ORIGINAL RESEARCH

Cardiovascular complications in recovered COVID-19 patients: A prospective observational study

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ABSTRACT

Introduction: The COVID-19 caused by novel single-stranded RNA enveloped severe acute respiratory syndrome coronavirus-2 first appeared in Wuhan, China. Presence of cardiovascular complication had shown to be a significant contributor of increased fatality in COVID-19 patients. Cardiac injury was seen in studies reported from the national health commission which reported elevated T-troponin (TnT) levels and/or new onset of electrocardiographic (ECG) /echocardiographic abnormalities in COVID-19 recovered patients. Hence, this study evaluated the cardiac changes in recovered COVID-19 positive patients by 2D echocardiogram. **Material and Methods:** In this prospective, observational study, 139 participants recovered from COVID-19 illness were identified and recruited after obtaining the Informed concerned form. The patients once enrolled were subjected to 2D echo and ECG as part of routine clinical practice. **Results:** Among 139 patients, 89 (64.03%) were males and the rest were females. Based on severity scale 13 (9.35%) participants had suffered severe form of COVID-19 infection. Left ventricular ejection fraction (LVEF%) was found to be normal in all the 139 participants. Left ventricular global strain (LVGLS) was found to be abnormal in 70 (50.36%) participants. Similarly on right ventricular functional assessment, right ventricular global strain (RVGLS) was found to be abnormal in 72 (51.80%) participants. Arrythmias was reported in 31 (22.30%) participants, among them 30 participants had sinus bradycardia. **Conclusion:** Our study demonstrates the association between COVID-19 and cardiac changes/ incidence of cardiovascular complications in recovered COVID-19 patients and provides first hand evidence of the incidence of abnormal LVGLS and RVGLS in COVID-19 recovered patients

Key words: COVID-19, 2D echo, left ventricle, right ventricle

INTRODUCTION

The corona virus disease of 2019 (COVID-19) is a global pandemic because of the unusually fast rate of spread. It is caused by novel single-stranded RNA enveloped Severe acute respiratory syndrome coronavirus -2 (SARS CoV-2).[1] Pulmonary complications of COVID is well reported till now. The presence of cardiovascular complications needs to be evaluated, which can be a significant contributor of increased fatality in COVID-19 patients.[2] According to several case report, cardiovascular associated clinical manifestations includes myocarditis [3,4], arrhythmias, veno-thromboembolic events, acute coronary syndrome (ACS)[5] and pericarditis.[6] An early diagnosis of cardiac injury was seen in Chinese studies reported from the national health commission almost 11.8% of patients without underlying cardiovascular disease had cardiac injury during hospitalization, showed by elevated T-troponin (TnT) levels and/or new onset of electrocardiographic (ECG) /echocardiographic abnormalities.[7] Similarly, retrospective studies in hospitalized COVID-19 patients revealed a greater requirement of both non-invasive and invasive mechanical ventilation and higher mortality rate due to severe respiratory diseases in patients with cardiac injury.[8,9] This background indicates that SARS-CoV-2 infection is associated with a wide range of cardio-vascular complications. Hence this observational study was intended to evaluate the effects on cardiovascular system of recovered COVID-19 infection patients post recovery from the infection.

MATERIAL AND METHODS

The research study was a prospective, single centre, observational study. Male and female subjects aged 18

years & above who tested positive for COVID-19 through the RT-PCR diagnostic test for COVID-19 and had recovered from COVID-19 infection and visited the hospital within 3 months of recovery or who underwent treatment for COVID-19 at hospital or in home isolation were included in study. Subjects whose cardiovascular condition can be attributed to other cardiac complications except COVID-19 infection or those who had pre-existing cardiac conditions were excluded from study. The patients who qualified for the study based on the inclusion and exclusion criteria were enrolled into the study after obtaining written informed consent from the patient. Total of 139 recovered COVID-19 infection patients were evaluated. After subject enrolment, Medical history, vitals and other parameters were recorded.

