

## Different Modalities to Assess Right Ventricular Function in Post-COVID Taking ST-Elevation as a Gold Standard and Arrhythmias in Post-COVID

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### Abstract

The COVID-19 caused by novel single-stranded RNA enveloped severe acute respiratory syndrome coronavirus-2 (SARS CoV-2) first appeared in Wuhan, China. A lot of focus has been given to pulmonary complications. According to several case reports, cardiovascular associated clinical manifestations include myocarditis, arrhythmias, veno-thromboembolic events, acute coronary syndrome (ACS), and pericarditis. Different modalities in diagnosis like 2D, doppler can help in the early diagnosis of right ventricular function. This study evaluates the cardiac changes in recovered COVID-19 positive patients by 2D echocardiogram and other modalities. In this prospective observational study, 139 participants recently recovered from COVID-19 illness were identified and recruited after obtaining the Informed concerned form (ICF). The patients once enrolled were subjected to 2D echo and ECG as part of routine clinical practice. Out of 139 patients, 89 (64.03%) were males, and the rest were females. Based on the severity scale, 13 (9.35%) participants had suffered a severe form of COVID-19 infection. Right ventricular functional assessment, right ventricular global strain (RVGLS) was abnormal in 72 (51.80%) participants. Arrhythmias were reported in 31 (22.30%) participants; among them, 30 participants had sinus bradycardia. Our study demonstrates the association between COVID-19 and cardiac changes/ incidence of cardiovascular complications in recovered COVID-19 patients. This study provides first-hand evidence of the incidence of abnormal LVGLS and RVGLS in COVID-19 recovered patients. In addition, there was a higher incidence of arrhythmias.

**Keywords:** Cardiovascular outcomes, Post-COVID, Right ventricular function, ST elevation, 2D echocardiography.

### Introduction

The coronavirus disease of 2019 (COVID-19) caused by novel single-stranded RNA enveloped severe acute respiratory syndrome coronavirus-2 (SARS CoV-2) first appeared in Wuhan, China [1, 2]. In March 2020, the World health organization (WHO) officially declared it a global pandemic because of the unusually fast rate of spread [1, 2].

Respiratory symptoms mostly dominate clinical manifestations related to COVID-19, The most common severe complications are acute respiratory disease syndrome (ARDS) and

systemic inflammatory response syndrome (SIRS), which can lead to multiorgan failure (MOF) and shock.

While a lot of focus has been given to pulmonary complications, clinicians need to equally evaluate the presence of cardiovascular complications, which can be a significant contributor to increased fatality in COVID-19 patients.

According to several case reports, cardiovascular associated clinical manifestations includemyocarditis [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 the underlying cardiovascular disease had a cardiac injury during hospitalization, showed by elevated T-troponin (TnT) levels and new onset of electrocardiographic (ECG) /echocardiographic abnormalities [7]. Currently, the underlying mechanism behind the COVID-19 related cardiac injury is not clearly understood. However, various pathophysiological pathways are proposed; multifactorial direct and indirect mechanisms include [8, 9]:

1. Down regulation of ACE2 expression in the heart as demonstrated in a murine model of SARS-CoV-2 infection [10].
2. Cytokine storm.
3. Cyto-toxic effect on macrophages or interstitial cells within cardiac tissue [11].
4. Other mechanisms like low blood oxygen levels or hypoxia can lead to an intracellular influx of calcium ions, resulting in the apoptosis of cardiomyocytes [12].

This background indicates that SARS-CoV-2 infection is associated with a wide range of cardiovascular complications. Hence, this observational study is intended to evaluate Different modalities to assess RV function in post COVID taking STE as a Gold standard.

## Materials And Methods

This prospective, single-center, observational study was planned to evaluate different modalities to assess RV function post COVID taking STE as a Gold standard. The patient was enrolled in the study only after obtaining written informed consent from them. Recruitment of 139 recovered COVID-19 patients was done to evaluate the association between COVID-19 infection and incidence of cardiovascular complications in recovered COVID-19 patients.

The patients who qualify for the study based on the inclusion and exclusion criteria were enrolled in the study after obtaining written informed consent. As mentioned in case report forms (CRF), medical history, vitals, and other parameters were captured at baseline.

The results were recorded in CRF, and the data obtained were analyzed post-completion of the study for all the patients.

## Inclusion Criteria

Subjects meeting with following criteria were included in the study:

1. Male and female subjects aged 18 years & above.
2. Subjects who have tested positive for COVID-19 through the RT-PCR diagnostic test.
3. Subjects who have recovered from COVID-19 infection and visit the hospital within three months of recovery.
4. Subjects who underwent treatment for COVID-19 at the hospital or in-home isolation.
5. Subjects who are willing to undergo the diagnostic tests (2D echo and ECG).
6. Subjects willing to provide informed written consent.

## Exclusion Criteria

Subjects meeting with following criteria were excluded from the study:

1. Subjects whose cardiovascular condition can be attributed to other cardiac complications except for COVID-19 infection.
2. Subjects who have pre-existing cardiac conditions.
3. Subjects with any other illness or health condition in the study investigator's opinion/medical judgment make the subject ineligible to participate in the study.

