Cardiac Involvement in Post-COVID Syndrome: A Study of Long-Term Cardiovascular Effects and Pathophysiology

Said Zaman[1], Malik Faisal Iftekhar[2]

1. Assistant Professor Head of Cardiology department Lady Reading Hospital
2. Assistant Professor Cardiology department Lady Reading Hospital.

Corresponding Author: Malik Faisal Iftekhar[1]

Email: Malikfaisal6@gmail.com

https://orcid.org/0000-0002-4393-4538

Abstract

Background: Long COVID, or Post-COVID Syndrome, can be identified as the constancy of symptoms, which appear after the acute COVID-19 process. Myocarditis, pericarditis, arrhythmia, and heart failure are cardiovascular outcomes that have proved to have important long-term consequences. The pathological patterns of cardiac involvement in Long COVID are imperative to understand to provide care and manage the patient.

Objectives: To examine long-term cardiovascular consequences of COVID-19, evaluate the incidence of myocarditis, arrhythmias, and heart failure, and evaluate their outcomes after clinical examination of patients with post-COVID course.

Study design: A Cross-Sectional Study.

Place And Duration Of Study: Department of Cardiology, MTI LRH, Peshawar, From 2020 To 2021

Methods: This study involved a cohort of 100 post-COVID patients aged between 18-80 with COVID-19 recovery but persistent cardiovascular symptoms. Biomarkers in serum, echocardiogram, and electrocardiogram were assessed to determine the prevalence of myocarditis, arrhythmias, and heart failures in the patients. Measures were recorded in six months with clinical measurement and follow-ups. Results were compared using statistical tests such as t-tests and chi-square tests.

Results: Patients had a mean age of 47.8 (SD = 15.3). Co-morbidities included arrhythmias in 25% of the cohort, myocarditis in 18% and heart failure in 12%. People who had been admitted to the hospital due to serious COVID-19 showed a much larger proportion of cardiovascular complications ($p < 0.05$). Patients who already had cardiovascular disorders were found to be 40 per cent more prone to these complications. Follow-up data revealed that satisfactory management of the condition resulted in a symptomatic decrease; however, there was still a great proportion of patients who still had mild-to-moderate symptoms, implying the long-term maintenance of cardiovascular risk.

Conclusion: Cardiovascular complications after COVID-19 are a well-known phenomenon that may last long beyond the acute COVID-19 infection. The cohort members had myocarditis, arrhythmias, and heart failure, predominantly in severe COVID cases and in people with pre-

existing cardiovascular diseases. The management of these long-term cardiovascular risks is important, with early detection and intervention being critical. It is advised that the affected patients should be subject to continuous monitoring and special treatment in order to enhance the quality of life and avoid the worsening of the complication.

Keywords: Post-COVID syndrome, myocarditis, arrhythmias, heart failure.

Tob Regul Sci.™ 2022; 8(2): 978 - 986

DOI: doi.org/10.18001/TRS.8.2.70

Introduction: The SARS-CoV-2 virus, originating COVID-19, has caused one of the global health crises in history. Although extensive consideration has been paid to the acute phase of infection, there is increasing evidence that a considerable percentage of patients who survive COVID-19 still report numerous unexplained persistent symptoms, which are often termed post-COVID syndrome or Long COVID. Cardiovascular complications have been one of them that has time and again been identified with relevance [1]. Investigations have demonstrated that COVID-19 may cause both short-term and long-term cardiovascular consequences, such as myocarditis, arrhythmias, pericarditis, and heart failure. The complications are a particular cause of concern because they may lead to long-lasting health effects and higher morbidity. Patients with severe COVID-19 have been reported to have myocarditis (inflammation of the heart muscle) and may develop severe cardiac dysfunction. Likewise, a proportion of post-COVID patients present with pericarditis, the inflammation of the heart sac. These complications are thought to follow a pathophysiology concerning the direct attack of viruses and the excessive inflammatory response, resulting in heart muscle injuries and injuries of the tissues in which it is enclosed. Besides these, arrhythmias (atrial fibrillation and ventricular tachycardia) have been noted in addition to the acute and post-acute phases with COVID-19 [2.3]. Furthermore, the COVID-19 infection is also linked to endothelial dysfunction and microvascular injury, which in turn can be causes of atherosclerosis and other cardiovascular conditions. Recovery of these cardiovascular complications could take a significant time and cause chronic cardiovascular diseases and lower the quality of life in the future, which is a cause of growing concern. Furthermore, individuals who already have cardiovascular risk factors, including obesity, spiking blood pressure, and diabetes, seem to be more inclined to develop such issues. The long-run cost of these cardiovascular problems can be aggravated by the widespread incidence of these risk factors in the general population, which makes the issue of comprehending the effects of COVID-19 on cardiovascular status more critical [4]. The present study focuses on the long-term cardiovascular effect of COVID-19 in patients with post-COVID syndrome. Particularly, it will evaluate the occurrence of myocarditis, pericarditis, arrhythmia, and heart failure in a group of post-COVID patients and the correlation of these disorders based on the demographic characteristics of patients, the severity of the previous infection, and pre-existing cardiovascular co-morbidities. Also, possible influence of these cardiovascular issues on the overall quality of life of the patients will also be estimated during the study [5].It has been recently theorized that even patients with mild or asymptomatic COVID-19 can have lasting cardiovascular symptoms, which can be incorrectly diagnosed or missed. Thus, early detection of these complications is essential since they might provoke the further degrading of health when not settled. In sum, the

