




ORIGINAL ARTICLE

Is Serum Troponin-I Evaluation Necessary in Pediatric Emergency Departments? A Single-Center Experience

Çocuk Acil Servislerinde Serum Troponin-I Değerlendirilmesi Gerekli mi? Tek Merkez Deneyimi

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ABSTRACT

Aim: Troponin, a structural protein of myocardial cells, is frequently used as an indicator of adult cardiac injury, but there are no established guidelines for its routine use in pediatric clinical practice. In this study, we aimed to retrospectively evaluate the demographic characteristics, symptoms, and follow-up results of patients who applied to the pediatric emergency service with various clinical complaints and requested troponin levels, and the role of serum troponin levels in diagnosis.

Materials and Methods: We retrospectively analyzed the demographic characteristics, symptoms, and follow-ups of patients aged one month to 18 years, admitted to our pediatric emergency department, and requiring troponin levels over two years.

Results: Out of the 1890 patients included in the study, 50.9% were female, and their mean age was 12.36±4.32 years. The most common reasons for requesting cardiac troponin were chest pain (59.1%), poisoning (10%), palpitations (8.3%), and syncope (7%). Only 55 (2.9%) of the cardiac troponin tests were found to be elevated based on the normal reference range. Among the patients with elevated troponin levels, chest pain was the most frequently observed complaint (n=29, 52.7%). On further examination, five patients were diagnosed with myocarditis and two patients with multisystem inflammatory syndrome (MIS-C), while the most common noncardiac cause of troponin elevation was carbon monoxide poisoning.

Conclusions: Performing troponin tests in patients with suspected cardiac pathology based on their medical history, physical examination, and electrocardiography is necessary to reduce unnecessary testing and costs. Additionally, interpreting troponin levels should take into account the patient's overall clinical evaluation.

Keywords: Cardiac, Child, Pediatric emergency medicine, Troponin

ÖZ

Amaç: Miyokardiyal hücrelerin yapısal bir proteini olan troponin, erişkin kardiyak hasarın bir göstergesi olarak sıklıkla kullanılmasına rağmen, pediatrik hasta klinik uygulamalarında rutin kullanımı için belirlenmiş bir kılavuz yoktur. Bu çalışmada çocuk acil servisine çeşitli klinik şikayetlerle başvuran ve troponin düzeyi istenen hastaların demografik özellikleri, semptomları ve takip sonuçları ile serum troponin düzeylerinin tanıdaki rolünü retrospektif olarak değerlendirmeyi amaçladık.

Yöntemler: İki yıllık sürede çocuk acil servisimize başvuran ve troponin düzeyi istenen 1 ay-18 yaş arası hastaların demografik özellikleri, semptomları, tetkikleri ve takipleri retrospektif olarak incelendi.

Bulgular: Çalışmaya alınan 1890 hastanın %50,9'u kız ve yaş ortalamaları 12,36±4,32 yıl idi. En sık kardiyak troponin isteme nedenleri göğüs ağrısı (%59,1), zehirlenme (%10), çarpıntı (%8,3) ve senkop (%7) idi. Kardiyak troponin testi sadece 55'inde (%2,9) normal referans aralığına göre yüksek bulunmuştur. Troponin düzeyi yüksek olan hastalarda en sık görülen yakınma göğüs ağrısıydı (n=29, %52,7). İleri incelemede beş hastaya miyokardit ve iki hastaya multisistem inflamatuvar sendromu (MIS) tanısı konulurken, troponin yüksekliğinin en yaygın kardiyak olmayan nedeni karbon monoksit zehirlenmesiydi.

Sonuçlar: Tıbbi öykü, fizik muayene ve elektrokardiyografi ile kardiyak patoloji şüphesi olan hastalarda troponin testi yapılması gereksiz tetkik ve maliyetleri azaltmak için gereklidir. Ek olarak, troponin düzeylerinin yorumlanmasında hastanın genel klinik değerlendirilmesi dikkate alınmalıdır.