## Statistical analysis

Following data collection, the obtained data was transferred from paper CRFs into an excel sheet for analysis. All statistical analysis was

performed using the software ‘STATA version 15.0’. All data were summarized descriptively. For continuous variables, data was represented using means  $\pm$  SD. For categorical data, the number and percentages were used in the data summaries.

## Results

A total of 139 COVID-19 recovered patients were enrolled in our study after taking written consent from all the participants for participating in this prospective observational study. The mean age of the participants was  $38.57 \pm 12.10$  years. Among these 139 COVID-19 recovered patients, 64.03% (89) were males, and the rest were females. Thus, a significant proportion of 77.70% (108) study population was reported to have a mild type of COVID-19 severity followed by 12.95% (18) having moderate type and 9.35% (13) suffering from a severe form of COVID-19, as shown in Table 1.

As shown in Table 2, 28.78% (40) of the study population was obese. While Hypertension (HTN), diabetes mellites (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.

51.80% (72) COVID-19 recovered patients had abnormal RV dysfunction and abnormal global longitudinal strain for right ventricular function (RVGLS). (Table 3) These were done using color flow mapping and doppler studies.

In total, 31 (22.30%) patients were diagnosed with arrhythmias, 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)	$38.57 \pm 12.10$
<b>Gender</b>	
Male	89 (64.03%)
Female	50 (35.97%)
Height (cm)	$163.52 \pm 9.60$
Weight (Kg)	$69.56 \pm 12.39$
Body surface area (m <sup>2</sup> )	$1.70 \pm 0.19$
Systolic blood pressure (mm Hg)	$132.23 \pm 17.77$
Diastolic blood pressure (mm Hg)	$85.14 \pm 9.68$
Heart rate (Beat/min)	$92.56 \pm 14.02$
<b>Severity in (%)</b>	
Mild	108 (77.70%)
Moderate	18 (12.95%)
Severe	13 (9.35%)

**Table 2.** Medical History Details of the Patients

Parameters	N = 139
Diabetes mellitus, n (%)	12 (8.63%)
Hypertension, n (%)	27 (19.42%)
Smokers, n (%)	16 (11.51%)
Alcoholics, n (%)	12 (8.63%)

Obese, n (%)	40 (28.78%)
Hypothyroid, n (%)	10(7.19%)
Snoring, n (%)	56 (40.29%)
ECG performed, n (%)	139 (100.00%)
X-ray (chest) performed, n (%)	60 (43.16%)

**Table 3.** Assessment of Right Ventricular Dysfunction by Color Flow Mapping and Doppler Studies

Parameters	Result (N= 139)
Normal LV systolic function	139 (100.00 %)
<b>Right ventricular dysfunction</b>	
Normal	67 (48.20%)
Abnormal	72 (51.80%)
<b>Global strain of R.V., n (%)</b>	
Normal	67 (48.20%)
Abnormal	72 (51.80%)

**Table 4.** Details of Occurrence of Arrhythmias in Patients

Parameters	Result (N= 139)
<b>Arrhythmia</b>	
Present	31 (22.30%)
Absent	108 (77.0%)
<b>Types of arrhythmias</b>	
Sinus Bradycardia	1 (0.72%)
Sinus Tachycardia	30 (21.58)

## Discussion

In this prospective observational study of predominantly COVID-19 recovered patients, Echocardiography allows the noninvasive assessment of biventricular function and can provide important insights into possible mechanisms [13]. A recent meta-analysis conducted on seven studies concludes that lower RVGLS and LVGLS were independently associated with poor outcomes in COVID-19 recovered patients [14]. In our study, 51.80% of patients were having reduced or abnormal RVGLS. Lassen et al. also reported lower RV-LS in patients with COVID-19 than those without it [15]. A smaller study showed that there was no significant difference in terms of RV-GLS between those without COVID-19, with COVID-19, and COVID-19 + increased cardiac troponin [16].

A study showed no significant difference in RV-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 RV-GLS [17, 18].

As most of the studies conducted in this area of research [21, 27-29], our study population was also middle-aged, predominantly male (64.03%) with 77.01% mild COVID-19 severity. As seen in previously reported studies, this study population also has 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 [19, 20].

This study comprehensively evaluates the Right ventricular function using conventional Echocardiography and 2DSTE in patients with COVID-19; it is very well known that patients having a 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.

According to the recommendations of standard guidelines, RV function should be evaluated using conventional Echocardiography- parameters [21] which include TAPSE, RVFAC%, and S', but recently 2DSTE has also been recommended as a superior method to assess RV function.

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, [22-24] and TV dysfunction is not only a sign of increased pulmonary pressure but also directly contributes to cardiac insufficiency.

COVID-19 related cardiac arrhythmias were first reported by [25] and colleagues; they reported a 17% incidence of arrhythmias. Like this report, our study reports 22.30% of arrhythmias in our study population. A study by

[26] 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 cardiovascular complications post-infections [27-29].

## Conclusion

Our study had demonstrated that there is a high incidence of cardiovascular complications in recovered COVID-19 patients by assessing their RVGLS. Accordingly, the present study also revealed the importance of utilizing standard diagnosing tools like 2D-echocardiogram and electrocardiogram to monitor cardiovascular-related complications in recovered COVID-19 patients.

## Conflicts of Interest

We have no conflict of interest to declare.

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