiac surgery [1]. Though cardiac patients are at high risk for COVID-19 severe illness, major of surgical cases has been postponed because intensive care units were dedicated to COVID-19 patients. People are also waiting too long becoming to the hospital because they are afraid of getting infected with the virus. This would translate the increased mortality and morbidity of these patients regardless of a SARS-Cov2 infection [2]. To adapt to these exceptional circumstances, many cardiac surgery centers are currently being strained to enact

drastic measures and implemented policies in order to care for cardiac surgery patients and to resume surgical activity in safety in time of the pandemic. Here, we present 8 cases of postoperative patients who tested positive for SARS-CoV-2 virus after cardiac surgery.

Department scenario and patient selection

The current COVID-19 pandemic has profoundly affected all healthcare professionals, including heart surgeons. While it was safe to be admitted and operated in the department of cardiovascular surgery during the first and the second waves of the pandemic with the low number of infected persons, patients

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are at high risk for COVID-19 severe illness with the third and the fourth waves. During the crisis of COVID-19, we have reduced our routine caseload. We were performing 6 to 7 major cardiac operations each week selecting emergency patients while deferring the majority of cases. Patients were referred to us and accepted for surgery in context of emergency such as ascending aortic dissection, acute coronary syndrome and symptomatic coronary artery disease unsuitable for percutaneous intervention and acute valvular endocarditis. We admitted also patients who were at greatest risk of adverse event that can cause heart failure and even sudden death such as symptomatic critical aortic stenosis or regurgitation, symptomatic mitral valve regurgitation despite optimized medical therapy, aortic aneurysm at risk based on size and cardiac tumour at risk of obstruction or embolization.

Preoperative management and COVID-19 screening: After detection of the first positive patient, cardiac surgery activity was immediately suspended. COVID-19 tracing was performed for all patients and health care workers. There were 4 postoperative patients diagnosed with COVID-19 at the same period during the third wave (between February and March). Two of them died because of COVID-19 pneumonia. The two others fully recovered from SARS-CoV2 infection. At that time, RT-PCR tests were not performed preoperatively due to limited hospital resources. These patients were scheduled for elective surgery during COVID-19 pandemic, but in a condition that was not optimal in terms of readiness and experience in management of this disease by our division. Perioperative course is described in Table 1.

After this third outbreak and since then following appropriate measures, no further positive cases for SARS-CoV-2 were detected in 3 months with the only exception of one patient who was rapidly

diagnosed and isolated. In view of the large contaminations found in patients undergoing cardiac surgery, strict measures of screening and operating protocols were introduced to manage safely both the patient and the attending clinicians.

All patients presenting for cardiac surgery were be-screened preoperatively for the presence of the coronavirus to detect infected individuals. The urgency of the surgery will be further evaluated in patients tested positive whereas if the RT-PCR test is negative, then the operation will be carried out. However, the absence of a positive test may not indicate that the patient is free from infection.

CASE PRESENTATION

Case 1

The first patient with symptoms of COVID-19 was a 63-year-old woman who was presented to our department with dyspnea related to a severe mitro-aortic stenosis. The transthoracic echocardiography showed normal heart function and severe mitro-aortic stenosis. As the patient had no fever and the X-ray was anodyne, she was not tested preoperatively. The hospital stay before surgery was three days. A double valve replacement was performed without surgical complications. She was extubated 4 hours after surgery and the initial postoperative course was uneventful. However, on day 4 from operation, the patient presented a worsening in respiratory function requiring nasal oxygen supplementation. Furthermore, she started spiking fever for 2 days continuously with non-productive cough. Nasopharyngeal swab was performed confirming the diagnosis of COVID-19. She was promptly isolated and transferred to the COVID-19 Intensive Care Unit (ICU). After short period,

Table 1: Perioperative course of COVID-19 patients undergoing cardiac surgery with cardiopulmonary bypass.

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6	Patient 7	Patient 8
Operative details								
Operation Type	Double valve replacement	CABG	CABG	CABG	Aortic valve replacement	CABG	Double valve replacement	Ascending aortic replacement
CPB Time, min	85	72	65	68	52	60	135	124
Cross clamp time, min	65	57	52	55	36	49	103	90
Postoperative results								
Postoperative intubation time, hour	4	6	28	3	10	5	12	30
Complications	Respiratory failure, Acute kidney dysfunction	Respiratory and multi-organ failure	ARDS	ARDS	ARDS	ARDS	Acute kidney dysfunction, Respiratory failure, multiorgan failure	Acute kidney dysfunction, Respiratory failure, multiorgan failure
Readmission to ICU	-	-	-	-	+	-	-	-
Reopening for bleeding	-	-	+	-	+	-	-	+
ECMO	-	-	-	-	-	-	+	-
Hemodiafiltration	-	-	-	-	-	-	+	+
Intensive care unit length of stay, day	6	7	5	7	2	3	3	3
In-hospital length of stay, day	13	20	14	19	14	14	6	3
COVID-19 unit length of stay, day	4	5	3	2	2	3	2	1
Outcome	Dead	Dead	Discharged	Discharged	Discharged	Discharged	Dead	Dead

