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Mitral Annular Plane Systolic Excursion: An Early Marker of Subclinical Left Ventricular Function in COVID-19 Survivors

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ABSTRACT

Introduction: The left ventricular (LV) function can be affected by COVID-19. Mitral annular plane systolic excursion (MAPSE) is a measurement that reflects the function of the LV. The association between MAPSE and LV function in COVID-19 survivors is not well understood, and this study aimed to explore that relationship.
Material and methods: The retrospective cross-sectional study comprised 99 patients with a history of SARS-CoV-2 infection. These patients experienced symptoms lasting more than 2 months following the initial SARS-CoV-2 virus infection, including fatigue, shortness of breath, chest pain, and cough. The patients were categorized into two groups based on their MAPSE measurements: those with low MAPSE (<12 mm) and those with non-low MAPSE (>12 mm). MAPSE measurements were acquired using transthoracic echocardiography (TTE).
Results: COVID-19 patients with low MAPSE, global longitudinal strain (GLS) (%) ([-17.61±0.95] - [-18.90±1.08], p <0.001) and mitral E/A ratio ([0.83±0.39] - [0.97±0.23], p = 0.028) were statistically significant compared to the the group without low MAPSE. Left atrial volume index (LAVI) in mm/m² ([37.24±2.11] - [35.34±2.50], p =0.001) was higher in the group of COVID-19 patients with lower MAPSE. High-sensitivity troponin T (Hs-TnT) (OR: 2.019, 95% CI: 1.043-3.712, p =0.028), intensive care unit (ICU) admission (OR: 1.432, 95% CI: 1.004-2.708, p =0 .037) and need for invasive mechanical ventilation (IMV) support (OR: 1.306, 95% CI: 1.128-2.630, p =0.004) were identified as independent predictors of reduced MAPSE.
Conclusions: SARS-CoV-2 infection may lead to reduced or impaired MAPSE values, indicative of impaired LV function, in COVID-19 survivors. Additionally, our study revealed that elevated levels of (Hs-TnT), admission to the ICU, and the need for IMV support were predictive factors for low MAPSE values. These findings underscore the potential cardiac implications of COVID-19 and highlight the importance of monitoring cardiac function in patients with severe disease manifestations.

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Excursión sistólica del plano anular mitral: un marcador temprano de la función subclínica del ventrículo izquierdo en sobrevivientes de COVID-19

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RESUMEN

Introducción: La función del ventrículo izquierdo (VI) puede verse afectada por el COVID-19. La excursión sistólica del plano anular mitral (MAPSE) es una medición que refleja la función del VI. La asociación entre MAPSE y la función del VI en los sobrevivientes de COVID-19 no se comprende bien y este estudio tuvo como objetivo explorar esa relación.
Material y métodos: Estudio transversal retrospectivo que incluyó a 99 pacientes con antecedentes de infección por SARS-CoV-2. Estos pacientes experimentaron síntomas que duraron más de dos meses después de la infección inicial por el virus SARS-CoV-2, incluyendo fatiga, dificultad para respirar, dolor en el pecho y tos. Los pacientes se clasificaron en dos grupos según sus mediciones de MAPSE: aquellos con MAPSE bajo (<12 mm) y aquellos con MAPSE no bajo (>12 mm). Las mediciones MAPSE se adquirieron mediante ecocardiografía transtorácica (ETT).
Resultados: Pacientes con COVID-19 con MAPSE bajo, tensión longitudinal global (GLS) (%) ([-17,61±0,95] - [-18,90±1,08], p<0,001) y relación E/A mitral ([0,83±0,39] - [0,97±0,23], p = 0,028) fueron estadísticamente significativos en comparación con el grupo sin MAPSE bajo. El índice de volumen auricular izquierdo (LAVI) en mm/m2 ([37,24±2,11] - [35,34±2,50], p =0,001) fue mayor en el grupo de pacientes con COVID-19 con MAPSE más bajo. Troponina T de alta sensibilidad (TnT-Hs) (OR: 2,019, IC 95%: 1,043-3,712, p = 0,028), ingreso a unidad de cuidados intensivos (UCI) (OR: 1,432, IC 95%: 1,004-2,708, p = 0,037) y la necesidad de soporte de ventilación mecánica invasiva (VMI) (OR: 1,306, IC 95%: 1,128-2,630, p = 0,004) se identificaron como predictores independientes de MAPSE reducido.
Conclusiones: La infección por SARS-CoV-2 puede provocar valores reducidos o alterados de MAPSE, indicativos de una función del VI alterada, en los supervivientes de COVID-19. Además, nuestro estudio reveló que los niveles elevados de (TnT-Hs), el ingreso en UCI y la necesidad de soporte de VMI eran factores predictivos de valores bajos de MAPSE. Estos hallazgos subrayan las posibles implicaciones cardíacas de la COVID-19 y resaltan la importancia de controlar la función cardíaca en pacientes con manifestaciones graves de la enfermedad.

