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Original Article

Clinical and biochemical parameters for the selective use of chest computed tomography in pediatric blunt trauma patients

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ABSTRACT

Background: The aim of the present study was to investigate the predictive role of clinical and biochemical parameters whether thoracic CT scan rate could be decreased in high energy blunt thoracic trauma in children.

Materials and Methods: This retrospective study included 15 pediatric patients who received chest computed tomography, out of 165 consecutive high-energy pediatric trauma patients admitted to our pediatric emergency department within one year. 15 Patients were divided into two groups. Normal tomography findings (Group I; n = 8) and revealing thoracic pathology (Group II; n = 7). The groups were compared in terms of age, gender, weight, type of trauma, fever, pulse and respiratory rate per minute, systolic blood pressure, peripheral blood oxygen saturation and biochemical parameters. Glasgow Coma Scale, Pediatric Trauma Score, Modified Trauma score, and Injury Severity Score were also calculated and evaluated.

Results: There was no statistically significant difference between the two groups in terms of age, gender, weight, type of trauma, fever, respiratory rate, systolic blood pressure, and pulse rate ($p > 0.05$), whereas a statistically significant difference was determined between two groups with respect to peripheral blood oxygen saturation ($p = 0.013$), white blood cell count ($p = 0.008$), blood glucose ($p = 0.003$), alanine transaminase ($p = 0.033$), and aspartate transaminase ($p = 0.012$). When the trauma scores were evaluated; Glasgow Coma Score ($p < 0.001$), Pediatric Trauma Score ($p = 0.002$), and Modified Trauma Score ($p < 0.001$) were found to be statistically low in the second group while Injury Severity Score ($p = 0.001$) was higher.

Conclusions: Peripheral blood oxygen saturation, white blood cell count, blood glucose, alanine transaminase, aspartate transaminase, and Glasgow Coma Score, Pediatric Trauma Score, Modified Trauma Score, Injury Severity Score shall be predictive parameters for a thoracic pathology and need for chest computed tomography.

Key Words: pediatric blunt thoracic trauma, computerized chest tomography, predictive parameter

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Introduction

Blunt chest trauma is the second most common cause of deaths after head trauma in children [1]. Although seen rarely, it is an indicator of a high energy trauma and is associated with increased mortality [2]. It has been reported that multitrauma with thoracic trauma increases the frequency of mortality by 20 times in children [3].

Chest x-ray (CXR) is the first imaging method in patients who are suspected of having thoracic trauma because it has less radiation exposure and cheaper. Computed tomography (CT) is used for more limited indications because it contains 100-500 times more radiation and expensive. Therefore, CT scan is recommended in the presence of abnormal physical examination findings and high-energy trauma [3-8]. Although some authors suggest that abnormal findings in thoracic CT cannot make any difference in acute treatment [9,10], others suggest a more widespread use of CT because of the change in the management of 10-20% of the patients [11-16].

In this study, we sought to determine the clinical and biochemical parameters to identify a subset of patients for the selective use of chest CT in pediatric blunt trauma patients.

Materials and Methods

A total of 165 high-energy trauma patients, admitted to our pediatric emergency department within one year were retrospectively evaluated. 15 patients who had screened with chest CT were included in the study. Patients who had found negative for injury were grouped as Group I and with positive findings as Group II. Age, gender, weight, mechanism of trauma, fever, pulse, the respiratory rate per minute, systolic blood pressure, and peripheral blood oxygen saturation were recorded. Glasgow Coma Score (GCS), Pediatric Trauma Score (PTS), Modified Trauma Score (MTS) and Injury Severity Score (ISS) were also calculated for all patients.

Also, biochemical parameters such as white blood cell count, neutrophil count, hematocrit, platelet count, blood glucose, urea, creatinine, creatinine kinase, amylase, alanine aminotransferase (ALT), aspartate aminotransferase (AST), sodium, potassium, troponin, blood pH, pCO2, pO2, HCO3, base deficit, prothrombin time (PT), activated partial thromboplastin time (aPTT), and INR were studied. With the additional imaging methods, the presence of head and abdominal trauma, and extremity fractures were investigated. The necessity of intensive care unit treatment and length of stay, the need for surgery and mortality rates were evaluated.

Statististical Analysis

SPSS 20.0 (SPSS Inc., Chicago, Illinois, USA) was used for statistical analysis. In the comparison of the numerical data, Student's t-test was used to compare the normal distribution parameters, and the Mann-Whitney U test was used for the parameters that had abnormal distribution. Chi-square test was used to compare the categorical data. $P < 0.05$ was considered as statistically significant.

