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Evidence of Cardiac Manifestations and Their Correlation with Biochemical Parameters in COVID-19 Patients: A Prospective Observational Study

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ABSTRACT

Background: Coronavirus disease 2019 (COVID-19) is associated with significant cardiovascular involvement including myocarditis, myocardial infarction, arrhythmias, heart failure, and thromboembolic complications. [1-5] Cardiac injury in COVID-19 has been linked to inflammatory and biochemical markers such as CRP, ferritin, D-dimer, LDH, neutrophil-lymphocyte ratio (NLR), troponin I, CK-MB, and BNP. [6-8]

Aim: To study the spectrum of cardiac manifestations in COVID-19 patients and correlate these manifestations with biochemical and inflammatory parameters.

Materials and Methods: This hospital-based prospective observational study was conducted at a tertiary care hospital from 1 February 2024 to 31 January 2026. A total of 108 confirmed COVID-19 patients with cardiac manifestations were included. Demographic data, clinical findings, biochemical markers, lipid profile, cardiac biomarkers, echocardiographic findings, and outcomes were analyzed. Statistical significance was considered at $p<0.05$.

Results: The mean age of participants was 54.3 ± 6.1 years. Males constituted 61.1% of the study population. The most common cardiac manifestation was myocarditis (38.9%), followed by myocardial infarction and arrhythmias (20.4% each). Troponin I positivity was observed in 41.7% patients. Elevated inflammatory markers including CRP, ESR, ferritin, LDH, D-dimer, and NLR showed significant association with myocarditis and myocardial infarction ($p<0.05$). BNP and CK-MB levels were significantly elevated in myocarditis and heart failure. Mortality was observed in 29.7% patients.

Conclusion: COVID-19 is associated with diverse cardiac manifestations, with myocarditis being the most common in the present study. Elevated inflammatory and cardiac biomarkers strongly correlate with myocardial injury and adverse outcomes. [7-9]

Keywords: COVID-19, myocarditis, myocardial infarction, arrhythmia, biomarkers, troponin I.

INTRODUCTION

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), initially emerged as a respiratory illness but rapidly evolved into a multisystem disease with major cardiovascular implications. [1,2]

Cardiac manifestations reported in COVID-19 include myocarditis, acute coronary syndrome, arrhythmias, heart failure, cardiogenic shock, thromboembolism, and stress cardiomyopathy. [3-5]

Several studies have demonstrated that elevated inflammatory markers and cardiac biomarkers are associated with disease severity and mortality. [6-9]

Myocardial injury has been recognized as an important predictor of poor prognosis in COVID-19 patients. Elevated troponin levels have been associated with higher mortality, intensive care admission, and increased need for ventilatory support. [7,8]

COVID-19 can induce endothelial dysfunction, hypercoagulability, and cytokine storm, leading to myocardial injury and thrombotic complications. [10-12]

Although several studies have described cardiovascular involvement in COVID-19, data correlating cardiac manifestations with biochemical markers remain limited in the Indian population. Therefore, the present study was undertaken to evaluate cardiac manifestations in COVID-19 patients and analyze their association with inflammatory and cardiac biomarkers.

MATERIALS AND METHODS

Study Design: This was a hospital-based prospective observational study.

Study Duration: The study was conducted from 1 February 2024 to 31 January 2026.

Study Population: All confirmed COVID-19 patients presenting with cardiac manifestations at a tertiary care hospital were screened.

Inclusion Criteria

Patients aged more than 18 years
Patients willing to provide informed consent
Confirmed cases of COVID-19 infection
Patients with cardiac manifestations

Exclusion Criteria

Patients below 18 years of age
Comatose patients unable to respond
Patients with psychosomatic disorders

Sample Size

A total of 113 patients were initially screened. Three patients refused consent and two forms were incomplete. Hence, the final sample size was 108 patients.

Data Collection

Demographic profile, symptoms, laboratory investigations, ECG findings, cardiac biomarkers, lipid profile, and echocardiographic findings were recorded.

