ORIGINAL ARTICLE

Cardiovascular Involvement and its Relationship with the Severity of the Acute Phase and Persistent Symptoms during Recovery from COVID-19 Infection

Compromiso cardíaco y su relación con la gravedad del cuadro agudo y los síntomas persistentes en la convalecencia de infección por COVID-19

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ABSTRACT

Background: The acute phase of COVID-19 infection is associated with cardiovascular involvement, but there is limited information regarding this relationship in the recovery phase from this disease both in patients with or without persistent symptoms.
Objectives: The aims of this study were: 1. To analyze cardiovascular involvement by echocardiography in the recovery phase from COVID-19 disease, and 2. To explore its association with: a) the severity of the acute phase and b) the presence of persistent symptoms.
Methods: An analytical, observational, prospective and single-center study was carried out, including consecutive patients attending the center for post-COVID-19 evaluation who underwent a transthoracic color Doppler echocardiogram looking for pathological outcomes.
Results: A total of 600 patients were included from September 1, 2020 to May 1, 2021, and 29 of these patients (4.8%) presented pathological findings in the echocardiogram. Patients with moderate or severe acute phase COVID-19 infection had a higher prevalence of wall motion disorders (4.3% vs. 0.5%, p=0.02) and pericardial effusion (4.3% vs. 0.24%, p=0.01) compared with those with asymptomatic or mild symptoms; however, after multivariate adjustment, this association did not reach statistical significance. In 28.6% of cases, patients reported persistent symptoms, with no evident association between their presence and pathological echocardiographic results.
Conclusion: The prevalence of cardiovascular involvement evaluated by echocardiography was 4.8% in the recovery phase from COVID-19 disease. Patients with more severe initial clinical presentation exhibited more pathological findings, but the significance was not sustained in the multivariate analysis. Persistent symptoms were not associated with greater cardiovascular involvement.

Key words: COVID-19/complications, SARS-CoV-2, Myocarditis, Cardiomyopathy, Echocardiography

RESUMEN

Introducción: La infección por COVID-19 se asocia a compromiso cardiovascular en su etapa aguda. La información sobre el compromiso cardíaco en la etapa de convalecencia de la enfermedad tanto en pacientes con y sin síntomas persistentes es limitada.
Objetivos: 1. Analizar el compromiso cardíaco mediante ecocardiograma en la etapa de convalecencia de la enfermedad por COVID-19; 2. Explorar su asociación con: a) gravedad del cuadro agudo y b) persistencia de síntomas.
Métodos: Estudio analítico, observacional, prospectivo y unicéntrico. Se incluyeron pacientes consecutivos que consultaron al centro para realizar evaluación post- COVID. Se realizó ecocardiograma Doppler color transtorácico en busca de hallazgos patológicos.
Resultados: Se incluyeron 600 pacientes desde el 01/09/2020 al 01/05/2021. Veintinueve (4,8%) presentaron hallazgos patológicos en el ecocardiograma. Los pacientes con cuadros iniciales moderados o graves presentaron mayor prevalencia de trastornos de motilidad parietal (4,3% versus 0,5%, p=0,02) y derrame pericárdico (4,3% versus 0,24%, p=0,01) en comparación con aquellos con cuadros asintomáticos o leves. En el ajuste multivariado esta asociación no alcanzó significación estadística. El 28,6% de los pacientes referían síntomas persistentes, no observándose una asociación entre la presencia de los mismos y los hallazgos ecocardiográficos patológicos.
Conclusión: La prevalencia de compromiso cardíaco evaluado mediante ecocardiograma en la etapa de convalecencia de la enfermedad por COVID-19 fue de 4,8%. Los pacientes con cuadros iniciales más graves presentaron más hallazgos patológicos. La significancia no se sostuvo en el análisis multivariado. Los síntomas persistentes no se asociaron a mayor compromiso cardíaco.

Palabras clave: COVID-19/ complicaciones, SARS-CoV-2, Síndrome post-agudo COVID-19, Miocarditis, Cardiomiopatía, Ecocardiografía.

