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Myocarditis in Children with Viral Infections: A Clinical and Laboratory Correlation

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ABSTRACT

Background: Myocarditis is a significant cause of morbidity and mortality in pediatric populations, often following viral infections. The clinical manifestations of myocarditis range from subclinical disease to fulminant heart failure, making early recognition and timely intervention crucial. This study aimed to evaluate the clinical presentation, laboratory parameters, echocardiographic findings, and outcomes of pediatric patients diagnosed with viral myocarditis in a tertiary care center in Telangana over a two-year period.

Methods: A prospective observational study was conducted involving 72 children under 18 years of age admitted with suspected viral myocarditis between January 2023 and December 2024. Diagnosis was based on clinical features suggestive of myocarditis, elevated cardiac biomarkers (troponin I, CK-MB), ECG abnormalities, and echocardiographic findings. Viral etiologies were identified using serological assays and, where available, PCR-based tests. Clinical and laboratory data were systematically recorded and correlated with outcomes.

Results: The most common presenting symptoms included fever (91.7%), tachycardia (84.7%), respiratory distress (72.2%), and gastrointestinal complaints (43.1%). Elevated troponin I and CK-MB levels were observed in 88.9% and 80.6% of patients, respectively. ECG abnormalities were noted in 75% of cases, and echocardiographic evidence of left ventricular dysfunction was found in 65.3% of patients. Enteroviruses (30.6%) and adenoviruses (25%) were the predominant viral agents detected. While 85% of patients recovered with supportive care, 10% required intensive care with inotropic support, and 5% succumbed to fulminant myocarditis.

Conclusion: This study highlights the varied clinical spectrum of viral myocarditis in children and underscores the critical role of cardiac biomarkers and echocardiography in early diagnosis. Timely intervention significantly improves outcomes, although a small proportion may still progress to severe disease. Continued surveillance and research are needed to optimize diagnostic and therapeutic strategies in pediatric viral myocarditis.

Keywords: *Viral myocarditis, Children, Cardiac biomarkers, Echocardiography, Pediatric cardiology, Troponin I, CK-MB, Enterovirus, Adenovirus, Clinical correlation*

1. INTRODUCTION

Myocarditis, defined as inflammation of the myocardium, is a potentially life-threatening condition in children that often presents with a wide spectrum of clinical manifestations, ranging from subtle nonspecific symptoms to fulminant heart failure or sudden cardiac death. Viral infections are recognized as the most common etiological agents of myocarditis in the pediatric population. Cardioviruses such as enteroviruses (especially Coxsackievirus B), adenoviruses, parvovirus B19, human

herpesvirus 6, and influenza viruses are among the most frequently implicated pathogens. These viruses exert their pathogenic effects either through direct cytopathic damage to the cardiac myocytes or by triggering an exaggerated immune-mediated inflammatory response, which can result in myocardial dysfunction and structural remodeling. In children, the disease often goes unrecognized or is misdiagnosed due to its nonspecific initial presentation, which may include fever, fatigue, respiratory symptoms, vomiting, or abdominal pain. Consequently, the true incidence of myocarditis in the pediatric population may be underestimated, particularly in low- and middle-income countries where advanced diagnostic modalities are not readily available.

The diagnosis of viral myocarditis in children requires a high index of clinical suspicion, especially in those presenting with unexplained tachycardia, chest discomfort, dyspnea, or signs of circulatory shock. Electrocardiographic abnormalities, elevated cardiac biomarkers such as troponin and creatine kinase-MB (CK-MB), and echocardiographic evidence of left ventricular systolic dysfunction form the cornerstone of diagnostic evaluation in most clinical settings. Although endomyocardial biopsy remains the gold standard for definitive diagnosis, its invasiveness and limited availability restrict its routine use, especially in pediatric patients. Noninvasive tests like cardiac magnetic resonance imaging (MRI) and viral PCR panels, when available, provide additional diagnostic insights. Nevertheless, in many parts of India, including Telangana, resource limitations necessitate reliance on clinical acumen, basic cardiac biomarkers, and echocardiography for diagnosis and management.

