Original Article

Cardiothoracic Surgery during COVID-19: Our Experience with Different Strategies

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Abstract

Background: An acute respiratory disease (COVID-19), caused by a novel coronavirus (SARS-CoV-2,), has been declared a pandemic by WHO. A surgery on COVID-19 patients not only involves a risk of spread of the disease but also there is a serious concern for the patient's surgical outcomes and resources requirement. **Aim:** The retrospective study is aimed to provide a protocol for pre-operative testing of SARS CoV-2 using RT-PCR in the patient undergoing cardio-thoracic surgeries. **Material and Methods:** To analyze the impact of pre-operative testing of SARS- CoV-2 using RT-PCR in the patient undergoing elective cardio-thoracic surgeries. The patient who underwent surgical interventions during the COVID-19 lockdown period was divided into two phases. Phase I (without COVID-19 RT-PCR testing) and Phase II (with pre-operative COVID-19 RT-PCR testing). The retrospective comparison between the two study groups was done using Student t-test, Mann–Whitney *U*, and Chi square ($\chi 2$) test depending upon the clinical variable to be analyzed. **Results:** During the early phase (phase I), 26 patients underwent cardio-thoracic surgery without COVID-19 RT-PCR test. Whereas, during phase II, all patients were tested for COVID-19 using RT-PCR, preoperatively and a total of 64 surgeries were performed during this phase. One patient planned for CABG was positive on RT-PCR for COVID-19 and was sent to the quarantine ward. The difference in the pre-operative hospital stay between two groups was found to be statistically significant and a significant decrease in the number of PPE kits used, during the phase I. **Conclusion:** All asymptomatic patients should be tested for COVID-19 using RT-PCR prior to cardio-thoracic surgeries not only to contain the disease but to avoid potential implications of COVID-19 on the perioperative course, without added financial implications.

Keywords: *COVID-19, cardio-thoracic surgery, RT-PCR test*

Introduction

The epidemic caused by the severe acute respiratory syndrome coronavirus-2 (SARS- CoV-2) virus, the causative agent of coronavirus disease 2019 (COVID-19), is the third pandemic caused by coronaviruses, the previous being SARS coronavirus-1 (2002) and Middle East respiratory syndrome coronavirus (2012).[1,2] Due to very high infectivity of SARS- CoV-2 and in the absence of treatment and vaccine, healthcare systems are under tremendous pressure. There are several guidelines to optimize the use of resources and triaging of the patients in need of urgent/emergency surgical interventions.[3-5] However, limited recommendations are currently available for the patient in need of cardiac surgeries.[6–9] The patient requiring cardiac surgery, during this COVID-19 pandemic, constitutes an important and critical category because these are highly invasive procedures associated with prolonged hospital or ICU stay. Hence, going ahead with cardiac surgery in COVID-19 pandemic is a challenge. On one side we have risk of mortality/morbidity if surgery is not performed and on other side there is a risk of inpatient Covid-19 infection. This has aroused the interest of the cardiologist/cardiac surgeons to design, develop, and implement guidelines and algorithms, to be followed for elective/urgent/emergency cardio-thoracic surgeries during this ongoing pandemic, while considering relatively progressive nature of cardiac diseases and the consequences associated with deferring such surgical procedures. In addition the risk of COVID-19 spread and transmission to the healthcare worker and to the patient needs consideration. Another challenge for the health care facilities is

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to optimize and rationalize the use of personal protective equipment (PPE) and other resources without escalating the cost of the surgery and hospitalization, to the patient. Considering all the above mentioned challenges, it is important to understand the impact of preoperative testing for COVID-19 in this scenario.

We have been performing around 1500 cardio-thoracic surgical procedures in a year. These may include CABG, valve surgery, vascular surgeries, pediatric and congenital defect repair, and thoracic procedures. This retrospective study is aimed to analyze the impact of pre-operative testing of SARS- CoV-2 using RT-PCR in the patient undergoing elective cardio-thoracic surgeries, on their average hospital stay (pre and post-operative) and rational use of PPE kits by the health care workers. In addition, a preoperative testing algorithm for SARS- CoV-2 with rationalized use of PPE is proposed.