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1. INTRODUCTION

Coronavirus disease 2019 (COVID-19), which is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), primarily affects the respiratory system, but it can also impact other organs in the body, such as the heart [1]. In some cases, COVID-19 can cause heart complications, especially in those with underlying heart conditions like heart failure (HF) [2]. A variety of factors can lead to HF, including coronary artery disease, high blood pressure, and infections [3]. HF can be aggravated by COVID-19 because it can cause inflammation and fluid build up in the lungs, which can make it difficult for the heart to pump blood. Furthermore, COVID-19 may lead to HF in some cases, even in those without underlying heart conditions [4, 5].
MAPSE (Mitral Annular Plane Systolic Excursion) measures the movement of the annulus of the mitral valve in order to assess the function of the left ventricle (LV). The MAPSE is measured using an echocardiogram, a non-invasive imaging technique [6]. HF or cardiomyopathy can cause a decrease in MAPSE, which can indicate a problem with the left ventricle's function [7]. In echocardiography, longitudinal strain measurements are used to assess cardiac function [8]. However, it is not always feasible to measure strain in patients with inadequate echocardiographic views. It is also time consuming and not available in all ultrasonography systems. The importance of MAPSE in assessing longitudinal systolic function has been emphasized in many studies [9, 10]. To our knowledge, there has been no study investigating the correlation between MAPSE and left ventricular function in survivors of COVID-19.
The purpose of this study was to investigate the determinants of MAPSE in COVID-19 survivors with preserved LV ejection fraction (LVEF) and to investigate the relationship

between MAPSE and clinical and echocardiographic parameters.

2. MATERIAL AND METHODS

The retrospective cross-sectional study included patients hospitalized and discharged with COVID-19 pneumonia between March 2020 and January 2021. A total of 663 individuals diagnosed with COVID-19 were initially screened for inclusion in the study. However, after applying the exclusion criteria, only 99 patients met the eligibility criteria and were included in the analysis. Our study encompassed all consecutive patients who had been discharged from COVID-19 wards following treatment for COVID-19 pneumonia. These patients had been out of the hospital for a minimum of 2 months at the time of review. They subsequently presented to cardiology and chest diseases outpatient clinics with persistent symptoms related to their prior COVID-19 infection (e.g. fatigue, chest pain, shortness of breath, cough, anosmia, defect of vision, difficulty concentrating, depression). Patients with COVID-19 real-time polymerase chain reaction (RT-PCR) positive or CT results compatible with COVID-19 pneumonia were included in the study. Combined throat/nose swab samples were taken, and SARS-CoV-2 (RT-PCR) tests. Non–intensive care unit (Non-ICU) and intensive care unit (ICU) admissions were made in line with the recommendations of the scientific committee in our country [11].

