International Journal of Advances in Medicine
Adiga KB et al. Int J Adv Med. 2022 Apr;9(4):468-472
http://www.ijmedicine.com
pISSN 2349-3925 | eISSN 2349-3933
DOI: https://dx.doi.org/10.18203/2349-3933.ijam20220786

Original Research Article

A study on echocardiography findings in severe COVID-19 pneumonia patients

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Received: 20 February 2022
Accepted: 08 March 2022

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ABSTRACT

Background: Whilst the COVID-19 predominantly affects the respiratory tract, it is also observed to cause a wide range of cardiac complications. Accordingly, the ECHO findings range from specific regional wall motion abnormalities to different degrees of global cardiac dysfunction. Thus, there is a need to better understand the interactions between COVID-19 and the cardiac functions.
Methods: In this retrospective observational study, 86 subjects admitted with severe COVID-19 pneumonia were considered. Those with pre-existing heart-diseases were excluded. The ECHO parameters were assessed as right heart or left heart abnormalities; they were correlated with Inflammatory markers.
Results: Right heart abnormality was the most common finding (51.1%). 23% had combined right and left heart abnormalities, 4.6% had left heart abnormality, rest 21% had a normal 2D-ECHO findings. 55.8% had evidence of pulmonary hypertension. RV dilatation and dysfunction is associated with a pro-thrombotic, inflammatory state reflected by elevation of CRP and D-dimer levels; however, these ECHO findings did not correlate with increase in marker levels ($p=0.227$, >0.05).
Conclusions: RV dysfunction is more common than LV dysfunction among COVID-19 patients. 2D-ECHO findings may serve as a useful guide in optimization and modification of treatment strategies in critically ill COVID-19 patients, but are not independent predictors of mortality ($p=0.09$, >0.05).

Keywords: COVID-19, Echocardiography, Inflammatory markers

INTRODUCTION

First seen in Wuhan, China at the end of 2019, a novel coronavirus, named severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2), became responsible for a pandemic acute respiratory disease around the world, for which world health organization (WHO) termed as COVID-19 "Coronavirus disease 2019". Whilst the SARS-CoV-2 responsible for COVID-19 predominantly affects the respiratory tract, patients with cardiovascular risk factors or known cardiac disease and those with elevated cardiac biomarkers appear to be more susceptible and to have a worse prognosis.[1]

It is observed that COVID-19 can cause a wide range of cardiac complications including acute myocardial infarction, myocarditis and takotsubo cardiomyopathy.[2-4] Accordingly, the echocardiographic findings range from specific regional wall motion abnormalities of the left ventricle (LV) or RV to different degrees of global cardiac dysfunction related to myocarditis or a systemic deregulated inflammatory response.[5] Thus, there is an urgent need to better understand the interactions between COVID-19 and the cardiac functions.

Echocardiography is well placed for the further understanding, being inexpensive, portable, and widely accessible. Echocardiography thus plays crucial role

indistinguishing various patterns of involvement, guiding therapeutic approaches, and tracking the clinical response over time. Hence this study was conducted to understand the bed side transthoracic echocardiograpgy (TTE) findings and its correlation with the inflammatory markers such as D dimer and CRP, in patients who are admitted with severe COVID-19 pneumonia, at a tertiary care hospital in Bangalore.

METHODS

In this retrospective observational study, conducted at intensive care unit (ICU) at Victoria hospital, Bangalore medical college and research institute, Bengaluru, 86 subjects admitted between May to August 2021, with microbiologically confirmed severe COVID-19 pneumonia, above the age of 18 years and underwent Bedside transthoracic echocardiography were considered for the study. Those with pre-existing ischemic heart disease/valvular heart disease/congenital heart disease were excluded from the study. Microbiological confirmation of COVID-19 infection was done by reverse-transcriptase-polymerase chain reaction (RT-PCR) or rapid antigen testing (RAT) for COVID-19. The grading of severity of COVID-19 was done based on WHO COVID-19 disease severity as per WHO COVID-19 clinical management guidelines. The echocardiographic parameters that were considered for the study were:chamber-size and shape, valves, ejection fraction (%), pulmonary artery systolic pressure (PASP in mmHg), presence or absence of pericardial effusion, clots or vegetations.

