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The study of electrocardiographic changes in 5-15 years old children referred with chest pain to Hajar and Imam Ali hospitals in Shahrekord, Southwestern Iran, in year 2017

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Abstract

BACKGROUND: Chest pain is a common complaint among children referred to treatment centers. This study aimed to investigate the electrocardiographic changes in children aged 5-15 years with chest pain referred to Hajar and Imam Ali Hospitals of Shahrekord.

METHODS: In this descriptive-analytic study, 350 children with chest pain who were referred to Hajar and Imam Ali Hospitals were included. After clinical examination, electrocardiography was performed. Echocardiography was conducted in cases with electrocardiographic changes, and CPK-MB and troponin I tests were performed if required. Data were analyzed using SPSS-22 software.

RESULTS: The children's ages ranged from 5 to 15 years, with a mean of 10.6 ± 2.7 years. Abnormal electrocardiographic findings were observed in 28 (8%) of the 350 children. Findings included left axis deviation (2.6%), ST elevation (2.9%), ST depression (0.3%), shortened PR interval (0.9%), delta wave changes (0.06%), and cardiac hypertrophy (0.9%). Echocardiography was performed in 70 cases (23.33%), of which 28 (40%) were normal and 42 (60%) had abnormal findings. Mild changes were observed in 39 cases (55.7%), moderate changes in 2 cases (2.9%), and elevated pulmonary arterial pressure in 1 case (1.4%). Thirty girls (8.5%) and 12 boys (3.4%) experienced tachycardia, while 1 boy (0.2%) presented with bradycardia. Troponin I tests were conducted on 2 boys, with both results being negative.

CONCLUSION: Given the importance of heart disease, electrocardiography is recommended for all children presenting with chest pain. Electrocardiography may also serve as a valuable tool for screening heart disease in such cases.

Keywords: Chest Pain; Electrocardiography; Heart Disease; Old Children; Troponin 1

Introduction

Generally, after a heart murmur, chest pain is the most common reason for children to visit cardiologists[1]. In adults, this condition increases the likelihood of organic diseases, such as ischemic heart disease, while in children, it is more commonly associated with non-cardiac disorders[2]. Non-cardiac chest pain is the most frequent type of chest pain in children, accounting for over 80% of cases[3]. Gender, race, age, weight, and physical activity play significant roles in the onset of chest pain in children. The mean age for chest pain in children is 11–14 years, although it can occur at any age, even as early as four years. Chest pain is slightly more common in boys than girls[4].

Chest pain in childhood can increase the risk of mental disorders and certain physical symptoms in adulthood. Additionally, recurrent episodes in children are often associated with physical symptoms, leading to increased school absenteeism, reduced participation in extracurricular activities, and limited opportunities for reciprocal relationships[2,5].

The causes of chest pain in children include trauma or injury to the chest, infections, musculoskeletal problems (20-30%), pulmonary disorders (6-20%), and gastrointestinal problems (2-10%), hematology, obesity, mental and psychological problems and other unknown factors noted[6]. Causes of childhood chest pain although not very common but it is very important; some children's heart disease may be come with chest pain includes drooping mitral valve, myocarditis, pericarditis, increased heart wall thickness with left ventricular ejection obstruction, aortic valve stenosis, heart rate irregularities and abnormal blood supply of coronary arteries[1]. Considering the dangerous nature of cardiovascular diseases and the need for early diagnosis, this study was designed to investigate electrocardiographic changes in children aged 15-5 years with chest pain in patients referring to Hajar and Imam Ali Hospitals in Shahrekord in 2017.

Materials and Methods

This is a descriptive-analytic study. After the approval of the ethics committee of Shahrekord University of Medical Sciences (ethic code: IR.skums.rec.1396.248), the project was registered in the university's research system, and after obtaining permission from the deputy research office, the investigation began.

In this study, 350 patients aged 5–15 years who were admitted to Imam Ali Clinic and Hajar Hospital in Shahrekord during the first half of 2017 with complaints of chest pain were included. The inclusion criteria comprised ages between 5–15 years, complaints of chest pain, no history of heart disease, and no genetic disorders. If patients met the required criteria, detailed explanations were provided, and consent from the patients or their parents was obtained. All participants were selected by convenience sampling.

