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KEY WORDS: Chest pain, Lactate, Pediatric Emergency Department.

THE ASSOCIATION BETWEEN PEDIATRIC CHEST PAIN AND LACTATE

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ABSTRACT

Introduction: Chest pain is a common reason for Pediatric Emergency Department visits, account for 0.3-0.6%. However, most chest pain in children is associated with benign or self-limited illness, such as costochondritis, muscle strain or lung or cardiac disorders. In this study, we aimed to assess the association between pediatric chest pain and lactate.

Methods: Children ageing from 6 to 17 years, taken to the Pediatric Emergency Department with the complaint of chest pain were included in the study. Demographics, complaints, symptoms, electrocardiogram (ECG), echocardiogram (ECHO) and laboratory test results including arterial blood gas, lactate, creatine kinase myocardial band (CK-MB), troponin and final diagnosis were recorded.

Results: Totally 100 patients were included. Of them, 54 were girl and 46 were boy. The mean age was 11.86±3.51 year (range 6 to 17). The final diagnosis was myalgia in 32 patients, reflux in 12 patients, panic attack in 13 patients, myocarditis-cardiac disorder in 16 patients, asthma in 12 patients and pneumonia in 15 patients. 2 patients died because of cardiac arrest. The mean lactate levels were significantly higher in patients with fever, cardiac disorder, abnormal ECG and ECHO and increased blood gas. Also, positive correlations were determined between lactate and CK-MB and lactate and troponin; lactate increased as CK-MB and troponin increased.

Conclusion: The most common cause of chest pain is idiopathic in children. A careful history and physical examination can reveal important clues and save many unnecessary examinations. Patients who have normal lactate, history, and ECG could be considered to be at low risk for AMI and referred for the appropriate tests sooner than with a standard 24-hour rule-out procedure, but patients who have higher lactate, presenting with chest pain should be followed carefully .

INTRODUCTION

Because of the chest pain is a common complaint to pediatrics, especiallyin pediatric emergency departments, account for 0.3–0.6% (1), clinicians and parents face with the fear of any heart disease. However, most chest pain in children are benign such as costochondritis, muscle strain or lung infections. The causes of chest pain in children are classified as idiopathic, musculoskeletal, pulmonary, cardiovascular, and gastrointestinal. Idiopathic chest pain is the most common reason in children, accounting for 20% to 45% of all cases (2-9).

Lactate is a well-known marker of insufficient systemic perfusion and the resultant tissue hypoxia (10). The landmark study by Broder and Weft demonstrated the prognostic value of excess lactate in shock, a finding which has been reproduced in many subgroups of critical illness (11-13). The prognostic impact of hyperlactatemia on mortality has been documented in patients with cardiogenic shock and in those with cardiac arrest even if there is no cut-off value of lactate to be associated with worse outcome or to guide resuscitation or hemodynamic management in adults (14).

In the present study, we aimed to assess the association between pediatric chest pain and lactate and seek the answer whether lactate can be used to distinguish pediatric chest pain as benign or pathological at Emergency Department admission.

MATERIAL AND METHODS

Children ageing from 6 to 17 years, taken to the Pediatric Emergency Department with the complaint of chest pain were included between 1 January 2011 and 31 December 2014. Children with any chronic disorder and congenital or acquired heart disease and history of trauma caused the chest pain were excluded. Demographics, complaints, symptoms, electrocardiogram (ECG), echocardiogram (ECHO) and laboratory test results including arterial blood gas, lactate, creatine kinase myocardial band (CK-MB), troponin and final diagnosis were recorded. Also, correlation analysis was performed among lactate, CK-MB and troponin. The study was approved by the local ethics committee and written informed consent was obtained from the parents of the patients.