Data Collection

The data was collected from the diagnostic findings such as 2D echo &ECG and entered into paper case report forms (CRF). Data collected include demographic details such as age, sex, height, weight, etc., medical history, medication history, and diagnostic findings (2D echo and ECG). The 2D echo was performed by two independent observers to omit any interobserver variability. In case of any discrepancy or disagreement in 2D echo results by independent observers, a third opinion was taken from a qualified professional. The outcomes as elucidated above were recorded and evaluated.

Data Analysis

All statistical analysis was performed using the software 'STATA version 15.0'. All data was summarized descriptively. For continuous variables, data was represented using means ± SD. For categorical data, the number and percentages were used in the data summaries.

RESULTS

The mean age of the participants was 38.57 ± 12.10 years. Among these 139 COVID-19 recovered patients 64.03% (89) were males and rest were females. A major proportion of 77.70% (108) study population was reported to have mild type of COVID-19 severity followed by 12.95% (18) having moderate type and 9.35% (13) suffering from severe form of COVID-19 as shown in Table 1.As shown in graph1, 28.78% (40) of study population was found to be obese. While Hypertension (HTN), diabetes mellitus (DM), and hypothyroidism with 27 (19.42%), 12 (8.63%), and 10(7.19%) were the second, third and fourth most common medical conditions present in our study population, respectively. ECG was performed on 139 (100.00%) patients and on only 60 (43.16%) patient's chest X-ray was performed.

The mean LVEF% was 66.29 ± 9.10%, and as shown in table 3 all the 139 (100%) study participants were having a normal LVEF%. As we can see clearly from table 2, echocardiogram- 2D speckle imaging (2D-SI) and tissue doppler imaging (TDI) parameters were assessed in all the patients to evaluate the global longitudinal strain for left ventricular function (LVGLS). More than half (50.36%) of the study population was reported to have an abnormal LVGLS.

Normal left ventricular (LV) systolic function was observed in 100.00% (139) patients. As table 3 clearly demonstrates none of the cases were reported for deranged LV diastolic function. Whereas 51.80% (72) COVID-19 recovered patients were having abnormal right ventricular (RV) dysfunction and abnormal global longitudinal strain for right ventricular function (RVGLS).

In total, 31 (22.30%) patients were diagnosed to have arrythmias and within them a large proportion of 30 patients were reported to be suffering from Sinus Tachycardia as shown in table 4.

Table 1: Demographic details of the patients.

PARAMETERS	N= 139
Age (years)	38.57 ± 12.10
Gender	
Male	89 (64.03%)
Female	50 (35.97%)
Height (cm)	163.52 ± 9.60
Weight (Kg)	69.56 ± 12.39
Body surface area (m^2)	1.70 ± 0.19
Systolic blood pressure (mm Hg)	132.23 ± 17.77
Diastolic blood pressure (mm Hg)	85.14 ± 9.68
Heart rate (Beat/min)	92.56 ± 14.02
Severity in (%)	
Mild	108 (77.70%)
Moderate	18 (12.95%)
Severe	13 (9.35%)

Table 2: Parameters used for assessment of LVEFef and Left ventricular strain.

PARAMETERS	RESULT (N= 139)
LVEF %	66.29 ± 9.10 %
Normal , n (%)	139 (100%)
Echocardiogram- 2D speckle tracking	
GLPS PLAX (%)	17.81 ± 4.17 %
GLPS AP4C (%)	18.04 ± 4.20
GLPS AP2C (%)	17.38 ± 3.99
GLPS Ave (%)	17.78 ± 3.81
Echocardiogram- Tissue Doppler Imaging	
Medial Annulus	
Peak Velocity (S wave) cm/s, n (%)	
Abnormal	3 (2.16 %)
Normal	136 (97.84 %)
Lateral Annulus	
Peak Velocity (S wave) cm/s, n (%)	
Abnormal	3 (2.16 %)
Normal	136 (97.84%)
Anterior Annulus	
Peak Velocity (S wave) cm/s, n (%)	
Abnormal	2 (1.44 %)
Normal	137 (98.56%)
Inferior Annulus	
Peak Velocity (S wave) cm/s, n (%)	
Abnormal	1 (0.72 %)
Normal	138 (99.28%)
Posterior Annulus	
Peak Velocity (S wave) cm/s, n (%)	
Abnormal	4 (2.88 %)
Normal	135 (97.12 %)
RV free wall Annulus (N >9.5)	
Peak Velocity (S wave) cm/s, n (%)	
Abnormal	0 (0.00%)
Normal	139 (100%)
Left Ventricular GLS	-18.11 ± 4.13
Abnormal	70 (50.36)
Normal	69 (49.74%)