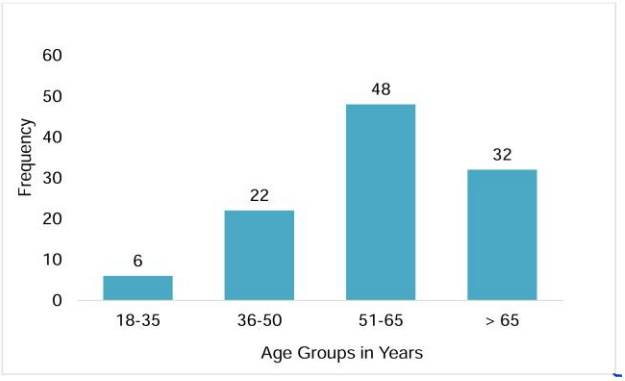
Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS software. Quantitative variables were expressed as mean ± standard deviation and categorical variables as percentages. Statistical significance was considered at $p<0.05$.

RESULTS

Age Distribution

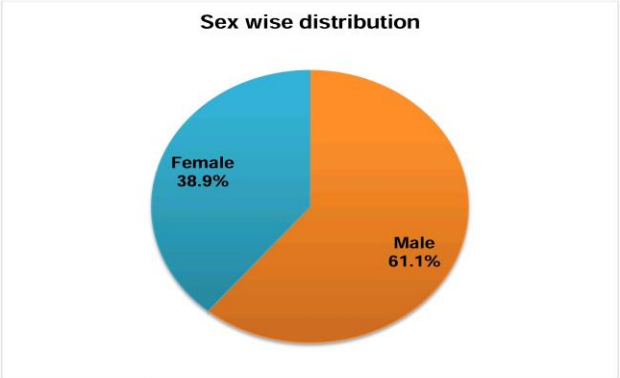
AGE GROUPS (Years)	FREQUENCY	%
18-35	06	5.6
36-50	22	20.4
51-65	**48**	**44.4**
> 65	32	29.6
TOTAL	108	100.0



Among 108 patients, 76 (70.4%) were aged ≤65 years while 32 (29.6%) were aged >65 years. The mean age was 54.3 ± 6.1 years.

Gender Distribution

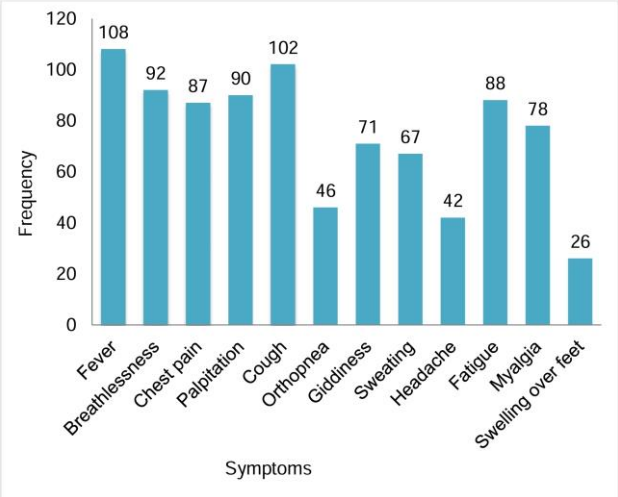
SEX	FREQUENCY	%
FEMALE	42	38.9
MALE	**66**	**61.1**
TOTAL	108	100.0



Out of 108 patients, 66 (61.1%) were males and 42 (38.9%) were females with a male-to-female ratio of 1.57:1.

Distribution of Symptoms

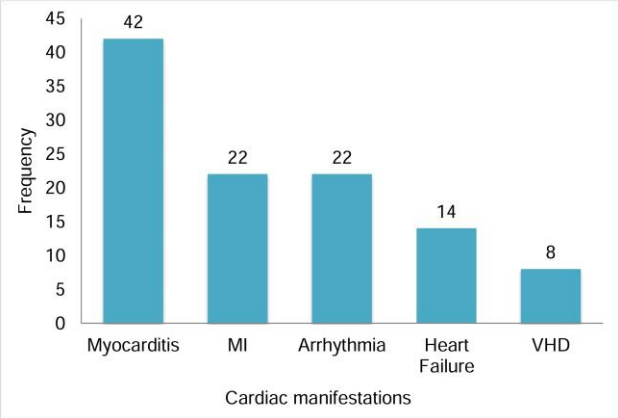
Symptoms	FREQUENCY	%
Fever	**108**	**100%**
Breathlessness	**92**	**85.2%**
Chest Pain	**87**	**80.6%**
Palpitations	**90**	**83.4%**
Cough	**102**	**94.4%**
Orthopnea	46	42.6%
Giddiness	**71**	**65.7%**
Sweating	**67**	**62.0%**
Headache	42	38.9%
Fatigue	**88**	**81.5%**
Myalgia	**78**	**72.2%**
Swelling over feet	26	24.1%