Data were reported as mean, standard deviation (SD), frequency and percentage. Mean differences and 95% confidence intervals (CIs) were used to compare the means. Pearson chi-square test and Fisher's exact test were used to analysing continuous and categorical data, respectively. Non-normally distributed data were compared by Mann Whitney U test. The significance level was set at P<0.05 and the advanced significance level was set at P<0.01. All statistical tests were performed using SPSS V.11.0 software.

RESULTS

Totally 100 patients were included the study. Of them, 54 were girl (54%) and 46 were boy (46%). The mean age was 11.86±3.51 year (range 6 to 17). The final diagnosis were as following; myalgia in 32 patients, reflux in 12 patients, panic attack in 13 patients, myocarditis-cardiac disorder in 16 patients, asthma in 12 patients and pneumonia in 15 patients. 2 patients died because of cardiac arrest.

The mean lactate level was 1.850±0.980 mmol/L in the whole cohort. It was significantly higher in patients with fever (1.674±0.765 vs 2.385±1.110 mmol/L) (p=0.003). There was a significant difference between patients with and without a cardiac disease (3.916±0.765 vs 1.813±0.887 mmol/L) (p=0.008). Also, it was significantly higher in patients have increased arterial blood gas (2.865±0.969 vs 1.563±0.657 mmol/L) (p<0.001) (Table 1).

Seventy-five patients had normal ECG result, and 25 had abnormal ECG result. Lactate levels were 3.088±0.985 in patients with abnormal ECG and 1.753±0.858 in patients with normal ECG. The difference was statistically significant (p<0.01). ECHO was normal in 88 patients and abnormal in 12 patients. Similarly, lactate levels significantly differed between the patients with or without abnormal ECHO results (1.854±0.942 vs 3.597±0.327 mmol/L) (p=0.0093) (Table 1).

Table 1: Lactate levels of cases based on the clinical and laboratory variables.

		Lactate level (±SD) mmol/L	p
Fever	Febrile (n=21)	2.385±1.110	0.043**
	Afebrile (n=79)	1.674±0.768	
Tachycardia	Yes (n= 33)	**3.916±0.992**	0.008**
	No (n= 67)	1.813±0.887	
Saturation	Normal (n= 64)	1.563±0.657	0.000**
	Abnormal (n= 36)	**2.865±0.969**	
ECG	Normal (n= 84)	1.753±0.858	0.0084**
	Abnormal (n= 16)	**3.088±0.985**	

ECHO	Normal (n= 84)	1.854±0.942	0.0093**
	Abnormal (n= 16)	**3.597±0.327**	

*p<0.05 **p<0.01

Lactate, CK-MB and troponin levels significantly differed according to the final diagnosis. Lactate level was significantly highest in cases with asthma, followed by cases with myocarditis-cardiac disorders. CK-MB level was significantly highest in cases with myocarditis-cardiac disorders. Similarly, troponin level was significantly highest in cases with myocarditis-cardiac disorders (Table 2).

Table 2: Lactate, CK-MB and troponin levels of cases based on the diagnosis.

Diagnosis	Lactate (±SD) mmol/L p= 0.000**	CK-MB (±SD) ng/mL p= 0.001**	Troponin (±SD) ng/mL p=0.022*
Myalgia (n=32)	1.344±0.416	0.610±0.607	0.057±0.140
Reflux (n=12)	1.486±0.365	0.462±0.211	0.254±0.865
Panic attack (n=13)	1.572±0.323	2.742±6.736	0.702±1.233
Myocarditis-cardiac disorder (n=16)	**2.952±1.134**	**15.374±16.532**	**1.688±2.243**
Asthma (n=12)	3.044±1.064	0.955±0.913	0.003±0.006
Pneumonia (n=15)	1.795±0.723	2.682±6.270	0.483±0.824

*p<0.05 **p<0.01

Based on the correlation analysis, positive correlations were determined between lactate and CK-MB (p=0.000) and lactate and troponin (p=0.005). Lactate increased as CK-MB and troponin increased (Figure 1 and 2).