Note: CPB: Cardio Pulmonary Bypass; CABG: Coronary Artery Bypass Graft; ICU: Intensive Care Unit; ECMO: Extra Corporeal Membrane Oxygenation; ARDS: Acute Respiratory Distress Syndrome

she experienced a severe hypoxemia and rapid deterioration of respiratory conditions that required emergency intubation and mechanical ventilation. The patient died 4 days after having been transferred to ICU, as the result of severe respiratory and renal failure.

Case 2

The second patient was a 65-year-old male with a history of hypertension, diabetes, dyslipidemia and morbid obesity. He was diagnosed with coronary artery disease (CAD). Coronary angiogram showed severe triple vessel disease with an ejection fraction of 63%. Troponin levels were within the normal range. Preoperative COVID-19 assessment was not performed, as he did not complain of any symptoms suggestive of a respiratory infection and had no recent fevers nor documented COVID-19 exposure. His inflammatory markers were normal and chest X-ray showed cardiomegaly with normal appearance of both lungs. Quadruple-vessel coronary artery bypass graft was carried out 8 days after admission. The patient was weaned from cardiopulmonary bypass without difficulty and was transferred to the ICU where he was extubated 6 hours after surgery. The patient's condition worsened on the fifth postoperative day with an onset of fever and hypoxemia. He was tested positive for COVID-19 and transferred to the ICU isolation room. Unfortunately, the patient died after 5 days in the ICU from respiratory distress followed by multiorgan failure.

Case 3

A 63-year-old man, current smoker, with CAD was scheduled for an elective coronary artery bypass graft. At the time of admission, preoperative RT-PCR was not performed as he had no fever or respiratory signs, his chest X-ray showed normal appearance of both lungs before surgery. Coronary angiography showed a critical stenosis of distal left main artery associated with a 3-vessel CAD with a 55% ejection fraction. The surgery was carried out 6 days after admission. The bypass was performed using two grafts, left internal mammary artery to the left anterior descending and right internal mammary artery to marginal and to posterior descending artery was performed. The patient was placed in the ICU but he was taken back for hemostasis revision. The patient was extubated the next day. His early postoperative course was uneventful. However, after 3 days, the patient developed dyspnea with decreased PaO₂ and low oxygen saturation, despite high O₂ flow supplementation. Hence, the patient was tested positive for COVID-19 with an RT-PCR. He was transferred to COVID-19 unit and was treated with supportive measures and monitoring for worsening respiratory function. Fortunately, he was weaned from oxygen and was discharged on day 3 of his hospitalization with instructions to self-isolate for one week.

Case 4

A 47-year-old man with multiple cardiovascular risk factors including diabetes, active smoking and morbid obesity was admitted with unstable angina. Coronary angiogram showed severe triple vessel disease. He had mild left ventricular dysfunction. Preoperative RT-PCR was not performed at the time of admission, as he was asymptomatic. He had to wait 10 days to optimize medical treatment but also to have intensive care unit bed available before undergoing coronary artery bypass surgery. Coronary

revascularization consisted of the left internal mammary artery to the left anterior descending artery and the right internal mammary artery to diagonal artery and marginal circumflex. The patient was extubated 3 hours later. On the fifth postoperative day, the patient developed fever with dyspnea requiring supplemental oxygen flow. An RT-PCR test for COVID-19 was performed and was positive. He was transferred immediately to dedicated COVID-19 unit where he stayed for two days and was discharged at home to continue isolation.

