Echocardiographic Evaluation of Cardiac Involvement in Patients with COVID-19

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Abstract

Cardiac involvement in coronavirus disease 2019 (COVID-19) is closely associated with morbidity and mortality. Patients with preexisting cardiovascular disease and/or cardiovascular involvement have poor prognoses. This prospective study aimed to identify patients requiring cardiac function evaluation using echocardiography. Data from 243 patients with a confirmed COVID-19 diagnosis between June and November 2021 were analyzed. The demographic and clinical characteristics of all participants were recorded, and echocardiographic examinations were performed. The patients were divided into two groups according to the presence or absence of abnormalities on echocardiography. Echocardiographic findings were normal in 133 (54.7%) patients and abnormal in 110 (45.3%) patients. Abnormal findings were significantly more common than normal findings in patients requiring intensive care and patients with elevated cardiac biomarker (troponin I and/or brain natriuretic peptide) levels ($p < 0.001$, in both). Conversely, normal findings were significantly more common than abnormal findings in patients requiring isolated wards and the indication of suspected left and/or right ventricular failure ($p < 0.001$, in both). The results suggest that high cardiac biomarkers and requiring intensive care may facilitate the selection of patients who can benefit from echocardiographic imaging, which is important given the increased risk of viral transmission when performing echocardiography.

Keywords: COVID-19, cardiac involvement, echocardiograpy, heart failure

COVID-19 Hastalarında Kardiyak Tutulumun Ekokardiyografik Değerlendirilmesi

Öz

Koronavirüs hastalığı 2019 (COVID-19) kardiyak tutulum, morbidite ve mortalite ile yakından ilişkilidir. Önceden kardiyovasküler hastalığı ve/veya kardiyovasküler tutulumu olan hastaların prognozu kötüdür. Bu prospektif çalışma, ekokardiyografi kullanarak kardiyak fonksiyon değerlendirmesi gerektiren hastaları belirlemeyi amaçladı. Haziran ve Kasım 2021 arasında COVID-19 tanısı doğrulanmış 243 hastanın verileri analiz edildi. Tüm katılımcıların demografik ve klinik özellikleri kaydedildi ve ekokardiyografik incelemeleri yapıldı. Hastalar ekokardiyografide anormallik olup olmamasına göre iki gruba ayrıldı. Ekokardiyografik bulgular 133 (%54,7) hastada normal, 110 (%45,3) hastada anormaldi. Yoğun bakım takibi gerektiren hastalarda ve kardiyak biyobelirteç (troponin I ve/veya beyin natriüretik peptid) seviyeleri yüksek olan hastalarda anormal bulgular normal bulgulardan anlamlı olarak daha yaygındı (her ikisinde de p < 0,001). Tersine, izole servislerde takip edilen ve şüpheli sol ve/veya sağ ventrikül yetmezliği belirtisi olan hastalarda normal bulgular anormal bulgulara göre anlamlı derecede daha yaygındı (her ikisinde de p < 0,001). Sonuçlar, yüksek kardiyak biyobelirteçlerin ve yoğun bakım gerektirmenin, ekokardiyografi yapılırken artan viral bulaşma riski göz önüne alındığında, takipte önemli olan ekokardiyografik görüntülemeden yararlanabilecek hastaların seçimini kolaylaştırabileceğini düşündürmektedir.

Anahtar Kelimeler: COVID-19, kalp tutulumu, ekokardiyografi, kalp yetmezliği

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1. Introduction

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2, has been causing severe morbidity and mortality worldwide for nearly two years and has been declared a pandemic by the World Health Organization (Sharma et al., 2020). COVID-19 primarily affects the respiratory tract (Huang et al., 2020). Patients with preexisting cardiovascular disease and/or cardiovascular involvement have poor prognoses (Li et al., 2020). Left-sided heart failure secondary to myocarditis and right-sided heart failure secondary to pulmonary embolism or pneumonia are the most common cardiac conditions associated with COVID-19 (Shi et al., 2020).

Echocardiography is well positioned for the diagnosis of these clinical conditions because it is reproducible, portable, and relatively widely accessible. However, the risk of viral transmission and the need for personal protective equipment when performing echocardiography should be considered. Therefore, we aimed to draw attention to potential selection criteria for echocardiography performed for clinical reasons in patients with a confirmed COVID-19 diagnosis.

