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Correlation of Troponin I and Echocardiogram in Children with Myocarditis: A Retrospective Study

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ABSTRACT

Background

Myocarditis, an inflammatory condition of the myocardium, presents a significant health concern in pediatric populations. Detecting and monitoring myocardial injury in children with myocarditis is crucial for timely intervention and improved patient outcomes. This study investigates the correlation between troponin I levels and echocardiographic findings in pediatric patients diagnosed with myocarditis. The primary objective is to determine the strength and significance of the relation between troponin I levels and echocardiographic parameters in pediatric myocarditis patients. Secondary objectives include evaluating the diagnostic utility of troponin I as a biomarker for myocardial injury in this population and assessing the predictive value of echocardiographic findings in relation to clinical outcomes.

Method

The research design encompasses a retrospective analysis of medical records of pediatric patients (age range: 1 month to 192 months) admitted to Northwest General Hospital and Research Center, Peshawar, with suspected or confirmed myocarditis over a specified period (Jan 2015 - July 2023). Troponin I levels and echocardiographic data, including left ventricular dimensions

and ejection fraction, were collected and statistically analyzed to explore potential associations. Data was retrieved from the hospital database and was analyzed using SPSS 25.

Result

The study groups comprised 48 patients with confirmed/suspected myocarditis. The mean age was 27 months (1–146 months), and 68.75% ($n=33$) were male while 31.3% ($n=15$) were female. When patients were classified according to the clinical severity of the disease on the basis of Echo, 17 (35.42%) patients were having normal Echocardiogram, 16 (33.33%) patients were having severe LV dysfunction, 10 (20.83%) patients were having moderate LV dysfunction while 05 (10.42%) patients were having mild LV dysfunction. On the basis of troponin I levels there were 14 (29.2%) patients having troponin I levels in between 10-100 ng/ml, 12 (25%) having troponin I levels in between 101-200 ng/ml, 07 (14.58%) having troponin I levels in between 201-500 ng/ml, 03 (6.25%) having troponin I levels in between 501-1000 ng/ml, 07 (14.58%) having troponin I levels in between 1001-2000 ng/ml, while 04 (8.33%) having troponin I levels greater than 2000 ng/ml. ANOVA showed no statistically significant variation among troponin I levels and echocardiogram, with a P value of 0.055.

Conclusion

Both troponin I levels and echocardiogram should be done in patients with acute myocarditis/suspected myocarditis, as troponin I will aid in the timely diagnosis of the disease, while echo will aid in assessing the severity of the disease, as both are correlated to each other.

Key Words

Paediatric Myocarditis, Myocarditis in Children, Troponin I levels, Echocardiogram

INTRODUCTION

Myocarditis, characterized by inflammation of the heart muscles, can result from various infections, inflammatory conditions, and exposure to toxins. Pediatric cases of myocarditis can manifest as mild upper respiratory tract infections with chest discomfort to severe cardiogenic shock.¹ Due to the broad spectrum of symptoms that can mimic other medical conditions, promptly and precisely diagnosing myocarditis presents a significant challenge. Therefore, it is crucial to maintain a heightened level of suspicion for myocarditis to prevent delayed diagnosis, as most pediatric myocarditis-related deaths occur within 72 hours of hospitalization². Clinical signs and echocardiographic irregularities may only become apparent later in the disease progression, making it difficult to establish an accurate diagnosis. Consequently, patients might initially exhibit reasonable exercise tolerance, with systolic abnormalities emerging in the later stages of the illness.

In the pursuit of improving diagnostic precision and prognostic astuteness, the utility of cardiac biomarkers alongside advanced imaging techniques such as echocardiography, cardiac troponin I (cTnI), a highly sensitive and specific marker of myocardial injury, has emerged as a promising investigation for aiding in the diagnosis and risk stratification of myocarditis.³ In conjunction with traditional diagnostic methods and imaging, cTnI measurements may offer valuable additional information regarding the extent of myocardial damage and ongoing inflammatory processes. Echocardiography, a non-invasive imaging technique, provides essential cardiac structure, function, and hemodynamics data. Integrating cTnI levels with echocardiographic findings can augment our understanding of the pathophysiology of pediatric myocarditis, facilitate early detection, and guide targeted therapeutic interventions.²⁴

This retrospective research study investigates the correlation between troponin I levels and echocardiographic parameters in children with myocarditis. The unique patient population and the regional prevalence of certain infectious and environmental triggers provide an intriguing backdrop for this study. By examining the relationship between cTnI levels and echocardiographic characteristics, we aim to elucidate this correlation's diagnostic and prognostic implications specific to our local context. The objective was to determine the relation between elevated troponin I levels and abnormal echocardiogram findings in children with myocarditis. To evaluate the diagnostic accuracy of troponin I levels versus echocardiogram findings in identifying myocarditis in children.