Patients were hospitalized if they exhibited any of the following symptoms:

- Moderate to severe pneumonia, characterized by bilateral widespread pneumonia findings on chest X-ray or tomography.
- Hypotension (blood pressure < 90/60 mm Hg) and tachypnea (respiratory rate ≥ 30/min) or arterial oxygen saturation < 93% without supplemental oxygen.
- Severe abnormalities in laboratory parameters, including high sensitivity C-reactive protein (CRP) > 40 mg/dL, lymphopenia, or ferritin > 1000 ng/mL, despite unilateral lung infiltration.

Patients were admitted to the ICU if they displayed any of the following symptoms:

- Respiratory rate ≥ 30/min.
- Oxygen saturation < 90% and partial oxygen pressure (PaO2) of 70 mmHg despite nasal oxygen supplementation of > 5 L per minute.
- Heart rate > 100 beats/min and systolic blood pressure < 90 mmHg or mean arterial blood pressure < 65 mmHg.
- PaO2/Fraction of inspired oxygen (FiO2) ratio ≤ 300.
- Lactate levels > 2 mmol/L.

Biochemical and hemogram parameters were extracted from peripheral blood samples collected upon admission to the hospital, employing standard laboratory techniques. Body temperatures were noted as being ≥38.0°C.

We excluded patients with a history of coronary artery disease, history of coronary artery bypass surgery, chronic obstructive pulmonary disease, severe renal (eGFR < 30 [mL/min/1.73m2]) and liver failure (ALT and AST > 3x the upper limit of normal), cerebrovascular disease, thromboprophylaxis contraindications, malignant disease, atrial fibrillation and atrial flutter, heart failure (LVEF ≤40%), moderate or severe heart valve stenosis or insufficiency, prosthetic heart valves, muscle and joint diseases (such as rheumatoid arthritis, fibromyalgia), anxiety, depression, mental disorders, visual impairment, poor echocardiographic window, and patients younger than 18 years of age.

The study was approved by the local ethics committee (approval no: 2023/05-01, date no: 22.03.2022). The Declaration of Helsinki was complied to in all study procedures. Both verbal and written informed consent was obtained from the participants.

Blood pressure levels were measured just before starting echocardiographic imaging. All patients underwent echocardiographic examinations by connecting simultaneous electrocardiography using a Vivid 7 Pro device (GE, Vingmed, Horten, Norway). The left lateral position was used for echocardiographic measurements. Two experienced cardiologists assessed LVEF, left atrium (LA), left ventricular end-diastolic volume (LVEDV), left ventricular end-systolic volume (LVESV), left atrial volume index (LAVI) and other echocardiographic measurements. LA's endocardium was traced using the apical 4-chambers (A1) and apical 2-chambers (A2) views at ventricular end systole. LA length (L) was measured from back wall to line across hinge points of mitral valve, and LA volume was calculated using [(0.85) x (A1xA2/L)]. A LAVI is obtained by dividing the LA volume by the body surface area (BSA) [12]. Strain analysis was performed in a separate on the computer, apical long axis, apical 4 spaces, LV endocardium and epicardium from apical 2-cavity view speckle tracking with manual drawing of boundaries based on the EchoPAC analysis package (General Electric, Horten, Norway) was performed using. The average of the measurements was used. The MAPSE measurement is typically taken from the apical four-chamber view of the heart [13]. The distance between the peak systolic position and the end-diastolic position of the mitral annulus is measured using M-mode echocardiography. The average normal value has been reported to be 12-15 mm [14]. In our study, patients were divided into two groups: those with low (<12 mm) lateral MAPSE and non-low (>12mm). Left ventricular volume, LVEF and left cardiac chambers measurements were made in accordance with the imaging guidelines recommended by the American and European Heart Associations [15]. Figure 1A-B shows an example of MAPSE measurement and strain analysis.