For all children presenting with chest pain, an electrocardiogram (ECG) was performed. Electrocardiographic changes were evaluated in terms of rhythm, rate, P wave size, QRS wave size, ST-T changes, P-R interval, QTc, the presence of delta waves, and signs of ventricular hypertrophy. Additionally, relevant information was provided to patients and their companions. Data regarding demographic characteristics, history of genetic or chronic diseases, immune deficiency disorders, medication use, smoking habits (by the patient or a family member), and a history of cardiovascular disease in the patient or first-degree relatives (father, mother, sister, or brother) were collected.

Also, if significant changes indicating ventricular hypertrophy, increased pulmonary pressure, prolonged P waves, abnormal rhythms, or acute pain were observed, echocardiography was conducted. If required, CPK-MB and troponin I tests were also performed. Any changes identified in the ECG were documented, and the type and rate of changes were analyzed and discussed in relation to their associated diseases.

Statistical analysis

Data were presented as means ± standard deviation (SD) for quantitative variables and as frequency with percentages for qualitative variables. The Kolmogorov–Smirnov test was used to check the normality assumption. The Chi-square test or Fisher's exact test (if required) was used for comparing categorical variables, while the independent t-test was used for continuous variables. Statistical analysis was performed using SPSS software (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.), and P-values <0.05 were considered statistically significant.

Results

The aim of this study was to determine the changes in electrocardiography in children aged 5–15 years with chest pain, who were referred to Hajar and Imam Ali health centers in Shahrekord in the year 2017. In total, 350 pediatric patients with chest pain were examined, including 148 (42.3%) girls and 202 (57.7%) boys. The age of the children ranged from 5 to 15 years, with a mean of 10.6 ± 2.7 years. The mean age of the boys was 10.52 ± 2.42 years, and the mean age of the girls was 10.61 ± 2.98 years. The mean heart rate and QTc interval of the children were 92.15 ± 19.08 and 404.51 ± 17.41, respectively. The mean heart rate in boys was 89.96 ± 20.17, which was significantly lower than that of girls (95.22 ± 17.02, P = 0.006). The mean QTc interval in boys was 404.61 ± 16.94, and in girls, it was 404.26 ± 17.47, which were not significantly different (P = 0.82).

According to the results shown in Table 1, the deviation of the heart axis to the left was observed in 9 (6.2%) children (5 boys and 4 girls), ST elevation in 10 (2.9%) children (7 boys and 3 girls), ST depression in 1 (0.3%) child (1 boy), PR interval shorter than normal in 3 (0.9%) children (2 boys and 1 girl), delta wave changes in 2 (0.6%) children (1 boy and 1 girl), and heart hypertrophy in 3 (0.9%) children (3 girls).

In this study, 70 (23.33%) children (39 boys and 31 girls) underwent echocardiography. These children had abnormal electrocardiographic findings or experienced recurrent chest pain, prolonged chest pain, and symptoms associated with chest pain, such as dyspnea, cyanosis, nausea, vomiting, orthopnea, paroxysmal nocturnal dyspnea, night sweats, exertional dyspnea, and cardiac palpitations. Echocardiography was also performed in cases where there was a family history of heart disease or congenital heart disease. Among these children, 28 (40%) (12 girls and 16 boys)

Table 1. Quality Characteristics of Children's Electrocardiogram under Study

Variable		Girl	Boy	Total	P-Value*
		N (%)	N (%)	N (%)	
Rhythm	Sinus	148 (100)	202 (100)	350 (100)	>0.99
Regular heart beat	yes	148 (100)	202 (100)	350 (100)	>0.99
Heart axis	Normal	144 (97.3)	197 (97.5)	341 (97.4	0.89
	Deviation to the left	4 (2.7)	5 (2.5)	9 (2.6)	
Atrial contraction wave (P)	Normal	148 (100)	202 (100)	350 (100)	>0.99
Anomaly of ST segment and T wave	Normal	145 (98)	194 (96)	339 (96.9)	0.50
	Elevation	3 (2)	7 (3.5)	10 (2.9)	
	depression	0 (0)	1 (0.5)	1 (0.3)	
P-R interval	Normal	148 (99.3)	200 (99)	347 (99.1)	>0.99
	Less than normal	1 (0.7)	2 (1)	3 (0.9)	
Delta wave	no	147 (99.3)	201 (99.4)	348 (99.4)	>0.99
	yes	1 (0.7)	1 (0.5)	2 (0.6)	
Heart hypertrophy	no	145 (98)	202 (100)	347 (99.1)	0.075
	yes	3 (2)	0 (0)	3 (0.9)	