METHODS

A retrospective analysis of patient records was conducted at Northwest General Hospital, Peshawar, a tertiary care referral hospital, focusing on individuals under the age of 16 who initially sought care at the pediatric emergency department, were admitted, and had a discharge diagnosis of acute myocarditis or suspected myocarditis. The data spanned from January 2015 to July 2023. To identify these patients, we searched the hospital's database for all children who carried an International Classification of Diseases, 11th revision, clinical modification discharge code corresponding to myocarditis. Subsequently, we precisely screened and selected cases, resulting in a cohort of 48 patients.

All the cases in our selected cohort received a definitive diagnosis of acute myocarditis, primarily based on the following criteria: (i) the presence of acute heart failure symptoms and physical findings with a rapid deterioration in health, in the absence of pre-existing cardiac conditions; (ii) a history of flu-like illness within the two weeks leading up to the diagnosis; (iii) evidence of cardiomegaly, characterized by a cardiothoracic ratio exceeding 0.5 on chest radiography (iv) impaired heart contractility, as indicated by an ejection fraction below 50% on echocardiography; and (v) elevated levels of cardiac enzymes, with troponin I (cTnI) exceeding 10 ng/ml.⁵

We established specific exclusion criteria for our study, which included the following conditions and situations:

- Acute neonatal myocarditis.
- Pre-existing collagen vascular diseases.
- Secondary cardiomyopathies resulting from conditions such as Kawasaki disease, neuromuscular disorders, exposure to cardiotoxic agents, inborn errors of metabolism, familial syndromes, malformation syndromes, or sepsis.
- Anomalies of the coronary arteries.
- Congenital heart diseases.
- Chronic bacterial sepsis.
- Chronic primitive arrhythmias.
- Patients who had undergone cardiac surgical procedures.

These exclusion criteria were applied to ensure that the study cohort was focused specifically on cases of acute myocarditis without the confounding influence of these associated conditions and factors.⁶

We conducted adjustments for age and gender when analyzing the cardio-thoracic ratio and ECG findings, which included low voltage complexes, ST segment changes, as well as the duration of PR and QT intervals. Left ventricular dysfunction, as assessed through echocardiography, was

defined by an ejection fraction of less than 50% and categorized as mild (40–49%), moderate (30–39%), or severe (<30%).

We established a threshold of a P value less than or equal to 0.05 to determine statistical significance. Any findings with a P value meeting or falling below this threshold were considered statistically significant in our analysis.

The descriptive statistical analysis was performed using SPSS statistical software (version 25).

Data were expressed as percentages for categorical variables. The categorical variables are expressed as number (*n*) and percentage (%).

This study was approved by the Local Ethical Committee of Northwest General Hospital and Research Center Peshawar.

RESULTS

The study groups consisted of 48 patients with confirmed/suspected myocarditis. The mean age was 27 months and median of 12 months (1–14 months), and 68.75% (*n* = 33) were male while 31.3% (*n*=15) were female. When patients were classified according to the clinical severity of the disease on the basis of Echo, 17 (35.42%) patients were having normal Echocardiogram, 16 (33.33%) patients were having severe LV dysfunction, 10 (20.83%) patients were having moderate LV dysfunction while 05 (10.42%) patients were having mild LV dysfunction. On the basis of troponin I levels there were 14 (29.2%) patients having troponin I levels in between 10-100 ng/ml, 12 (25%) having troponin I levels in between 101-200 ng/ml, 07 (14.58%) having troponin I levels in between 201-500 ng/ml, 03 (6.25%) having troponin I levels in between 501-1000 ng/ml, 07 (14.58%) having troponin I levels in between 1001-2000 ng/ml, while 04 (8.33%) having troponin I levels greater than 2000 ng/ml.

