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Role of Speckle Tracking Echocardiography in the Assessment of Subclinical Left Ventricular Dysfunction in Post COVID-19 Patients

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: The utilization of two-dimensional speckle-tracking echocardiography (2-D STE) serves as a precise measurable technique for conducting an assessment of both global and localized cardiac performance, exhibiting remarkable sensitivity. Its utility is particularly noteworthy in the early identification of cardiac impairments that are not clinically evident. This study's objective was to investigate the effectiveness of STE in identifying latent left ventricular dysfunction among individuals who have recuperated from COVID-19.
Methods: This study was conducted at a single center; this analytical cross-sectional analysis involved 100 individuals over the age of 18. The study comprised two cohorts: one with 50 post COVID-19 patients, confirmed through a positive PCR test within a month of diagnosis, and a

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control group of 50 healthy subjects be compatible for age, sex, and risk factors. Subsequently, the post COVID-19 patients were stratified based on high-sensitivity troponin levels into two subgroups: Group I included those exhibiting signs of myocardial damage, while Group II consisted of patients showing no evidence of myocardial injury.

Results: Elderly individuals, a greater prevalence of hypertension (HTN), raised levels of D-dimer and, serum C-reactive protein (CRP) along with increased Left ventricular end-diastolic volume (LVEDV) and diminished Left ventricular global longitudinal strain (LVGLS) over a one-month observation period, were all significantly linked to myocardial injury, as indicated by a p-value < 0.05. The LVGLS was a reliable indicator of cardiac injuries in COVID-19 survivors, with an AUC of 0.947 and a CI ranging from 0.886 to 1.00 (P < 0.001), particularly at a threshold of ≤ -20%, where it achieved 87.2% sensitivity and 100% specificity. Approximately 35 patients exhibited an LVGLS below this threshold. Furthermore, D-dimer and CRP levels post COVID-19 were notably elevated in those with cardiac injuries in comparison with those not, a difference that was statistically significant (P < 0.05). Furthermore, during the follow-up after one month period, post COVID-19 CRP levels, LVEDV, and LVGLS remained significantly higher in patients with myocardial injury in comparison with those didn't have myocardial injury (p < 0.05).

Conclusions: LV GLS is acknowledged as a noteworthy, autonomous predictor of outcome for myocardial injury in individuals diagnosed with COVID-19. This metric offers preliminary insights into the infection's severity, potentially aiding in the early intervention and management strategies for affected patients.

Keywords: CRP; post COVID-19 patients; subclinical left ventricular dysfunction; speckle tracking echocardiography.

1. INTRODUCTION

The worldwide occurrence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which is accountable for the coronavirus disease 2019 (COVID-19), has led to in a pandemic that has had noteworthy impacts on lifestyles. Severe instances of COVID-19 demonstrate a wide array of clinical presentations, notably characterized by release of cytokines, failure of organs, sever pulmonary disorders, and fatality [1].

There is a notable prevalence of pre-existing cardiovascular disease (CVD) among individuals diagnosed with COVID-19, which is associated with increased death rates. Moreover, COVID-19 seems to worsen the development of cardiovascular problems, such as myocardial damage, arrhythmias, acute coronary syndrome (ACS), and venous thromboembolism. The infection has the potential to generate direct or indirect effects on the myocardium via pathways triggered by cytokine storms [2]. Various forms of myocardial damage have been observed during the active stage of the infection, which may be identified using tests including measuring cardiac troponin levels and using transthoracic echocardiography.

Concurrent cytokine storm, which is distinguished by heightened concentrations of D-dimer, ferritin, lactate dehydrogenase, as well as interleukin-6 (IL-6), might give rise to myocardial damage. Conversely, it is plausible that this phenomenon might arise as a result of myocardial dysfunction directly triggered by the consequence of SARS on the heart function [3].

In recent times, speckle-tracking echocardiography (STE) has become a reliable ultrasound technique for evaluating cardiac activity. This method examines the movement of speckles seen on regular 2D sonograms, providing a precise and objective way to measure cardiac abnormality, as well as left ventricular systolic and diastolic dynamics. By trailing the movement of these speckles during the heart's cycle, strain and strain rate can be easily calculated after capturing enough images [4].

