

Original Research

Long-Term Cardiovascular Health Consequences of COVID-19 Infection and Recovery

Dr. Jui Tarodi Patil¹, Dr. Mukesh Patil²

¹Assistant Professor, Department of Physiology, Vedantaa Institute of Medical Sciences, Dahanu, Maharashtra, India

²Consultant Gynaecologist, GMC Mumbai and JJ Group of Hospitals, Mumbai; Founder and Chief of Dr. Mukesh Patil's Centre for Women's Health Hospital and My Nest Test Tube Baby Centre, Vasai, Maharashtra, India

Corresponding Author

Dr. Jui Tarodi Patil

Assistant Professor, Department of Physiology, Vedantaa Institute of Medical Sciences, Dahanu, Maharashtra, India

Email: juhpatil0204@gmail.com

Received: 26 November 2024

Accepted: 30 December 2024

ABSTRACT

Background: Concerns have been expressed about the COVID-19 pandemic's potential long-term effects on cardiovascular health. Myocarditis, arrhythmias, and thromboembolic events are among the persistent cardiovascular problems that people healing from COVID-19 may encounter, according to new research. The long-term effects of COVID-19 infection and recovery on cardiovascular health are examined in this research.

Materials and Methods: 500 adult patients who recovered from laboratory-confirmed COVID-19 between March 2020 and December 2021 were included in this retrospective cohort analysis. Acute phase clinical and radiological symptoms were used to stratify patients into three severity groups: mild (n = 200), moderate (n = 200), and severe (n = 100). At six, twelve, and twenty-four months after recovery, follow-up assessments were carried out. Cardiovascular evaluations included biomarker measurements for troponin T and NT-proBNP, echocardiography, and 24-hour Holter monitoring. To evaluate the connection between the severity of the illness and cardiovascular outcomes, statistical studies were conducted.

Results: Cardiovascular problems were noted in 35% of patients in the severe group, 18% in the moderate group, and 5% in the mild group 24 months after recovery (p<0.001). Reduced left ventricular ejection fraction (8%), arrhythmias (10%), and myocardial fibrosis (12%) were frequent side effects. In 20% of severe cases, biomarker levels remained high, suggesting ongoing subclinical inflammation. Long-term problems were more likely to occur in patients with comorbid conditions including diabetes and hypertension.

Conclusion: The necessity for prolonged follow-up and care of at-risk groups is highlighted by the substantial long-term cardiovascular effects linked to COVID-19 infection, especially in severe instances. The significance of integrated post-COVID care techniques is highlighted by the potential for early diagnosis and intervention to reduce negative outcomes.

Keywords: COVID-19, cardiovascular health, long-term consequences, myocarditis, arrhythmias, post-COVID care, biomarkers.

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-Non Commercial-Share Alike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

INTRODUCTION

The SARS-CoV-2 virus, which produced the worldwide COVID-19 epidemic, has had serious public health repercussions that go beyond short-term sickness to long-term effects [1]. Even though COVID-19 primarily affects the respiratory system, there is growing evidence that the virus also affects other parts of the body, including the cardiovascular system [2]. Myocarditis, arrhythmias, thrombosis, and chronic inflammation are among the cardiovascular

problems linked to COVID-19 that may put people at risk for long-term morbidity and death [3,4]. The pathogenesis of COVID-19's cardiovascular involvement seems to be complex, including endothelial dysfunction, dysregulated immunological responses, and direct viral invasion of cardiac tissue [5]. Moreover, those who already have cardiovascular comorbidities including coronary artery disease, diabetes, or hypertension are more vulnerable to severe illness and poor cardiovascular outcomes [6].

Although controlling acute COVID-19 has received a lot of attention, it is important to comprehend the virus's long-term cardiovascular implications, particularly as millions of people recover from the infection globally. Reducing the burden of cardiovascular diseases and improving post-recovery care may be achieved by determining the prevalence, risk factors, and processes underlying these problems [7]. With an emphasis on clinical and subclinical cardiovascular problems, this research attempts to assess the long-term cardiovascular health effects of COVID-19 infection and recovery. The research aims to shed light on the frequency and severity of cardiovascular sequelae as well as their correlation with the initial severity of the illness by evaluating patients throughout a 24-month follow-up period.

MATERIALS AND METHODS

This retrospective cohort study was conducted to evaluate the long-term cardiovascular health consequences of COVID-19 infection. A total of 500 adult patients who recovered from laboratory-confirmed COVID-19 between March 2020 and December 2021 were included. Patients were categorized into three groups based on the severity of their acute infection: mild (n=200), moderate (n=200), and severe (n=100). Severity classification was determined using clinical symptoms, radiographic findings, and oxygen requirements during the acute phase.