2. Materials and Methods

2.1. Patients and Data Collection

This was a single-center prospective study involving consecutive patients with COVID-19. The diagnosis was confirmed by real-time polymerase chain reaction (RT-PCR). A total of 243 patients hospitalized between June and November 2021, including patients requiring intensive care, were included in the study. Patients under the age of 18 years and patients with a history of severe valve pathology, coronary artery disease, cardiomyopathy, left ventricular systolic dysfunction, heart failure, severe pulmonary disease, current pregnancy or breastfeeding, and uncontrolled endocrine disorders were excluded. The participants' demographic and clinical characteristics, including age, gender, comorbid diseases, symptom severity, presence of pneumonia, need for intensive care, and echocardiography indications, were recorded. Routine hematological and biochemical laboratory findings, including troponin I (TP I) and brain natriuretic peptide (BNP), were also recorded.

2.2. Clinical Definitions

Mild illness was defined as mild pneumonia, a respiratory rate of <30/min, and O2 saturation of >90% when breathing room air. These patients were managed in the outpatient clinic. Severe illness was defined as spread pneumonia on computed tomography. These patients were managed in isolated wards. Critical illness was defined as hemodynamic instability and the need for noninvasive or invasive mechanical ventilation. These patients were treated in intensive care units.

2.3. Echocardiography

All transthoracic echocardiographic examinations were performed with a Philips EPIQ 7C device using an X5-1 (1–5 MHz) probe. Echocardiographic images comprising three cardiac cycles were obtained from standard apical and parasternal images after expiration. All imaging procedures conformed to the recommendations of the American Society of Echocardiography and the European Society of Cardiovascular Imaging (Lang et al., 2015). The patients were divided into two groups according to the presence or absence of abnormal findings on echocardiography, and the obtained data were compared between the two groups.

2.4. Statistical Analysis

Categorical variables were compared with the chi-square test and shown as percentages (%). For the analysis of continuous variables, their distribution was evaluated using the One-Sample Kolmogorov-Smirnov test. Continuous variables were shown as mean ± standard deviation if normally distributed and median [minimum–maximum] if not normally distributed. The t-test was used in the continuous variables between the two groups normally distributed, and the Mann Whitney U test was used if they were not normally distributed. Statistical significance value was considered as $p \leq 0.05$. All data obtained were transferred to SPSS version 22 and analyzed (IBM, SPSS Statistics, USA).

3. Results

Of the 243 participants, 133 (54.7%) had normal echocardiograms, and 110 (45.3%) had abnormal echocardiograms. The patients' demographic and clinical characteristics are presented in Table 1. The median age of the participants was 42 (range: 22–71) years, and 66.7% (n = 162) were male. Patients with abnormal findings had a significantly older mean age than patients with normal findings (45 [range: 28–71] vs. 37 [range: 22–67] years, *p* =

0.038). There was no statistically significant difference between the two groups in terms of gender (70% vs. 63.9%, $p = 0.316$). The prevalence of hypertension and diabetes mellitus was significantly higher among patients with abnormal than with normal echocardiograms (29.9% vs. 42.7%, $p = 0.03$ and 17.3% vs. 28.2%, $p = 0.042$, respectively), while the prevalence of dyslipidemia did not differ significantly between the two groups (15% vs. 16.4%, $p = 0.777$). Abnormal findings were significantly more common than normal findings in patients requiring intensive care (61% vs. 39%, $p < 0.001$) and patients with elevated cardiac biomarker (troponin I and/or brain natriuretic peptide) levels (55.3% vs. 44.7, $p < 0.001$). Conversely, normal findings were significantly more common than abnormal findings in patients requiring isolated wards (63.4% vs. 36.6%, $p < 0.001$) and the indication of suspected left and/or right ventricular failure (66.7% vs 33.3%, $p < 0.001$). Elevated cardiac biomarker (TP I and/or BNP) levels were the most common indications (54.3%) for echocardiography).

Table 1. Demographic and clinical characteristics of the patients

	Overall (n=243)	Normal Scan (n=133)	Abnormal Scan (n=110)	*p* Value
Age, years	42 [22–71]	37 [22–67]	45 [28–71]	*0.038*
Gender, n (%)				
Male	162 (66.7)	85 (63.9)	77 (70)	0.316
Female	81 (33.3)	48 (36.1)	33 (30)	
Comorbidities, n (%)				
Hypertension	86 (35.4)	39 (29.3)	47 (42.7)	*0.03*
Diabetes mellitus	54 (22.2)	23 (17.3)	31 (28.2)	*0.042*
Dislipidemia	38 (15.6)	20 (15)	18 (16.4)	0.777
Severity of symptoms				
Severe / Isolated wards	161 (66.3)	102/161 (63.4)	59/161 (36.6)	**< 0.001**
Critical / Intensive care	82 (33.7)	32/82 (39)	50/82 (61)	
Echocardiography indication, n (%)	132 (54.3)	59/132 (44.7)	73/132 (55.3)	**< 0.001**
Elevated TP I and/or BNP	111 (45.7)	74/111 (66.7)	37/111 (33.3)	
Suspected LV or RV failure				