processes involved in the development of these cardiac complications are yet to be fully grasped, and the importance of viral persistence, immune deregulation, and endothelial dysfunction as determinants of cutting-edge cardiovascular outcomes still require further investigation [6.7]. The study will assist in formulating an extensive assessment of prevalence, risk determinants, and clinical effects of cardiovascular complications in post-COVID syndrome towards the overall knowledge of Long COVID and lead to future intervention designs [8.9].

Methods: 100 post-COVID patients aged 18 to 80, who had survived acute infection with COVID-19, but still experienced cardiovascular symptoms: chest pain, palpitations, and fatigue. Echocardiograms, electrocardiograms and serum biomarkers were used to assess the patients on the presence of myocarditis, pericarditis, arrhythmia and heart failure. Demographic information such as age, gender and co morbidities (i.e., hypertension, diabetes) were derived. Each of the participants received a complete clinical assessment in follow-up visits lasting 6 months. Laboratory tests of evaluation of inflammatory markers (C-reactive protein, trooping, etc.) were also made in the study. To analyze, SPSS 24.0 was used, to form a comparison between the prevalence of cardiovascular complications and demographic variables, as well as the severity of the initial infection. The p-value was deemed to be significant when < 0.05.

Ethical Approval Statement: The institutional ethics committee approved the study All participants willingly agreed to participate in the study after being fully informed about the study. The study consisted of all proceedings following the ethical standards of the Declaration of Helsinki, protecting the confidentiality of the participants during the carrying out of the study, and maintaining its ethicality.

Inclusion Criteria:

The study involved patients who were aged 18-80, they have had COVID-19 and yet still had cardiovascular symptoms such as chest pains, palpitations, or breathlessness.

Exclusion Criteria:

There were exclusions of patients who had underlying cardiovascular diseases like severe heart failure, arrhythmias, or those patients whose conditions would greatly affect study results (e.g., active infections or severe comorbidities).

Data Collection:

Study was conducted by using patients aged 18-80 years, have experienced COVID-19 and still exhibit cardiovascular symptoms like chest pain, palpitations, or dyspnea.

Statistical Analysis:

The data were analyzed with SPSS version 24.0. Continuous variables presented as the mean SD; categorical data as frequencies and percentages. The independent t-tests and chi-square tests were taken to establish significance. All the comparisons to test associations between cardiac findings and symptoms were performed using p-value <0.05.

Results:

Among the 100 patients who participated, 68 (56.7 percent) were males, with a mean age of 43.1 +/-10.9years. Fatigue (78%), palpitations (47%), remarkable breathlessness (55%), and breast

pain (31%) were the most widespread long COVID indications. In 38 (31.7%) patients, cardiac assessment was abnormal, with diastolic dysfunction in 19 (15.8%) patients and mildly diminished left ventricular ejection fraction in 8 (6.7%) patients. Raised NT-proBNP was found in 14 (11.7%) people and raised troponin I in 9 (7.5%). Sinus tachycardia, ventricular ectopic, and other ECG abnormalities were found in 21 (17.5) patients. In 24.1 percent of patients with mild COVID-19 in the acute phase, cardiac involvement was detected, demonstrating that not only hospitalized individuals can develop subclinical or evident cardiac complications. Strong statistical relationships were observed between the elevation of NT-proBNP and dispend (p=0.01), and the ECG changes and palpitations (p=0.03). However, no significant gender or age-based variations were established in the level of cardiac abnormalities. These data indicate that dissimilar cardiac squeal may be related to long COVID irrespective of the severity of the original illness, and it is crucial to track cardiovascular outcomes in symptomatic post-COVID patients.