Inclusion and Exclusion Criteria: Inclusion criteria were adults aged 18–75 years with a confirmed diagnosis of COVID-19 and at least one follow-up visit within the study period. Exclusion criteria included patients with pre-existing severe cardiovascular diseases, pregnancy, or incomplete medical records.

Data Collection: Comprehensive clinical, laboratory, and imaging data were collected at baseline (during acute infection) and during follow-up visits at 6, 12, and 24 months.

Data sources included electronic health records and direct patient interviews. The clinical evaluations focused on cardiovascular symptoms such as chest pain, palpitations, and fatigue.

Cardiovascular Assessments: Cardiovascular evaluations included:

1. Echocardiography: Left ventricular ejection fraction (LVEF) and structural abnormalities were assessed.
2. 24-hour Holter Monitoring: Used to detect arrhythmias.
3. Biomarkers: Serum levels of troponin T and NT-proBNP were measured to evaluate myocardial injury and stress.
4. Electrocardiography (ECG): Performed to identify conduction abnormalities.
5. Cardiac MRI: Conducted in a subset of patients to detect myocardial fibrosis and inflammation.

Statistical Analysis: Descriptive statistics were used to summarize baseline characteristics. Comparative analyses were performed using chi-square tests for categorical variables and t-tests or ANOVA for continuous variables. Logistic regression was used to identify risk factors associated with long-term cardiovascular complications. A p-value <0.05 was considered statistically significant.

RESULTS

Patient Demographics and Clinical Characteristics: A total of 500 patients were included in the study, with 200 classified as having mild COVID-19, 200 as moderate, and 100 as severe. The mean age of participants was 45.2 ± 12.6 years, and 55% were male. Patients with severe disease had a higher prevalence of comorbidities, including hypertension (60%), diabetes (50%), and obesity (35%), compared to the moderate and mild groups (Table 1).

Table 1: Baseline Demographics and Clinical Characteristics of Study Participants

Parameter	Mild (n=200)	Moderate (n=200)	Severe (n=100)	p-value
Mean age (years)	42.1 ± 11.3	46.8 ± 12.1	51.6 ± 13.5	0.01
Male (%)	52%	55%	58%	0.38
Hypertension (%)	25%	40%	60%	<0.001
Diabetes (%)	20%	35%	50%	<0.001
Obesity (%)	15%	25%	35%	<0.001

Cardiovascular Complications: At 24 months post-recovery, cardiovascular complications were most prevalent in the severe group (Table 2). Myocardial fibrosis was detected in 12% of severe cases, compared to 5% in the moderate and 1% in the mild groups (p<0.001). Similarly, arrhythmias were

identified in 15%, 8%, and 2% of patients with severe, moderate, and mild disease, respectively. Reduced left ventricular ejection fraction (<50%) was observed in 10% of the severe group, 4% of the moderate group, and 1% of the mild group.

Table 2: Prevalence of Long-Term Cardiovascular Complications

Complication	Mild (n=200)	Moderate (n=200)	Severe (n=100)	p-value
Myocardial fibrosis (%)	1%	5%	12%	<0.001
Arrhythmias (%)	2%	8%	15%	<0.001
LVEF < 50% (%)	1%	4%	10%	<0.001
Elevated biomarkers (%)	5%	12%	20%	<0.001

Serum troponin T and NT-proBNP levels remained elevated in 20% of patients with severe COVID-19 at 24 months compared to 12% in the moderate group and 5% in the mild group (Table 2). Logistic regression analysis identified severe disease (OR 3.5, 95% CI 2.2–5.4), hypertension (OR 2.8, 95% CI 1.8–4.3), and diabetes (OR 2.5, 95% CI 1.5–3.9) as significant predictors of long-term cardiovascular complications ($p < 0.001$).

These findings highlight the substantial burden of cardiovascular sequelae in individuals with severe COVID-19, emphasizing the importance of early intervention and long-term monitoring in this population.

DISCUSSION

This research highlights the increased risk of cardiovascular problems, especially in individuals with severe illness, and offers important insights into the long-term cardiovascular effects of COVID-19 infection. Our results are consistent with other research that indicates the effects of COVID-19 go beyond acute infection and have a long-lasting effect on the cardiovascular system [1,2]. Both direct and indirect effects of the SARS-CoV-2 virus are responsible for the reported consequences, which include lower left ventricular ejection fraction, arrhythmias, and myocardial fibrosis. Cardiac damage is probably caused by endothelial dysfunction, immune-mediated injury, and viral invasion of cardiac cells [3,4]. The involvement of chronic inflammatory processes in post-COVID cardiovascular sequelae is highlighted by persistent inflammation, which is shown by increased biomarkers such as troponin T and NT-proBNP[5].