Materials and Methods

To analyze the impact of pre-operative testing of SARS- CoV-2 using RT-PCR in the patient undergoing elective cardio-thoracic surgeries, on their average hospital stay (pre and post-operative) and rational use of PPE kits by the health care workers. The patients who underwent surgical interventions during the COVID-19 epidemic were divided in two phases. Phase I (without COVID-19 RT-PCR testing), includes the patients operated upon, during the initial phase of the lockdown, without being tested for COVID-19, taking all standard precautions as laid down by Indian Council of Medical Research (ICMR) in view of the pandemic [Flow Chart 1]. On the other hand, Phase II (with pre-operative COVID-19 RT-PCR testing phase) includes the patients, who were preoperatively tested for COVID-19 using RT-PCR, during the later phase of the lockdown [Flow Chart 2]. ICMR approval for COVID-19 RT-PCR testing at our own institute facilitated surgical protocol followed during phase II. The effectiveness of both protocols were assessed and compared to each other. The average pre-operative stay of patients (from admission to the surgical procedure), post-op hospital stay (from surgical procedure to discharge from hospital) and number of additional PPE kits (face protection glasses and mask or face shield, gloves, gown or coverall, head cover, shoe covers) used in view of current pandemic was analyzed. Institute ethical committee permission was taken to conduct this study (letter no. 531).