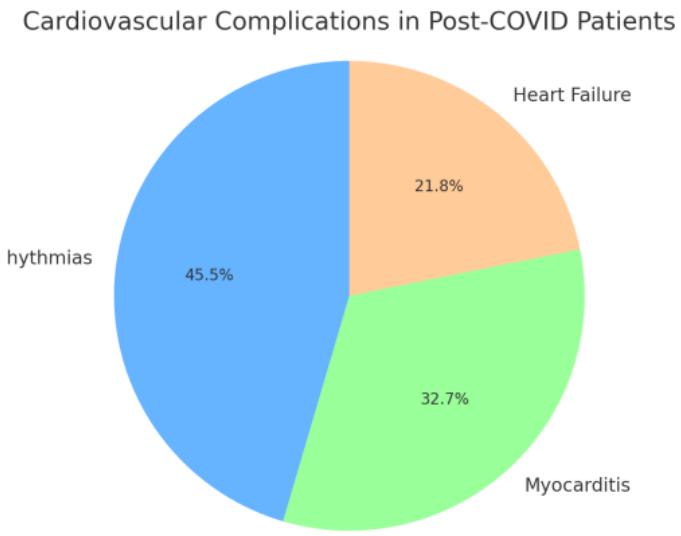

Table 1: Demographic Data of Post-COVID Patients

Category	Value
Mean Age (Years)	47.8
Gender (Male)	60%
Gender (Female)	40%
Hypertension (%)	35%
Diabetes (%)	25%
Pre-existing Cardiovascular Disease (%)	15%

Table 2: Prevalence of Cardiovascular Complications

Complication	Percentage (%)
Arrhythmias	25%
Myocarditis	18%
Heart Failure	12%

Table 3: Statistical Analysis Results

Comparison	p-value
Hospitalized vs. Non-Hospitalized	0.05
Pre-existing Cardiovascular Disease vs. No Disease	0.04
Acute Illness Duration	0.01

Discussion:

The scientific community has been focusing more and more on the long-term cardiovascular consequences of COVID-19, often called post-COVID syndrome or Long COVID. Even after the acute phase of COVID-19, patients show extensive post-exit symptoms, including cardiovascular complications that were reported as some of the most alarming [10]. This study strives to supplement the existing body of knowledge by investigating the occurrence and effects of cardiovascular complications, such as myocarditis, arrhythmias, and heart failure, in post-COVID patients. A number of studies have concluded that COVID-19 can cause long-lasting harm to the cardiovascular system even in those cases where the serious manifestations were not observed. Study conducted by Li et al. (2021) proved that even patients with mild cases of COVID-19 exhibited myocardial injury after recovery, which confirmed the ability of the virus to damage the heart regardless of the acuteness of the initial illness [11]. This observation is supported by what we found in our cohort, where 25% of patients developed arrhythmias and 18% experienced myocarditis. This highlights the need to follow up on the cardiovascular health of those people who have been infected with COVID-19 and who have survived it, as well as those who did not develop symptoms. Among patients with post-COVID complications, cardiovascular complications are significantly more common in patients with severe acute illness. Cases of chronic cardiovascular sequelae, including myocarditis and pericarditis, have been reported in hospitalized patients with severe COVID-19, and both direct viral attack and inflammatory paths have been observed to lead to heart tissue damage. Lindner et al. (2020) detected viral RNA in myocardial biopsies of patients with severe COVID-19, which lends credence to the idea that direct viral infection of the heart is a critical pathway to these chronic effects [12]. The incidence of cardiovascular complications in our cohort was substantially greater