Pulmonary function was tested twice with Viasys spirometry device according to the American Thoracic Society (ATS) criteria and the best test was recorded [16]. The weight of the patients was calculated by wearing light sportswear, and their height was measured by standing barefoot and touching a thin rod parallel to the ground to the head during deep inspiration, and the distance between the ball of the foot and the top of the head was measured with an accuracy of 0.5 cm.

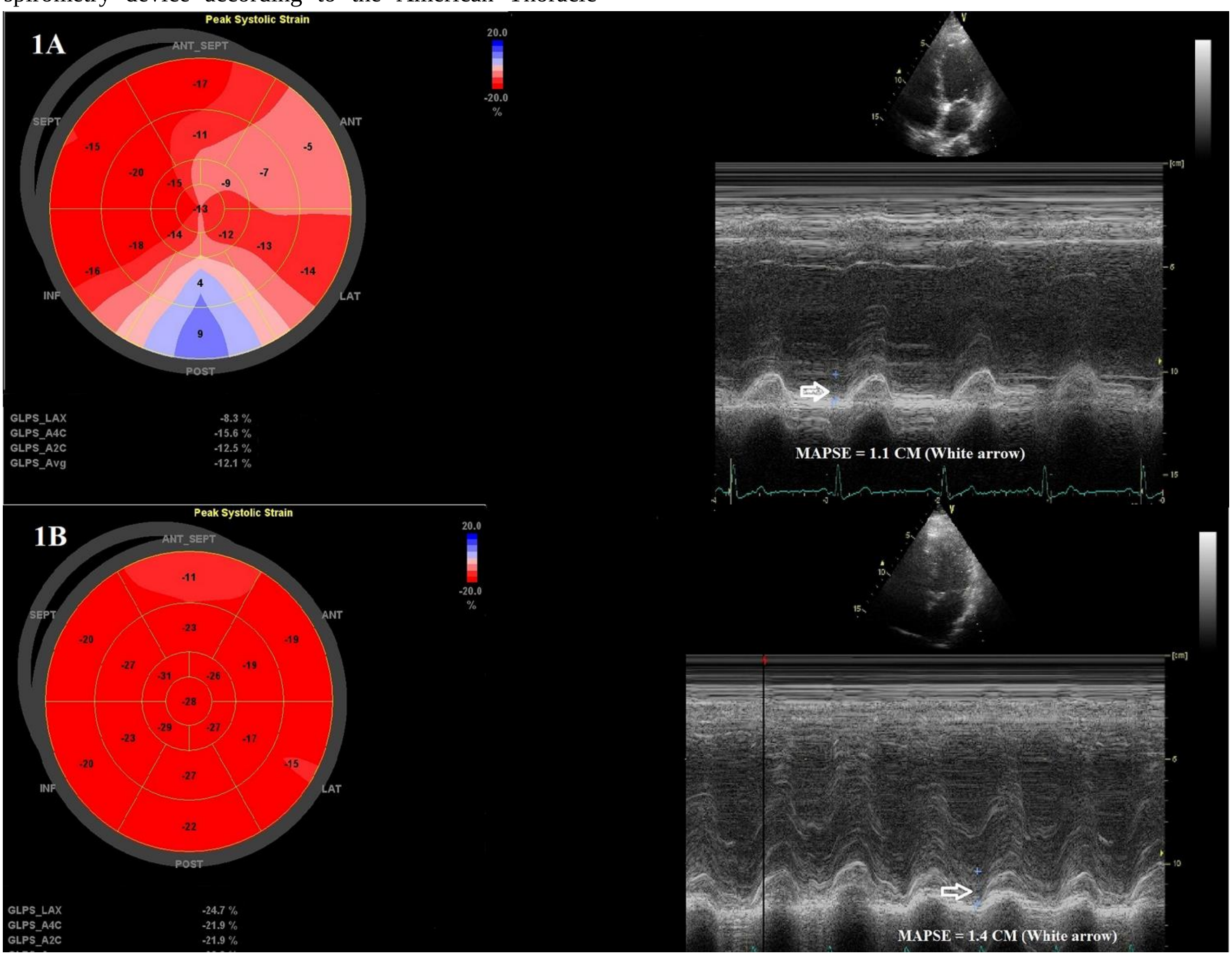

Figure 1: *MAPSE measurement and Strain analysis. A) Presentation of a patient with low MAPSE with strain analysis B) Presentation of a patient with normal MAPSE with strain analysis.*