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Abbreviations

ACEI	Angiotensin-converting enzyme inhibitors	**EF**	Ejection fraction
ARBs	Angiotensin II receptor blockers	**FAC**	Fractional area change
BMI	Body mass index	**LVDD**	Left ventricular diastolic diameter
BP	Blood pressure	**LVSD**	Left ventricular systolic diameter
CMR	Cardiac magnetic resonance	**TAPSE**	Tricuspid annular plane systolic excursion
COVID-19	Coronavirus disease 19	**TDI**	Tissue Doppler imaging
ECG	Electrocardiogram	**TTE**	Transthoracic color Doppler echocardiography

INTRODUCTION

The pandemic caused by the SARS-CoV-2 virus, or COVID-19, has drastically changed people's life (1) and medical inpatient and outpatient care. (2). In the last year, ambulatory consultations for post-COVID-19 monitoring represented a very important share of the total number of consultations.

Clinical manifestations of COVID-19 infection involve from mild respiratory symptoms to severe pulmonary and systemic disorders. (3) Presence of preexisting diseases, cardiovascular risk factors and older age have been shown to be predictors of worse clinical outcome, higher admission to intensive care units and mortality. (4)

Some publications have observed that a significant proportion of patients present some type of sequel or persistent respiratory, cardiac or neurological symptom in the recovery phase. (5) Up to 90% of patients have reported persistent symptoms that could last up to 6 months after the acute phase. (6, 7) As yet, there is no consensus to define Post-Acute COVID-19. The COVID-19 Symptom study has described it as the persistence of symptoms beyond 3 weeks after the start of the infection. (8)

It has not been established which studies should be performed to evaluate sequelae or myocardial injury after the acute infection. Currently, follow-up of these patients in their recovery phase is carried out based on expert consensus, with so far, no clinical evidence-based process. (9, 10)

Several studies reporting cardiovascular involvement by cardiac magnetic resonance (CMR) imaging have been published in patients suffering from COVID-19 infection. (11) Puntmann et al. reported cardiovascular involvement by CMR in 78% of patients. (12) In a retrospective study with 26 patients recovering from moderate conditions, Huang et al observed 58% of cases with pathological findings in CMR. (13) In the CMR of 26 athletes recovered from mild conditions, Raipal et al. reported myocarditis in 15% of cases and some pathological finding in 30%. (14) However, recent publications have described the presence of cardiovascular involvement by CMR in less than 3% of patients. (15-17) Some of these works, (15) which included transthoracic color Doppler echocardiography (TTE), found cardiac disorders in 0.9% of patients. This heterogeneity in the prevalence of cardiovascular involvement has still no definite answer.

OBJECTIVES

The primary objective of this study was to evaluate the prevalence of cardiovascular involvement by Doppler echocardiography in the recovery phase from COVID-19 disease.

Secondary objectives were: a) To analyze the association between the severity of the acute phase of COVID-19 disease and the echocardiographic pathological findings during recovery; b) To analyze the association between the presence of post-COVID-19 persistent symptoms and these echocardiographic findings.

METHODS

An analytical, observational, prospective study was carried out in a cardiology ambulatory care center in the Buenos Aires Province, Argentina.

It included non-selected consecutive patients who had consulted for diagnosis of COVID-19 according to the definitions of the Ministry of Health of Argentina (18) (laboratory confirmation or clinical/epidemiological criterion) and were in the recovery phase of the disease, between 15 and 120 days after diagnosis.

Patients presenting another known or possible cause of cardiac disease, such as ischemic-necrotic disease, restrictive or dilated hypertrophic myocardial disease, severe heart valve diseases, or any other severe cardiac disease, were excluded from the study.

Medical history was taken identifying risk factors, relevant history, severity of COVID-19 disease and presence of persistent symptoms in the recovery phase, including not previously referred dyspnea on exertion, palpitations, precordial pain and/or asthenia. A physical exam, electrocardiogram (ECG), TTE, lab tests and chest X-rays were performed. Additional myocardial injury and inflammatory biomarker assessments were recommended in the lab tests of patients with persistent symptoms or pathological findings in complementary studies, or other studies, such as 24-hour Holter monitoring or stress test.

Transthoracic echocardiography was performed by specialists with at least 500 studies per year. In case of diagnostic doubt, studies were reviewed by another professional. As part of the TTE, left ventricular wall peak systolic velocities [tissue Doppler imaging (TDI) S´ wave] were systematically evaluated as surrogate of fiber dysfunction, considering as definitely altered fibers, a septal value <7 cm/s, or lateral, anterior or inferior values <8 cm/s.