Abbreviations: TP I, Troponin I; BNP, Brain Natriuretic Peptide; LV, Left ventricle; RV, Right Ventricle

The echocardiographic examination characteristics of the patients are presented in Table 2. Left ventricular abnormalities were detected in 82 (33.7%) patients. Left ventricular dilatation was observed in 43 (17.7%) patients, reduced ejection fraction was noted in 32 (13.2%) patients, mitral valve regurgitation was seen in 11 (4.5%) patients, and segmental wall motion abnormalities were found in seven (2.9%) patients. Right ventricular abnormalities were detected in 67 (27.6%) patients. Right ventricular dilatation was observed in 32 (13.2%) patients, tricuspid valve regurgitation was seen in 22 (9.1%) patients, elevated pulmonary artery pressure was noted in 18 (7.4%) patients, and D-shaped left ventricles were seen in nine (3.7%) patients. Pericardial abnormalities were detected in 17 (7%) patients. The most frequently seen disorders were hyperechogenicity (n = 12; 4.9%) and effusion (n = 9; 3.7%). Cardiac involvement was sufficiently severe to cause hemodynamic deterioration in 11 (4.5%) of the patients.

Table 2. Echocardiographic examination characteristics of the patients

	n (%)
Normal	133 (54.7)
Abnormal	110 (45.3)
Left ventricular abnormality	82 (33.7)
Dilatation	43 (17.7)
Reduced ejection fraction	32 (13.2)
Mitral valve regurgitation	11 (4.5)
Segmental wall motion abnormalities	7 (2.9)
Right ventricular abnormality	67 (27.6)
Dilatation	32 (13.2)
Tricuspid valve regurgitation	22 (9.1)
Elevated pulmonary artery pressure	18 (7.4)
D-shaped left ventricle	9 (3.7)
Pericardial abnormality	17 (7)
Hyperechogenicity	12 (4.9)
Effusion	9 (3.7)

4. Discussion

In this study, we analyzed echocardiographic findings obtained from patients with a COVID-19 diagnosis confirmed by RT-PCR. The results showed that nearly half of all patients undergoing echocardiography had abnormalities and that these abnormalities were sufficiently severe to cause hemodynamic deterioration in 4.5% of the patients. Moreover, the incidence of abnormal findings was highest in echocardiograms performed with the indication of cardiac biomarker elevation.

Numerous studies have shown that patients with preexisting cardiovascular disease, risk factors such as diabetes mellitus, or elevated cardiac biomarkers have an increased susceptibility to COVID-19 and increased risks of severe illness and death (Zhou et al., 2020). The rate of abnormal echocardiograms is highest when the indication for imaging includes elevated cardiac biomarkers, whereas normal findings are more likely on echocardiograms performed with clinical indications. During the natural process of severe pneumonia, clinical indications appear to be misleading (Skulstad et al., 2020).

The pattern of cardiac injury observed in our study appears to be consistent with cardiovascular involvement in patients with other severe viral respiratory tract infections (Majdid et al., 2007; Kwong et al., 2018). Left ventricular abnormalities were observed in one-third of the patients, while right ventricular abnormalities were observed in one-fourth of the patients and were more common in patients with more severe symptoms. These are also likely to occur in severe respiratory diseases, including viral pneumonia itself, as well as myocarditis and subclinical pulmonary thromboembolism (Cui et al., 2020).

This study has certain limitations. As in clinical practice in general, operator-reported findings are considered correct. It is difficult to confirm the results of echocardiographic cardiac function evaluations. Moreover, the application of echocardiography may be suboptimal due to viral transmission concerns.

5. Conclusion

Our findings suggest that elevated cardiac biomarkers and requiring intensive care may facilitate the selection of COVID-19 patients who can benefit from echocardiography, which is important given the increased risk of viral transmission when performing echocardiography. However, further clinical studies are needed to determine whether cardiac biomarkers can better guide clinical imaging and improve patient outcomes.

Ethics in Publishing

Our study was designed in accordance with the Helsinki Declaration of 1975, as revised in 1983. Ethics committee approval was received from the institutional ethics committee (date: 07/07/2020, meeting no: 07 and protocol number: 06) and the Republic of Turkey Ministry of Health. Patients have given their informed consent for participation in the research study.

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