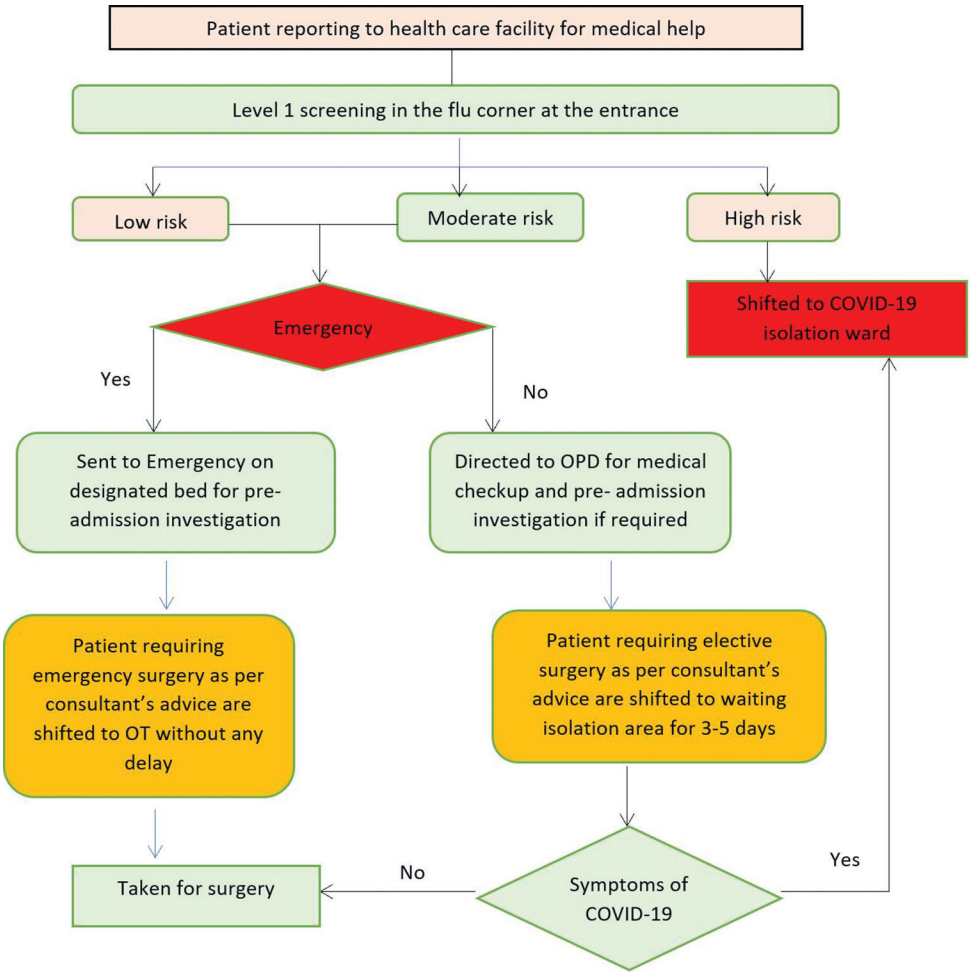
Phase I

- ***Screening before admission (first line screening):*** Admission to the hospital is either through OPD or through emergency. Any patient reporting to hospital undergoes thermal screening and a detailed contact and travel history relevant to COVID-19, at the entrance of the hospital
- ***Categorizing patients:*** Based upon evaluation at the first line screening, all patients were divided into three groups: high risk, moderate risk, and low risk of being infected with COVID-19
  - ***High-risk patients****:* Symptomatic (fever, sore throat, cough, shortness of breath) with a history of travel to COVID-19-affected area/resident of COVID-19-affected area or contact with COVID-19 patient
  - ***Moderate risk patients****:* Asymptomatic with a history of travel to COVID-19-affected area/resident of COVID-19-affected area and/or elderly people (above 65 years) and/or hypertensive, diabetic, asthmatic, and immuno-compromised patients
  - ***Low risk patients:*** An asymptomatic patient not falling in above two categories
  - High-risk patients are shifted to COVID-19 isolation ward created for COVID-19 suspected patients and taken care off as per guidelines laid down by ICMR. Low and moderate risk patients were directed to OPD or emergency as per clinical requirement of the patient, for initial workup, taking all standard precautions, considering all these patients as potential carrier of COVID-19
- In case there was an urgent requirement of surgical intervention, patient was shifted on designated bed for pre-admission investigation and taken up for surgery, without any delay. Patient coming through OPD and after the initial investigation requiring any elective surgery, as per consultant's advice are shifted to waiting isolation area for 3–6 days (depending upon the risk of COVID-19 involved/severity of the disease/emergency of the required surgical intervention). During the waiting period, if the patient develops any signs and symptoms of COVID-19, the patient is shifted to COVID-19 isolation ward and taken care accordingly. However, in the absence of any presenting symptom during the waiting period, patient was taken up for surgery. All the surgeries were performed using full PPE and taking other necessary precautions in view of COVID-19 [Flow Chart 1].

Note: Operating surgeon, surgeon assistant, surgical nurse were wearing sterile plastic apron and sterile surgical gown apart from face shield and mask (N-95) and shoe cover. The PPE kits were worn by floor sister, anaesthesiologist, perfusionist, technician, and floor helper.

Phase II

- The initial protocol for screening and categorization of the patients at the entrance of the health care facility was the same as followed during the Phase I. All the patients requiring any surgical intervention or admission to the health care facility were subjected to COVID-19 testing. Nasopharyngeal swab of all these patients were collected, and immediately sent to the laboratory for COVID-19 testing using RT-PCR



Flow Chart 1: Protocol followed for cardiac surgery (Phase 1: without COVID-19 testing) during COVID-19 pandemic. (Note: All the surgeries were taken up using full PPE and other necessary precautions during, pre and post-operative period)

- The patient requiring emergency surgery after the initial workup and pre-admission investigation, were taken up for surgery, without waiting for COVID-19 report. Patient coming through OPD and after the initial investigation requiring any elective surgery, as per the decision of the treating cardiologist/cardiac surgeon were shifted to waiting/isolation area till the time report was awaited (Turnaround time – 12–24 h). If the patient was reported COVID-19 positive, the patient was shifted to COVID-19 isolation ward and taken care of accordingly. However, if the patient reported negative for COVID-19, was taken up for surgery. All the emergency surgeries were taken up using full PPE and other necessary precautions. If patient tested negative for COVID-19, the use of PPE and other precautions were optimized [Flow Chart 2].