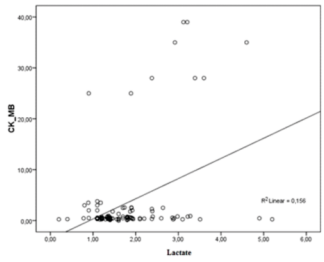

Figure 1. The correlation between lactate and CK-MB.

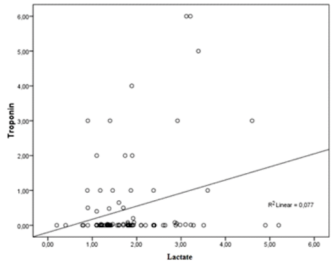

Figure 2. The correlation between lactate and troponin.

DISCUSSION

Chest pain which account for 0.3-0.6%, in all visits to the pediatric emergency departments (ED) is a common complaint of pediatric patients (1). Also, it is one of the most common reason for referral to pediatric cardiologists (2, 6, 15,).

The difficulty in assessing chest pain patients with nondiagnostic ECGs and determining their disposition in the first hours after initiation of symptoms are the continuing problem in emergency medicine. It is estimated that 2% to 8% of patients with acute myocardial infarctions (AMIs) are initially sent home from the ED (16-17) and that 25% of these have a preventable complication (18). There are many adjuncts to making the diagnosis of AMI, such as ECG, echocardiography (ECHO), and serologic tests for ischemic damage, yet none is sufficiently sensitive to consistently rule out AMI in the first 3 hours after symptoms begin (19).

It has been reported that chest pain in children is generally benign (20). Cardiac disease remains an uncommon cause for chest pain in children. The mean age of children and adolescents with chest pain is 12 to 14 years, but it can occur in children as young as four years of age (3). In our study, the mean age of 100 children with chest pain was 11.86±3.51 year. It is slightly higher than previous studies (9.4±2.8 year). The reported male to female ratio is fairly even, ranging from 1:1 to 1.6:1 (6, 21, 22) and we found that male to female ratio was 0.85:1.

Our final diagnosis were as following; myalgia in 32 % of patients, reflux in 12%, panic attack in 13 %, myocarditis-cardiac disorder in 16 % ,asthma in 12% and pneumonia in 15%. 2 % of patients died because of cardiac arrest . Our results showed that most of patients were given a diagnosis of noncardiac chest pain, which was similar to previous studies (23-26).

According to our findings, pulmonary origin of chest pain reported 30% (15% pneumonia, 15% asthma) that was higher than some other studies (3-5).

Lin et al. previously described 103 children who applied to ED in Taiwan for chest pain; chest radiographs were obtained in 98% and abnormalities were found in 28% and ECGs were obtained in 85%. Four (4.6%) showed abnormalities (27). Selbst et al. showed from patients with chest pain that ECGs were obtained in 191/235 children that 31 cases (16%) were abnormal and ECHO was performed in 139/235 that 17 cases (12%) were abnormal (5). In our study, ECG was obtained in all patients that 25% of them was abnormal. Similarly, our all patients received ECHO and 88 %of them were normal. Gastesi et al. showed that the most commonly seen types were idiopathic and/or musculoskeletal chest pain (1). Zavaras-Angelidou et al. showed that, an association was detected between chest pain and actual cardiac disease in 15% of pediatric cases with chest pain (28).

Schmiechen et al. (29) reported that venous lactate levels taken at ED presentation for chest pain in adult patients had 96% sensitivity (95% CI, 89% to 100%) for AMI, it was noted that the sensitivity of lactate was significantly higher than the sensitivity of CK with CK-MB. Not all of the AMI patients were identifiable by history and initial ECG. Presenting heart rate and blood pressure were very poor predictors of AMI. The authors concluded that a whole blood lactate level taken at ED presentation may be sensitive enough to be used with the history and ECG to exclude the diagnosis of AMI in the initial triage of patients with chest pain.