Fever was present in all patients (100%). Other common symptoms included cough in 102 (94.4%), breathlessness in 92 (85.2%), palpitations in 90 (83.4%), fatigue in 88 (81.5%), chest pain in 87 (80.6%), and myalgia in 78 (72.2%) patients.

Distribution of Cardiac Manifestations

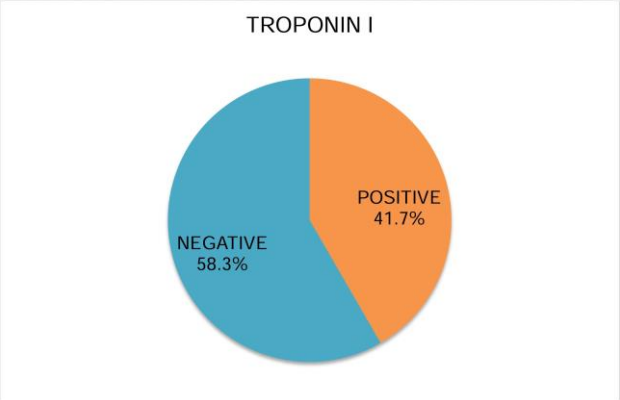
Cardiac Manifestations	FREQUENCY	%
Myocarditis	**42**	**38.9%**
Myocardial infarction (MI)	22	20.4%
Arrhythmia	22	20.4%
Heart failure	14	13.0%
Valvular Heart Disease (VHD)	8	7.4%



The most common cardiac manifestation was myocarditis seen in 42 (38.9%) patients. Myocardial infarction and arrhythmias were observed in 22 (20.4%) patients each. Heart failure was present in 14 (13%) patients while valvular heart disease was noted in 8 (7.4%) patients.

Troponin I Positivity

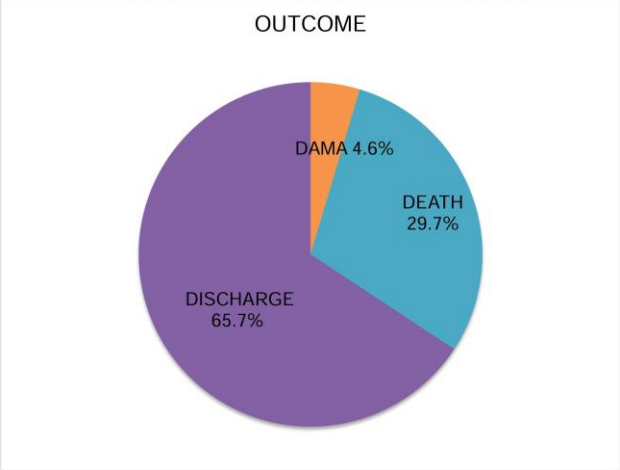
TROPONIN-I	FREQUENCY	%
POSITIVE	45	41.7
NEGATIVE	63	58.3
TOTAL	108	100.0



Troponin I positivity was observed in 45 (41.7%) patients.

Clinical Outcomes

OUTCOME	FREQUENCY	%
DAMA	5	4.6
DEATH	32	29.7
DISCHARGE	**71**	**65.7**
TOTAL	108	100.0



Among the study population, 71 (65.7%) patients recovered and were discharged, whereas 32 (29.7%) patients died.