Transthoracic echocardiographic findings compatible with post-COVID-19 cardiovascular involvement, were previously unknown presence of left ventricular ejection fraction (LVEF) ≤52% in men or ≤54% in women, regional wall motion abnormalities, or pericardial effusion.

A CMR imaging study was suggested in case of echocardiographic pathological findings or ventricular arrhythmia to confirm the presence of cardiovascular involvement, including left ventricular dysfunction, pericardial effusion and/or late gadolinium enhancement with non-ischemic pattern, associated or not with myocardial edema.

An exploratory analysis was performed in the subgroup of patients undergoing CMR. However, the request of this and other studies was left to the criterion of the treating physician.

COVID-19 infection was considered mild in the presence of symptoms but without evidence of pneumonia; moderate, in patients with clinical-radiological evidence of pneumonia with or without need of admission to the general ward; and severe, in case of admission to the intensive care unit, with or without need for mechanical respiratory assistance (MRA).

Statistical analysis

Continuous variables were expressed as mean ± standard deviation (SD) and categorical variables as percentages. Continuous variables between groups were compared using Student's t test or the Mann-Whitney-Wilcoxon test, according to their distribution, and categorical data were analyzed with the chi-square test or Fisher's exact test.

The relationship between COVID-19 severity and pathological echocardiographic findings was evaluated by means of multivariate analysis, adjusting for clinical variables that in the univariate analysis were significantly different. A multivariate analysis was not performed to evaluate the association between persistent symptoms and echocardiographic findings, as there were no significant differences in the echocardiographic variables of interest in the univariate analysis.

Statistical significance was defined for a two-tailed $p<0.05$. STATA 13 (Stata Corp. College Station, TX) software package was used for the statistical analysis.

Ethical considerations

The study protocol was reviewed and approved by the institutional Ethics Committee and the research was conducted according to the declaration of Helsinki principles. All study patients granted their informed consent to participate in the study.

RESULTS

A total of 600 patients were included in the study from September 2020 to May 2021. Mean age was 41±14.8 years and 48% were men. Population characteristics are detailed in Table 1. Median time between COVID-19 diagnosis and inclusion in the study was 40 days (range 16-120 days).

The acute phase of COVID-19 was asymptomatic in 3.7% of patients, mild in 81.8%, moderate in 12.6% and severe in 1.9%, with only 0.6% requiring MRA (Figure 1).

Twenty-nine patients (4.8%) presented previously unknown pathological findings in TTE, compatible with post-COVID-19 cardiovascular involvement. Among them, ventricular dysfunction was observed in 18 patients (62%), wall motion abnormalities in 4 (13.8%), both findings in 3 (10.4%) and pericardial effusion in 4 (13.8%).

Patients with moderate-severe acute phase COVID-19 conditions presented more wall motion abnormalities (4.3% vs. 0.5%, p=0.02) and more pericardial effusion (4.3% vs. 0.24%, p=0.01). In the multivariate analysis, adjusted by age and cardiovascular risk factors (diabetes, dyslipidemia, hypertension and body mass index), this difference lost statistical significance. No differences were found in left ventricular systolic function assessed by LVEF, or in the analysis of tissue systolic velocity analysis, as surrogate of myocardial fiber dysfunction, in acute moderate-severe versus mild-asymptomatic conditions. Only the anterior wall evidenced lower S' wave velocity in patients coursing moderate-severe conditions, that despite reaching statistical significance, might not have clini-

Table 1. Baseline population characteristics

	N = 600
Age, years, mean (SD)	41.7 (14.8)
Male gender (%)	48.6
BMI, mean (SD)	26.16 (4.9)
Total cholesterol, mg/dl, mean (SD)	196.1 (38.2)
LDL-C, mg/dl, mean (SD)	116.7 (33.2)
HDL-C, mg/dl, mean (SD)	55.9 (14.5)
Systolic BP, mmHg, mean (SD)	121.2 (14.8)
Diastolic BP, mmHg, mean (SD)	73.4 (9.4)
Hypertension (%)	18.6
Diabetes (%)	6.5
Dyslipidemia (%)	21.2
Active smoking (%)	7.2
Ex-smoker (%)	11.8
Obesity (BMI >30) (%)	16.8
Use of ACEI/ARBs (%)	9
Use of aspirin (%)	3.3

SD: Standard deviation; BMI: Body mass index; BP: Blood pressure; ACEI: Angiotensin converting enzyme inhibitors ARBs: Angiotensin II receptor blockers.