Lactate analysis is a reliable and rapid triage test which can be used to direct more immediate attention to potentially critically ill patients. Chest pain patients with an atypical presentation (e.g., younger patients, women, patients with epigastric pain) still pose a significant challenge to rapid triage and diagnosis, with no less mortality risk. Serum lactate may be a sensitive marker. Specificity is not as crucial in a screening triage test, and it is improved when lactate is correlated with history, physical examination, ECG, and standard serologic tests. Schmiechen et al. (29) have prospectively shown that hyperlactatemia also correlates with critical illness and mortality in ED patients presenting with chest pain. A lactate level of 2.0 mmol/L or higher was 83% specific (95% CI, 74% to 90%) for death or need for prolonged ICU admission and an odds ratio of 4.7 for patients with critical illness (95% CI, 2.3 to 9.6). For patients with lactate levels greater than 3.0 mmol/L, the odds ratio for critical illness climbed to 20 (95% CI, 4.6 to 89).

Recently, available evidence strongly suggests that stress hyperlactatemia is due to increased aerobic lactate production with or without lactate clearance and that it is probably due to adrenergic stimulation. In other words, increased lactate levels are indicative of stress response and lactate is a source of energy and not a waste product. Some investigators assessed whether lactate values are a diagnostic tool in patients with chest pain. In 129 adult patients with chest pain (29), lactate values measured on arrival identified those chest pain patients with critical cardiac illness (i.e., severe congestive heart failure), while lactate concentrations within the normal range had a high negative predictive value for

the diagnosis of AMI. In patients arriving at the emergency department for suspected AMI (30), lactate values on arrival reported highly sensitive for the diagnosis of AMI, mainly in those patients with more than two hours of chest pain. In 229 patients admitted to the coronary care unit (30), admission lactate showed the greatest predictive power for shock development. To date, the prognostic significance of lactate in acute coronary syndrome (ACS), that is unstable angina, no ST-elevation myocardial infarction and ST-elevation myocardial infarction (STEMI), has been investigated in observational, mainly single-centre, studies (14,31,32).

The mean lactate level was 1.850 ± 0.980 mmol / L in all of our cohorts. Lactate levels were high in patients with fever, tachycardia, low saturation, abnormal ECG and abnormal ECHO findings, and most of these patients had chest pain due to cardiac disease.

Most serologic tests, such as CK-MB, the troponins, and myoglobin, rely on ischemic cell damage leading to release of markers into the serum rather than on physiologic measures of cardiac impairment; they, therefore, have poor sensitivities in diagnosis of AMI before 4 to 6 hours after symptom onset (33-38). On the other hand, lactate production is thought to rise rapidly because of poor systemic perfusion secondary to uncompensated cardiac ischemia, without the development of lactic acidosis (10,39).

Limited information is available about the use of serum troponin screening for risk stratification in children with chest pain. In a recent study, Brown et al. (40) evaluated patients under 22 years of age, who presented with chest pain, who were not previously known to have cardiac disease, and whose troponin levels were evaluated by the emergency department during a 7-year period. Of the 212 patients with chest pain, troponin levels were increased in 37 (17%) patients. Of tem, 18 (48%) cases were attributed to primary cardiac diagnosis. The most common discharge diagnosis was myocarditis or pericarditis. In a study by Sert et al. (41), serum troponin I levels were studied in 150 of 380 patients (39.4%) who presented with chest pain and it was found that troponin levels were within the normal limits in all patients. In the present study, CK-MB and troponin levels were significantly highest in cases with myocarditis-cardiac disorders.

CONCLUSION

The most common cause of chest pain is idiopathic in children. A careful history and physical examination can reveal important clues and save many unnecessary investigations. Patients who have normal lactate, history, and ECG could be considered to be at low risk for cardiac reason ,but patients who have higher lactate, presenting with chest pain should be followed carefully for the risk of cardiac disease (39-41).

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