The 2-D STE represents a quantitative approach for evaluating both global and regional myocardial function, demonstrating high sensitivity. Its particular value lies in its ability to detect subclinical cardiac dysfunction, making it a valuable tool in clinical practice [5].

In this study, we aimed to determine if STE may help patients recovering from COVID-19 to detect subclinical left ventricular dysfunction.

2. METHODS

Researchers conducted a cross-sectional analysis at a single center in Egypt. The study involved 100 participants over 18 years old. Half (50) had recovered from COVID-19 (post-COVID-19 group). The other half (50) were healthy controls matched for age, sex, and risk factors. To be included in the post-COVID-19 group, participants had to be asymptomatic with no clinical signs of heart disease one month after a positive PCR-confirmed COVID-19 diagnosis. The data collection period spanned from November 2022 to May 2023.

Individuals were not included in the research if they exhibited poor echogenic windows, were under 18 years old, presented with clinical heart failure even with preserved ejection fraction (EF) and reduced EF, with less than 50% left ventricular EF (LVEF), whether symptomatic or not, presented with acute CVD, acute heart failure, acute coronary syndrome (ACS), rapid tachyarrhythmia including atrial fibrillation and ventricular arrhythmias, idiopathic lung fibrosis, severe chronic obstructive pulmonary disease, or renal failure (< 30ml/min glomerular filtration rate). The COVID-19 individuals were then categorized into two groups depending on positive high-sensitivity troponin (hs-TnI) levels: Group I encompassed participants with myocardial injury, and Group II encompassed participants without myocardial injury.

All participants underwent history taking, clinical examination, and lab examinations involving kidney tests (urea, serum creatinine), D-dimer, as well as C-reactive protein (CRP) during the COVID period and post COVID-19 follow-up. Additionally, hs-TnI levels were measured during the COVID-19 period and post COVID-19 follow-up. Twelve-lead electrocardiography (ECG) and echocardiography were also performed for all patients.

2.1 12 Lead ECG

It was done for every patient to detect the presence of any ischemic changes, brady or tachyarrhythmias and chamber enlargement.

2.2 Echocardiography

A comprehensive echocardiographic assessment protocol for all patients within one month following their COVID-19 infection. Conventional two-dimensional (2D) echocardiography and two-dimensional speckle-tracking echocardiography (2-DSTE) were performed utilizing the S5-1 probe of the Philips Epic 7 ultrasound machine. The echocardiographic assessments adhered rigorously to the guidelines and recommendations outlined by the European Association of Cardiovascular Imaging and the American Society of Echocardiography. Echocardiographic images were acquired from standard views, including parasternal long axis, short axis, apical two-chamber, apical three-chamber, and apical four-chamber views. In addition to the standard 2D imaging, M-mode, tissue Doppler imaging, and pulsed and continuous Doppler flow measurements across various cardiac valves were obtained, following the recommendations of the American Society of Echocardiography. Specific measurements, such as left ventricular end-systolic and end-diastolic diameters, left ventricular posterior wall thickness, and interventricular septum thickness, were obtained from the left parasternal long-axis view at the level of the mitral valve tips. These measurements were taken perpendicular to the longitudinal axis of the ventricle, ensuring accurate assessment of the cardiac structures. This comprehensive echocardiographic protocol, adhering to established guidelines and best practices, facilitated a thorough evaluation of cardiac function and structure in patients recovering from COVID-19 infection, enabling the detection of potential cardiac manifestations or complications associated with the disease [6]. LVEF was assessed using a commercially available software program.

