








Cardiac Evaluation of Children Presenting with Trauma

Travma ile Başvuran Çocuklarda Kardiyak Değerlendirme

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Abstract

Background: Trauma is a critical public health issue, particularly impacting the young and causing significant financial and moral losses. Approximately one-third of trauma-related hospitalizations and 20-25% of trauma-related deaths are caused by serious chest injuries. We aimed to determine the prognostic value of changing pediatric global troponin levels in the emergency department after trauma.

Materials and Methods: Patients who applied to the emergency department with complaints of trauma between January 1, 2015 and January 31, 2022 were evaluated. Records of pediatric patients between the ages of 0 and 18 were reviewed. The cause and severity of the trauma, electrocardiography and echocardiography results, and laboratory data (biochemical, hemogram, C-reactive protein, pro-BNP, CK-MB, troponin, etc.) of the patients were evaluated. This study is an observational and retrospective.

Results: Falling from height was the most prevalent cause of injury, accounting for 43% of cases. Chest trauma was observed in 55 patients (56%). All patients with chest trauma exhibited elevated troponin levels. Troponin levels were found to be significantly higher in patients with chest trauma ($p=0.011$).

Conclusions: Our findings highlighted the prognostic importance of cardiac troponins, especially in pediatric patients presenting with trauma.

Key Words: Trauma, Emergency medicine, Echocardiography, Pediatric cardiology, Troponin

Öz

Amaç: Travma, özellikle gençleri etkileyen, önemli finansal ve manevi kayıplara yol açan kritik bir halk sağlığı sorunudur. Travma ile ilgili hastane yatışlarının yaklaşık üçte biri ve travma kaynaklı ölümlerin %20-25'ine ciddi göğüs yaralanmaları neden olmaktadır. Travma sonrası acil servise başvuran pediatrik hastalarda troponin düzeylerinin prognostik değerini belirlemeyi amaçladık

Materyal ve Metod: 1 Ocak 2015 ile 31 Ocak 2022 tarihleri arasında acil servise travma şikayetiyle başvuran hastalar değerlendirildi. 0 ile 18 yaş arası çocuk hastaların kayıtları incelendi. Hastaların travma nedeni ve şiddeti, elektrokardiyografi ve ekokardiyografi sonuçları, laboratuvar verileri (biyokimyasal, hemogram, C-reaktif protein, pro-BNP, CK-MB, troponin vb.) değerlendirildi. Bu araştırma gözlemsel ve retrospektiftir.

Bulgular: Yüksekten düşme en yaygın yaralanma nedeni olarak bulundu (%43). 55 (%56) hastada göğüs travması saptandı. Göğüs travması olan tüm hastalarda troponin yüksekliği mevcuttu. Göğüs travması olan hastalarda troponin seviyeleri anlamlı olarak yüksek bulundu ($p=0.011$).

Sonuç: Bulgularımız, özellikle travma ile başvuran pediatrik hastalarda kardiyak troponinlerin prognostik önemini vurguladı.

Anahtar Kelimeler: Travma, Acil tıp, Ekokardiyografi, Pediatrik kardiyoloji, Troponin

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Introduction

Trauma stands out as a significant public health problem among young adults. Trauma, which is one of the leading causes of death in this age group, causes serious material and moral losses. It is known that in 1/3 of trauma patients, severe chest trauma is the cause of hospitalization, and 20-25% of deaths occur due to chest trauma (1,2). In children, the rib cage is more flexible than adults, making them more prone to lung injuries (3). Lung contusion can result in impaired gas exchange and subsequent hypoxemia, often occurring without obvious external signs of injury (4). Reports indicate that blunt cardiac injuries in children cause significant arrhythmias and even long-term cardiac dysfunction (5,6). Cardiomyocyte injury is determined by evaluating cardiac troponin levels and electrocardiography (ECG) and echocardiography (ECHO) results (7). Cardiac troponins are regarded as the most sensitive and specific biomarkers for diagnosing cardiomyocyte damage. As with other mechanisms, these biomarkers are released into the circulation in the presence of myocardial or cardiomyocyte injury, providing significant implications for acute cardiac ischemia (8,9). In polytrauma patients, high plasma cardiac troponin levels are associated with severity of injury and higher mortality rates (7); however, their predictive value for cardiac injury is still being discussed (10). In terms of pediatric polytrauma, there is limited knowledge regarding the significance of troponin assessment in the emergency department and its role in predicting outcome-related endpoints (11).

The aim of this study is to emphasize the predictive value of troponin, which is used in practice as a biomarker of post-traumatic cardiac damage in pediatric patients.

Materials and Methods

Study Population

The analysis focused on data from 97 pediatric patients, aged between 0 and 18, who were admitted to the emergency department for trauma between January 1, 2015, and January 31, 2022. Sociodemographic characteristics of the patients (age, gender), the cause and severity of the trauma, patient progression, electrocardiography and echocardiography results, laboratory data (biochemical, hemogram, C-reactive protein, pro-BNP, CK-MB, troponin, etc.) were evaluated retrospectively. Patients with a medical history of heart disease were not included in the study.