Anahtar kelimeler: Çocuk, çocuk acil, kardiyak, troponin

Introduction

Troponin is found in the structure of myofibrils in the myocardial cell and is a biomarker with high specificity and sensitivity for determining myocardial damage (1). If myocardial cells are damaged by acute ischemia or another mechanism, these proteins are released into the bloodstream. In adults, myocardial damage typically develops due to ischemia due to coronary artery disease, while in children, myocardial damage can occur due to a variety of etiologies, both cardiac and non-cardiac. As a result, myocardial damage occurs due to ischemic or non-ischemic causes

(myocarditis, arrhythmia, trauma, poisoning, hypoxia, hypotension, sepsis, etc.), and troponin levels increase (2,3). However, in some cases, the causes of high (positive) troponin levels may not be explained even after careful clinical evaluation and exclusion of all possible pathologies that could cause myocardial cell damage (4). Although chest pain is a common reason for hospital visits during childhood, cardiac causes play a minor role in its etiology. It has been shown that cardiac causes such as congenital and acquired heart diseases (including arrhythmias, cardiomyopathies, rheumatic

heart diseases, and coronary artery abnormalities) account for only 0-15% of all causes of chest pain (5,6).

Non-cardiac chest pain can often be attributed to musculoskeletal, gastrointestinal, respiratory, psychogenic, and idiopathic reasons. Due to these differences in etiology, the approach to chest pain with elevated troponin levels should differ between children and adults. However, it has been shown that pediatricians tend to unnecessarily request troponin tests and/or recommend referral to pediatric cardiology due to insufficient knowledge on this subject or parental concerns (6). Therefore, it is essential to be aware of the reasons for elevated cardiac troponin levels in children and to plan follow-up and treatment accordingly.

This study aimed to determine the reasons for requesting troponin in the pediatric emergency clinic of our hospital and the frequency of patients with high troponin levels, to determine the diagnoses and to evaluate the diagnostic efficiency of troponin examination.

Material and Method

Study design

In our study, we retrospectively reviewed the files of patients aged 1 month to 18 years who presented to the Pediatric Emergency Department of Gülhane Training and Research Hospital at Health Sciences University and had cardiac troponin tests requested between January 2019 and December 2020.

Patients under the age of one month and over the age of 18 years, those with missing information in their files, and trauma patients evaluated by the adult emergency department were excluded from the study.

Data collection

A list of patients who had cardiac troponin tests requested was obtained from the laboratory records, and the patients' files were retrieved from the Hospital Registration System. The patient's age, gender, month of presentation, symptoms, cardiac troponin level, electrocardiogram (ECG) results, cardiology consultation results, diagnosis, and follow-up status were recorded. Those with repeated test requests in the same presentation were included in the study.

Cardiac troponin-I tests were performed in our hospital using the Beckman Coulter DXI 800 hormone auto-analyzer (electrochemiluminescence immunoassay

method-ELISA). The normal reference range for troponin-I, according to the kits used, was 0-19 pg/mL. The findings of ECG were evaluated for rate, rhythm, presence of pathological waves, and ST-segment elevation/depression.

Statistical evaluation

The Statistical Package for Social Sciences for Windows, version 23.0 (SPSS Inc., Chicago, IL, USA) software was used for the data analysis. Descriptive analyses were used to determine the mean and standard deviations of the demographic and clinical data of the patients. The frequency data were presented as numbers and percentages. The normal distribution of the data was checked using the Kolmogorov-Smirnov test.

Ethical considerations

Approval was obtained from the University of Health Sciences Gülhane Training and Research Hospital Clinical Research Ethics Committee (2021-343) and the Medical Specialization Training Board for the collection of data.

Results

In the study, a total of 2040 cardiac troponin tests were requested for 1890 patients. Of these patients, 50.9% were female, and the mean age was 12.36 ± 4.32 years. The most frequent time of presentation was during the winter season (37.2%), with December being the most common month for hospital visits (13.5%).

The reasons for requesting cardiac troponin tests were ranked as follows: chest pain (59.1%), poisoning (10%), palpitations (8.3%), syncope (7%), shortness of breath (6.3%), and gastrointestinal complaints (4.8%).