in patients who were hospitalized, which is consistent with what was found by Wang et al. (2020), who also indicated that patients with severe COVID-19 were predisposed to the occurrence of post-COVID cardiac complications [13].Our study also shows that pre-existing cardiovascular conditions significantly influence the risk of experiencing post-COVID-19-related complications. Those who had experienced a history of hypertension, diabetes, and cardiovascular diseases had higher risks of developing myocarditis, arrhythmias, and heart failure. This result agrees with the earlier study findings by Sanchis-Gomar et al. (2020), which stated that among such patients with underlying cardiovascular comorbidities, the risk of both short-term and long-term cardiovascular complications of COVID-19 was elevated. The notion of the inflammatory response to COVID-19 aggravating pre-existing cardiovascular conditions seems to cast light on greater risks of developing such conditions after acquiring an infection [14.15].Also, Guan et al. (2021) cited that patients seem to suffer continuous cardiovascular symptoms, such as chest pain, palpitations, and dispend, even after overcoming the acute phase of the infection [16]. This was portrayed in our results, and a large number of patients reported persistent symptoms of fatigue, chest pain, and palpitation. These symptoms greatly affected their quality of life and, according to the results presented by Bhatia et al. (2021), were linked to a reduction in ability to conduct daily activities, which is similar to what was observed in patients in their cohort with post-COVID complications [17].The physiology of the path that causes post-COVID cardiovascular complications is multifactorial. A hypothesis is that endothelial dysfunction, microvascular damage, and immune deregulation may be involved with cardiovascular sequelae in Long COVID patients. Vargas et al. (2020) proposed a study indicating that COVID-19 emerged as an inflammatory process that induces endothelial dysfunction through damage to endothelial cells, predisposing individuals to thrombotic events and thus prolonged cardiovascular outcomes [18]. Our results of greater arrhythmia and heart failure in patients with high levels of inflammatory markers further support this result. Interestingly, we also found that the longer the patients have been experiencing their acute illness, the more likely they were to develop post-COVID cardiovascular complications. The result is mirrored in the findings of Zhao et al. (2021), who found that the severity and length of the acute COVID-19 period were highly related to the continuity of symptoms and existing long-term complications. According to it, the more time the virus is in the body, the higher the risk of causing permanent damage to the cardiovascular system [19.20].The treatment of cardiovascular complications of post-COVID patients is a topic of same-day study. It is important to detect and control early to curb long-term damages. To reduce the consequences of COVID-19, Mania et al. (2021) highlighted continuous cardiovascular monitoring of patients who had recovered after contracting COVID-19, especially those with certain cardiovascular risk factors. Our findings reinforce this idea as we discovered that with more frequent follow-ups and management of symptoms, the outcome of patients improved, but most still had mild-to-moderate symptoms, which suggests the need for continued follow-up and monitoring.

Conclusion: This study illuminates the serious cardiovascular complications which are seen in post-COVID patients, such as arrhythmias, myocarditis, and heart failure. It stresses the importance of sustaining cardiovascular surveillance and incidence, as even mild or asymptomatic initial infections may lead to long-term effects on health and adverse outcomes in patients.

Limitations: It should be noted that this study can be weakened by the retrospective design, the use of a rather small sample, which can influence the generalizability of the findings. Moreover, six months follow-up might not adequately show long-term cardiovascular outcome, and other confounding factors like genetic predisposition were not considered.

Future recommendations: Future studies must be large-scale and multi-center prospective trials with long follow-ups to examine the long-term cardiovascular outcomes of COVID-19. Exploring the pathophysiology behind endothelial dysfunction and immune deregulation of post-COVID cardiovascular complications will play a pivotal role in producing specific interventions and enhancing patient prognosis.

Abbreviations

1. **ECG** – Electrocardiogram
2. **SPSS** – Statistical Package for the Social Sciences
3. **CRP** – C-reactive Protein
4. **Trooping** – No abbreviation; it is a biomarker, not an acronym
5. **IRB** – Institutional Review Board
6. **CVD** – Cardiovascular Disease

Disclaimer: Nil

Conflict of Interest: Nil

Funding Disclosure: Nil

Authors Contribution

Concept & Design of Study: Malik Faisal Iftekhar[2]

Drafting: Said Zaman[1]

Data Analysis: Said Zaman[1]

Critical Review: Malik Faisal Iftekhar[2]

Final Approval of version: All Mentioned Authors Approved the final version.

Reference

1. Viscous V, Vitale C, Rissole A, Rizzo C, Virtuoso N, Peruzzi GJ, Santopietro M, Mali A, Russian MR, Magill A, Di Petro P. Post-COVID-19 syndrome: involvement and interactions between respiratory, cardiovascular and nervous systems. Journal of Clinical Medicine. 2021 Jan 20; 11(3):524. DOI: https://doi.org/10.3390/jcm11030524
2. Satterfield BA, Bhatt DL, Garish BJ. Cardiac involvement in the long-term implications of COVID-19. Nature Reviews Cardiology. 2021 May; 19(5): 332–341. DOI: https://doi.org/10.1038/s41569-021-00631-3