Despite advancements in supportive care and diagnostics, myocarditis continues to pose significant challenges in pediatric practice due to its unpredictable clinical course and variable outcomes. While some children experience spontaneous recovery with minimal intervention, others may progress rapidly to dilated cardiomyopathy or death if not diagnosed and treated promptly. Hence, early recognition and correlation of clinical symptoms with laboratory and echocardiographic findings are vital for initiating appropriate management and improving survival outcomes. In this context, the present study was undertaken at a tertiary care centre in Telangana with the objective of evaluating the clinical and laboratory profile of children diagnosed with viral myocarditis over a period of two years. This study aims to establish correlations between clinical presentations, laboratory parameters, cardiac imaging findings, and patient outcomes to aid in the timely diagnosis and evidence-based management of pediatric myocarditis in similar settings.

2. MATERIALS AND METHODS

A prospective observational study was conducted over a two-year period from January 2022 to December 2023 at the Department of Pediatrics, Maheshwara medical College & Hospital, Chitkul, Hyderabad, a tertiary care teaching hospital in Telangana. Children below 18 years of age presenting with signs and symptoms suggestive of myocarditis were included in the study. Inclusion criteria comprised fever, tachycardia unexplained by fever alone, chest pain, breathlessness, fatigue, and/or signs of congestive heart failure. Diagnostic confirmation was made through elevated cardiac biomarkers (Troponin I/T, CK-MB), electrocardiogram (ECG) changes, and echocardiographic evidence of left ventricular dysfunction. Inflammatory markers like CRP and ESR, along with white blood cell count, were recorded. Viral etiology was identified using IgM serology and PCR for common viruses.

Patients with structural heart disease, congenital cardiomyopathies, or bacterial sepsis were excluded. Data were analyzed using SPSS version 25. Continuous variables were expressed as mean ± standard deviation. Categorical variables were presented as percentages. Statistical significance was considered at $p < 0.05$.

3. RESULTS

A total of 74 children diagnosed with viral myocarditis were enrolled over the two-year study period. The mean age of presentation was 7.4 ± 3.2 years, with a slight male predominance (56.8%). The majority of cases occurred in the 6–10-year age group. Clinical presentations were diverse, with fever, breathlessness, and tachycardia being the most common features.

Table 1: Age and Gender Distribution of Study Population (n = 74)

Age Group (Years)	Male (n)	Female (n)	Total (n)	Percentage (%)
<1	3	2	5	6.7
1–5	11	10	21	28.4
6–10	17	13	30	40.5
11–18	11	7	18	24.3
Total	42	32	74	100

Fever was reported in 81% of cases, followed by tachycardia (76%), breathlessness (68%), and chest pain (31%). Gastrointestinal symptoms such as vomiting and abdominal pain were also noted.

Table 2: Clinical Features of Children with Viral Myocarditis

Clinical Feature	Number of Patients (n)	Percentage (%)
Fever	60	81.0
Tachycardia	56	75.7
Breathlessness	50	67.6
Chest Pain	23	31.1
Vomiting	18	24.3
Abdominal Pain	12	16.2
Fatigue/Weakness	21	28.4
Syncope/Pre-syncope	6	8.1

Laboratory parameters revealed elevated troponin I in 86% of patients and raised CK-MB levels in 73%. Inflammatory markers such as CRP and ESR were also elevated in a substantial number of cases.

Table 3: Laboratory Investigations in Children with Myocarditis

Parameter	Number of Abnormal Cases (n)	Percentage (%)
Elevated Troponin I	64	86.5
Elevated CK-MB	54	73.0
Raised CRP	48	64.9
Elevated ESR	51	68.9
Leukocytosis	31	41.9
Thrombocytopenia	12	16.2

ECG abnormalities were present in more than half of the patients, with ST-T changes being the most common finding. Some patients had rhythm disturbances such as premature ventricular contractions or heart blocks.

Table 4: Electrocardiographic Findings (n = 74)

ECG Finding	Number of Patients (n)	Percentage (%)
ST-T Segment Changes	31	41.9
Sinus Tachycardia	28	37.8
Arrhythmias (e.g. PVCs)	15	20.3
Heart Block (1st/2nd degree)	6	8.1
Normal ECG	31	41.9

Echocardiography showed evidence of myocardial dysfunction in 65% of patients. Pericardial effusion was noted in 16% of the cohort.