Among the poisoning cases, 81 patients had taken medication, 70 patients experienced carbon monoxide poisoning, and 27 patients had other poisonings (e.g., thinner, disinfectant, acetone, lighter fluid, bleach, detergent, lime solvent, grease remover, polish, and gasoline ingestion; tear gas and pepper spray inhalation; substance abuse), and 11 patients had alcohol poisoning. The characteristics of the patients evaluated for cardiac troponin are presented in Table 1.

The mean of troponin levels were 33.32 ± 455.12 pg/mL in patients with chest pain, 7.35 ± 49.61 pg/mL in non-carbon monoxide poisoning, 26.88 ± 83.55 pg/mL in carbon monoxide poisoning, 5.34 ± 22.10 pg/mL in patients with palpitations, 14.39 ± 73.35 pg/mL in patients with syncope, 3.44 ± 10.59 pg/mL in patients

with shortness of breath, and 2.30 ± 3.82 pg/mL in patients with gastrointestinal complaints.

Table 1. Characteristics of pediatric patients evaluated for cardiac troponin

Age (years), mean \pm SD	12.36 \pm 4.32 (One month-17 years)
Gender	
Female	962 (50.9%)
Male	928 (49.1%)
Admission season	
Winter	705 (37.3%)
Spring	307 (16.2%)
Summer	344 (18.2%)
Autumn	534 (28.3%)
Signs and symptoms on admission	
Chest pain	1117 (59.1%)
Poisonings	189 (10%)
Palpitation	156 (8.3%)
Syncope	133 (7%)
Shortness of breath	119 (6.3%)
Gastrointestinal complaints	90 (4.8%)
Other reasons*	85 (4.5%)
Fever	82 (4.3%)
Change of consciousness	31 (1.6%)
Electrical shock	6 (0.3%)
Follow-up	
Outpatient treatment	1190
Emergency monitoring	688
Children's polyclinic service	10
Intensive care	2

*Other reasons: Arm pain, arm numbness, back pain, joint pain, scorpion sting, tick bite, weakness, myalgia, general condition disorder, SD: Standard deviation

According to the kits used in our hospital, the normal reference range for troponin-I was 0-19 pg/mL. Based on these values, serum cardiac troponin levels were high in 55 patients (2.9%). Of these patients, 29 (52.7%) had chest pain, 13 (23.6%) had carbon monoxide poisoning, five (9.1%) had syncope, four (7.3%) had palpitations, and two (3.6%) had multisystem

inflammatory syndrome (MIS-C) due to SARS-CoV-2 (COVID-19) infection. Patients with high troponin levels are shown in Table 2.

Table 2. Patients with elevated cardiac troponin

Complaints	n=55 (%)
Chest pain	29 (52.7%)
Carbon monoxide poisoning	13 (23.6%)
Syncope	5 (9.1%)
Palpitation	4 (7.3%)
Multisystem inflammatory syndrome due to COVID-19	2 (3.6%)
Alcohol poisoning	1 (1.8%)
Electrical shock	1 (1.8%)

COVID-19: Sars CoV-2 virus

Cardiac troponin tests were repeated in 115 patients during the same presentation for control purposes. The most common reasons for repeating the troponin test were chest pain (52 patients), carbon monoxide poisoning (22 patients), and drug and other poisonings (18 patients).

Out of the patients with elevated troponin levels, 40 (72.7%) had a normal sinus rhythm reported in their ECGs. Pathological findings were detected in the ECGs of 15 patients, including sinus tachycardia, ST elevation, ST depression, and supraventricular tachycardia.

Among the patients with evaluated troponin levels, 110 were referred for consultation with pediatric cardiology. Echocardiography results were normal in 105 patients, and 5 patients were diagnosed with myocarditis.

The characteristics of patients with heart pathology are presented in Table 3. Of the patients, 688 were kept under observation in the emergency department, 10 were followed in the pediatric ward (Myopericarditis in five patients, poisoning in three patients, fever due to upper respiratory tract infection in one patient, and supraventricular tachycardia in one patient) and two were transferred to the intensive care unit (ICU).