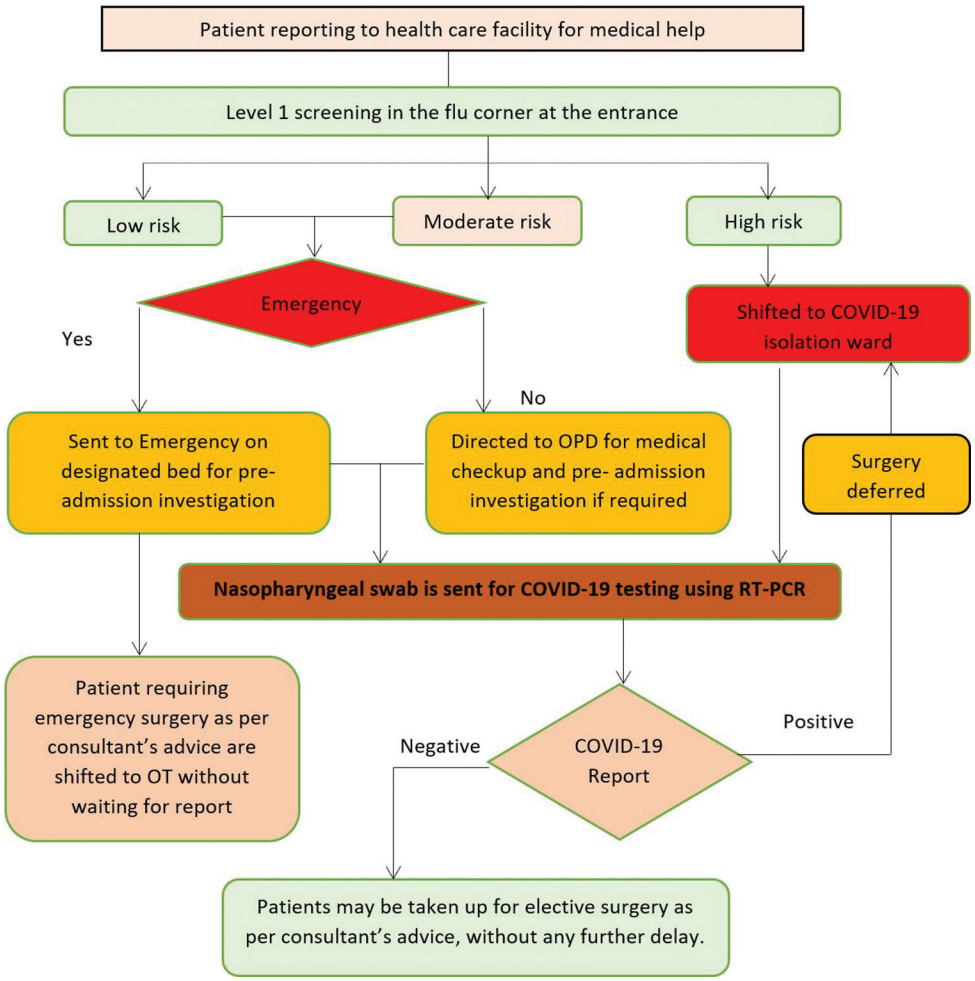
Note: Only the operating surgeon, surgical assistant and scrub nurse wore the sterile sets as earlier but the floor sister, helpers and anesthesiologist did not wear the PPE kits.

Anesthesia protocol

All the patients underwent bedside pre-anesthesia check-up. All necessary precautions were taken to prevent the aerosol-based spread of virus, for example, use of a self-designed intubation box and use of video assisted laryngoscopy. Intermittent positive-pressure ventilation (IPPV) during pre-oxygenation before intubation was avoided. Only one consultant and one technician were allowed in the operation theatre and were not supposed to come out till the patient was shifted out. Anesthesiologists donned the complete PPE kit during first phase of the study; however use of PPE kit was rationalized during the second phase.

Surgical protocol

All CABG were done on beating heart and without use of extra corporeal circulation (ECC). As a standard protocol, 95% of CABG patient received total arterial conduits (bilateral internal mammary arteries). Out of 70 patients, three patients received vein grafts in addition to mammary arteries. Valvular surgeries and atrial septal



Flow Chart 2: Protocol followed for cardiac surgery (Phase 2: with COVID-19 testing) during COVID-19 pandemic. (Note: All the emergency surgeries were taken up using full PPE and other necessary precautions. If patient tested negative for COVID 19 the use of PPE and other precautions can optimized)

defects (ASD) were performed using extracorporeal circulation (ECC) as standard procedure.

Visitor screening

Only one attendant was allowed to visit the patient twice a day for a period of half an hour. All the visitors were screened clinically at the entry and their travel history and contact details were meticulously noted. Any visitors with the positive relevant history and symptoms were not allowed.

Post discharge follow-up

All the patients were followed-up on an average for 5 weeks; either by hospital visit or by consultation through telemedicine.