2.3 LV STE

Cine loops comprising at least three ECG-gated entire cardiac cycles of the left ventricle were recorded in apical four-chamber, apical three-chamber, and apical two-chamber views in cine loop format. The process involves the acquisition of three consecutive end-expiratory cardiac cycles at high frame rates, exceeding 70 frames per second, through the utilization of harmonic imaging. Subsequently, manual delineation of the endocardial border at end-systole was performed, enabling the software to automatically track the region of interest within the myocardium across each view. Following the optimization of these regions of interest, the software generated strain curves for various myocardial segments. Specifically, in the apical four-chamber view, longitudinal strain (LS) was evaluated across the basal, mid, and apical segments of the inferior septum, as well as the basal, mid, and apical segments of the lateral wall. Similarly, in the apical two-chamber view, LS was assessed across the basal, mid, and apical segments of the inferior wall, in addition to the basal, mid, and apical segments of the anterior wall. This methodological approach facilitated the comprehensive evaluation of myocardial strain dynamics through the analysis of strain curves generated for multiple segments within the cardiac chambers, leveraging the high temporal resolution afforded by the harmonic imaging technique and the automated tracking capabilities of the software.

In the apical long axis view, Global Longitudinal Strain (GLS) was computed as the mean strain value of all 17 myocardial segments. Strain values for each segment were recorded and averaged to derive the GLS. Subsequently, a topographic representation illustrating the regional and GLS of all 17 analyzed segments (Bulls eye configuration) was automatically generated. The normal range for GLS is approximately -19.7 ± 3% [7].

2.4 Statistical Analysis

The analysis was conducted using SPSS version 28 software (IBM, United States). Normality assessments were performed through the Kolmogorov-Smirnov test, Shapiro-Wilk test, and visual inspection of the data. Quantitative variables were summarized as means and standard deviations, depending on their distribution, while categorical data were summarized as frequencies and percentages. Comparisons between groups and assessment of myocardial injury were made using appropriate statistical tests based on the normality of the data. Specifically, the independent t-test or Mann-Whitney U test was utilized for normally and non-normally distributed quantitative variables, respectively. Categorical data were compared using the Chi-square or Fisher's exact test. Receiver Operating Characteristic (ROC) analysis was directed to estimate the ability of left ventricular global longitudinal strain (LVGLS) in expecting cardiac injuries. The AUC, diagnostic indices, and the best cutoff point were estimated. Correlations between LVGLS and other parameters were assessed using Spearman's correlation coefficient. Furthermore, multivariate logistic regression analysis was performed to determine the foretelling ability of LVGLS for cardiac injuries, with odds ratios and 95% confidence intervals reported. All statistical tests were two-tailed, and a p-value less than 0.05 was judged statistically significant.

3. RESULTS

3.1 General Characteristics, Laboratory, ECG and Echocardiographic Findings of the Studied Groups

In the patients' group, there were significantly lower levels of oxygen saturation (O_2 saturation), and lymphocytic count compared to the control group ($p < 0.05$). Conversely, levels of CRP, post COVID-19 CRP, post COVID-19 hs-TnI, creatinine, D-dimer, left ventricular end-diastolic volume (LVEDV), left ventricular end-systolic volume (LVESV), and LVGLS exhibited considerably higher values in comparison to the control group ($p < 0.05$).

However, age, HTN, diabetes mellitus (DM), smoking status, dyslipidemia, mean arterial blood pressure (MAP), heart rate (HR), ECG findings, and echocardiographic measurements including left ventricular internal diameter in diastole (LVIDD), left ventricular internal diameter in systole (LVISD), and EF showed insignificant differences among the two groups.

3.2 General Characteristics, Laboratory, ECG and Echocardiographic Findings Matching to Caradiac Injuries

There was a notable increase in age and hypertension prevalence among individuals with myocardial injury compared to those without injury ($p < 0.05$). Conversely, factors such as sex distribution, DM, smoking status, dyslipidemia, heart rate (HR), mean arterial pressure (MAP), O_2 saturation, lymphocytic count, creatinine levels, ECG findings, and echocardiographic measurements including LVESV, and EF displayed insignificant differences between the two groups. However, levels of D-dimer and CRP were significantly elevated in patients with myocardial injury in comparison to didn’t have injury ($p < 0.05$).