2.1. STATISTICAL ANALYSIS

Statistical analysis was performed using SPSS version 19.0 software (SPSS Inc., Chicago, IL, USA). Data were expressed as mean ± SD, or median (interquartile range) values. Categorical variables were expressed as number (n) and percentage (%). Parameters exhibiting a normal distribution were compared using Student's t-test, while those not displaying normal distribution were assessed using the Mann-Whitney U-test. The Chi-squared test or Fisher's Exact test was employed to compare the probability ratios of categorical variables. Pearson and Spearman tests were used for correlation analysis. Univariate and multivariate logistic regression analyses were conducted to identify independent variables associated with reduced MAPSE. Significant variables for multivariate logistic regression were selected using a stepwise method after univariate analysis. Results of both analyses are reported as odds ratios with corresponding 95% confidence intervals. A value of $p < 0.05$ was considered statistically significant.

group with MAPSE < 12 (p =0.001). In addition, LAVI was found to be higher in the group with MAPSE < 12 (p =0.001). Based on the results of the pulmonary function test (PFT), no statistical differences were observed between the two groups (Table 2).

Table 1: Demographic, laboratory findings and clinical characteristics of COVID-19 patients

Variable	COVID-19 (n=99)	MAPSE <12 (n=67)	MAPSE >12 (n=32)	p-value
Age (years)	65.0±14.1	62.24±14.65	63.34±13.15	0.708
Gender				
Male	58	41	17	0.586
Female	41	26	15	
Smoking, n (%)	39 (39.4)	30 (44.8)	9 (28.1)	0.172
DM, n (%)	7 (7.1)	4 (6)	3 (9.4)	0.678
HT, n (%)	9 (9.1)	8 (11.9)	1 (3.1)	0.264
BMI (kg/m^2)	26.13±1.25	25.38±1.07	26.74±0.42	0.227
Heart rate	83.02±11.65	82.7±3.21	86.14±4.30	0.320
SBP (mmHg)	133.7±9.13	132.92±2.16	133.21±2.23	0.540
DBP (mmHg)	80.3±7.2	79.98±0.84	80.09±0.73	0.514
Creatinine (mg/dl)	0.87±0.35	0.95±0.39	0.88±0.23	0.268
Hemoglobin (g/dl)	12.7 (11.3-14.0)	12.7 (11.3-14.2)	12.6 (10.5-13.7)	0.353
Hs-TnT, ng/L	14.7 (8.8-28.44)	16.5 (10.2-34.0)	10.0 (5.2-17.3)	0.002
Serum Ferritin	518.0 (210.4-878.4)	571.8 (308.2-953.1)	351.2 (114.7-759.6)	0.051
D-dimer (ugFEU/mL)	220 (130-788)	240 (160-500)	180 (110-302)	0.015
Hospital stay (days)	12 (7-21)	14 (8-21)	9 (6-18)	0.029
ICU admission, n (%)	19 (19.2)	17 (25.4)	2 (6.3)	0.047
IMV, *n (%)*	9 (9.1)	9 (13.4)	0 (0)	0.029
Common symptoms				
Fatigue	23 (23.2)	15 (22.4)	8 (25)	0.973
Chest pain	4 (4)	3 (4.5)	1 (3.1)	0.749
Shortness of breath	22 (22.2)	20 (29.9)	2 (6.3)	0.017
Cough	5 (5.1)	3 (4.5)	2 (6.3)	0.657
Anosmia	1 (1)	1 (1.5)	0 (0)	1.000
Defect of vision	1 (1)	1 (1.5)	0 (0)	1.000
Difficulty concentrating	2 (2)	2 (3.0)	(0)	1.000
Depression	2 (2)	1 (1.5)	1 (3.1)	0.544

DM: Diabetes mellitus; HT: Hypertension; BMI: Body mass index; SBP: Systolic blood pressure; DBP, Diastolic blood pressure; Hs High-sensitive cardiac troponin; ICU: Intensive care unit; IMV: Invasive mechanical ventilation.