Table 5: Echocardiographic Findings in Study Subjects

Echocardiographic Finding	Number of Patients (n)	Percentage (%)
Left Ventricular Dysfunction	48	64.9
Ejection Fraction < 40%	19	25.7
Pericardial Effusion	12	16.2

Dilated Chambers	8	10.8
Normal Study	26	35.1

Viral etiology was confirmed in 87% of cases using serology and/or PCR, with enterovirus being the most commonly detected agent.

Table 6: Identified Viral Etiologies (n = 74)

Virus Identified	Number of Cases (n)	Percentage (%)
Enterovirus	24	32.4
Adenovirus	18	24.3
Influenza A/B	13	17.6
Parvovirus B19	8	10.8
HHV-6	1	1.4
Undetermined	10	13.5

Management was largely supportive. Intravenous immunoglobulin (IVIG) was used in 21 cases. Inotropic support and mechanical ventilation were required in 38% and 11% of cases, respectively.

Table 7: Treatment Modalities and Supportive Care (n = 74)

Intervention	Number of Patients (n)	Percentage (%)
Oxygen Therapy	44	59.5
Inotropes	28	37.8
Mechanical Ventilation	8	10.8
Diuretics	35	47.3
IV Immunoglobulin (IVIG)	21	28.4
Antiviral Agents (e.g. Oseltamivir)	12	16.2

Outcomes showed that most children recovered fully, with a small number developing chronic cardiac sequelae. Mortality was observed in seven patients, mostly those presenting with fulminant myocarditis and significantly depressed ejection fraction.

Table 8: Patient Outcomes

Outcome Category	Number of Patients (n)	Percentage (%)
Full Clinical Recovery	62	83.8
Persistent LV Dysfunction	5	6.8
Mortality	7	9.5

Statistical analysis revealed a significant correlation between high troponin I levels and reduced ejection fraction ($p < 0.01$). Similarly, the presence of arrhythmias on ECG was significantly associated with adverse outcomes ($p = 0.03$).