3.3 Echocardiography and Lab Findings According to Myocardial Injury During Follow up

For 1 month follow up period, post COVID-19 CRP levels, LVEDV and LVGLS were considerably more in patients with myocardial injury compared to those without myocardial

Table 1. General characteristics, laboratory, ECG and echocardiographic findings of the studied groups

		Patients (n = 50)	Controls (n= 50)	P
Age (years)		56 ±15	52 ±14	0.202
Sex	Males	24 (48.0%)	35 (70.0%)	0.025*
	Females	26 (52.0%)	15 (30.0%)	
HTN		26 (52.0%)	23 (46.0%)	0.548
DM		21 (42.0%)	22 (44.0%)	0.84
Smoking		26 (52.0%)	24 (48.0%)	0.689
Dyslipidemia		24 (48.0%)	27 (54.0%)	0.548
MAP		81 ±9	81 ±9	0.913
Mean HR		90 ±11	88 ±14	0.551
O_2 saturation		93 ±2	94 ±1	<0.001*
Laboratory findings				
Lymphocytic count		890 ±244	1844 ±450	<0.001*
CRP		95 (14 - 273)	11 (5 - 36)	<0.001*
CRP post-COVID		32 (4 - 98)	9 (4 - 30)	<0.001*
hs-TnI		99.2 (2.6 - 280.9)	4.9 (2.4 - 14.7)	<0.001*
hs-TnI post COVID		30 (2 - 89)	4 (2 - 9)	<0.001*
Creatinine		1.4 ±0.4	1.2 ±0.3	0.000*
D. Dimer		656 (132 - 1438)	178 (92 - 374)	<0.001*
ECG findings				
Inverted T-wave		9 (18.0%)	7 (14.0%)	0.181
RBBB		2 (4.0%)	0 (0.0%)	
Sinus bradycardia		1 (2.0%)	1 (2.0%)	
Sinus tachycardia		13 (26.0%)	16 (32.0%)	
ST depression		8 (16.0%)	2 (4.0%)	
Normal sinus rhythm		17 (34.0%)	24 (48.0%)	
Echocardiographic findings				
LVIDD		50.7 ±4.1	51.3 ±3.2	0.419
LVISD		36.3 ±2.5	37.1 ±2	0.106
LVEDV		95 ±15	80 ±7	<0.001*
LVESV		39 ±7	33 ±4	<0.001*
EF (%)		61 ±4	61 ±4	0.762
LVGLS		-18.5 (-21.7 - -14)	-20.6 (-21.9 - -19.2)	<0.001*

*COVID: Coronavirus disease, CRP: C-reactive protein, DM: diabetes mellitus, ECG: electrocardiogram, EF: ejection fraction, HR: heart rate, HTN: hypertension, Hs: high sensitivity, LVEDV: left ventricular end-diastolic volume, LVIDD: left ventricular internal dimension in diastole, LVESV: left ventricular end-systolic volume, LVGLS: left ventricular global longitudinal strain, LVISD: left ventricular internal dimension in systole, MAP: mean arterial blood pressure, RBBB: right bundle branch block, Data are presented as mean ± SD or median (IQR) or frequency (%). *Significant p value <0.05.*

injury (P<0.05). However, LVESV and EF measurements during follow up were insignificantly difference between the two groups (P > 0.05).

3.4 Correlation between LVGLS and other Parameters in COVID Patients

Age, CRP, post COVID-19 CRP levels, hs-TnI and post COVID-19 hs-TnI levels, LVEDV, LVESV showed significant negative correlations with GLS (r = -.531, P < .001, r = -0.886, P < .001, r = -.788, P < .001, r = -.931, P < .001,r = -.888, P < .001,r = -.713, P < .001 ,r = -.592, P < .001, respectively). Non-significant correlations were found with GLS regarding MAP (r = 0.061, P = 0.677), mean HR (r = 0.156, P = 0.285), O_2 saturation (r = 0.104, P = 0.477), lymphocytic count (r = -0.161, P = 0.27), creatinine (r = 0.136, P = 0.351), D-Dimer (r = -0.005, P = 0.972), LVIDD (r =-0.275, P = 0.056), and LVISD (r =-0.046, P =0.756), EF% (r = 0.009, P = 0.949).