Compliance with Ethical Requirements

This study received approval from the Dicle University Medical Faculty Ethics Committee for Noninterventional Studies (Approval date: 12.05.2022 / Approval number: 207). This study adhered to the principles outlined in the Helsinki Declaration.

Statistical Analysis

Statistical analysis was used SPSS version 24 (SPSS Inc., Chicago, Illinois) software. In descriptive statistics, numerical variables were expressed as mean ± standard deviation

(Minimum – maximum), median to range and/or interquartile range (IQR) while categorical variables were expressed as number of cases and (%). Normality of variables was checked using visual and analytical methods (Kolmogorov-Smirnov tests). Descriptive statistics were presented as the median for variables that were not normally distributed and as the mean for those that were normally distributed. Relationships between variables, if at least one was non-normally distributed or ordinal, were assessed using Spearman’s Rank Correlation or Pearson’s Correlation Coefficient. For comparing quantitative variables between two groups, either the Mann-Whitney U test or Student’s T-test was applied. The Chi-square test compared categorical variables, with statistical significance set at $\alpha < 0.05$.

Results

The study included 97 trauma patients, consisting of 32 females (33%) and 65 males (67%) in Table 1.

Table 1. Demographic and Clinical Data

Age, month median (range)	117 (3–216)
Sex n, (%)	
Female	32 (%33)
Male	65 (%67)
Duration of hospital stay, days, median (range)	27,2 (1–288)
Number of patients discharged n, (%)	89 (%90,8)
Number of patients died n, (%)	9 (%9,2)

When examining the patients according to trauma mechanisms, blunt injuries were found in 92% of cases, while penetrating injuries accounted for 8%. Falling from height was identified as the most common cause of injury, representing 43% of cases (Table 2).

The laboratory data of the patients at the first admission are shown in Table 3.

Elevated troponin levels were detected in 60.8% of the patients. The mean length of hospital stay for these patients was 27.2 days. While 90.8% of the 97 patients were discharged with full recovery, 9 (9.2%) of the patients died. Chest trauma was found in 55 (56%) patients. There was no statistical difference in CK and CK-MB levels between patients with and without chest trauma. However, troponin levels were significantly higher in patients with chest trauma ($p=0.011$), as illustrated in Table 4. ECG was performed in all patients, and sinus tachycardia was detected in 22 (22.6%) patients. No malignant arrhythmia was detected in any patient. All patients underwent ECHO.

Table 2. Causes of Trauma

Falls from height n, (%)	43 (%44.3)
Out-of-vehicle road traffic accidents n, (%)	20 (%20,6)
In-vehicle road traffic accidents n, (%)	18 (%18,5)
Gunshot wounds n, (%)	4(%0,41)
Horse kick injuries n, (%)	2(%0,2)
Getting trapped under debris n, (%)	2(%0,2)
Sharp object injuries n, (%)	4(%0,41)
Falling object injuries n, (%)	4 (%0,41)

Table 3. Laboratory Data

	Min.	Max.	Mean± SD
HGB, g/dL	6	17	11,1± 6,2
PLT, 10 ³ /µL	35	760	297 ± 115,4
WBC, 10 ³ /µl	6.5	35.2	19,6 ± 7,19
NA, mmol/L	129.9	151	136,3± 3,3
K, mmol/L	2.93	5.5	3,8± 0,55
CL, mmol/L	97.3	122	107,5± 4,6
CA, mg/dL	5.8	10.2	8,5± 0,95
MG, mg/dL	1.31	2.24	1,79± 0,21
CRP, mg/L	0.001	7.38	0,6±1,45
Troponin, ng/L	0.1	24909	1026,06±3889
CK-MB (Mass) µg/L	0.22	268	35,9± 61,7
CK U/L	5.91	16150	1448±2838

Min.-minimum; Max.-maximum; SD- Standart Deviation

Table 4. Comparison of patients with and without chest trauma in terms of Troponin, CK-MB and CK values

	Patients with chest trauma (n:55)	Patients without chest trauma (n:42)	p
Troponin	1198,7± 4183	2,3±2,1	0,011
CKMB	37,01 ± 61,5	29,6±65	0,6
Creatine Kinase (CK)	2176±4125	1325,6±2549	0,3

n: Number of patients, Mann-Whitney U test, Student's T-test

In Table 5, mild pericardial effusion was detected in only 3 patients. The mean troponin value of the discharged patients was 1093.5±4078ng/L, and the mean troponin value of the patients who died was 371.2±263ng/L, and there was

no notable statistical disparity identified between the two cohorts. Furthermore, there was no notable difference in CK and CK-MB levels between patients who were discharged and those who passed away.