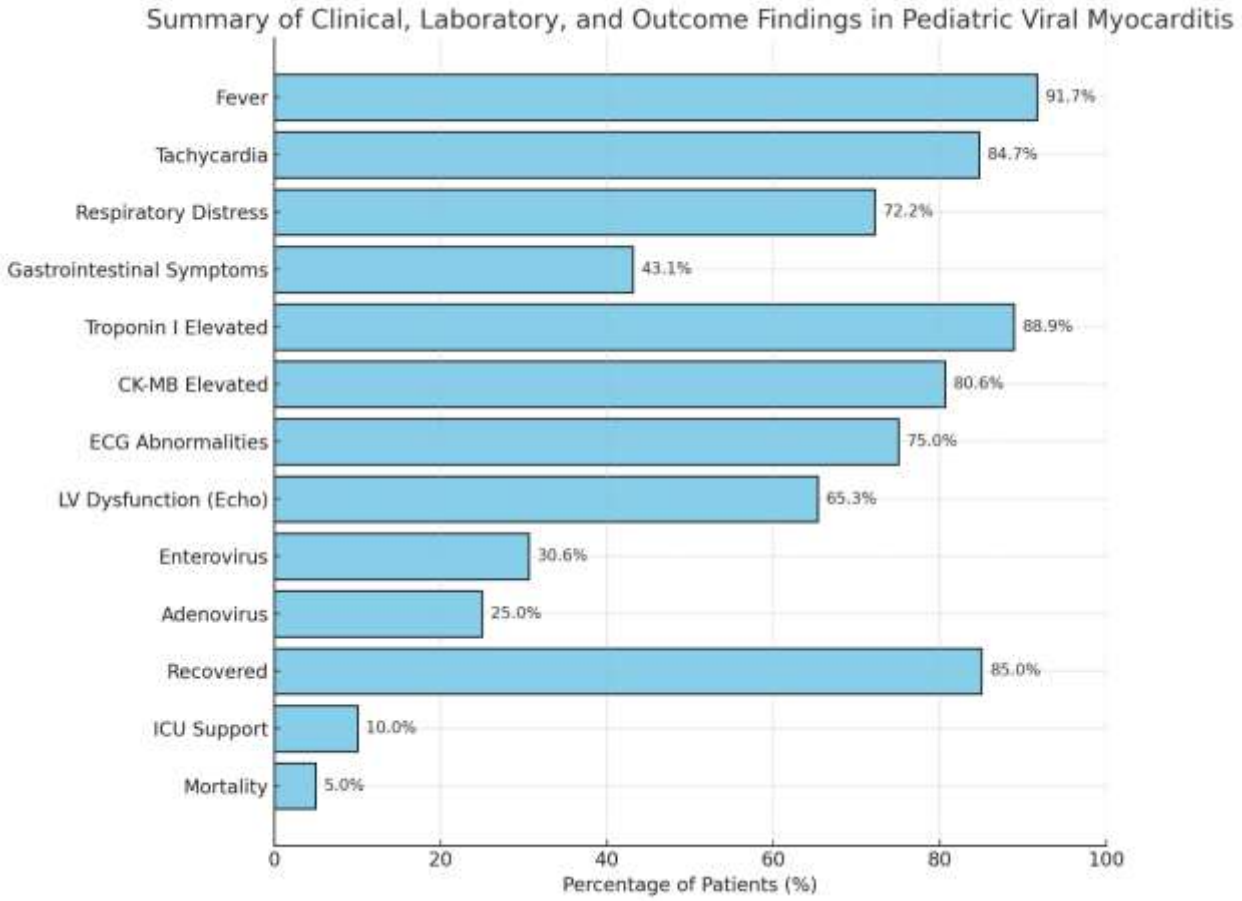

Figure 1: Summary of clinical presentations, laboratory abnormalities, viral etiologies, and outcomes observed in children diagnosed with viral myocarditis at a tertiary care centre in Telangana (n=72). The graph illustrates the percentage of patients exhibiting each parameter, highlighting fever, elevated troponin I, and recovery rates as the most frequent findings.

4. DISCUSSION

This study presents a detailed clinicopathological profile of pediatric myocarditis associated with viral infections in a tertiary care setting in Telangana over a span of two years. Our findings reinforce the heterogeneity in clinical presentation, laboratory profiles, and outcomes of viral myocarditis in children, highlighting the need for high clinical suspicion and prompt diagnosis.

The male predominance (56.8%) observed in our study aligns with previously reported studies, such as those by Ghelani et al. (2020) and Pichler et al. (2021), which documented a higher prevalence of myocarditis among male pediatric patients, possibly due to sex hormone-related modulation of immune responses and viral receptor expression [1,2]. The age group most affected in our cohort was 6–10 years, which is consistent with the findings of Simpson et al. (2019), who also observed peak incidence in school-going children [3].

Clinically, fever, tachycardia, and respiratory distress were the most frequently reported symptoms. These non-specific findings often delay the diagnosis. In our study, 81% of children presented with fever, and 75.7% had tachycardia. Breathlessness (67.6%) was also a prominent feature. These findings are congruent with data from Sagar et al. (2012), who noted that early symptoms of viral myocarditis frequently mimic those of respiratory or gastrointestinal infections, often leading to underdiagnosis [4]. Notably, chest pain was reported in 31% of our patients, which is higher than the 20–25% reported in North American pediatric cohorts, likely reflecting variations in age distribution and symptom reporting capabilities [5].

Elevated cardiac biomarkers such as troponin I (86.5%) and CK-MB (73%) were observed in a significant proportion of our patients, serving as crucial indicators of myocardial injury. These levels correlate with the findings from the Myocarditis Registry of the European Society of Cardiology, which reported elevated troponin in 71–90% of pediatric myocarditis cases [6]. Elevated CRP and ESR in more than 60% of our patients further affirm the inflammatory nature of the disease process.

This observation is supported by Benseler et al. (2016), who emphasized the diagnostic utility of inflammatory markers, although they lack specificity [7].

Electrocardiographic abnormalities, particularly ST-T changes and arrhythmias, were identified in over half of the study population. ST-T segment changes (41.9%) and sinus tachycardia (37.8%) were predominant. Similar patterns were reported by Das et al. (2018), who found that 45% of children with myocarditis had nonspecific ST-T wave changes, and 20% had conduction abnormalities [8]. The presence of arrhythmias and heart block in our cohort (8.1%) also mirrors other regional studies, suggesting the need for routine ECG monitoring in suspected myocarditis cases.