These ECHO parameters were assessed as right heart or left heart functions and abnormalities; they were correlated with inflammatory markers.

All these data were collected from the available data sources, compiled and a case reporting form was created for each patient. These data were compiled in the MS-Excel format into tabular forms and used in further statistical Analysis. Continuous numeric variables were expressed as means or medians and categorical variables were expressed as frequency (percentage).

The echocardiography findings were further interpreted and discussed so as to reason the pathophysiology of cardiac complications in patients with severe COVID-19 infections and explore the further treatment options in the patients of COVID-19 with cardiac abnormalities. These ECHO parameters were then correlated with inflammatory markers of COVID-19 infection.

RESULTS

In this retrospective observational study, conducted at intensive care unit (ICU) at Victoria hospital, Bangalore medical college and research institute, Bengaluru, it was observed that among the 86 subjects with microbiologically confirmed COVID-19 severe pneumonia 48% (n=42) of the patients were males and 52% (n=44) were females (Figure 1). The mean age of the subjects at presentation was 51.5 years (Range: 25-84 years).

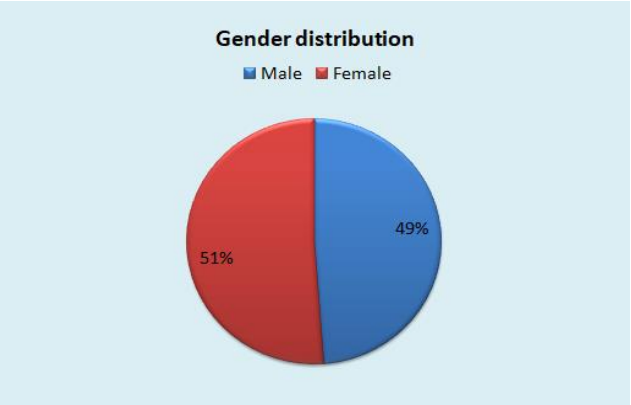

Figure 1: Gender distribution of patients.

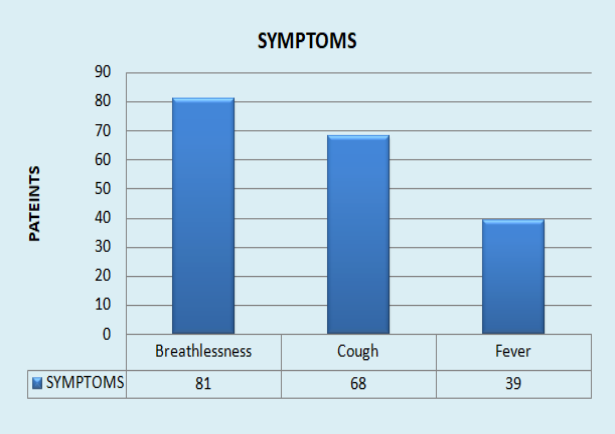

Figure 2: Symptomatology of patients at presentation.

Breathlessness was the chief presenting complaint in majority of the subjects (94%, n=81), followed by cough (79%, n=68) and fever (45%, n=39) (Figure 2). The 83% (n=72) of the subjects had one or more comorbid conditions, excluding those with ischemic/ valvular/ congenital heart diseases who were excluded from the study. The most common co-morbid condition was hypertension (47%, n=41) followed by diabetes mellitus (39%, n=34) and chronic kidney disease (22%, n=19) COPD in 9 patients (10.4%). Among the other conditions, 9 (10.4%) patients had hypothyroidism, 12 (14%) patients had history of cerebrovascular accident in the past, 4 (4.6%) patients had tuberculosis (Pulmonary/ extrapulmonary), 3 (3.4%) had pneumothorax and empyema, 1 (1.2%) had cancer and 4 (4.6%) patients had sino-nasal mucormycosis (Figure 3).