Nucleic acid amplification tests for viral RNA

Nasopharyngeal swab specimens were used for the detection of SARS COV-2 RNA using real time polymerase chain reaction (RT-PCR). The specimen was collected in a viral transport media and is transported to microbiology lab as per ICMR guidelines. Viral RNAs extracted from the specimen using an ICMR approved viral RNA extraction kit and was amplified using reverse transcription-PCR. A cycle threshold value (Ct-value) less than 37 was defined as a positive test and Ct-value of 40 or more was defined as a negative test. At a Ct-value of 37 to 40, retesting is recommended for confirmation.[10-11]

Statistical analysis

The data obtained were presented as a mean ± standard deviation, frequencies (number of cases), and relative frequencies (percentages) as appropriate. For independent quantitative variables, comparison between the two study groups was done using Student t-test and Mann–Whitney *U* test for parametric and non-parametric data, respectively. For comparing categorical data, Chi square ($\chi 2$) test was performed and exact test was used when the expected frequency is less than 5. A probability value (*P* value) less than 0.05 was considered statistically significant. All statistical calculations were done using Statistical Package for the Social Science (SPSS, version 21).

Results

A total of 845 patients were admitted in the cardiac unit of our hospital during Phase I & II. Out of these, 91 patients

were scheduled for surgical procedures during both the phases.

Phase I (without RT-PCR testing)

During early phase of lockdown (Mar 23–April 18, 2020) a total 26 patients underwent surgical procedures, including both elective and urgent surgeries. These surgeries included, coronary artery bypass grafting (CABG), valvular surgery (AVR), pericardial window creation, tracheal repair, arterial embolectomy, and left atrial myxoma excision [Table 1]. All the CABG cases were of unstable angina and needed urgent surgery. All cases during this phase were taken up without COVID-19 RT-PCR test. Out of 26 surgical procedures performed during first phase, no mortality or morbidity was reported.

Phase II (with RT-PCR testing)

During phase II, all patients were tested for COVID-19 using RT-PCR. The surgeries for these patients were planned based on the severity of the disease. A total of 64 surgeries were performed during the Phase-II (April 19 to May 29, 2020) of this retrospective analysis, with CABG as the predominant procedure undertaken [Table 1]. All the patients requiring CABG had acute coronary syndrome or unstable angina or severe left ventricular dysfunction for which urgent surgery was indicated. However one of these patients with unstable angina has to undergo CABG for the second time. The patients requiring valvular surgeries were in grade 3/4 of dyspnoea and required urgent surgery whereas embolectomies were done as limb saving procedure. One lower segment cesarean section (LSCS) was also performed, as the patient had peripartum cardiomyopathy and required extensive monitoring during the procedure. Incision and drainage were done for pacemaker placement site hematoma drainage.

During phase II of the study, a patient, operated for aortic valve replacement with repair of co-arctation of aorta expired of myocardial failure. This patient had very poor left ventricle function. Renal dysfunction was the only perioperative morbidity and which was managed pharmacologically without dialysis. All patients were discharged in stable and healthy condition from the hospital. None of the patient required post-op intra-aortic balloon pumps (IABP), prolonged ventilation, continuous renal replacement therapies (CRRT), prolonged high doses of ionotropes or reintubation.

During the Phase II, one patient, requiring elective procedure was tested positive for COVID-19. As his cardiac condition was stable, the surgery was deferred and was shifted to COVID-19 isolation ward. The patient was discharged after two subsequent nasophryngeal swabs tested negative for COVID-19 RT-PCR, collected 48 h apart. (As per prevailing ICMR guidelines) Hospital staff that came in contact with the said patient was screened and quarantined depending on high/low risk. High risk contacts were tested for COVID-19 using RT-PCR after 7 days of quarantine. All of them were reported negative and allowed to resume their duties.

Post-discharge follow-up

No morbidity was reported during the average 5 week follow-up period and none of the patients presented with any symptoms of COVID-19 after discharge from the hospital.

Statistical analysis

Age and sex

Out of 90 surgical patients, the youngest patient operated was of 17 yrs. and the oldest was of 85 yrs. The average age of the patients in Phase I was 55.5. ± 14.7 years and in phase II it was 58.03 ± 14.2 yrs. This age difference between the two groups was not statistically significant (*P value > 0.05).* Number of male patients was predominant over the number of female patients during both the phases of the study. However, the difference in the distribution of male and female patients during the two phases of the study was not statistically significant (*P value > 0.05*) [Table 2].