Case 5

A 46-year-old male patient with a history of hypertension was admitted to our department for surgical management of aortic valve endocarditis. On arrival, he had neither fever nor respiratory compromise. He initially tested negative for SARS-CoV-2. Blood cultures were positive persistently for *Enterococcus faecalis*, and the patient received appropriate culture sensitivity based antibiotics during 11 weeks. Echocardiography revealed dilatation of the left ventricular cavity with a preserved ejection fraction of 58%, tricuspid aortic valve, a mobile vegetation formation on right aortic cusp and severe aortic insufficiency. The cranial magnetic resonance imaging scan with angiography showed a 4 mm aneurysm of the right middle cerebral artery. An aortic valve replacement was performed 8 days after the admission. A biological valve was implanted without complications, and the patient was transferred to ICU. Six hours later, the patient was taken back to the operating room for hemostasis revision. We found neither active bleeding nor any problem during the sternum closure. Mechanical ventilation disconnection was performed 10 hours after surgery, and the patient presented an adequate postoperative recovery the first 24 hours. On the second postoperative day, he had difficulty breathing and sputum production with fever without hypoxemia, suggesting COVID-19 pneumonia. The result of SARS-CoV-2 test was positive. The patient was placed on the fourth day after surgery in the COVID-19 isolation ward and was discharged forty-eight hours after hospitalization.

Case 6

A 58-year-old woman with a history of hypertension and dyslipidemia, was diagnosed with CAD in 3 vessels with an ejection fraction of 61%. The patient was scheduled for coronary artery bypass graft surgery. He underwent surgery after COVID-screening using a checklist provided by our division. The patient's condition worsened on the third day after surgery with persistent fever accompanied with an increase in oxygen requirements and a rapid progression of opacities in the thorax X-ray. She was tested positive for COVID-19 with an RT-PCR. The patient was transferred to the COVID-19 unit. She presented a clear clinical improvement in the following 48h, with a decrease in C - Reactive Protein (CRP) value. The patient was discharged at home twenty-four hours after with no further complications.

Case 7

A 36-year-old man with a history of smoking and drug addiction was transferred to our department with fever and orthopnea due to pulmonary oedema complicating a mitro-aortic insufficiency. Transesophageal echocardiography revealed mobile vegetation measuring 10 mm attached to the anteromedial leaflet of the

mitral valve associated with vegetations on all three aortic cusps with severe mitro-aortic insufficiency by valve destruction. He was started on intravenous (IV) antibiotics and a double valve replacement with prosthetic valve was urgently performed because of the severe mitro-aortic regurgitation and worsening symptoms of heart failure. Blood cultures drawn on admission and valve tissue culture yielded *Enterococcus faecalis*. The patient was placed in ICU where he was extubated 12 hours later but rapidly required re-intubation twenty hours after disconnection because of severe hypoxia and dyspnea with fever. Despite testing negative initially for COVID-19 RT-PCR swab, he was tested positive for SARS-CoV2 virus on the 3rd postoperative day. He was promptly isolated and transferred to the COVID-19 (ICU). Arterial blood gas analysis was routinely examined showing a partial pressure of arterial oxygen-to-fraction of inspired oxygen ratio ($\text{PaO}_2/\text{FiO}_2$) <85 mmHg and uncompensated metabolic acidosis with $\text{pH}<7.15$ despite receiving continuous hemodiafiltration. Therefore, the patient underwent veno-venous extracorporeal membrane oxygenation for ARDS but he died 2 days after surgery as the result of acute kidney dysfunction followed by multiorgan failure.

Case 8

A 65-year-old patient with a history of uncontrolled hypertension presented to the emergency department with sudden intense chest pain. CT showed a dissection of the aorta originating from the proximal aortic root and extending all the way into the right common iliac artery with no radiologic evidence for COVID-19 pneumonia. A transthoracic echocardiogram confirmed the diagnosis of acute type A aortic dissection. There was neither noaortic regurgitation nor pericardial effusion. The patient was transferred to our department and an emergency ascending aortic replacement was performed using axillary cannulation. Distal anastomosis was performed under a moderate hypothermia with short circulatory arrest of 10 minutes with retrograde cerebral perfusion and without an aortic cross-clamp. After surgery, the patient was transferred to the ICU and due to persistent hypoxia with high oxygen (fraction of inspired oxygen of 60%) she could not be extubated. On the 2nd postoperative day, the patient underwent re-exploration for hemostasis revision without an identifiable site bleeding. She was eventually extubated 6 hours after reopening for bleeding, however, his hypoxemia gradually exacerbated. Thus, she was reintubated and diagnosed with SARS-CoV-2 the day after hemostasis revision. The patient was treated for 2 days in the isolation (ICU) and received continuous hemodiafiltration for acute kidney dysfunction but she died on post-operative day 3 of multiorgan failure essentially resulting from progressive respiratory failure and acute renal failure.