The mean hemoglobin concentration (Hb%) was 11.7 mg/dL, mean total leukocyte count (TLC) was 13,200 cells/cumm, mean neutrophil to lymphocyte ratio was 8.3, mean platelet count was 2.2 lakh cells/cumm.

Inflammatory biomarkers: C-reactive protein levels were eleveated in 97% (n=84) of the subjects, and the mean CRP levels were 89.3 mg/L. 94% (n=81) of the patients had elevated D-Dimer values and the mean D-Dimer levels were 2.68 microgram/mL. Ferritin levels were increased in 79% (n=68) of the patients, and mean ferritin levels were 669 nanogram/mL. Lactate dehydrogenase levels were raised in 82.5% (n=71) of the patients, and mean LDH was192 IU/L (Table 1).

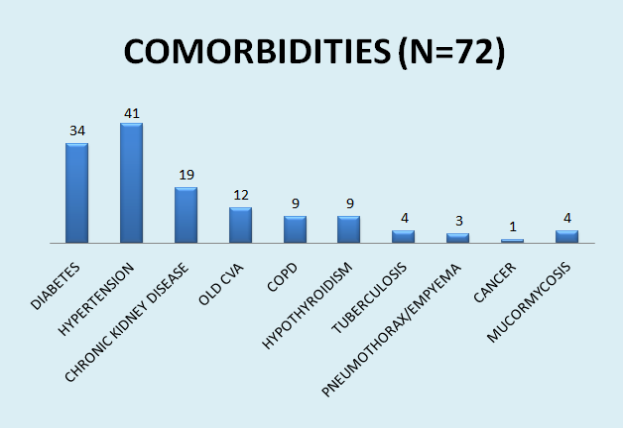

Figure 3: Comorbid conditions in patients admitted with severe COVID-19 pneumonia.

Bedside trans-thoracic echocardiography findings were recorded and was found to be normal in 21% of the patients (n=18), isolated left heart abnormality was seen in 4 patients (4.6%), isolated right heart abnormality was seen in 44 patients (51.1%), combined left and right heart abnormality was seen in the 20 patients (23%) shown in the Figure 4.

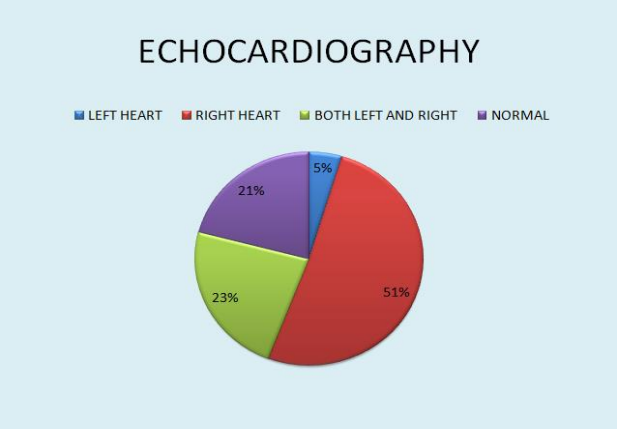

Figure 4: 2D echocardiographic patterns of involvement in patients with severe COVID-19 pneumonia.

Left heart abnormalities: left ventricular hypertrophy was seen in 23% (n=20), hypokinesia or akinesia was observed in 4.6% (n=4). Right heart abnormalities dilated ventricles were seen in 14% (n=12), 55.8% of the patients (n=48) had pulmonary hypertension, of which, 29 patients had only mild pulmonary hypertension (60%), 11 patients had moderate pulmonary hypertension (23%) and 8 patients had severe pulmonary hypertension (16%) (Figure 5). Mild mitral regurgitation was observed in 14 patients, mild tricuspid regurgitation was seen in 16 patients, sclerotic aortic valves were seen in 44 patients. No severe valvular heart disease was found. Mean left ventricular ejection fraction was 52%, mean pulmonary arterial systolic pressure was 44 mmHg. Five patients had mild to moderate pericardial effusion (Figure 6). No patient had a clot/vegetation during echocardiography.