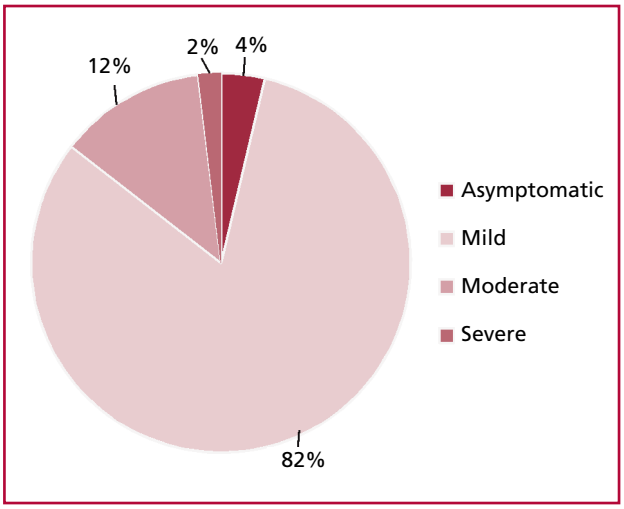

Fig. 1. Severity of the acute phase of COVID-19 infection

cal relevance because the value was within normal parameters (Table 2).

A total of 23 patients underwent CMR. Fifteen of these patients (65.2%) presented some finding compatible with post-COVID-19 cardiovascular involvement. Among them, 6 (40%) presented intramyocardial non-ischemic late gadolinium enhancement, 2 (13.4%) left ventricular dysfunction, 2 (13.3%) both findings and 5 (33.3%) pericardial effusion. Considering CMR as the "gold-standard", echocardiography showed 67% sensitivity, 63% specificity an 70% positive predictive value to diagnose cardiovascular involvement.

At the time of inclusion, 28.6% of patients described persistent symptoms, with 6.4% referring palpitations, 12.1% dyspnea, 15.5% asthenia and 4% precordial pain. (Figure 2). There was no association between persistent symptoms during recovery from COVID-19 disease and pathological echocardiographic findings (Table 3).

DISCUSSION

The evaluation and follow-up of patients coursing COVID-19 infection poses challenges and interrogations that still have no definite answers. In our study we observed cardiovascular involvement in 4.8% of TTE-evaluated patients. This percentage is clearly inferior to the ones observed in the first studies where patients were analyzed by CMR, (12-14) but closer to those of more recent studies. (15-17)

We understand that the rate of cardiovascular involvement was not affected by the quality of TTE studies, since the protocol was very detailed and complete, and TTEs were analyzed by trained and experienced physicians. Neither age, previous health status or the evolution time at the moment of patient evaluation, seem to have been factors explaining this difference. The hypotheses to elucidate the discrepancy with respect to the initially published high rates are:

1- The CMR used in those reports could detect myocarditis and mild fibrotic processes not involving ventricular function or producing significant motility abnormalities and mild pericardial effusions, that might not be detected by TTE. Cardiac magnetic resonance imaging could also identify findings not associated with COVID-19 infection (11)

2- Patients included in the first studies coursed a more severe infection than those included in this and other more recent studies.

Other factors such as the study population (some reports only included university athletes), (15-17) design and size of the different studies, time between the acute infection and evaluation, severity of the acute infection and different definitions of cardiovascular involvement, among other causes, could be additional reasons for heterogeneity in the prevalence of cardiovascular involvement published so far.

Patients with moderate-severe COVID-19 conditions presented more cardiovascular involvement by TTE. However, this relationship losses statistical significance in the multivariate analysis, which could be related to the low number of pathological findings recorded, but also to the fact that moderate-severe patients had greater prevalence of cardiovascular risk factors than patients developing milder disease conditions.