3.5 Myocardial Injury Prediction using Multivariate Logistic Regression

Cardiac injuries were expected using LVGLS by multivariate logistic regression analysis. The model revealed that GLS was a significant independent predictor of myocardial injury (OR = 0.013, 95% CI = 0.003 – 0.673, P = 0.013), controlling for age, sex, hypertension, diabetes, smoking, and dyslipidemia.

Table 2. General characteristics, laboratory, ECG and echocardiographic findings according to myocardial injury

		Myocardial injury		
		Yes (n = 40)	**No (n = 10)**	**P**
Age (years)		58 ±14	45 ±14	0.015*
Sex	Males	21 (52.5%)	3 (30.0%)	0.203
	Females	19 (47.5%)	7 (70.0%)	
HTN		24 (60.0%)	2 (20.0%)	0.024*
DM		18 (45.0%)	3 (30.0%)	0.390
Smoking		20 (50.0%)	6 (60.0%)	0.571
Dyslipidemia		19 (47.5)	5 (50.0%)	0.887
MAP		80 ±9	83 ±11	0.470
HR		90 ±12	90 ±10	0.950
O_2 saturation		93 ±2	94 ±2	0.352
Laboratory Findings				
Lymphocytic count		890 ±254	890 ±213	1.0
CRP		106 (18 - 273)	19 (14 - 43)	<0.001*
Creatinine		1.4 ±0.4	1.7 ±0.4	0.061
D-Dimer		1120 (312-1438)	612 (132-1101)	0.023*
ECG findings				
Inverted T-wave		7 (17.5%)	2 (20.0%)	0.513
RBBB		1 (2.5%)	1 (10.0%)	
Sinus bradycardia		1 (2.5%)	0 (0.0%)	
Sinus tachycardia		12 (30.0%)	1 (10.0%)	
ST depression		7 (17.5%)	1 (10.0%)	
NSR		12 (30)	5 (50)	
Echocardiographic findings				
LVIDD		51.1 ±4.3	49.2 ±2.9	0.184
LVISD		36.3 ±2.6	36.5 ±2.5	0.787
LVEDV		97 ±15	89 ±5	0.060
LVESV		40 ±7	35 ±5	0.069
EF (%)		61 ±4	60 ±4	0.673
LVGLS		51.1 ±4.3	49.2 ±2.9	0.184

*COVID: Coronavirus disease, CRP: C-reactive protein, DM: diabetes mellitus, ECG: electrocardiogram, EF: ejection fraction, HR: heart rate, HTN: hypertension, Hs: high sensitivity, LVEDV: left ventricular end-diastolic volume, LVIDD: left ventricular internal dimension in diastole, LVESV: left ventricular end-systolic volume, LVGLS: left ventricular global longitudinal strain, LVISD: left ventricular internal dimension in systole, MAP: mean arterial blood pressure, NSR: normal sinus rhythm, RBBB: right bundle branch block, Data are presented as mean ± SD or frequency (%). *Significant p value <0.05.*

Table 3. Echocardiography and laboratory findings according to myocardial injury during follow up

	Myocardial injury		
	Yes (n = 40)	**No (n = 10)**	**P**
CRP post COVID	43	11	<0.001*
LVEDV during follow up	100.08	88.4	0.013*
LVESV during follow up	51.6	35.6	0.22
EF% during follow up	73.1	60.4	0.302
LVGLS	-18.1 (-21.3 - -14)	-20.6 (-21.7 - -20.1)	<0.001*

*COVID: Coronavirus disease, CRP: C-reactive protein, EF: ejection fraction, Hs: high sensitivity, LVEDV: left ventricular end-diastolic volume, LVESV: left ventricular end-systolic volume, LVGLS: left ventricular global longitudinal strain, Data are presented as mean ± SD or frequency (%). *Significant p value <0.05.*