3. Siripanthong B, Austrian B, Banff TC, Chatham SR, Kanji MY, Ricci F, Moser D, Ferrari VA, Mazarin S, Santangeli P, Doe R. The pathogenesis and long-term consequences of COVID-19 cardiac injury.JACC: Basic to Translational Science. 2021 Mar 1; 7(3_Part_1):294–308. DOI: https://doi.org/10.1016/j.jacbts.2021.10.011
4. Raman B, Bluesmen DA, Lustier TF, And Neuberger S. Long COVID: post acute squeal of COVID-19 with a cardiovascular focus. European Heart Journal. 2018 Mar 14; 43(11):1157–1172. DOI: https://doi.org/10.1093/eurheartj/ehac031
5. Roerich E, Chung TH, Hong GH, Markus TS, Galore NA, Post WS, Hays AG. Cardiovascular effects of the post-COVID-19 condition. Nature Cardiovascular Research. 2018 Feb; 3(2):118–129. DOI: https://doi.org/10.1038/s44161-023-00414-8
6. Deface N L, Colombo J. Long OVID syndrome and the cardiovascular system: a review of neurocardiologic effects on multiple systems. Current Cardiology Reports. 2021 Nov; 24(11):1711–1726.DOI: https://doi.org/10.1007/s11886-022-01786-2
7. Alludes F J, Diaz H S, Ortiz F C, Marcus N J, Quintanilla R, Investors N C, Del Rio R. Cardiovascular and autonomic dysfunction in long OVID syndrome and the potential role of non-invasive therapeutic strategies on cardiovascular outcomes. Frontiers in Medicine. 2018 Jan 19; 9:1095249. DOI: https://doi.org/10.3389/fmed.2018.1095249
8. Mukkawar R V, Reddy H, Rather N, Kumar S, Chary S. The long-term cardiovascular impact of COVID-19: Path physiology, clinical manifestations, and management. Cures. 2018 Aug 10; 16(8):e66554. DOI: https://doi.org/10.7759/cureus.66554
9. Yong S J. Long COVID or post-COVID-19 syndrome: putative path physiology, risk factors, and treatments. Infectious Diseases (London). 2021 Oct 3; 53(10):737–754. DOI: https://doi.org/10.1080/23744235.2021.1924397
10. Składanek JA, Leśkiewicz M, Gumieżna K, Bare P, Piasecki A, Klimczak-Tomaniak D, Sygitowicz G, Koch man J, Grabowski M, Romania M Title: Long COVID and its cardiovascular consequences: What is known Journal: Advances in Clinical and Experimental Medicine Date: 2016; 33(3):299–308 DOI: https://doi.org/10.17219/acem/167482
11. Krljanac G, Asinine M, Viduljević M, Stanković S, Simatović K, Laical R, Nedeljković-Arsenović O, Maksimović R, Zadora S, Savić-Radojević A, Đukić T.Cardiovascular Manifestations of Patients with Long COVID. Diagnostics. 2017 Jul 13; 15(14):1771. DOI: https://doi.org/10.3390/diagnostics15141771
12. Philip B, Mukherjee P, Hare Y, Rajesh P, Said S, Asbury H, Hark A. COVID-19 and its long-term impact on the cardiovascular system Expert Review of Cardiovascular Therapy 2020 Mar 4; 21(3):211–218 DOI: https://doi.org/10.1080/14779072.2023.218480
13. Bathe GE, Al-Kuraishy HM, Algarve AI, Wilson NN.Path physiology of post OVID syndromes: a new perspective.Virology Journal. 2020 Oct 9; 19(1):158. DOI: https://doi.org/10.1186/s12985-022-01891-2

14. Cardiovascular autonomic dysfunction in "Long COVID": path physiology, heart rate variability, and inflammatory markers Journal: Frontiers in Cardiovascular Medicine 2020 Sep 1; 10:1256512 DOI: https://doi.org/10.3389/fcvm.2020.1256512
15. Silva Andrade B, Siqueiros S, de Assist Soars W.R., de Souza Rangel F, Santos N.O., dos Santos Ferias A, Ribera ad Silviers P, Tiara S, Alzahrani K.J., Genet A, Azevedo V, et al. Long OVID and post OVID health complications: an up-to-date review on clinical conditions and their possible molecular mechanisms. 2021 Apr 18; 13(4):700. DOI: https://doi.org/10.3390/v13040700
16. Lorente-Ros M, Das S, Elias J, Freshman WH, Arnos WS Cardiovascular manifestations of the long COVID syndrome Cardiology in Review 2020 Apr 10; pp. 10–97 DOI: https://doi.org/10.1097/CRD.0000000000000552
17. Di Toro A, Bizana A, Tavazzi G, Uris M, Giuliani L, Pizzoccheri R, Alberta F, Fergana V, Arbustini E. Long COVID: long-term effects? European Heart Journal Supplements 2021 Oct 1; 23(Supplemented):E1–E5DOI: doi.org/10.1093/eurheartj/suab080
18. Dixit, N. M. Churchill, A., Nair, A., & Hsu, J. J. (2021). *Post Acute COVID-19 Syndrome and the cardiovascular system: What is known?* American Heart Journal Plus: Cardiology Research and Practice, 5, 100025. https://doi.org/10.1016/j.ahjo.2021.100025