In agreement with recent publications, a high percentage of patients in our study (almost 1 out of 3) presented persistent symptoms in post-COVID monitoring. (5-8) The statistical office of the United Kingdom has reported that approximately 21% of patients presented persistent symptoms for more than 5 weeks after COVID-19 infection, with asthenia and dyspnea as the more prevalent ones. (19) Persistent symptoms after recovery from the acute phase, a condition known as post-acute COVID-19 or "long COVID" syndrome, presents great variations in symptom estimation due to study differences in the recruitment methods, follow-up periods and sample size. (20) The presence of persistent symptoms in the post-COVID syndrome did not predict cardiovascular involvement in our study (we did not observe association between these symptoms and TTE abnormal findings). Cardiac dysfunction is probably more related with the severity of the initial clinical condition and patient baseline and cardiovascular risk characteristics.

¿Do we have to evaluate patients after COVID-19 infection? We understand that the answer is yes. According to our study, almost a third of patients coursing this disease will have persistent symptoms affecting their quality of life. Almost 5% of patients will have significant clinical pathological findings in TTE, but the presence of persistent symptoms does not allow the selection of patients to be evaluated, as in our study they were not associated with greater cardiovascular involvement than in asymptomatic patients.

Transthoracic echocardiography findings have enough relevance to consider a different approach with respect to patients with normal TTE. A different follow-up, other complementary studies and a return to a possibly slower and more controlled physical activity, especially in subjects performing moderate and intense exercise, or athletes, will have to be considered. Another, not minor aspect of the evaluation, is the reassurance effect in patients with normal studies, who are worried for having coursed the disease, and even more, in those with persistent symptoms. This reassurance may have positive effects in clinical and emotional aspects, allowing an earlier return to work and physical activities. Additionally, this evaluation represents a physician-healthcare monitoring meeting opportunity whose impact will be assessed in future publications.

What should this post-COVID-19 patient evaluation include? Given the incidence of this infection and the need for testing an important number of persons, it is necessary to define an adequate evaluation that allows detecting those cases that require special clinical considerations. Transthoracic echocardiogra-

Table 2. Clinical and echocardiographic findings according to the acute phase of COVID-19 severity

	COVID Asymptomatic - Mild (N=413)	COVID Moderate - Severe (N=70)	p
Age, years, mean (SD)	40.8 (14.6)	50.9 (14.1)	**<0.005**
BMI, mean (SD)	25.8 (4.8)	28.2 (5.1)	**<0.005**
Male gender (%)	52.8	47.1	0.38
Hypertension (%)	16	32.9	**0.001**
Smoking (%)	7.3	7.1	0.98
Diabetes (%)	5.8	12.9	**0.03**
Dyslipidemia (%)	19.1	23.3	**0.016**
LVDD, mm, mean (SD)	46.1 (5.2)	46.5 (4.4)	0.566
LVSD, mm, mean (SD)	28.1 (4.6)	28.1 (5.1)	0.990
Shortening fraction, mean (SD)	0.39 (0.07)	0.40 (0.09)	0.530
Septum, mm, mean (SD)	9.1 (1.6)	9.8 (1.8)	**<0.005**
Posterior wall, mm, mean (SD)	8.3 (1.3)	8.6 (1.4)	**0.041**
Left atrium, cm2, mean (SD)	16.9 (3.2)	17.6 (3.4)	0.093
Ejection fraction, %, mean (SD)	64.0 (6.2)	63.4 (6.4)	0.472
Mitral E wave, m/s, mean (SD)	0.82 (0,18)	0.70 (0.22)	**<0.005***
Mitral A wave, m/s, mean (SD)	0.61 (0.45)	0.69 (0.19)	0.166
Septal S´, cm/s, mean (SD)	9.9 (2.4)	9.3 (1.4)	0.161
Septal e´, cm/s, mean (SD)	12.2 (3.7)	10.6 (2.9)	**0.015**
Septal a´, cm/s, mean (SD)	9.2 (2.9)	10.0 (2.9)	0.169
Lateral S´, cm/s, mean (SD)	11.7 (2.8)	11.5 (2.3)	0.756
Anterior S´, cm/s, mean (SD)	10.7 (2.2)	10.6 (1.7)	**0.021***
Inferior S´, cm/s, mean (SD)	9.8 (1.7)	9.5 (1.6)	0.058
E/e´ ratio, mean (SD)	7.2 (2.4)	6.9 (2.3)	0.411
RV S´, cm/s, mean (SD)	14.4 (3.0)	14.8 (2.7)	0.476
TAPSE, mm, mean (SD)	25.4 (3.7)	24.7 (4.3)	0.262
RVDD, mm, mean (SD)	25.2 (5.7)	23.3 (4.1)	0.052
Systolic pulmonary pressure, mmHg, mean (SD)	21.5 (5.3)	23.9 (5.4)	**0.03**
RV Tei index, mean (SD)	0.91 (2.1)	0.48 (0.04)	0.744
RV FAC, mean (SD)	0.49 (0.06)	0.47 (0.06)	0.429
Aortic regurgitation, % (n)	3.4 (14)	2.9 (2)	0.584
Mitral regurgitation, % (n)	24.2 (100)	28.6 (20)	0.435
LV diastolic dysfunction, % (n)	5.1 (21)	7.1 (5)	0.489
Pericardial effusion, % (n)	0.24 (1)	4.3 (3)	**0.01**
LV systolic dysfunction, % (n)	3.6 (15)	7.1 (5)	0.17
Wall motion abnormalities, % (n)	0.5 (2)	4.3 (3)	**0.02**