Table 4. Correlation between LVGLS and other parameters in COVID patients

	GLS (%)	
	R	**P**
Age (years)	-.531	<.001*
MAP	0.061	0.677
HR	0.156	0.285
O_2 saturation	0.104	0.477
Lymphocytic count	-0.161	0.27
CRP	-0.886	<.001*
CRP-post COVID	-.788	<.001*
hs-TnI	-.931	<.001*
hs-TnI post COVID	-.888	<.001*
Creatinine	0.136	0.351
D-Dimer	-0.005	0.972
LVIDD	-0.275	0.056
LVISD	-0.046	0.756
LVEDV	-.713	<.001*
LVESV	-.592	<.001*
EF%	0.009	0.949

*EF (%): ejection fraction; GLS: global longitudinal strain; LVEDV: left ventricular end-diastolic volume; LVIDD: left ventricular internal diameter in diastole; LVESV: left ventricular end-systolic volume; LVGLS: left ventricular global longitudinal strain; LVISD: left ventricular internal diameter in systole; r: Pearson coefficient, *Significant P-value at P < 0.05.*

Table 5. Multivariate logistic regression analysis to predict myocardial injury

	B	SE.	Wald	OR (95% CI)	P
Age (years)	-0.127	0.097	1.714	0.881 (0.729 - 1.065)	0.190
Sex	-0.593	1.318	0.203	0.552 (0.042 - 7.313)	0.652
Hypertension	2.899	1.764	2.701	18.151 (0.572 - 575.605)	0.10
Diabetes	-0.57	1.428	0.159	0.565 (0.034 - 9.288)	0.690
Smoking	-0.597	2.033	0.086	0.55 (0.01 - 29.586)	0.769
Dyslipidemia	2.084	2.249	0.858	8.037 (0.098 - 660.409)	0.354
GLS (%)	-4.314	1.999	4.658	0.013 (0.0003 - 0.673)	0.031*

*B: regression coefficient; GLS: global longitudinal strain; OR: odds ratio; SE: standard error, *Significant P-value at P < 0.05; 95% CI: 95% confidence interval.*

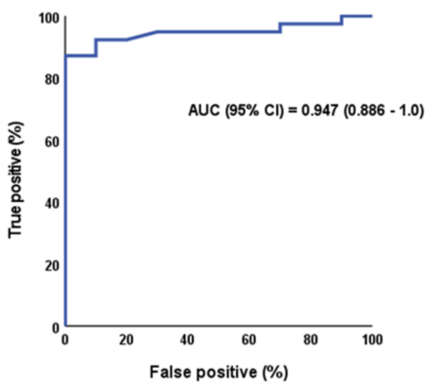

Fig. 1. ROC analysis of LVGLS to predict cardiac injuries

LVGLS can significantly predict myocardial injury in COVID patients (AUC= 0.947, CI= ranging from 0.886 to 1.00, P < 0.001) at ≤ -20%, at 87.2% sensitivity and 100% specificity. Among the 50 patients included in the study, about 35 patients have LVGLS below that cut off value (-20%).

Analysis of these 35 patients showed that 28 patients (80%) had myocardial injury with elevated cardiac troponin values and only 7 patients (20%) did not have myocardial injury Fig. 1.

4. DISCUSSION

The COVID-19 pandemic, stemming from infection with the innovative coronavirus SARS, has arose as an international emergency impacting all facets of society. SARS, a single-stranded RNA virus, gains entry into cells by binding to the ACE2 receptor. COVID-19 primarily impacts the respiratory system, but it can also influence CVS [8].

In our study, the patient group exhibited statistically significant reductions in lymphocytic count, alongside higher levels of both CRP, D-dimer, and hs-TnI compared to the control group, with p-values < 0.001. This was similar to El-Sayed Mohamed Farag et al. [9] who found higher CRP, D-dimer and lower lymphocytic count between the 2 studied groups.