Table 5. Thorax CT, Echocardiography and Electrocardiography Data

Thorax CT			
Lung injury	n:14 (%14,4)		
Cardiac injury	n: 2 (%2,06)		
ECHO	Minimum	Maximum	Mean ± Standard Deviation
EF	72	79	76,5±2,5
LVEDD:	32	49	39±8,4
ECG			
Sinus Tachycardia	n: 22 (%22,6)		
Normal ECG:	n: 91(%77,4)		

n: Number of patients, CT: Computed tomography ECHO: Echocardiography, ECG: Electrocardiography

Discussion

In our study, we presented the data of 97 pediatric poly-trauma patients who applied to our tertiary emergency department. The predominance of patients in our study being admitted to the hospital due to falls from a height, depending on the nature of the trauma, aligns with findings in other literature. This high rate of falls is linked to the extremely high temperatures during the summer months in our country, especially in Diyarbakır, where this study took place, causing people to sleep on their rooftops. Parents need to be careful in terms of their children falling from heights. Evidence on the clinical benefits of the use of cardiac troponins in determining cardiac involvement after chest trauma is limited. Cardiac troponin values measured in 128 patients with chest trauma were found to be elevated in 31% of the patients (12). Troponin elevation was found in all of our patients with chest trauma. Even if some of these patients had minimal troponin elevation, our study shows the importance

of troponin in determining cardiac injury. Unlike pulmonary contusion, cardiac contusion in children has been reported to be rare (6,13), therefore, the specificity of troponins in determining direct cardiac injury after trauma is questionable. In a large postmortem study, signs of cardiac injury in autopsy were found only in 41 of the 282 children, and most of the patients had died at the scene or soon after admission to hospital (14). In our study, although high troponin levels were observed in 60.8% of the patients, 9.2% of these patients died. This shows that although troponin levels may indicate cardiac injury, the relationship between troponin levels and mortality is not clear. An assessment of a research study involving patients admitted to the pediatric intensive care unit indicated that troponin levels at the time of admission were a significant predictor of mortality (15). ECG changes in patients with trauma are nonspecific and do not directly indicate myocardial contusion but are alerting in

terms of cardiac involvement and possible complications (16). ECG is a commonly employed diagnostic tool for identifying myocardial contusion. A meta-analysis by Maenza et al. highlighted a notable correlation between significant cardiac complications and abnormal ECG results, emphasizing the critical role of ECG in the diagnostic process (17). Blunt cardiac injuries can cause arrhythmias, and high troponin levels may predict the incidence of arrhythmias (18). Such arrhythmias have been described previously (5). In our study, abnormal ECG findings were found in 22 of the 97 patients. Sinus tachycardia was detected in all of these 22 patients. No other pathology was found on electrocardiography. No malignant arrhythmia requiring treatment was detected in any of our patients. Therefore, we could not clearly explain the relationship between chest trauma and arrhythmia in our study. In studies, the diagnostic success rate of ECHO was found to be 67% and it was acknowledged as one of the best diagnostic methods; in addition, it was stated that patients with normal ECHO and ECG results did not require monitoring in the intensive care (19). In our study, bedside echocardiography was performed on all patients. In only 3 patients, mild pericardial effusion was detected. Other patients had normal echocardiographic findings. In our study, we observed that while deceased patients exhibited higher troponin levels compared to those who were discharged, this difference did not reach statistical significance. On the other hand, troponin levels were notably elevated in patients with chest trauma as opposed to those without, indicating a distinct correlation between elevated troponin levels and chest injuries. These data show that troponin level can be a valuable marker in the detection of lung contusion and cardiac injury in children and prove the importance of measuring the troponin levels in pediatric patients with chest trauma. Cardiac injuries are life-threatening problems in patients with polytrauma, especially chest trauma. However, since there are no definitive criteria for the diagnosis of cardiac injuries in trauma patients, the true incidence of cardiac injuries is unknown. Electrocardiography is thought to be a sensitive test in the diagnosis of blunt cardiac injuries. In this regard, all heart rhythm disorders must be carefully evaluated to ensure that no injury is missed. Evaluating troponin levels is especially important in patients with abnormal ECG results in terms of detecting increased risk of death. Patients presenting with blunt chest trauma, those with a history of heart disease, those who are hemodynamically unstable, those with abnormal ECG results, those with high troponin and CK-MB levels, and those with high trauma severity scores should be followed up with appropriate cardiac monitoring. In addition, patients presenting with chest pain, rib and sternum fractures, and lung injuries as a result of blunt chest trauma should be kept under observation for at least 24 hours for blunt cardiac injury. In order to predict cardiac injury in pediatric patients with chest trauma, electrocardiography should be performed and CK-MB and troponin levels should be measured.

Conclusion

Troponin level may be a valuable marker in the detection of lung contusion and cardiac damage in children and may prove the importance of measuring troponin levels in pediatric patients with chest trauma.

Limitations

Since no malignant arrhythmia was detected in the patients included in our study, we were not able to present our opinion on arrhythmias that were reported in patients with blunt chest trauma in previous studies.

Ethical Approval: This study received approval from the Dicle University Medical Faculty Ethics Committee for Noninterventional Studies (Approval date: 12.05.2022 / Approval number: 207).

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