SD: Standard deviation; BMI: Body mass index; LVDD :Left ventricular diastolic diameter; LVSD: Left ventricular systolic diameter; RV. Right ventricular; TAPSE: Tricuspid annular plane systolic excursion; RVDD: Right ventricular diastolic diameter; FAC: Fractional area change; LV: Left ventricular.
* Preserved statistical significance in the multivariate analysis

phy represents a useful tool for the diagnosis of post-COVID cardiovascular injury, as it is a low-cost, accessible study in terms of equipment and trained staff availability. Although its sensitivity is below that of CMR, a recent publication reported that cardiopulmonary symptoms and TTE were the best way to select patients who would have cardiovascular involvement in the CMR (OR 3 and 37, respectively). (15) Cardiac magnetic resonance imaging is more costly, less accessible and could detect cases not requiring a differentiated clinical management. In our study, which included non-selected patients, TTE allowed, within the framework of a disease that has a very high rate of patients with persistent symptoms, the identification of those in need of more investigation and closer follow-up, and being more cautious at the time of consenting the resumption of intensive physical activity.

It will be necessary to continue accumulating information to better define the way of evaluation patients after COVID-19 infection, so as to utilize the scarce resources available in a cost-effective manner. Future studies to know these patients' mid- and long-

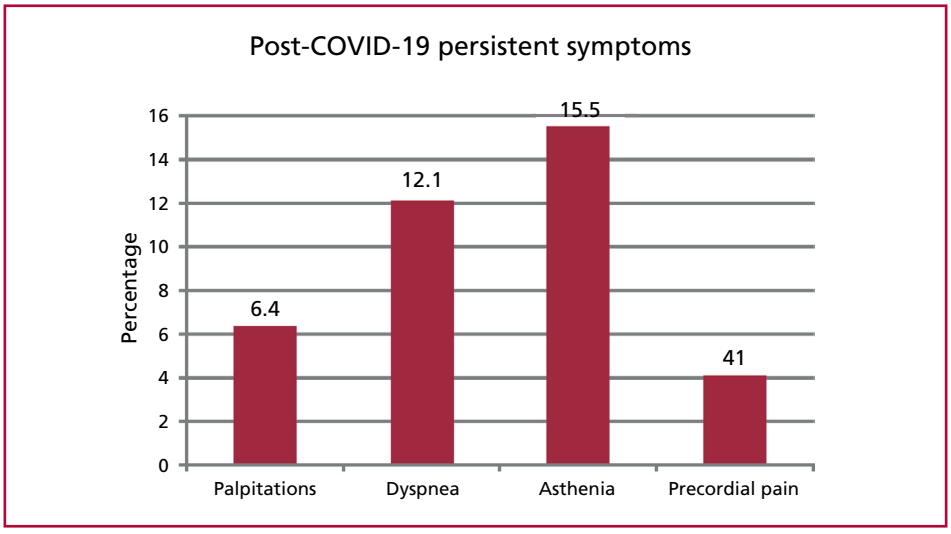

Fig. 2. Prevalence of post-COVID-19 persistent symptoms in the first consultation.