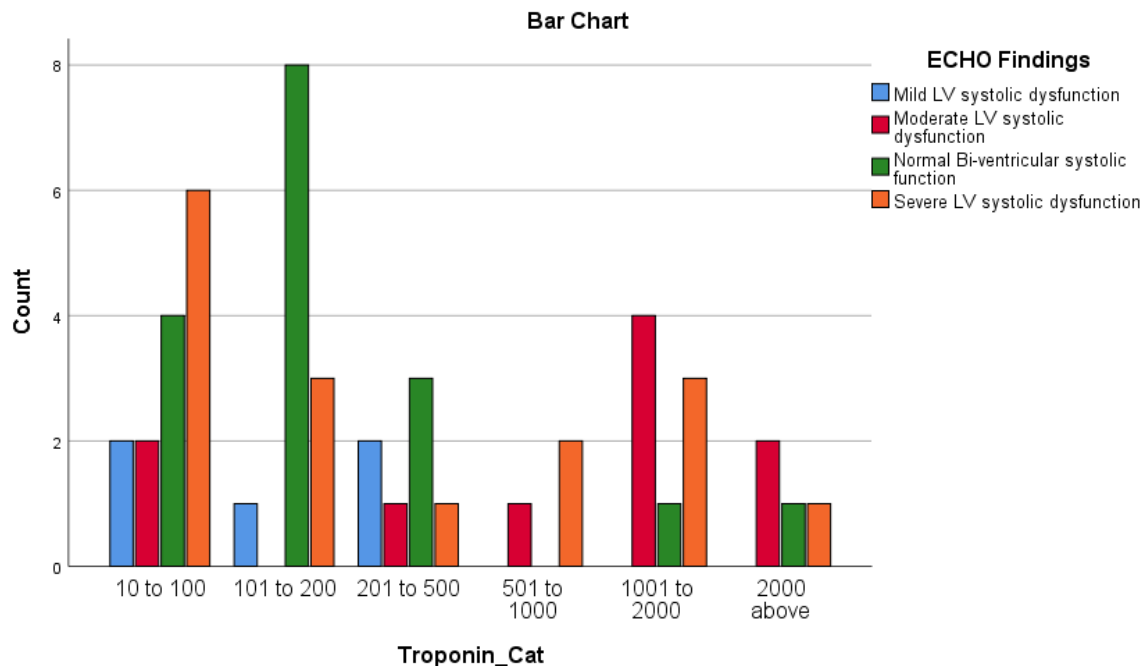
Table 1: Demographic Characteristics and Echo Findings of the patients

	Myocarditis patients (<i>n</i> = 48)
Age, months, median (range)	12 (1–214)
Age distribution, <i>n</i>, (%)	
01 Month – 12 Months	26 (54.2)
13 Months – 24 Months	07 (14.6)
25 Months – 48 Months	08 (16.7)
49 Months – 72 Months	01 (2.1)
73 Months – 96 Months	02 (4.2)
97 Months – 120 Months	01 (2.1)
121 Months – 150 Months	03 (6.3)
Gender, male, <i>n</i>, (%)	33 (68.8)
Gender, female, <i>n</i>, (%)	15 (31.3)
Classifications of Echo severity, <i>n</i>, (%)	
Normal Bi-ventricular Function	17 (35.4)
Mild LV Systolic Dysfunction	5 (10.4)
Moderate LV Systolic Dysfunction	10 (20.8)
Severe LV Systolic Dysfunction	16 (33.3)

Table 2: The demographic Characteristics and Echocardiogram Findings of Patient Groups

	Normal Echocardiogram (n = 17, 35.4%)	Abnormal Echocardiogram (n = 31, 64.6%)
Age, months, median (range)	09 (1–126)	13 (1–146)
Gender, male, n, (%)	13 (76.47)	20 (54.52)
Gender, female, n, (%)	4 (23.53)	11 (35.48)

Troponin I (ng/mL)	Severe LV Systolic Dysfunction	Moderate LV Systolic Dysfunction	Mild LV Systolic Dysfunction	Normal Bi- ventricular Function	Total
10–100	6	2	2	4	14
101–200	3	0	1	8	12
201–500	0	1	1	3	5
501–1000	3	1	1	0	5
1001–2000	3	4	0	1	8
>2000	1	2	0	1	4
Total	16	10	5	17	48

**Figure 1**

While comparing Troponin I levels with Echocardiogram findings out of 17 patients who were having normal Echocardiograms, 04 (23.52%) patients were having troponin I levels in between

10-100 ng/ml, 08(47.05%) were having troponin I levels in between 101-200 ng/ml, 03 (17.64%) were having troponin I levels in between 201-500 ng/ml, 01 (5.88%) having troponin I levels in between 1001-2000 ng/ml while 01 (5.88%) patient was having troponin I levels greater than 2000 ng/ml. Out of 16 patients having severe LV systolic dysfunction, 06 (37.5%) were having troponin I levels in between 10-100 ng/ml, 03 (18.75%) were having troponin I levels in between 101-200 ng/ml, 01 (06.25%) having troponin I levels in between 201-500, 02 (12.5%) having troponin I levels in between 501-1000 ng/ml, 03 (18.75%) were having troponin I levels in between 1001-2000 while 01 (06.25%) was having troponin I level greater than 2000 ng/ml. Out of 10 patients with moderate LV dysfunction 02 (20%) were having troponin I levels in between 10-100 ng/ml, 01 (10%) having troponin I levels in between 201-500 ng/ml, 01 (10%) having troponin I level in between 501-1000 ng/ml, 04 (40%) having troponin I levels in between 1001-2000 ng/ml while 02 (20%) having troponin I levels greater than 2000 ng/ml. Out of 05 patients with mild LV dysfunction 02 (40%) were having troponin I levels in between 10-100 ng/ml, 01 (20%) having troponin I level in between 101-200 ng/ml while 02 (40%) were having troponin I levels in between 201-500 ng/ml. And 60% of the times troponin I levels on the basis of elevation from baseline were corresponding to echocardiogram changes (severity of LV dysfunction). The ANOVA showed no statistically significant variation among the groups as the *P* value was 0.055.