3. RESULTS

Our study consisted of 99 patients (58 males and 41 females). The mean age was 65.0±14.1 years. Out of the total 99 patients included in the study, 19 individuals required treatment in ICUs, and among those, 9 patients necessitated invasive mechanical ventilation. In Table 1, we summarize a patient's demographic, laboratory, and clinical characteristics.

Based on MAPSE values, we divided the patients into two subgroups: 67 patients had MAPSE < 12 and 32 patients had MAPSE > 12. Even though the LVEF values were not statistically different between the groups, left ventricular global longitudinal strain (GLS) values were lower in the

There was no correlation between MAPSE and LVEF (r = 0.173, p =0.087). However, correlation analysis shows a significant relationship between MAPSE and GLS (r = -0.684, p =0.001). Negative and significant correlation was observed between E/e' and MAPSE (r = -0.663, p =0.001) (Table 3).

Logistic regression analysis, including both univariate and multivariate approaches, was employed to examine the clinical factors affecting MAPSE ≤ 12mm. Parameters with a non-adjusted P-value less than 0.1 in the univariate analysis were determined as potential risk factors and were then included in the multivariate analysis High-sensitive cardiac troponin T (Hs-TnT) level (OR: 2.019, p=0.028), ICU admission (OR: 1.432, p =0.037) and need for invasive mechanical ventilation (IMV) support (OR: 1.306, p =0.004) were independent predictors of MAPSE<12 mm (Table 4).

Table 2: Echocardiographic and pulmonary function test parameters of the study population

Variable	COVID-19 (n=99)	MAPSE <12 (n=67)	MAPSE >12 (n=32)	p-value
MAPSE (mm)	10.95±1.88	9.85±1.11	13.28±0.58	< 0.001
LVEDD (mm)	43.11±5.16	43.21±5.09	42.91±5.37	0.791
LVESD (mm)	28.16±3.68	28.34±4.04	27.78±279	0.423
LVEDV (mL)	98.64±3.33	100.92±0.36	93.87±0.42	< 0.001
LVESV (mL)	35.70±1.96	37.04±0.20	32.90±0.29	< 0.001
LVEF (%)	57.89±5.20	57.42±5.25	59.00±4.84	0.144
GLS (%)	-18.03±1.16	-17.61±0.95	-18.90±1.08	< 0.001
IVS thickness (mm)	11.97±3.23	11.82±3.21	12.28±3.29	0.510
PW thickness (mm)	9.92±3.10	9.79±3.10	10.19±3.13	0.472
Mitral E/A ratio	0.97±0.14	0.83±0.39	0.97±0.23	0.028
E/e' ratio	11.87±1.31	12.53±0.74	10.50±1.19	< 0.001
LAVI (mm/m^2)	36.63±2.40	37.24±2.11	35.34±2.50	0.001
RA diameter (mm)	31.23±2.62	31.31±2.71	31.06±2.43	0.646
RV diameter (mm)	28.91±2.76	29.25±2.95	28.19±2.16	0.046
TAPSE (mm)	19.46±2.86	18.70±2.58	20.06±2.75	0.023
SPAP (mmHg)	20.34±2.70	21.12±2.76	19.97±2.30	0.033
Pulmonary function test parameters				
FVC, %	87.07±19.67	87.182±20.16	86.842±19.56	0.937
FEV1, %	86.95±20.82	87.102±20.90	86.882±20.94	0.961
FEV/FVC %	105 (98-114)	103.5 (98-114)	108 (101-115)	0.157
FEF(25%-75%)	78 (59-102)	76 (59-92)	87 (66-108)	0.102