*: Chi-square (or fisher exact test)/ N: number/ P wave: primary wave/ ST segment: section of the ECG between the end of the S wave and the beginning of the T wave/ T wave: occurs after the QRS complex and is a result of ventricular repolarization/ PR interval: the time from the beginning of the P wave to the beginning of the QRS complex.

had normal echocardiography findings. Mild changes were observed in 39 (55.7%) children (22 boys and 17 girls), moderate changes in 2 (2.9%) children (2 girls), and pulmonary arterial pressure (PAP) elevation in 1 (1.4%) child (1 boy). None of the aforementioned variables were significantly different between boys and girls (Table 1).

From the 350 children under study, 30 cases were girls (8.57%) and 12 were boys (3.4%) who had tachycardia. One boy (0.2%) had bradycardia. Troponin I was prescribed for two boys, both of whom tested negative.

Discussion

The aim of this study was to determine the changes in electrocardiography in children aged 5–15 years with chest pain, who were referred to Hajar and Imam Ali health centers in Shahrekord in the year 2017. In total, 350 pediatric patients with chest pain were examined, of whom 148 (42.3%) were girls and 202 (57.7%) were boys. The age of the children ranged from 5 to 15 years, with a mean of 10.6 ± 2.7 years. The mean age of the boys was 10.52 ± 2.42 years, and the mean age of the girls was 10.61 ± 2.98 years.

In a study by Danduran et al. in 2008, among 236 children with chest pain, 141 were boys and 122 were girls. The mean age of the children was 13.5 years, with a range of 5–22 years[7]. In the study by Torbizadeh et al., 200 children with chest pain included 107 (53.5%) boys. The children were aged between 3 and 17 years, with a mean age of 9.4 years[8]. In a study by Lin et al. in 2008 in Taiwan, among 103 children presenting with chest pain, 64 were boys and 39 were girls. The average age of the children was 13 years, with a range of 4–17 years[9]. In the study by Chun et al. in 2015 in Seoul, among 517 children with chest pain, the children were aged between 2 and 19 years (mean age: 6.9 years). Regarding the sex distribution of the 517 children, 302 (58.4%) were boys and 215 (41.6%) were girls[10].

In the present study, similar to the studies mentioned above, the number of boys patients was statistically higher than the girls, but the average age of children in the present study and also the studies mentioned above are different. It can be said that the prevalence of chest pain in boys is higher than in girls.

In a study by Selbst et al. in 1998, 407 children with chest pain were studied. The most common causes of chest pain were idiopathic (21%) and musculoskeletal (15%). Electrocardiography was requested for 47% (191 children). Electrocardiographic findings were abnormal in 31 (16%) out of 191 cases, and in 4 (25%) cases, they led to the diagnosis of heart disease. Echocardiography was performed in 139 (34%) children, of whom 17 (12%) had abnormal findings. In this study, the incidence of heart disease in 407 children was 17.4%[11].

In the present study, among the 350 children who underwent electrocardiography, abnormal findings were detected in 28 (8%) patients. Abnormal echocardiography findings were detected in 42 (60%) out of 70 children who underwent echocardiography, and cardiac disease was observed in 42 (12%) out of 350 children. The higher prevalence of heart disease and heart trouble detection through echocardiography could be due to performing electrocardiography on all children in this study. Differences may also arise from variations in the populations studied, measurement tools, and specialist skills.

In a study by Torbizadeh et al., among 200 children with chest pain, all cases underwent electrocardiography, and abnormal results were detected in 6 cases (3%). Of the 130 children (65%) who underwent echocardiography, abnormal results were reported in 9 cases (6.9%). In this study, the prevalence of heart disease in 200 children with chest pain was 9 cases (4.5%), which included 4 children with mitral valve prolapse, 1 child with aortic stenosis, 2 children with dilated cardiomyopathy, 1 child with hypertrophic cardiomyopathy, and 1 child with arrhythmia[8].

In the present study, the prevalence of heart disease cases diagnosed through electrocardiography and echocardiography

was higher compared to the above study. This could be attributed to the fact that, in the present study, most children with abnormal echocardiography findings showed mild changes and were considered problematic[12].