The patients in our research had significantly elevated levels of LVEDD and LVESV, while displaying decreased levels of LVGLS (p value <0.001). Nevertheless, there were no significant differences seen between the two groups in terms of LVIDD, LVISD, and EF (p value>0.05). This was aline with El-Sayed Mohamed Farag et al. [9] who found no difference among studied groups regarding LVEF. Also, Balaban Kocas et al. [10] showed no significant difference between the 2 studied groups regarding LVEF%.

As regards the laboratory findings according to myocardial injury, CRP & D-Dimer levels were significantly higher in patients with cardiac injuries with a significant P-value <0.05. This was concordant with both Balaban Kocas et al. [10] and Özer et al. [11] found higher CRP and D-dimer in those with myocardial injury and elevated troponin level.

Regarding the echocardiographic measurements, the LVIDD, LVISD, LVEDV, LVESV and EF did not differ significantly among the two studied groups (P>0.05). During the follow up, patients with myocardial injury had higher LVEDV and lower LVGLS (p value <0.05). No significant difference was observed between the 2 groups of patients regarding LVESV and EF, p value >0.05. Similar to our study, Balaban Kocas et al. [10] showed no significant difference between the 2 studied groups regarding LVEF%. Also, Özer et al. [11] didn't find any difference regarding LVESV and LVEDV. Most importantly, the LVGLS at follow up after one month showed a significant difference. The myocardial injury group showed a mean of -18.1 compared to -20.6 in the non-injury group. In agreement with those results, Zheng et al. [12] found that there was a strong correlation seen between raised troponin levels and disruption in the left ventricular-globular sphincter (LV-GLS), as well as an increase in disease severity and death. Also, Baycan et al. [13] found that elevation of cardiac troponin with COVID-19 patients is correlated with significantly lower LV-GLS and RV-GLS levels.

In our study, GLS was a significant independent predictor of myocardial injury (P = 0.013) after controlling for age, sex, hypertension, diabetes, smoking, and dyslipidemia & with the best cutoff was ≤ -20%. This was concordant with Özdemir et al. [9] who studied the use of strain echocardiography for the assessment of myocardial involvement in individuals experiencing persistent chest pain subsequent to COVID-19 infection. The multivariate analysis revealed that both GLS and GCS values were statistically significant, irrespective of age. A GLS value with a threshold of 20.35 demonstrated a sensitivity of 85.7% and specificity of 81%. Similarly, a GCS value with a threshold of 21.35 exhibited a sensitivity of 81% and specificity of 81% in diagnosing cardiac sequelae without the need for CMR assessment. Also according to Rui Li et al . [5] found that a total of 181 patients, comprising 83% of the study population, demonstrated a decrease in GLS below the threshold of < -21.0%, with a statistically significant p-value of < 0.001. Also, El-Sayed Mohamed Farag et al. [9] found that all control group participants had GLS values greater than or equal to 18, indicating normal values. In contrast, only 72.75% of cases exhibited GLS values within the normal range (>18), while 27.35% showed decreased GLS values (<18). This significant disparity between the two groups underscores the statistical difference observed.

The study is constrained by its small sample size and focus on a single site, which might impact the applicability of the results. Nevertheless, our research indicates that LVGLS has the potential to be a reliable indicator of myocardial damage in individuals who have recently recovered from COVID-19 infection. Furthermore, it is imperative to extend the duration of follow-up periods in order to conduct a more thorough evaluation of overall left ventricular strain utilizing speckle tracking echocardiography (STE) in this specific group of patients. It is recommended that future research initiatives take into account the inclusion of blood levels of other inflammatory markers and cytokine profiles in order to improve the accuracy of identifying specific predictors of myocardial damage in individuals with COVID-19.

5. CONCLUSIONS

The left ventricular GLS was impacted by COVID-19 and serves as a notable autonomous indicator of myocardial damage in individuals with COVID-19. This can offer preliminary insights into the extent of COVID-19 infection, hence aiding in the decision-making process for the management of this specific patient population.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

CONSENT AND ETHICAL APPROVAL

The study received ethical approval from Benha University Hospitals and written informed consent was obtained from all participants.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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