Average Pre/post-operative hospital stay of patient

The average pre-operative hospital stay of patients was 3.38 ± 1.8 in during the phase 1 and it was 2.61 ± 1.3 days during phase II of the study. This difference in the pre-operative stay between two groups was found to be statistically significant (*P value < 0.05*). There was no significant difference in the post-operative stay between the two groups (*P* value > 0.05) [Table 2].

Table 1: Profile of surgical procedures performed during phase I and phase II

Type of Surgery	Phase I	Phase II	Total
Coronary artery bypass grafting (CABG)	20	51	71
Valvular surgeries	1	5	6
Atrial septal defect (ASD) repair	0	3	3
Pericardial window creation	2	2	4
Resection of left atrial myxoma	1	0	1
Tracheal repair	1	0	1
Arterial embolectomy	1	0	1
LSCS (peripartum cardiomyopathy)	0	1	1
Incision & drainage of hematoma	0	2	2
Total	26	64	90

Table 2: Statistical analysis between phase I and phase II

	Phase I	Phase II	$\chi^2/t/U$	*P*
Age#	55.5±14.7	58.03±14.2	0.757	0.451
Sex♦: Female/Male	4 (15.4%) 22 (84.6%)	15 (23.4%) 49 (76.6%)	0.720	0.396
Pre-op hospital stay*	3.38±1.8	2.61±1.3	2.297	0.024
Post-op hospital stay*	7.19±3.2	7.31±2.8	0.064	0.949
PPE Kits used/patient*	3.96±0.5	1.17±0.6	7.996	0.001

#*t*-test; ♦χ^2 test; *Mann-Whitney U test

Number of PPE kits used

The average use of PPE kits were3.96 ± 0.5 during phase I whereas, the average number of PPE kits per patient used during the phase II were1.17 ± 0.6. The decrease in number of PPE kits used during the phase II was statistically significant (*P value < 0.05*) in comparison to the PPE kits used during the phase 1 [Table 2].

Discussion

A newly identified β-corona virus, SARSCoV-2 has been found to be associated with many cases of pneumonia reported from Wuhan, China during Dec., 2019. Despite the best of the efforts by most the countries to contain COVID 19, the disease has been declared an international emergency and subsequently a pandemic by WHO.[2,12] Patients of COVID-19 typically present symptoms of fever, sore throat, cough, dysponea, fatigue, and muscle pain[13-14], although a large number of patients can be asymptomatic too[15,16]. In India, the first case of COVID-19 was reported on March 9, 2020 and thereafter it continued to spread its wings through-out the country, despite proactive measures taken up by the Government of India.

The guidelines for management of COVID-19 positive patient were changing very frequently as the knowledge about the progression of the disease was based mainly on the recent experience gained from different cases. This situation was unique for cardiac surgeons and the patients in need of cardiac procedures. On one hand, there was a risk of spread of disease from patient to health care providers and vice-versa. On the other hand, there was a serious concern regarding the possibility of morbidity and mortality associated with continuation of conservative management of these cardiac patients requiring surgical intervention. In view of the escalated resource requirement for cardiac surgery during the COVID-19 era; the impact of pre-operative COVID-19 testing, optimal utilization of the PPE kits and pre/post-operative hospital stay was evaluated in the present study.