RESULTS AND DISCUSSION

From February 22, 2021 to July 6, 2021, 148 patients underwent cardiac surgery at the department of Cardiovascular Surgery of Abderrahmen Mami hospital. Among them, 8 patients were found positive for the new coronavirus early after surgery. The mean age of patients was 55 years (range from 36 to 65 years). Of the 8 patients, 5 were men and 3 were women. Four of them were operated between February 28, 2021 and March 29, 2021 during the third wave of the pandemic, one had his operation on May 17, 2021 and 3 patients underwent cardiac surgery between June 12,

2021 and June 22, 2021 during the fourth wave of pandemic. The mean time from surgery to COVID-19 diagnosis was 4.62 days. To achieve a much reduced length of stay, we have adopted a more aggressive approach in terms of early extubation and earlier hospital discharge. The median time of intubation was 12, 25 hours.

Four patients died on the postoperative course with a mean time from surgery to death of 3 days [1-5 days]. The presumed cause of death was severe postoperative COVID-19 pneumonia. Follow-up of the 4 survivors was obtained by directly contacting the patients if they had been discharged to home or the COVID-19 units where they were transferred. The clinical features are summarized in Table 2. On another hand, twelve hospital care workers were found to be positive for SARSCoV-2 (4 anesthetists, 2 doctors, 3 instrumentalists, 3 nurses) during this fourth wave. Nine of them were moderately symptomatic for cough, headache and mild dyspnea. The three others were asymptomatic. They did not need active medical treatment thus they were isolated at home.

The COVID-19 pandemic has overwhelmed health care systems across the globe. Many specialties, including cardiac surgery, have been particularly affected by the virus outbreak. Although many cardiac interventions have been delayed because of a hospital shortage of intensive care unit and intensive treatment unit beds due to the pandemic, it was essential to continue providing services to those in whom the risks of the natural history of their disease outweigh those of the risks of catching COVID-19 [3]. In the early phases, nasopharyngeal swabs facilities were not freely available and accessible. This combined with the indications for testing, and even concerns of a large percentage of false negatives, potentially contributed to the rapid disease progression. At that time, due to our initial lack of preparation and management of this disease, we were not aware of COVID-19 status of our four patients operated during the third peak of the pandemic. Hence, operating them in the acute phase of COVID-19 has constituted a high-risk approach despite being preoperatively clinically stable and thus had unfavourable outcomes.

Furthermore, performing heart surgery in patient with positive COVID-19 might reduce the immune system causing severe signs and symptoms. The systemic inflammatory response syndrome triggered by extracorporeal circulation [4,5] may last up to several days after surgery [6], but also may mask the typical COVID-19 laboratory findings. In some cases, this induced inflammatory cascade leading to acute respiratory distress syndrome, making the diagnosis more difficult [7]. Nonetheless, in the current circumstances of the COVID-19 pandemic, suspicious respiratory disease after cardiac surgery should be immediately investigated with RT-PCR for SARS-CoV-2 or even CT of the chest. Concomitant SARS-CoV-2 infection in patients undergoing cardiac surgery associated with comorbidities, especially in older patients, may precipitate the disastrous postoperative course. However, in our series, two deaths were reported in young adult (patient 7) and with no risk factors (patient 1).

At the present, few data are available on the effect of the SARS-CoV-2 virus in patients who recently had cardiac surgery. However, there are several recommendations available to guide decision-making for patients undergoing elective cardiac surgery during the novel corona-virus [8]. Haft and colleagues reported "The purpose of postponing cardiac operations is based on three principles

Table 2: Main characteristics of COVID-19 patients undergoing cardiac surgery with cardiopulmonary bypass.

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6	Patient 7	Patient 8
Demographic characteristics								
Age, yrs	63	65	63	47	46	58	36	62
Sex	F	M	M	M	M	F	M	F
BMI, kg/m ²	36,27	29,2	21,9	32,3	26,1	29,7	24,6	23,2
Baseline patient characteristics								
Cardiovascular risk factors	None	Hypertension, diabetes, dyslipidemia	History of smoking	Diabetes, history of smoking	Hypertension	Hypertension, dyslipidemia	History of smoking	Hypertension
Medical history	Rheumatic fever	None	None	None	None	None	Drug addiction	None
Cardiac Pathology	Mitro-aorticstenosis	Coronary artery disease	Coronary artery disease	Coronary artery disease	Aortic infective endocarditis	Coronary artery disease	Mitro-aortic valve infective endocarditis	Ascending aortic dissection
Leftventricle ejection fraction %	65	63	55	40-45	58	61	70	67
EuroSCORE II	2	3	2	2	0,55	0,69	6,74	7,81
Days from admission to surgery	3	8	6	10	8	7	1	0
COVID-19 diagnosis and symptoms								
Preoperative PCR	Not performed	Not performed	Not performed	Not performed	Negative	Negative	Negative	Not performed
CT of the chest	-	-	-	-	-	-	-	+
Symptoms at infection onset	Cough, dyspnea, fever	Fever, dyspnea	Cough, dyspnea	Fever, dyspnea	Dyspnea, sputum	Fever, dyspnea	Dyspnea, cough, fever	Dyspnea, fever
Days from surgery to symptoms	4	5	3	5	2	2	2	2
Days from surgery to COVID-19 diagnosis	6	7	5	7	4	3	3	3
Analytical parameters at the time of diagnosis								
WBC × 10 ³ /mm ³	12,8	10,9	7,3	8,9	6,7	5,6	15,3	11,2
Lymphocytes × 10 ³ /mm ³	1,6	1,4	2,8	2,2	2,5	2,8	1,2	1,8
CRP mg/l	156	118	98	104	130	94	164	122