MAPSE: Mitral annular plane systolic excursion; GLS: Global longitudinal strain; LVEDD: Left ventricular end diastolic dimension; LVESD: Left ventricular end systolic dimension; LVEDV: Left ventricular end-diastolic volume; LVESV: Left ventricular end-systolic volume; LVEF: Left ventricular ejection fraction; IVS: Interventricular septum; PW: Posterior wall; E: Peak transmitral flow velocities at early filling phase; A: Peak transmitral flow velocities at late filling phase; LAVI, left atrial volume index; RA: Right atrium; RV: Right ventricle; TAPSE: Tricuspid Annular Systolic Excursion; SPAP: Systolic Pulmonary Artery Pressure; FVC: Forced vital capacity; FEV1: Higher forced expiratory volume in one second; FEF25-75: Mean forced expiratory flow between 25 and 75% of the forced vital capacity.

3.1. INTRA-INTEROBSERVER VARIABILITY

Intraobserver and interobserver variability for echocardiographic parameters were assessed. The intraclass correlation coefficients (ICCs) for intraobserver and interobserver variability were determined to be 0.821 (95% CI: 0.659-0.914) and 0.847 (95% CI: 0.595-0.960), respectively.

4. DISCUSSION

In our study investigating COVID-19 survivors with symptoms, we examined determinants of MAPSE and analyzed its relationship with various clinical and echocardiographic parameters. Here are the key findings: 1) Shortness of breath, a common symptom among COVID-19 survivors, was more prevalent in the group with reduced MAPSE. 2) Patients requiring ICU hospitalization and/or IMV support exhibited lower MAPSE values. 3) Decreased MAPSE was identified as a clinical indicator of subclinical systolic dysfunction in COVID-19 survivors. 4) We observed a negative correlation between MAPSE and several parameters including GLS, systolic pulmonary artery pressure (sPAP), LAVI, E/e' ratio, serum ferritin, and Hs-TnT. 5) Finally, Hs-TnT levels, ICU hospitalization, and the need for IMV support emerged as independent predictors of decreased MAPSE.

LVEF, expressed as a percentage, is determined by dividing the volume of blood ejected from the left ventricle with each contraction by the total volume of blood in the left ventricle. A reduced LVEF value can also indicate a decrease in heart function. Subclinical systolic dysfunction refers to early or mild changes in heart function that may not be evident on routine physical examination or traditional cardiac tests [17]. In some cases, subclinical systolic dysfunction can be detected even when LVEF is normal. Longitudinal strain is a more complex measure of LV function compared to more

Table 3: Exploring the Relationship Between MAPSE and Clinical, Echocardiographic, and Laboratory Parameters		
Variable	**MAPSE**	
	r value	**p-value**
Age	0.120	0.238
LVEF	0.173	0.087
GLS	-0.684	< 0.001
sPAP	- 0.205	0.042
LAVI	-0.341	0.001
E/e'	-0.663	<0.001
IVS thickness	0.019	0.850
Serum Ferritin	-0.247	0.018
Hs-TnT	-0.228	0.025
D-dimer	-0.127	0.211

LVEF: Left ventricular ejection fraction; GLS: Global longitudinal strain; SPAP: Systolic Pulmonary Artery Pressure; LAVI: left atrial volume index; IVS: Interventricular septum; Hs-TnT: High-sensitive cardiac troponin T.

commonly used measures such as ejection fraction or fractional shortening [18]. To measure longitudinal strain, specialized software is used to analyze images obtained from echocardiography. This software tracks the movement of specific points in the myocardium (the muscle layer of the heart) throughout the cardiac cycle, allowing for calculation of longitudinal strain. Particularly in patients with subclinical or early-stage cardiac disease [19, 20].