DISCUSSION

The average age at which myocarditis patients presented in this study was 27 months. The male-to-female ratio was 2.2 to 1, indicating a slight male predominance within the study population. This observed gender difference suggests a higher incidence of myocarditis in males, possibly attributed to the cardioprotective effects of hormones in females.

The aim of the present study was to determine the clinical features, cardiac marker levels (troponin I) and echocardiographic findings at the time of admission have any correlation among them in patients with acute myocarditis.

The clinical course of acute myocarditis can vary significantly, ranging from severe illness upon presentation to the possibility of a full recovery. Biomarkers have gained growing importance as valuable clinical tools for evaluating cardiovascular conditions and the likelihood of developing heart failure. They serve multiple purposes, including the early detection of subclinical disease, establishing diagnoses, stratifying risk, monitoring the progression of the disease, and guiding treatment decisions. Furthermore, it's worth noting that many biomarkers are not only indicative of disease but also directly implicated in the underlying disease processes.⁷

Transthoracic echocardiography (TTE) stands as a secure and readily accessible cardiac imaging technique, proving to be exceptionally valuable in clinical practice, especially when conducting the initial evaluation of acute myocarditis. While echocardiography is indispensable for distinguishing between various cardiac conditions, its precision in identifying acute myocarditis is somewhat restricted.⁸ The American College of Cardiology (ACC), American Heart Association (AHA), and European Society of Cardiology (ESC) Working Group on Myocardial and Pericardial Diseases recommend on performing a transthoracic echocardiogram (TTE) as part of the standard protocol for patients who display clinical indications of myocarditis at their initial presentation.⁹

Acute myocarditis typically exhibits echocardiographic manifestations, which can include impaired function in the left ventricle (LV), right ventricle (RV), or both during both systole and diastole. Myocarditis may lead to several specific findings on echocardiography, such as segmental or global enlargement of the LV, localized thickening of the ventricular wall, regional

disturbances in wall motion, the presence of pericardial effusion, and focal areas of interstitial edema within the myocardium. These echocardiographic findings help in diagnosing and characterizing myocarditis.^{10,11}

We observed that cardiac marker (troponin I) was more correlating with our clinical findings as in 46 out of 48 patients (95.83 %) troponin levels were elevated from baseline while for echocardiogram 17 out of 48 patients (35.41 %) had normal echocardiograms but had clinical findings of acute myocarditis and when we compared both troponin I levels with our echocardiogram findings 29 (60.42%) out of 48 patients had both troponin I levels elevated from base line along with echocardiogram changes (LV systolic dysfunction).

Our study does have several limitations that should be considered. Firstly, our primary goal was to investigate the correlation or association between troponin I levels and echocardiogram findings. Due to practical constraints within a limited timeframe, we selected consecutive samples, and we did not perform a formal sample size calculation.

Secondly, we did not conduct endomyocardial biopsy, which is considered the gold standard for diagnosing myocarditis. This omission was due to a lack of expertise in performing this procedure at our institution.

Another limitation is the absence of long-term follow-up for the patients who survived. This means that we were unable to assess the long-term outcomes of these individuals.

Furthermore, our study focused solely on left ventricular function and ejection fraction findings from echocardiography.

These limitations should be taken into account when interpreting the results of our study, and further research with larger sample sizes, comprehensive diagnostic methods, and long-term follow-up is warranted to provide a more complete understanding of myocarditis and its outcomes.

CONCLUSION

Myocarditis in children remains a challenging condition to diagnose and manage. Children with clinical features of acute/suspected myocarditis have elevated levels of troponin in almost all cases (95%) but as far as echocardiogram is concerned only 64.58% of the patients had findings. We determined that troponin I is more accurate for acute myocarditis diagnosis and echocardiogram can aid in detecting severity (ejection fraction) and LV functioning while suspecting a case of myocarditis. Moreover, only 60% of the time both the troponin I levels and echocardiogram findings were corresponding to each other and ANOVA showed no statistically significant variation among troponin I levels and echocardiogram with *P* value of 0.055. So, both troponin I and echocardiogram should be done in patients with acute myocarditis/suspected myocarditis for timely diagnosis and severity of the disease.

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