Our findings are consistent with those of Puntmann et al., who used cardiac MRI to show that 60% of COVID-19 survivors had ongoing myocardial inflammation [6]. Similarly, even individuals with mild-to-moderate COVID-19 had a higher risk of significant adverse cardiovascular events, such as heart failure and arrhythmias, according to a research by Xie et al. [7]. Nonetheless, our research contributes to the body of literature by classifying outcomes according to the severity of the condition and showing a clear relationship between early severity and long-term cardiovascular risk. The need of routine cardiovascular monitoring after recovery is highlighted by the increased frequency of problems in patients with severe COVID-19. Following up with echocardiography and biomarker evaluations is advised by current recommendations, especially for patients who have ongoing symptoms or pre-existing comorbidities such as diabetes and hypertension [8,9]. The burden of long-term problems may be lessened and results may be improved with early identification and treatment of subclinical abnormalities [10]. In line with other research that found these comorbidities to be amplifiers of COVID-19 severity and post-recovery hazards, hypertension and diabetes were

shown to be substantial predictors of long-term problems [11,12]. These circumstances may contribute to negative outcomes because of their synergistic impact with endothelial dysfunction linked to COVID-19 [13]. This study's retrospective methodology, dependence on electronic medical records, and single-centre data collection are some of its drawbacks. Generalizability may be limited by the severe group's very small sample size. To confirm these results and investigate the underlying mechanisms of chronic cardiovascular injury, multicentre prospective studies with bigger cohorts and longer follow-up periods are necessary in the future [14,15].

CONCLUSION

In conclusion, our study highlights the significant burden of long-term cardiovascular complications following COVID-19, particularly in patients with severe disease. These findings underscore the importance of integrated post-COVID care strategies, focusing on early detection and management of cardiovascular abnormalities. Future research should aim to identify targeted interventions to mitigate these complications and improve the quality of life for COVID-19 survivors.

REFERENCES

1. World Health Organization. Coronavirus disease (COVID-19) pandemic. WHO; 2021.
2. Gupta A, Madhavan MV, Sehgal K, et al. Extrapulmonary manifestations of COVID-19. *Nat Med.* 2020;26(7):1017–32.
3. Bonow RO, Fonarow GC, O'Gara PT, Yancy CW. Association of coronavirus disease 2019 (COVID-19) with myocardial injury and mortality. *JAMA Cardiol.* 2020;5(7):751–3.
4. Long B, Brady WJ, Koyfman A, Gottlieb M. Cardiovascular complications in COVID-19. *Am J Emerg Med.* 2020;38(7):1504–7.
5. Puntmann VO, Carerj ML, Wieters I, et al. Outcomes of cardiovascular magnetic resonance imaging in patients recently recovered from COVID-19. *JAMA Cardiol.* 2020;5(11):1265–73.
6. Xie Y, Xu E, Bowe B, Al-Aly Z. Long-term cardiovascular outcomes of COVID-19. *Nat Med.* 2022;28(3):583–90.
7. Clerkin KJ, Fried JA, Raikhelkar J, et al. COVID-19 and cardiovascular disease. *Circulation.* 2020;141(20):1648–55.
8. Bansal M. Cardiovascular disease and COVID-19. *Diabetes Metab Syndr.* 2020;14(3):247–50.
9. Shi S, Qin M, Shen B, et al. Association of cardiac injury with mortality in hospitalized patients with COVID-19 in Wuhan, China. *JAMA Cardiol.* 2020;5(7):802–10.
10. Chen L, Li X, Chen M, et al. The ACE2 expression in human heart indicates new potential mechanisms of heart injury among patients infected with SARS-CoV-2. *Cardiovasc Res.* 2020;116(6):1097–100.
11. Zhou F, Yu T, Du R, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *Lancet.* 2020;395(10229):1054–62.

12. Wang D, Hu B, Hu C, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *JAMA*. 2020;323(11):1061–9.
13. Zuo Y, Estes SK, Ali RA, et al. Prothrombotic autoantibodies in serum from patients hospitalized with COVID-19. *Sci Transl Med*. 2020;12(570):eabd3876.
14. Boehmer TK, Kompaniyets L, Lavery AM, et al. Association between COVID-19 and myocardial infarction: a population-based study. *Am Heart J*. 2022;246:24–33.
15. Madjid M, Safavi-Naeini P, Solomon SD, Vardeny O. Potential effects of coronaviruses on the cardiovascular system: a review. *JAMA Cardiol*. 2020;5(7):831–40.