Results

Out of the 15 cases that had chest CT, eight cases were negative for injury (Group I) and seven cases revealed pathology (Group II). CXR revealed pathology in four (57%) of the patients of Group II. The pathologies detected in chest CT were as follows: unilateral contusion in three cases, bilateral contusion in one case, unilateral contusion and pneumothorax on the same side in one case and unilateral pneumothorax in two cases. There were no differences regarding age, gender, weight and the mechanism of trauma in patients with normal and abnormal chest CT. Fever, respiratory rate, systolic blood pressure and pulse values of the patients were similar. Demographic data and vital signs of patients were shown in Table 1.

Table 1. Demographic data and vital signs of patients.

Parameters	Group I n=8 Median (min-max)	Group II n=7 Median (min-max)	P* value
Age (year)	6 (6-12)	1 (1-3.5)	>0.05
Sex (male)	6 (%75)	5 (%71.4)	>0.05
Weight (kg)	20 (20-40)	11.5 (10-14.5)	>0.05
Mechanism of injury			
Fall-down	2	2	
Pedestrian	2	3	>0.05
Passenger	3	1	
Cyclist	1	1	
Fever	36.5 (36.5-37)	36.7 (36.7-37)	>0.05
Respiratory rate/min	30 (14-30)	30 (16-40)	>0.05
Systolic blood pressure (mmHg)	117 (104-117)	102 (67-112)	>0.05
Pulse/min	98 (87-100)	118 (100-140)	>0.05
Oxygen saturation (%)	98 (98-100)	94 (76-98)	0.013

* *Mann-Whitney U test*

Peripheral blood oxygen saturation value was lower in Group II compared to Group I and it was significant ($p < 0.05$). White blood cell count ($p = 0.008$), glucose ($p = 0.003$), ALT ($p = 0.033$), and AST ($p = 0.012$) values were also significantly higher in Group II (Table 2).

Table 2. Blood test results.			
Parameters	Group I n=8 Median (min-max)	Group II n=7 Median (min-max)	P* value
WBC (103/µL)	12300 (7150-12300)	23000 (15000-32000)	0.008
Neutrophil (103/µL)	5600 (5200-5600)	12500 (5500-20000)	>0.05
Hematocrit (%)	36 (34-36)	37 (32-38)	>0.05
Platelet (106/µL)	277 (232-277)	397 (354-480)	>0.05
Glucose (mg/dL)	131 (120-131)	171 (147-274)	0.003
Urea (mg/dL)	28 (15-28)	29 (23-33)	>0.05
Creatinine (mg/dL)	0.6 (0.6-0.7)	0.5 (0.5-1)	>0.05
Creatinine kinase (mg/dL)	205 (125-205)	526 (318-692)	>0.05
Amylase (mg/dL)	50 (23-57)	68 (55-105)	>0.05
Alanine amino transferase (U/L)	29 (7-30)	92 (46-884)	0.033
Aspartate transaminase (U/L)	29 (16-29)	227 (104-990)	0.012
Sodium (mmol/L)	138 (137-138)	135 (132-138)	>0.05
Potassium (mmol/L)	3.6 (3.5-3.6)	3.7 (3.5-4.2)	>0.05
Troponin (mg/dL)	0.9 (0.6-0.9)	0.05 (0.02-1.1)	>0.05
pH	7.38 (7.25-.39)	7.38 (7.30-7.39)	>0.05
pCO2 (mmHg)	38 (27-39)	33 (31-49)	>0.05
pO2 (mmHg)	97	98	>0.05
HCO3 (mEg/L)	19.3 (18.4-19.5)	19.1(15.8-24)	>0.05
Base excess (mEG/L)	-4.7 (-5.4)- (-4.7)	-5.4 (-10.7)-(-3.4)	>0.05
Prothrombin time (PT) (sec)	11.7 (10.6-12.9)	11.8 (11.1-12)	>0.05
Activated partial thromboplastin time (aPTT) (sec)	22.7 (20.4-25.1)	24 (21-26.9)	>0.05
International normalized ratio (INR) (%)	1 (0.9-1.1)	1 (0.9-1.1)	>0.05
** Mann-Whitney U test*			

When the trauma scores were evaluated, GCS ($p < 0.001$), PTS ($p = 0.002$), MTS ($p < 0.001$), and ISS ($p = 0.001$) were significantly worse in Group II (Table 3).

The rates of additional pathology in the abdominal and cranial CT and the likelihood of an extremity fracture were similar. While the rate of admission to the intensive care unit was higher in Group II patients, there was no significant difference in the incidence of surgical intervention ($p > 0.05$) and mortality rates ($p > 0.05$) (Table 3).