Lipid Profile

LIPID PROFILE	N	Minimum	Maximum	Mean	Std. Deviation
TG	108	128.0	254.0	167.676	27.3728
LDL	108	58.0	165.0	102.139	21.7537
HDL	108	19.0	72.0	57.731	14.5163

The mean triglyceride level was 167.67 ± 27.37 mg/dL. Mean LDL was 102.13 ± 21.7 mg/dL and mean HDL was 57.73 ± 14.5 mg/dL.

COVID Biomarkers

COVID Markers	N	Minimum	Maximum	Mean	Std. Deviation
CRP	108	25.0	260.0	114.38	55.66
ESR	108	21.0	82.0	41.09	14.20
Sr. Ferritin	108	387.0	1108.0	651.04	173.33
Sr. LDH	108	386.0	993.0	597.71	177.73
D- dimer	108	532.0	1564.0	953.67	283.37
NL Ratio	108	2.09	11.02	6.68	2.62
SpO2	108	69.0	99.0	87.593	7.76

Mean CRP was 114.38 ± 55.7 mg/dL. Mean ESR was 41.1 ± 14.2 mm/hr. Mean ferritin was 651.04 ± 173.3 mg/dL. Mean LDH was 597.71 ± 177.7 mg/dL. Mean D-dimer was 953.67 ± 283.37 µg/dL. Mean NLR was 6.68 ± 2.62.

Cardiac Biomarkers

Cardiac Markers	N	Minimum	Maximum	Mean	Std. Deviation
CK-MB	108	7.0	44.0	25.583	9.3069
BNP	108	79.0	123.0	97.944	9.8549
2D Echo (EF)	108	35.0	75.0	55.824	9.3487

Mean CK-MB was 25.6 ± 9.3 IU/L. Mean BNP was 97.94 ± 9.8 pg/mL. Mean ejection fraction was 55.8 ± 9.34%.

Association of Myocarditis with Biomarkers

Myocarditis		CRP	ESR	Sr. Ferritin	Sr. LDH	D-dimer	NL Ratio	SpO2
PRESENT	Mean	165.0	55.64	741.7	684.92	1092.7	8.73	81.90
	Std. Deviation	53.94	13.93	137.81	175.55	275.81	1.395	5.48
ABSENT	Mean	95.63	40.81	600.06	547.13	870.51	5.718	91.21
	Std. Deviation	50.41	16.91	172.52	159.54	255.15	2.506	6.78
P-value		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Myocarditis		CK-MB	BNP	2D Echo (EF)	TG	LDL	HDL
PRESENT	Mean	**47.143**	**101.623**	60.190	148.333	100.095	53.667
	Std. Deviation	**5.8040**	**6.8639**	6.0897	17.0375	9.6216	7.7920
ABSENT	Mean	**16.591**	**86.970**	53.045	140.439	97.894	60.955
	Std. Deviation	**10.8981**	**7.3715**	10.0160	32.0994	25.1819	16.4723
P-value		**<0.0001**	**0.0015**	0.092	0.184	0.179	0.316

MYOCARDITIS		PRESENT	ABSENT	Total	p
Troponin I	**POSITIVE**	**23 (54.8%)**	**22 (33.3%)**	**45 (41.7%)**	0.045
	NEGATIVE	19 (45.2%)	44 (66.7%)	63 (58.3%)	

Inflammatory markers including CRP, ESR, ferritin, LDH, D-dimer, and NLR were significantly elevated in patients with myocarditis ($p<0.05$). CK-MB and BNP levels were also significantly elevated. Troponin I positivity was observed in 23 (54.8%) myocarditis patients.

Association of Myocardial Infarction with Biomarkers

Myocardial infarction		CRP	ESR	Sr. Ferritin	Sr. LDH	D- dimer	NL Ratio	SpO2
PRESENT	Mean	132.38	60.091	706.545	762.091	987.727	6.9782	88.909
	Std. Deviation	63.682	19.046	159.858	192.619	290.862	2.434	8.2515
ABSENT	Mean	118.63	49.430	654.814	571.372	856.756	4.6717	87.256
	Std. Deviation	54.902	16.814	177.967	175.7771	272.6742	2.65179	7.6484
P-value		0.0020	0.0013	0.001	0.02	0.014	0.001	0.83