In a study by Lin et al. in 2008, 103 children referred to the emergency department in Taiwan for chest pain were examined. Chest X-rays were performed in 98% of the children, revealing abnormalities in 28%. Electrocardiography was conducted in 85% of the children, showing abnormal findings in 4 (4.6%) cases. Echocardiography was performed on 15 (14.6%) patients, revealing 6 partial malformations. The prevalence of heart disease in the 103 children was 5.82%[7].

In the study by Chun et al., 517 children with chest pain in Seoul were diagnosed with heart problems in 20 (3.8%) patients, including 13 cases of cardiac arrhythmias (65%), 6 cases of congenital heart disease (30%), and one case of coronary aneurysm due to Kawasaki disease (0.5%)[10].

In the study by Juli-Anne et al., 50 children with chest pain had no cardiac problems, which could be attributed to the small sample size in this study[11].

In the cohort study by Drossner et al. in 2011, 4436 children with chest pain were evaluated. Of these, 3% were excluded from the study due to a history of heart disease. Following evaluation, it was found that 25 (0.6%) children had heart disease. In this study, 92% of children with heart-associated chest pain underwent electrocardiography, compared to 27% of children with non-cardiac chest pain[13]. The prevalence of heart disease in the Drossner study was lower than in other studies, likely due to the exclusion of children with a history of heart disease.

As the results of the studies show, the prevalence of heart disease in children with chest pain in most studies is in the range of 5–5.5%[8,10,11]. This rate was 12% in the present study, although most children who underwent echocardiography (55.7% of 70 children) had mild changes. In most studies, electrocardiography has been requested for children with a possible heart disease. However, in the present study, contrary to other electrocardiographic studies, electrocardiography was requested for all patients, which seems to have led to the identification of more children with heart problems.

In the same vein, Swenson et al., in their study, examined whether chest X-ray and electrocardiography are still effective in identifying heart disease in children with heart murmurs or chest pain. In this prospective study, 106 children with chest pain or heart murmurs were divided into three groups: children without heart disease, children with a possible heart disease, and children with definite heart disease. These children underwent electrocardiography and radiography. Based on the results, in 4 children without heart disease, electrocardiography and radiography findings revealed a definite cardiac disease. In 25 children with a possible heart disease, electrocardiography and radiography showed no heart disease in 7 children and revealed definite heart disease in 5 children. The researchers finally concluded that electrocardiography and radiography helped diagnose heart disease in four patients without the possibility of heart disease. Additionally, in seven patients with a possible heart disease, these tools contributed to disease diagnosis. Since cost limitations are high in most parts of the world, performing electrocardiography and radiography remains a routine tool for pediatric cardiologists to evaluate patients with heart failure or chest pain[14].

In a study by Horton et al. regarding electrocardiographic efficacy, it was observed that 54% of the electrocardiography cases were requested in the pediatric emergency department for chest pain. Other cases included arrhythmias (11%), seizures and syncope (11%), drug exposure (8%), and miscellaneous causes (16%). Ten electrocardiography cases (14%) were performed improperly. Twenty-three cases (32%) were misinterpreted by pediatric cardiologists, and 14 cases (20%) had clinical

significance. Overall, 37 cases (52%) of the total electrocardiography performed were helpful in patient care[15].

Given the above, although chest pain is less common in children than in adults, it requires careful consideration due to the importance of heart disease and the need for early diagnosis. Usually, a thorough history and physical examination are sufficient to detect the cause of chest pain. However, using radiographs and electrocardiography in all children, or at least in those with warning signs, can be helpful in identifying heart problems.

Conclusion

Given the fact that early detection of heart disease in children is important it seems that performing electrocardiography in all children has a beneficial role in diagnosing heart problems in children with chest pain. Electrocardiography can also be helpful in screening for heart disease in cases of chest pain.

Given the importance of early detection of heart disease in children, it appears that performing electrocardiography on all children plays a beneficial role in diagnosing heart problems in children with chest pain. Electrocardiography can also be effective as a screening tool for heart disease in cases of chest pain.

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Conflict of interests

The authors declare no conflict of interest.

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Author's Contributions

Study Conception or Design: NA, MRM
Data Acquisition: NA, ME
Data Analysis or Interpretation: NA, SK
Manuscript Drafting: NA, SK
Critical Manuscript Revision: NA, MRM, SK, ME
All authors have approved the final manuscript and are responsible for all aspects of the work.

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