Several recommendations have been published on how to rationalize the available resources and triage patients requiring emergency care. Based upon these recommendations all elective surgical procedures have been postponed throughout the United States of America.[3-4,7-8] American College of Surgeons has also provided recommendations for cardiac procedures that can be safely postponed or needs prioritization, based upon high, low and intermediate acuity of the disease. Similar to the categorization followed in present study, they have also categorized the patients into three categories based upon the risk of COVID -19 infection involved in asymptomatic patients.[9] However, incidence and prevalence of COVID-19 was entirely different in USA compared to the situation in India at the time of present study with no community transmission documented. To our knowledge, there were practically no recommendations available for adult cardiac surgery patients, as far as Indian scenario was concerned. In the present study, a total of 90 patients' underwent surgical intervention during the study period at our cardiac surgery unit. Out of these, 26 patients had surgeries without preoperative COVID-19 testing during Phase I as there was no facility for testing during that time. The remaining 64 patients were operated with pre-operative COVID-19 testing during Phase II. Nevertheless, based upon the acuity of the need for surgical procedures, triaging of the surgeries was done. Patients in need of emergency surgeries were operated upon without any delay during both the phases of the study in the absence of COVID-19 test report while taking all precautions in view of COVID-19. During phase I, patient requiring an elective surgery were shifted to waiting isolation area for 3–6 days(depending upon the risk of COVID-19 involved/severity of the disease/emergency of the required surgical intervention). However during phase II, patients were shifted to waiting/ isolation area till the time COVID-19 RTPCR report was awaited. If the patient reported COVID-19 positive, the patient was shifted to COVID-19 isolation ward and taken care of accordingly. Else the patient was taken up for surgery if reported negative for COVID-19. A similar strategy on triaging of patients undergoing cardiac surgery and their pre-operative SARS-CoV-2 testing has also been recommended [9].

Pre-operative testing of the nasopharyngeal swab specimen of the patient for COVID-19 using RT-PCR may marginally add to the cost but with many advantages. A previous study from USA has shown that PCR testing is an effective strategy to restart endoscopic practice in the United States. Their findings support the testing of all patients requiring endoscopy. They also emphasized that all urgent endoscopies should be performed irrespective of testing result.[17] A comparable strategy has been used in the present study for taking up cardiac surgeries. In addition, a recent evidence-based study suggested that the surgery performed on patients in their incubation period of COVID 19, accentuated disease progression of COVID 19 and these patients were more susceptible to pneumonia and ARDS. Hence knowing a patient who had pneumonia status may help with postoperative management of the patient.[18] Nahshon *et al*. has also emphasized the need for mandatory pre-operative COVID-19 testing using RT-PCR to avoid potential hazardous implications on the peri-operative course.[19] Although, local prevalence rates and the availability of test kit with high sensitivity and specificity were the important contributing factors to determine the success of the protocol followed in the present study. In our study, all the patients during phase II were tested for COVID-19 using RT-PCR test (Altona diagnostic, Germany) which has an efficiency >96% and limit of detection (LOD) is 3.8 RNA copies/ml of the specimen for both the genes (E-gene and S-gene). This

is lowest in comparison to the other kits available in the market.[11] However, there is a probability of false negative results that may occur due to incorrect sampling, which was addressed by proper training and education of healthcare staff.[20-22] Zhen *et al*. have also affirmed that the availability of a reliable screening test (s) for COVID -19 is one of the main prerequisites for returning to elective surgeries and it forms the foundation of a safe and successful reboot. They have also highlighted the importance of appropriate case selection and prioritization keeping in view the escalated need of resources.[5] Al-Muharraqi on the other hand recommends a relatively more extensive test strategy for the patient to be taken up for elective surgeries, that is, both RT-PCR and antibody detection should be carried out pre-operatively. If RT-PCR is positive and antibody test is negative, the surgery should be deferred. Else, if RT-PCR is negative and antibody test positive or if both tests are negative, patient may be taken up for surgery.[23]

During phase–I of the study, the preoperative hospital stay was extended for the patients who had a moderate risk of infection with COVID-19 and required elective surgeries. This was to wait for appearance any symptoms in the absence of COVID-19 testing, in case the patient was in incubation. However, mandatory pre-operative testing of all the patients during the phase II of the present study decreased the average pre-operative hospital stay and usage of PPE kits significantly. This substantially decreased the cost of surgery for the patient, in addition to the other advantages discussed earlier. Nevertheless, knowing COVID-19 status of the patient pre-operatively will also optimize the resources during post-operative care of the patient, though this aspect has not been evaluated in the present study.

Conclusion

To conclude, elective cardiac surgery is challenge during COVID-19 pandemic. We recommend that the pre-operative COVID-19 testing should be mandatory as discussed in phase II protocol, to take up this challenge under the current situation. In addition, testing on all surgical patients, pre-operatively can also help in containment of the pandemic and can decrease the risks to patients and health care workers, without adding much cost to the surgery.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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