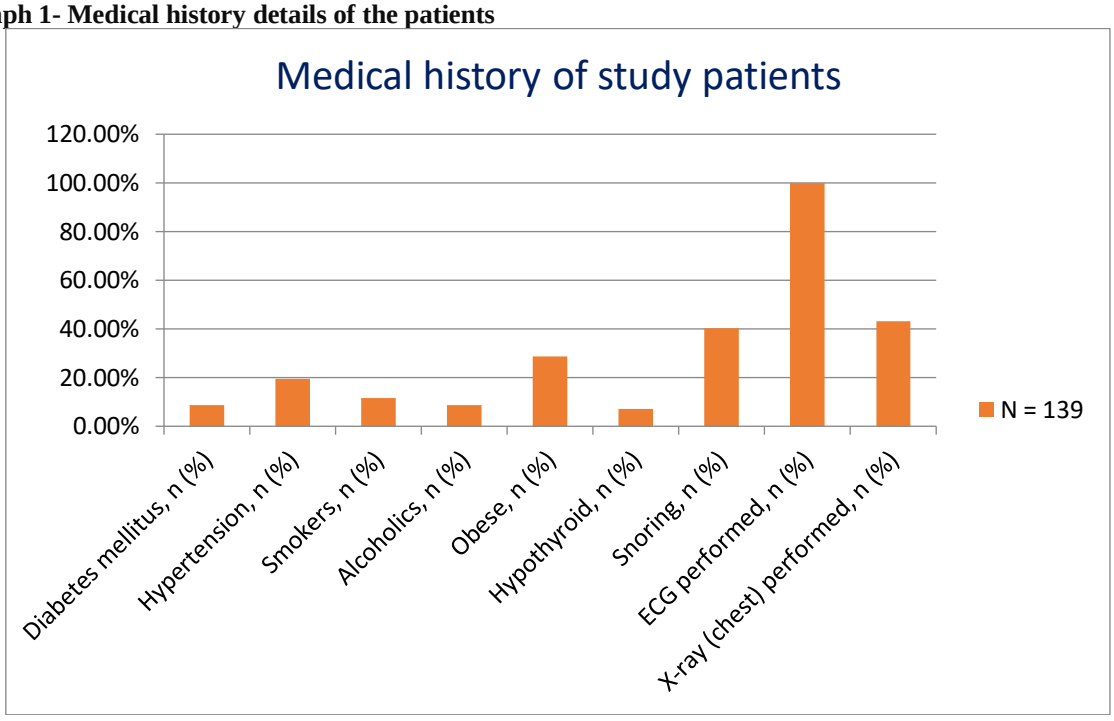
Table 3: Assessment of LV systolic and diastolic dysfunction and right ventricular dysfunction by color flow mapping and doppler studies.

PARAMETERS	RESULT (N= 139)
Normal LV systolic function	139 (100.00 %)
Deranged LV systolic function	0 (0.00%)
Deranged LV diastolic function	0 (0.00%)
LV E/e’	5.90 ± 1.94
Normal	139 (100.00 %)
Abnormal	0 (0.00%)
RV E/e’	4.43 ± 1.47
Normal	103 (74.10%)
Abnormal	36 (25.90 %)
Right ventricular dysfunction	
Normal	67 (48.20%)
Abnormal	72(51.80%)
Global strain of RV, n (%)	
Normal	67 (48.20%)
Abnormal	72 (51.80%)

Table 4: Details of occurrence of arrythmias in patients.