Myocardial infarction		CK-MB	BNP	2D Echo (EF)	TG	LDL	HDL
PRESENT	Mean	38.455	102.0	54.136	203.00	135.86	42.864
	Std. Deviation	3.6610	6.0079	3.5361	17.3370	12.7141	9.2649
ABSENT	Mean	20.291	86.253	59.023	131.64	93.512	69.326
	Std. Deviation	7.2027	4.8565	9.9894	21.525	13.641	9.4139
P-value		0.001	0.0001	0.0812	0.0001	0.0001	0.004

MYOCARDIAL INFACRTION		PRESENT	ABSENT	Total	p
Troponin I	**POSITIVE**	**22 (100.0%)**	**23 (26.7%)**	**45 (41.7%)**	**<0.001**
	NEGATIVE	0 (0.0%)	63 (73.3%)	63 (58.3%)	

Patients with myocardial infarction demonstrated significantly elevated inflammatory markers and abnormal lipid profile parameters ($p<0.05$). All myocardial infarction patients were troponin I positive.

Association of Arrhythmia with Biomarkers

Arrhythmia		CRP	ESR	Sr. Ferritin	Sr. LDH	D- dimer	NL Ratio	SpO2
PRESENT	Mean	77.59	34.09	554.364	487.455	802.591	4.8218	93.545
	Std. Deviation	42.5941	12.7649	174.9145	129.6224	181.4124	2.25356	5.0022
ABSENT	Mean	114.1	49.77	680.95	629.69	996.44	7.423	86.07
	Std. Deviation	60.7887	16.9695	164.6971	178.1669	292.4403	2.41839	7.6278
P-value		0.141	0.13	0.258	0.29	0.336	0.41	0.769

Arrhythmia		CK-MB	BNP	2D Echo (EF)	TG	LDL	HDL
PRESENT	Mean	20.273	97.364	59.273	150.500	98.818	58.909
	Std. Deviation	4.8910	7.3714	5.4000	30.4908	19.4683	13.7941
ABSENT	Mean	25.453	98.093	54.430	169.512	102.988	64.430
	Std. Deviation	9.2605	6.4269	9.6522	26.3964	22.3267	14.7581
P-value		0.214	0.988	0.375	0.620	0.163	0.221

ARRHYTHMIA		PRESENT	ABSENT	Total	p
Troponin I	POSITIVE	0 (0.0%)	45 (52.3%)	45 (41.7%)	<0.001
	NEGATIVE	22 (100.0%)	41 (47.7%)	63 (58.3%)	

Inflammatory markers and cardiac biomarkers were not significantly altered in arrhythmia patients (p>0.05).

Association of Heart Failure with Biomarkers

Heart failure		CRP	ESR	Sr. Ferritin	Sr. LDH	D- dimer	NL Ratio	SpO2
PRESENT	Mean	99.143	40.857	641.857	596.357	908.571	5.7950	90.571
	Std. Deviation	54.4608	15.7961	180.6104	144.2906	235.9663	2.7397	7.4598
ABSENT	Mean	116.138	47.436	657.149	601.372	965.351	7.0570	87.149
	Std. Deviation	62.2884	17.4871	173.5758	183.5881	290.4163	2.5513	7.7487
P-value		0.251	0.144	0.113	0.560	0.732	0.286	0.878

Heart failure		CK-MB	BNP	2D Echo (EF)	TG	LDL	HDL
PRESENT	Mean	21.786	**111.71**	33.571	**173.00**	**109.28**	**42.71**
	Std. Deviation	5.056	**7.2370**	2.376	**14.549**	**5.862**	**3.26**
ABSENT	Mean	25.894	**85.894**	58.394	**161.35**	**100.45**	**56.24**
	Std. Deviation	9.09	**8.463**	6.948	**26.965**	**22.936**	**14.95**
P-value		0.186	**<0.0001**	<0.0001	**0.029**	**0.0001**	**0.046**

HEART FAILURE		PRESENT	ABSENT	Total	p
Troponin I	POSITIVE	02 (14.3%)	43 (45.7%)	45 (41.7%)	0.01
	NEGATIVE	12 (85.7%)	51 (54.3%)	63 (58.3%)	

BNP levels were significantly elevated in heart failure patients. Reduced ejection fraction and lipid abnormalities were also significantly associated with heart failure.