MAPSE is a measurement of the systolic excursion of the mitral valve annulus, which reflects the contractility of the LV. MAPSE is typically measured using echocardiography, a non-invasive imaging technique that uses high-frequency sound waves to produce images of the heart. In clinical practice, MAPSE is commonly used as a parameter to assess LV function [14, 21]. Reduced MAPSE levels were associated with a higher death risk in COVID-19 patients, independently of other risk factors. Studies have shown that decreased MAPSE is associated with worse outcomes in patients with COVID-19, including longer hospital stays and higher mortality rates [22]. A reduced MAPSE value can indicate reduced LV systolic function, which can be a sign of myocardial injury, or other cardiac disorders [23]. As seen in our study, even if the patients were divided into subgroups according to MAPSE, no statistical differences were observed between the groups in terms of LVEF values, while the decreased MAPSE group had subclinical systolic dysfunction. As seen in our study, decreased MAPSE is accompanied by decreased GLS. These changes in echocardiographic parameters may indicate myocardial injury or dysfunction, which can be caused by a direct viral effect or secondary to the systemic inflammatory response associated with COVID-19. In addition to all these, our study revealed that LV diastolic function was impaired in the group with decreased MAPSE.

Troponin values are an important marker for assessing the health of the heart and detecting damage or disease. Elevated troponin levels can be a sign of heart damage, and measuring troponin levels is a key component of diagnosing and managing heart disease [24]. In our study, a significant and negative correlation was found between Hs-TnT values and MAPSE.

Table 4: Exploring the Relationship Between MAPSE and Clinical, Echocardiographic, and Laboratory Parameters			
Variable	**OR**	**95% CI**	**p-value**
Age	0.990	0.956-1.025	0.562
Serum Ferritin	1.001	0.994-1.064	0.104
Hs-TnT	2.019	1.043-3.712	0.028
HTN	1.245	1.042-2.543	0.067
ICU admission	1.432	1.004-2708	0.037
IMV treatment	1.306	1.128-2630	0.004

Hs-TnT: High-sensitive cardiac troponin T; HTN: Hypertension; ICU: intensive care unit; IMV: Invasive mechanical ventilation.

LAVI is an important marker of LV diastolic dysfunction [25]. Elevated LAVI is associated with increased risk of atrial fibrillation and adverse cardiovascular events [26]. According to our study data, increased LAVI values were found in the decreased MAPSE group. In our study, we found a negative correlation between MAPSE and LAVI. In the light of all this information, MAPSE provides information about LV function. In our study, decreased MAPSE values in COVID-19 patients are an important clinical clue for subclinical systolic functions as well as an important guide for impaired diastolic functions.

Our study had some limitations. MAPSE provides information only on the longitudinal contraction of the left ventricle and does not provide information on other aspects of left ventricular function, such as radial and circumferential function. This may limit its usefulness in the comprehensive assessment of left ventricular function. Although MAPSE is a useful parameter for assessing left ventricular function, a normal MAPSE value does not exclude the possibility of left ventricular dysfunction and should therefore be combined with additional ancillary parameters such as GLS, LAVI and E/e' rather than relying on MAPSE alone in clinical practice. Since there is no long-term prognosis study, we do not have information about the long-term clinical use of MAPSE. However, COVID-19 can affect multiple organ systems and the prognosis of COVID-19 depends on many factors such as age, comorbidities and disease severity. MAPSE alone may not be sufficient to predict the prognosis of COVID-19 and other diagnostic tests and clinical factors may need to be considered. Larger, prospective studies are needed to address the limitations of our study.

In conclusion, MAPSE can be measured easily and rapidly in routine echocardiographic imaging practice. MAPSE can be used as a sensitive indicator of cardiac function in patients with preserved LVEF in COVID-19 ssurvivors.

5. CONFLICT OF INTERESTS

The authors have no conflict of interest to declare. The authors declared that this study has received no financial support.

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