PARAMETERS	RESULT (N= 139)
Arrhythmia	
Present	31 (22.30%)
Absent	108 (77.0%)
Types of arrythmias	
SINUS BRADYCARDIA	1 (0.72%)
SINUS TACHYCARDIA	30 (21.58)

Graph 1- Medical history details of the patients



DISCUSSION

In this prospective observational study of predominantly COVID-19 recovered patients, Echocardiography allows the non-invasive assessment of biventricular function and can provide important insights into possible mechanisms. LV dysfunction, defined as either LV ejection fraction < 50% or global systolic dysfunction was not reported in any patient and LVEF% was normal in all the study subjects. A recent meta-analysis conducted on 7 studies clearly concludes that lower RVGLS, and LVGLS were independently associated with poor outcome in COVID-19 recovered patients [10]. In our study 50.36% of the COVID-19 recovered patients were having reduced/ abnormal LVGLS and 51.80% patients were having reduced or abnormal RVGLS. Lassen et al. also reported lower LV-GLS and RV-LS in patients with COVID-19 compared to those without it.[11] A smaller study showed that there was no significant difference in terms of LV-GLS between those without COVID-19, with COVID-19, and COVID-19 + increased cardiac troponin.[12] Croft et al. study showed that there was no significant difference in terms of LV-GLS in non-survivors compared to survivors, this is likely due to the high prevalence of hypertension in the patients. As hypertension is expected to reduce the LV-GLS.[13,14] Similar to most of the studies conducted in this area of research, [15,16]our study population was also middle aged, pre-dominantly male(64.03%) with 77.01% mild COVID-19 severity. As seen in previously reported studies, this study population also have a high prevalence of co-morbidities like obesity (28.78%), hypertension (19.42%), diabetes mellitus (8.63%), and hypothyroidism (7.9%). Smoking and alcohol consumption was seen more frequently in our study population, when compared to other studies.[17] This study comprehensively evaluate the Right ventricular function using conventional echocardiography and 2DSTE in patients with COVID-19, it is very well known that patients having greater degree of RV strain impairment were more likely to have higher heart rate, more high flow oxygen, higher incidence of acute heart injury, Acute respiratory distress syndrome (ARDS) and higher mortality. Khani M et al. also performed two-dimensional echocardiography and biventricular global longitudinal strain measurement and concluded that RVGLS and LVGLS can be acceptable prognostic factors to predict mortality, ICU admission, and intubation in hospitalized COVID-19 patients.[18]

According to the recommendations of standard guidelines RV function should be evaluated using conventional echo cardiograph- parameters [19] which includes TAPSE, RVFAC%, and S', but recently 2DSTE has also been recommended as a superior method to asses RV function. Zhang Y et al. reported by detecting RV endocardial contours and RV chamber orientation, followed by 3D speckle tracking analysis throughout a cardiac cycle that 3D right ventricular ejection fraction provided a higher predictive value over conventional RV function parameters.[20]

In our study population, a total of 72 (51.80%) COVID-19 recovered patients were found to have abnormal RV strain, various studies revealed that it is a strong prognostic indicator for various cardiovascular diseases,[21,22] and also TV(should it be RV) dysfunction is not only a sign of increased pulmonary pressure but also directly contributes to cardiac insufficiency.

COVID-19 related cardiac arrhythmias was first reported by Wang et al [23] and colleagues, they reported a 17% incidence of arrhythmias. Similar to this report, our study reports 22.30% of arrhythmias in our study population. A study by lei. et al [24] reported a 24% incidence of arrhythmias among COVID-19 patients. In some more severe cases of COVID-19, 60% of cases had arrhythmias. This can be attributed to the fact that SARS-CoV 2 is distinctly classified in the beta coronavirus family, belongs to the same genus as SARS-CoV, and MERS-CoV both of which had a long history of causing cardio vascular complications post - infections .[25,26]

CONCLUSION

Our study demonstrated the association between COVID-19 and cardiac changes/ incidence of cardiovascular complications in recovered COVID-19 patients. This study clearly showed the incidence of abnormal LVGLS and RVGLS in COVID-19 recovered patients, the LVEF % was normal in all the patients and a higher incidence of arrhythmias were also reported. Moreover, this study will guide the clinicians to closely monitor the right ventricular function which in turn will help to manage cardio-vascular complications early.

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