Table 3. Echocardiographic findings according to post-COVID-19 symptom persistence

	With Persistent Symptoms (n=126)	Without Persistent Symptoms (n=315)	p
LVDD, mm, mean (SD)	46.1 (5.0)	46.5 (4.8)	0.485
LVSD, mm, mean (SD)	27.8 (4.6)	28.3 (4.7)	0.290
Shortening fraction, mean (SD)	0.40 (0.08)	0.39 (0.08)	0.431
Septum, mm, mean (SD)	9.4 (1.7)	9.1 (1.6)	0.07
Posterior wall, mm, mean (SD)	8.3 (1.3)	8.4 (1.3)	0.585
Left atrium, cm2, mean (SD)	17.0 (2.8)	16.9 (3.3)	0.746
Ejection fraction, %, mean (SD)	63.7 (6.2)	64.3 (5.4)	0.279
Mitral E wave, m/s, mean (SD)	0.79 (0.21)	0.81 (0.19)	0.597
Mitral A wave, m/s, mean (SD)	0.62 (0.16)	0.58 (0.16)	0.009
Septal S´, cm/s, mean (SD)	9.9 (2.2)	9.9 (2.4)	0.980
Septal e´, cm/s, mean (SD)	11.8 (3.4)	12.2 (3.8)	0.385
Septal a´, cm/s, mean (SD)	9.5 (2.5)	9.2 (3.0)	0.571
Lateral S´, cm/s, mean (SD)	11.4 (2.5)	11.9 (2.9)	0.199
Anterior S´, cm/s, mean (SD)	11.0 (2.4)	11.0 (2.4)	0.930
Inferior S´, cm/s, mean (SD)	9.8 (1.5)	10.0 (1.9)	0.641
E/e´ ratio, mean (SD)	7.3 (2.3)	7.1 (2.5)	0.657
RV S´, cm/s, mean (SD)	14.3 (2.3)	14.5 (3.2)	0.621
TAPSE, mm, mean (SD)	25.0 (3.7)	25.6 (4.0)	0.242
RVDD, mm, mean (SD)	25.2 (5.5)	24.4 (5.2)	0.339
Systolic pulmonary pressure, mmHg, mean (SD)	22.8 (5.2)	21.3 (5.3)	0.101
RV Tei index, mean (SD)	0.40 (0.02)	0.42 (0.08)	0.540
RV FAC, mean (SD)	0.49 (0.06)	0.48 (0.06)	0.529
Aortic regurgitation, % (n)	0.,8% (5)	3.8% (12)	0.09
Mitral regurgitation, % (n)	22.2% (28)	25.1% (79)	0.527
LV diastolic dysfunction, % (n)	6.4% (8)	4.4 (14)	0.468
Pericardial effusion, % (n)	2.4% (3)	0.32% (1)	0.07
LV systolic dysfunction, % (n)	7% (9)	3.1% (10)	0.06
Wall motion abnormalities, % (n)	2.4 (3)	0.6% (2)	0.143

SD: Standard deviation; LVDD :Left ventricular diastolic diameter; LVSD: Left ventricular systolic diameter; RV. Right ventricular; TAPSE: Tricuspid annular plane systolic excursion; RVDD: Right ventricular diastolic diameter; FAC: Fractional area change; LV: Left ventricular

term evolution will allow more adequate diagnosis, care and public health policies. (21)

Therefore, we consider that it is necessary to perform a systematic evaluation of patients that suffered from COVID-19 infection, and this should always include cardiopulmonary symptom assessment and TTE.

Limitations

Our study has several limitations:

1. It was a single-center study.
2. More severe patients could complete their evaluation in the center where they were hospitalized, so as this was an ambulatory care center, patients included could have been less severe. In turn, patients who consulted could have been more interested in their health, more careful and healthier, contributing to the selection of a less sick COVID-19 subpopulation.

CONCLUSIONS

The prevalence of cardiovascular involvement assessed by TTE in the recovery phase from COVID-19 disease was 4.8%. Although there was a relationship between the severity of the clinical condition during the infection and cardiovascular involvement, this significance did not sustain after the multivariate analysis. The greater prevalence of pathological echocardiographic findings in patients with more severe initial conditions could be explained by the greater incidence of risk factors in this population. Nearly one third of patients presented persistent symptoms at the time of inclusion in the study. No relationship was found between persistent symptoms and cardiac injury.

Conflicts of interest

None declared.

(See authors' conflicts of interest forms on the website/ Supplementary material)

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