Discussion

The study found that various non-cardiac and cardiac diseases can lead to elevated troponin levels in children. Therefore, these patients must be evaluated through medical history in the first step and examined with electrocardiography and echocardiography in the second step. However, the progression and degree

Table 3. Characteristics of patients with elevated troponin and cardiac pathology

Age/Gender	Complaint	Troponin level (pg/mL)	Echocardiography	Diagnosis	Setting of Follow-up
16-year-old Males	Chest pain	1035	Compatible with myopericarditis	Myopericarditis	Service
15-year-old Males	Chest pain	2604	Compatible with myocarditis	Myocarditis	Service
14-year-old Females	Syncope, Chest pain	296	Compatible with myopericarditis	Myopericarditis	Service
17-year-old Females	Chest pain, shortness of breath	1229	Compatible with myocarditis	Myocarditis	Service
12-year-old Males	Fever, general condition disorder	321	Pleural Pericardial Effusion	MIS-C	ICU Referral
10-year-old Males	Fever, abdominal pain	33.9	None	MIS-C	ICU Referral
11-year-old Males	Chest pain	376	Compatible with myocarditis	Myocarditis	Service
5-year-old Males	Palpitation	29.7	Normal	Supraventricular tachycardia	Service

ICU: Intensive care unit, MIS-C: Multisystem inflammatory syndrome

of troponin elevation may not always help determine the underlying cause of myocardial damage in children, and even in the presence of heart disease in children, the clinical significance of this test is still controversial (7).

In our study, elevated troponin levels were found in 55 patients (2.9%). A multicenter study has shown that 12% of patients who underwent troponin level evaluation had elevated levels, and Dionne et al. reported this figure as 9.1% (7,8). Another study conducted in Turkey found the cardiac troponin elevation rate as 1.2% (9). In this study, the most common reason for requesting cardiac troponin tests was chest pain (59.1%). Similarly, in the study conducted by Akça et al., 40.7% of patients whose cardiac troponin levels were evaluated had complaints of chest pain (8). Chest pain is a concerning symptom for both the patient and their family in children, but its etiology is often non-cardiac (10-12). Cardiac causes of chest pain may include myocarditis, pericarditis, arrhythmia, rheumatic valve disease, cardiomyopathy, abnormal coronary artery, mitral valve prolapse, and Kawasaki disease. Cardiac-related chest pain is usually described as a feeling of pressure in the precordial region and may radiate to the arm and shoulder. Sweating, nausea, dizziness, palpitations, dyspnea, or syncope may also accompany chest pain (13). In cases of chest pain, cardiac troponin levels are often evaluated; however,

the benefit of troponin testing in children is debatable. Troponin testing may be useful in children with chest pain, but it may also lead to over-testing due to its limited usefulness (14-16). Studies have found elevated troponin in less than 5% of children with chest pain (8,17,18). Akça et al. reported that elevated troponin levels were present in 1.5% of 1028 children with chest pain (9). In the study in which 212 pediatric patients with chest pain were evaluated, it was found that troponin levels were elevated in 17% of the patients, and cardiac cause was found in 18 patients (14). In a study conducted in our country, it was observed that the majority of patients with elevated troponin levels due to cardiac reasons presented with chest pain (19). In our study, similar to the literature, troponin elevation was detected in 29 (2.59%) of the patients who applied with complaints of chest pain, and 5 of these patients (17.2%) were diagnosed with cardiac pathology. There are no clear clinical recommendations regarding the use of troponin assessment in patients presenting with chest pain. Prospective studies are needed to demonstrate the benefits of troponin assessment.

Hospital admissions due to poisoning are most commonly observed in emergency services. Cardiac effects such as arrhythmia, hypotension, and myocardial damage can result from drug or toxic agent-related poisoning, leading to elevated troponin levels. In our study, patients who presented with

poisoning were the second most frequent group to have been requested for cardiac troponin evaluation. Among these patients, the majority were those who presented with carbon monoxide poisoning (CO). Carbon monoxide is a cardiotoxic gas that affects oxygen delivery, particularly in tissues sensitive to hypoxia like the heart, leading to myocardial injury. Studies have shown that Troponin I levels increase in CO poisoning cases (20,21). In the study by Terlemez et al., CO poisoning was detected in 34.5% of children with troponin elevation (22). In our study, 13 patients (18.6%) with troponin elevation had CO poisoning. One of these patients had ST elevation on the ECG but had a normal echocardiogram. No pathological findings were observed on the ECG of other patients. Among the 11 patients who presented with alcohol poisoning, one had troponin elevation, and a regression in troponin levels was observed during their follow-ups. Cardiac troponin and ECG evaluation are necessary for children who present to the pediatric emergency department with carbon monoxide and alcohol poisoning. Cardiac effects and troponin levels may vary depending on the amount and duration of exposure.