Table 1: Inflammatory marker levels in patients admitted with severe COVID-19 pneumonia.

Inflammatory markers	Increased	Mean value
C reactive protein	84 (97%)	89.3 microgram /L
D dimer	81 (94%)	2.68 microgram/ mL
Ferritin	68 (79%)	669 nanogram/ mL
Lactate dehydrogenase	71 (82.5%)	192 IU/L

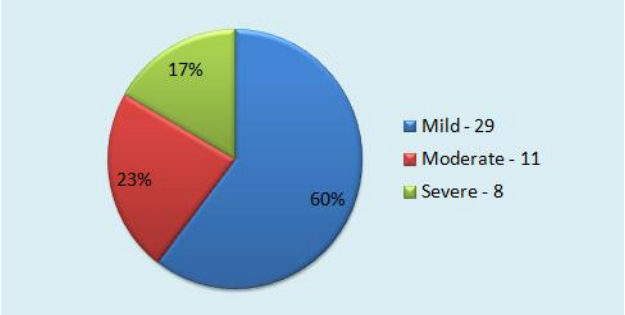

Figure 5: Pulmonary hypertension and grades of severity, (n=48).

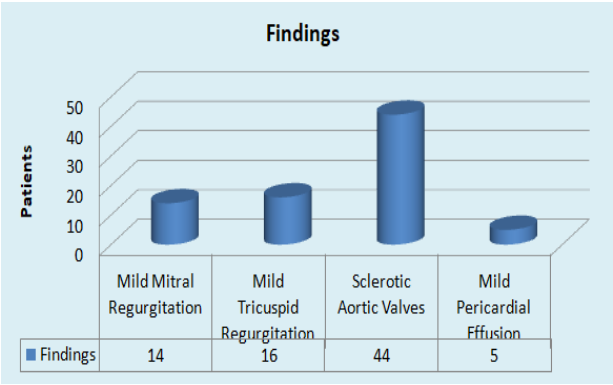

Figure 6: Other findings in 2D echocardiography.

All patients received treatment as prescribed in the prevailing COVID-19 management guidelines of the state. All patients received antibiotics according to their TLC, procalcitonin and culture reports. All patients received IV steroids (either injection methylprednisolone or injection

dexamethasone), anticoagulant (either injection heparin or injection enoxaparin), and antivirals (Injection remdesivir). Other supportive and symptomatic treatment were given, and management of comorbid conditions were done according to the treatment guidelines.

Table 1: Echocardiographic findings and mortality.

ECHO findings vs mortality	Normal ECHO	Isolated RV pathology	Isolated LV pathology	Combined RV and LV pathology	Total
Survivors	14	22	3	15	54
Death	4	22	1	5	32
Total	18	44	4	20	86

Chi-square statistic: 6.3427; p=0.096076 (>0.05).

Ventilation strategies were customized according to individual patient requirement, based on patient's progression (either improvement or deterioration), clinical condition, haemodynamic status and arterial blood gas analysis. Out of the 86 patients, 54 were discharged from ICU (63%) and 32 succumbed to death (37%) shown in the Table 2.