Association of Valvular Heart Disease with Biomarkers

Valvular Heart Disease		CRP	ESR	Sr. Ferritin	Sr. LDH	D- dimer	NL Ratio	SpO2
PRESENT	Mean	83.625	31.000	497.250	474.000	764.875	4.5875	92.250
	Std. Deviation	35.5525	5.8064	123.2764	65.9307	144.9792	1.54382	3.0589
ABSENT	Mean	115.7	47.83	667.80	610.86	972.32	7.0779	87.220
	Std. Deviation	62.4633	17.3718	171.3590	180.8039	286.9703	2.58145	7.9119
P-value		0.951	0.835	0.422	0.992	1.83	0.892	0.177

VHD		CK-MB	BNP	2D Echo (EF)	TG	LDL	HDL
PRESENT	Mean	19.50	84.75	52.02	151.25	98.50	62.000
	Std. Deviation	5.879	8.013	8.9762	10.264	16.18	4.598
ABSENT	Mean	26.23	90.20	55.410	148.59	101.7	57.07
	Std. Deviation	9.245	9.976	9.2966	28.124	21.34	14.84
P-value		0.865	0.239	0.068	0.055	1.03	0.46

VHD		PRESENT	ABSENT	Total	p
Troponin I	POSITIVE	0 (0.0%)	45 (45.0%)	45 (41.7%)	0.035
	NEGATIVE	8 (100.0%)	55 (55.0%)	63 (58.3%)	

Inflammatory markers and cardiac biomarkers were not significantly associated with valvular heart disease. All patients with valvular heart disease were Troponin I negative.

DISCUSSION

The present study evaluated cardiac manifestations in COVID-19 patients and correlated them with inflammatory and biochemical markers.

The mean age in the present study was 54.3 years with male predominance. Similar findings were reported in previous studies evaluating cardiovascular involvement in COVID-19. [10,11]

Myocarditis was the most common cardiac manifestation observed in this study, accounting for 38.9% of cases. [5,6] Elevated inflammatory markers such as CRP, ferritin, LDH, and D-dimer support the role of cytokine-mediated myocardial injury. [4-7]

Myocardial infarction was observed in 20.4% of patients and showed strong association with elevated inflammatory and cardiac biomarkers. COVID-19 has been shown to induce endothelial injury, plaque instability, and thrombosis, thereby increasing the risk of acute coronary syndromes. [10-13]

Arrhythmias were present in 20.4% patients. Previous studies have demonstrated that hypoxia, electrolyte disturbances, inflammation, and QT prolongation contribute to arrhythmogenesis in COVID-19. [12-14]

Heart failure was seen in 13% of patients and was significantly associated with elevated BNP levels and reduced ejection fraction. COVID-19-related myocardial dysfunction may occur due to myocarditis, ischemic injury, or cytokine-mediated myocardial depression. [11,14]

Inflammatory biomarkers were markedly elevated in the study population. Elevated CRP and ferritin levels reflect hyperinflammatory response, whereas increased D-dimer levels indicate activation of coagulation pathways and thrombotic tendency. [5,7,8]

The mortality rate in the present study was 29.7%, reflecting the severity of cardiovascular involvement in COVID-19.[7-9,15]

The findings of the present study emphasize the importance of early cardiac evaluation and biomarker assessment in COVID-19 patients to identify high-risk individuals and improve outcomes.

CONCLUSION

COVID-19 is associated with a broad spectrum of cardiovascular manifestations, with myocarditis being the most common manifestation in the present study. Elevated inflammatory markers including CRP, ferritin, LDH, D-dimer, and NLR significantly correlate with myocardial injury and adverse outcomes. Troponin I, CK-MB, and BNP serve as important indicators of cardiac involvement.

Early recognition of cardiovascular complications and timely biochemical assessment can help in risk stratification and prompt intervention in COVID-19 patients.

Declaration by Authors

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