Note: BMI: Body Mass Index; PCR: Polymerase Chain Reaction; CT: Computed Tomography; WBC: White Cell Count ; CRP: C-Reactive Protein.

protecting the cardiac patient, protecting the institution and society at large, and protecting the health care team” [1]. Given the large number of infected persons in the third wave of pandemic, our department policy has radically changed. We have established our own internal protocol (before, during, and after surgery) to prevent the spread of COVID-19 infection, but also to protect both patients and the health care workers community. In this regard, we have now a well-defined health care policy for major emergent operations during the COVID-19 pandemic. We have started managing the COVID-19 pandemic by banning the family visitation in which patients may catch the SARS-CoV-2 virus during their hospital stay. Only few visitors are allowed in certain exceptional circumstances particularly in patient with serious condition and this if the visitor can provide a negative recent nasopharyngeal swab.

Before admissions, most of the elective patients should present an RT-PCR before surgery. We advocated that all hospital transfer patients for consideration of surgery receive an RT-PCR on arrival. Patients who were admitted from home and have not been tested are placed in appropriate isolation in separate chambers until the nasopharyngeal swabs are processed. These areas are

adequately sterilized postoperatively. In such areas, health care workers must wear their FFP2 masks and the appropriate personal protective equipment in providing care. Periodic nasopharyngeal swab are performed to health care workers to detect COVID-19 positive individuals and isolate them. If the patient is negative, the operation can be performed with reasonable margin of safety. Positive patients are discharged with instructions to self-isolate if they did not require hospitalization. Otherwise, they are transferred to dedicated COVID unit.

In urgent cases, patients are explored by CT of the chest particularly in aortic disease or they are screened with rapid test with the possibility of having results in less than hour meanwhile having the final results of RT-PCR.

Nevertheless, although RT-PCR has emerged as the test of choice for detection of infected individuals, it doesn't guarantee a total safety and a negative RT-PCR test does not exclude the possibility of COVID-19 infection. There are clearly some patients with mild symptoms or even asymptomatic who are infected with SARS-CoV-2 that will not be detected by the current screening process [9]. These patients may be positive after their second or their third

repeat test while they were negative on their initial testing as can be seen in our patient 5 who was later proven to have been infected with SARS-CoV-2 through RT-PCR examination [10]. This patient was in the hospital for 8 days before he underwent surgery. During these 8 days, there are possibilities of nosocomial infection especially COVID-19 infection or even the patient may be infected from the beginning but he didn't show clear symptoms [1,11].

All patients needing cardiac surgery procedure may be exposed to the virus both before and after operation. We could not determine the date of the exact onset of the infection, yet it would be more lucid to suppose that the large numbers of infected patients have been contaminated after surgery. More data and experience regarding concomitant cardiac surgical procedures and COVID-19 infection are necessary to better guide decision-making for patients undergoing emergent operations and improve the management of this novel disease.

CONCLUSION

As the number of COVID-19 cases continues to rise, it is certain that we will have to live with this new coronavirus for some time with sudden major waves of infection. Performing heart surgery on a COVID-19-positive patient may be very risky for the patient. Actually, the postoperative course could be modified by SARS-CoV-2 infection and inversely the clinical course of COVID-19 infection could be altered by cardiac surgery procedure. Coronavirus disease may represent a major contraindication to surgery; however, urgent cases like acute type A aortic dissection are still problematic and cannot be delayed. With the lack of existing data, it remains inconclusive to suggest such decision.

CONFLICTS OF INTEREST

Authors reported no conflicts of interest.

CONSENT TO PARTICIPATE

Not applicable.

CONSENT FOR PUBLICATION

All the participants are consent.

AVAILABILITY OF DATA

Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

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AUTHORS CONTRIBUTION

All authors read and approved the final manuscript.

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