DISCUSSION

Despite its prevalent lung tropism, COVID-19 may trigger a multi-systemic disease including cardiac dysfunction. The pathophysiologic mechanisms of cardiovascular impact in COVID-19 include cardiac complications directly related to myocardial involvement which is exaggerated by the pre-existing systemic disease or secondary to pulmonary damage, leading to a broad spectrum of LV and RV dysfunction. These patterns may or may not be associated with biochemical damage.[6]

There are several patterns of cardiovascular dysfunction associated with COVID-19: It can be a result of direct inflammatory changes in Myocardium inducing myocarditis. It can be due to an ischemic (infarction) insult. COVID-19 may also result in hypovolemia, due to sustained fever and dehydration. There can be right ventricular (RV) dysfunction related to the effects of mechanical ventilation and/or pulmonary embolism. Also, cardiovascular dysfunction may occur due to super-imposed bacterial or fungal sepsis.[7-10]

Accordingly, the echocardiographic findings in COVID-19 patients may also be variable. They range from specific regional wall motion abnormalities of the left ventricle (LV) or RV to different degrees of global cardiac dysfunction related to myocarditis or a systemic deregulated inflammatory response to viral infection.

Echocardiography thus plays a crucial role in distinguishing these patterns. Numerous studies have been conducted so as to highlight the importance of the echocardiography in assessing the functional status of the cardia.

In a systematic review of literature by a group of Italian physicians: Messina et al twenty-nine studies were studied which included 3944 subjects. Overall, the studies included a median of 68.0% of patients admitted to ICU. Studies reported normal echocardiographic findings in 49±18% of cases. Seven studies (24.1%) analyzed the association between echocardiographic findings and mortality, mostly related to right ventricular (RV) dysfunction.[11]

These observations are comparable to the current study where in right heart abnormality was the most common finding (51.1%), 23% had combined right and left heart abnormalities, 4.6% of patients had left heart abnormality and the rest 21% of the subjects had a normal 2D-ECHO findings. The 55.8% of the patients had evidence of pulmonary hypertension of varying degrees.

In patients with COVID-19 pneumonia, RV dilatation and dysfunction is common and its presence is associated with a pro-thrombotic, inflammatory state reflected by elevation of CRP and D-dimer levels. In contrast, LV size remains normal and LV function is hyperdynamic in most of the patients. Also, there are no significant valvular abnormalities.[12] However it was found that these Echocardiographic changes did not correlate with an increase in inflammatory marker levels (p=0.227, >0.05).

Echocardiography may be beneficial in patients with COVID-19 in various aspects, so as to decide on therapeutic anticoagulation, fluid management and also in modifying ventilator strategies, by prompting the physician to limit the positive end expiratory pressure in patients with RV impairment and thereby avoid hypercapnic acidosis, which otherwise may result in further deterioration of RV function by inducing pulmonary arteriolar vasoconstriction and increased afterload.[12] Thus, echocardiography serves as an important tool in guiding therapeutic approach towards COVID-19 patients. However, Echocardiographic findings did not serve as an independent predictor of mortality (p=0.09, >0.05).

Limitations

This was a retrospective observational study; a prospective study needs to be carried out to further understand the cardiac manifestations of the disease and its Echocardiographic presentations. Secondly, the study was done in patients admitted with severe COVID-19

pneumonia; mild and moderate cases were not considered. Hence the findings of the study may not be representative of the general population. Thirdly, cardiac specific biomarkers such as troponin I and NT pro BNP were not assessed in this study. Study which takes into account the cardiac biomarkers would be beneficial in understanding the patterns of cardiac involvement.

CONCLUSIONS

Echocardiography is the first-line imaging modality in cardiac assessment and is an indispensable bedside tool, allowing non-invasive quantification of cardiac performance. Right ventricular dysfunction is more common than LV dysfunction among COVID-19 patients and it is associated with a pro-thrombotic, inflammatory state, but these ECHO findings do not correlate with raised inflammatory markers. 2D-ECHO findings may serve in the identification of cardiac abnormalities and these findings may serve as a useful guide in therapeutic optimization and modification of treatment strategies in critically ill COVID-19 patients, but these findings are not independent predictors of mortality.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Adiga KB, Shashibhushan BL, Deepa AS. A study on echocardiography findings in severe COVID-19 pneumonia patients. Int J Adv Med 2022;9:468-72.