There can be several causes for palpitations, and patients with these symptoms often seek care in the pediatric emergency department. In a study conducted in our country, it was found that 4% of patients having troponin levels checked applied to the pediatric emergency department with complaints of palpitations (9). In our study, 8.3% of patients with troponin evaluation had palpitations. Myocardial ischemia occurs due to decreased coronary perfusion and oxygen delivery due to tachycardia. Among these patients, troponin elevation was observed in 4 cases, and one of these patients was diagnosed with supraventricular tachycardia. Troponin evaluation was found to have a low predictive value in patients presenting to the pediatric emergency department with supraventricular tachycardia (23). This suggests that elevated troponin may not be detected in every patient with tachycardia.

Syncope is characterized by a sudden and brief loss of consciousness and postural tone. The causes of syncope are generally non-cardiac, but cardiac-related causes can be life-threatening. Syncope can occur in several medical conditions such as arrhythmias, myocarditis, myopericarditis, and cardiomyopathy, which lead to decreased cardiac output and cerebral perfusion (24,25). Among the patients who presented

with syncope and underwent troponin evaluation, 5 of them had elevated troponin levels, and two patients were diagnosed with myocarditis. It has been determined that 5-7% of children diagnosed with myocarditis present with syncope. Patients presenting with syncope should be carefully evaluated from a cardiac perspective (26). A detailed history, physical examination, and ECG can help establish a diagnosis for many patients presenting with syncope in the pediatric emergency department. Patients suspected of having cardiac pathology should undergo troponin and cardiology evaluation.

Medical conditions like systemic inflammatory response syndrome, sepsis, septic shock, hypotension, and hypovolemia can lead to troponin elevation due to circulatory disturbances. The shortened diastolic time of the heart due to tachycardia, an early sign of shock, results in reduced coronary perfusion and myocardial ischemia. MIS-C associated with COVID-19 infection is associated with myocarditis, valve insufficiency, and reduced cardiac function in previously healthy children. Troponin elevation in children diagnosed with MIS-C is linked to myocarditis and shock syndromes (27,28). In our study, two patients with COVID-19-associated MIS-C had elevated troponin levels and were referred to an ICU.

Electrical injuries can cause arrhythmias, direct myocardial damage, or coronary artery spasms. In our study, one out of six children presenting to the pediatric emergency department with electrical injuries had troponin elevation. The ECG of these patients was found to be normal. In a multicenter study evaluating adults and children, elevated troponin levels were determined to be predictive of cardiac injury risk in patients presenting with electric injuries (29). Cardiac evaluation is necessary in children presenting to the pediatric emergency department due to electrical injuries.

Although our study had a large patient sample, it has some limitations. First, we identified the patients retrospectively from the hospital records system. Second, there was no comparison group in our study. Furthermore, we could not evaluate the follow-up results of the patients.

Conclusion

In conclusion, cardiac troponin levels can elevate due to both cardiac and non-cardiac causes. However, even a mild increase in troponin levels in healthy children can lead to unnecessary invasive

and advanced investigations and cause concern for them and their families. If there is suspicion of a cardiac cause based on the patient's symptoms, it would be appropriate to have a detailed medical history, conduct a proper medical examination, and perform an ECG evaluation, followed by consultation with a pediatric cardiology team and planning further investigations if necessary. Elevated levels of cardiac troponin should be evaluated based on the patient's clinical condition.

Conflict-of-interest and financial disclosure

The authors declare that they have no conflict of interest to disclose. The authors also declare that they did not receive any financial support for the study.

Authors' Contribution Statement

All authors have made substantive contributions to the study, and all authors endorse the data and conclusions.

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