Table 3. Trauma scores and other findings.			
Parameters	Group I (n=8) Median (min-max)	Group II (n=7) Median (min-max)	P* value
Glasgow Coma Score (GCS)	15 (14-15)	11 (8-14)	<0.001
Pediatric Trauma Score (PTS)	10 (5-11)	6 (0-7)	0.002
Modified Trauma Score (MTS)	7.5 (7.5-7.5)	6.7 (5.3-7.5)	<0.001
Injury Severity Scores (ISS)	14 (2-14)	48 (29-59)	0.001
Pathological findings with abdominal CT	0	4	>0.05
Pathological findings with cranial CT	2	5	>0.05
Extremity fracture	1	1	>0.05
Admission to the intensive care unit	0	5	0.018
Length of stay in intensive care (day)	-	6 (3-20)	>0.05
Surgical intervention	2	4	>0.05
Exitus	0	1	>0.05
** Mann-Whitney U test*			

Discussion

The management of pediatric trauma patients presenting to the emergency department with a suspected trauma mechanism is controversial. Such as the fact that the examination of the abdomen alone is not reliable in the diagnosis of abdominal trauma, the sensitivity and specificity of the laboratory tests alone are low [17,18]. CXR and pelvic radiographs are thought to have low sensitivity [12,17,19]. Also, trauma-specific focused ultrasonography has been shown to be less sensitive in the pediatric population compared to adults, and its role is still uncertain [20].

Chest CT was used as a first line imaging modality in adult blunt trauma patients, but no official guidelines for pediatric trauma patients have been published [13]. Since there is a lack of consensus, the overuse of chest CT has been contributed in pediatric trauma patients. However, since children are ten times more susceptible to radiation concerning cancer morbidity and mortality and this sensitivity increases up to 14 fold with the younger age, the concept of malignancy caused by the radiation taken during CT is discussed by many authors [21-23]. Therefore, because of the risk of radiation exposure during CT imaging, routine use of CT as a primary screening tool in the evaluation of traumatic injuries is questioned [8,14,24]. In the study of Stephens et al., there was no change in chest CT utilization rates despite the pressures in reducing the use of chest CT at the initial examination of pediatric trauma patients [25]. For this reason, new markers should be determined separately from the chest radiograph in order to determine the patients who will benefit from chest CT. Khan et al, suggest that by utilizing clinical, biochemical and ultrasonographic parameters, almost ¾ th of the children with abdominal trauma could be avoided from unnecessary radiation by reducing the CT scan rate [26]. For this purpose, we investigated the predictive role of clinical and biochemical parameters whether chest CT rate could be decreased in high energy blunt thoracic trauma in children. A statistically significant difference was determined between two groups with respect to peripheral blood oxygen saturation, white blood cell count, blood glucose, ALT, and AST. Although we have small number of cases, these biochemical parameters shall be used but larger studies are needed.

In our study, the systolic blood pressure was lower and the pulse was higher. When the vital signs of the patients were evaluated, no difference was observed between the two groups. However, there was a relationship between low saturation values of patients and abnormal CT imaging. It was also consistent with the study of McNamara et al, which highlights that hypoxia was the easiest way to evaluate lung capacity and therefore thoracic trauma [27].

When the trauma scores of the patients were examined, GCS, PTS, and MTS were lower in the patients with abnormal chest CT, and the ISS was significantly higher. In the study by Peclet et al, patients with thoracic trauma were found to have higher ISS values than patients without thoracic injury (27 and 7, respectively; $p < 0.001$) [3]. Hence, there was no open fracture in both groups, and one patient had extremity fracture, we explain the high ISS values in patients with abnormal chest CT with the GCS that reveal mental state and consciousness and low systolic blood pressure. Again in the same study, the isolated thoracic injury was 5%, 20% were accompanied with abdominal trauma, and 35% with head trauma and 39% had thoracic, abdominal and head trauma together. In our study, the prevalence of patients' pathology in the abdomen or cranial CT was higher in patients who had abnormalities in their chest CT, but no statistically significant difference was found. Regarding the mechanism of trauma, there was not any difference between the groups as similar to that of Hershkovitz et al's study [10].

Ceran et al. reported that the most common pathology after thoracic trauma was pulmonary contusion [28]. This was followed by hemothorax, pneumothorax, and hemopneumothorax. In his article, Civil suggested that pneumothorax is the most commonly seen pathology in chest CT [29]. In our patients, as stated by Ceran et al, pulmonary contusion was more common than the others were. This difference is predicted to be due to the inclusion of blunt trauma patients in the study, and that the incidence of pneumothorax and hemothorax will increase more if penetrating injuries are involved.

In many studies, it is reported that chest CT increases the diagnosis of pediatric intrathoracic injury but does not change the management [9]. In our study, CXR determined the thoracic pathology in four cases but chest CT revealed additional pneumothorax in three cases (43%) and tube thoracostomy was performed.

We know that precise results cannot be obtained based on this study due to the limited number of patients. We planned this study as a preliminary study for giving the first results and planned to present it as the first step of a multi-center study.

As a conclusion we think that CT scan rate can be decreased by using trauma scores such as saturation, blood tests, GCS, ISS, MTS in patients with blunt trauma.

Declaration of conflicting interests

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