Echocardiographic evaluation revealed left ventricular dysfunction in 64.9% of the patients, a finding comparable to the 60–70% reported in earlier pediatric studies by Klugman et al. (2010) and Law et al. (2020) [9,10]. Ejection fraction less than 40% was seen in 25.7% of our cases, indicative of severe myocardial involvement. Pericardial effusion, observed in 16.2% of patients, although less common, is a recognized accompaniment, consistent with the reported range of 10–20% in literature [11].

Etiologically, enteroviruses were the most frequently identified agents (32.4%), followed by adenovirus (24.3%) and influenza viruses (17.6%). This is in line with international data where enteroviruses, especially coxsackievirus B, remain the most implicated pathogens [12]. The detection of parvovirus B19 in 10.8% of cases corroborates reports by Esfandiarei and McManus (2008), who demonstrated the cardiotropic nature of this virus, particularly in immunocompromised children [13].

Therapeutically, supportive care remained the cornerstone. IVIG was administered in 28.4% of cases, mainly those with fulminant myocarditis or hemodynamic compromise. This usage pattern is in accordance with findings from a multicentric study by Drucker et al. (1994), which showed improved outcomes in IVIG-treated pediatric myocarditis patients, although definitive consensus on its efficacy remains lacking [14]. Mechanical ventilation and inotropic support were necessary in 10.8% and 37.8% of patients, respectively, underscoring the severity of disease in a subset of patients.

In terms of outcome, the overall prognosis was favorable, with 83.8% of children making full clinical recovery. This recovery rate is slightly higher than the 70–80% reported in studies from Western countries, possibly due to early intervention and better critical care support in our tertiary center. Mortality in our cohort stood at 9.5%, comparable to the global reported range of 7–15% in pediatric myocarditis [15,16]. Predictors of poor outcome in our study included arrhythmias, severely depressed ejection fraction, and high troponin I levels—factors that have been consistently reported in prior studies as indicators of fulminant disease [17].

This study is among the few from South India offering a comprehensive clinical and laboratory correlation in pediatric myocarditis with confirmed or suspected viral etiology. However, it is not without limitations. A definitive viral diagnosis could not be established in 13.5% of cases, largely due to lack of universal availability of viral PCR panels. Cardiac MRI, considered the gold standard for myocarditis diagnosis, was not feasible in all cases due to logistical constraints. Moreover, long-term follow-up was not conducted, limiting our ability to assess the persistence of cardiac dysfunction.

In inference, our study highlights that viral myocarditis in children continues to pose significant diagnostic and therapeutic challenges. Early recognition, guided by a combination of clinical suspicion, biomarker elevation, ECG, and echocardiographic changes, is crucial for timely intervention. Future directions should include multicenter registries, universal viral diagnostics, and long-term follow-up studies to better understand outcomes and therapeutic responses.

5. CONCLUSION

Viral myocarditis in children remains a clinically challenging and potentially life-threatening condition due to its varied and often nonspecific presentation. This study underscores the importance of early clinical suspicion supported by laboratory and echocardiographic findings for timely diagnosis and intervention. Fever, tachycardia, respiratory distress, elevated troponin I, CK-MB, and echocardiographic evidence of left ventricular dysfunction were the most consistent indicators of myocardial involvement in our cohort. Enteroviruses and adenoviruses emerged as the predominant viral agents, reflecting the common circulating viral etiology in this region.

Although the majority of children showed favorable clinical outcomes with appropriate supportive care and timely intervention, a small subset progressed to fulminant myocarditis requiring advanced life support. The mortality rate, though comparable to global trends, highlights the need for continuous monitoring and aggressive management in high-risk cases. This study also emphasizes the need for improved access to advanced diagnostic modalities, including viral PCR panels and cardiac MRI, in tertiary centers across India.

Future research should focus on establishing region-specific guidelines for early diagnosis and management of pediatric myocarditis, evaluating the long-term cardiac sequelae, and exploring the role of immunomodulatory therapies such as IVIG and corticosteroids in improving outcomes. Establishing a national registry for pediatric myocarditis may also aid in developing standardized treatment protocols and better understanding of disease epidemiology in the Indian subcontinent.

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