

## ETIOLOGICAL FEATURES OF CASES WITH CHEST PAIN IN THE PEDIATRIC CARDIOLOGY OUTPATIENT CLINIC

### Göğüs Ağrısı ile Çocuk Kardiyoloji Polikliniğine Başvuran Vakaların Etiyolojik Özellikleri

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#### ABSTRACT

**Objective:** Chest pain in children, especially in adolescence, constitutes a significant proportion of the presentations to pediatric cardiology clinics. We aimed to determine the frequency of chest pain causes in the pediatric age group and the importance of echocardiography.

**Material and Methods:** We retrospectively examined the etiological and epidemiological characteristics of patients with chest pain who were admitted to Kırıkkale University Medical Faculty Hospital Pediatric Cardiology Clinic and Pediatric Emergency Service between 2014 and 2019.

**Results:** One thousand hundred sixty-four patients were enrolled in this study. The mean age of the patients was 12.9±2.0 years (range 10-17 years). Echocardiographic evaluation was performed in 87.9% (n=1023) of 1164 patients. In 769 (75.2%) patients, there was no cardiac abnormality. Mitral valve prolapse (MVP) was detected in 164 (16.0%) patients. Out of these patients, 116 (11.3%) also had mitral insufficiency (MI). There was a female preponderance (117/164, 71.4%) among the patients with MVP. Patients with normal echocardiography findings, were compared with patients who had MVP+MI with respect to mean hemoglobin, mean corpuscular volume, Creatine kinase, Creatine kinase-MB, troponin, pro-B-type natriuretic peptide, and C-reaktif protein levels. There was no significant difference between these groups with respect to these parameters.

**Conclusion:** We showed that MVP/MI is the most common cause of cardiac related chest pain in children. Therefore, chest pain, especially with physical examination findings, such as a murmur, should be evaluated by a pediatric cardiologist, ideally by echocardiography.

**Keywords:** Chest pain, mitral valve prolapse, cardiac markers

#### ÖZ

**Amaç:** Göğüs ağrısı çocuk popülasyonunda, özellikle adölesan dönemde çocuk kardiyoloji polikliniğine başvurularda önemli bir şikâyet bulgusudur. Çalışmanın amacı, göğüs ağrısı şikâyeti ile başvuran hastaların etiyolojik özelliklerinin sıklığını belirlemek bu konuda ekokardiyografinin önemini değerlendirmektir.

**Gereç ve Yöntemler:** 2014-2019 yılları arasında Kırıkkale Üniversitesi Tıp Fakültesi Hastanesi Çocuk Kardiyoloji Kliniği'ne göğüs ağrısı şikâyeti ile başvuran hastaların etiyolojik ve epidemiyolojik özelliklerini retrospektif olarak inceledik.

**Bulgular:** Bu çalışmaya bin yüz altmış dört hasta dahil edildi. Hastaların yaş ortalaması 12.9±2.0 (dağılım 10-17) idi. 1164 hastanın %87.9'una (n=1023) ekokardiyografik değerlendirme yapıldı. 769 (%75.2) hastada kardiyak anormallik yoktu. Mitral valv prolapsusu (MVP) 164 (%16.0) hastada saptandı. Bu hastaların 116'sında (%11.3) ayrıca mitral yetmezlik (MY) vardı. (117/164 (%71.4)). MVP'li hastalarda kadın üstünlüğü vardı (117/164, %71.4). Ekokardiyografi bulguları normal olan hastalar, ortalama hemoglobin (Hb), ortalama eritrosit hacmi (MCV), CK, CK-MB, Troponin, Pro-BNP ve CRP düzeyleri açısından MVP+MI olan hastalarla karşılaştırıldı. Bu parametreler açısından bu gruplar arasında anlamlı fark yoktu.

**Sonuç:** Çocuklarda kardiyak ilişkili göğüs ağrısının en yaygın nedeninin MVP/MI olduğunu gösterdik. Bu nedenle özellikle üfürüm gibi fizik muayene bulgusu olan göğüs ağrısı, bir pediatrik kardiyolog tarafından ideal olarak ekokardiyografi ile değerlendirilmelidir.

**Anahtar Kelimeler:** Göğüs ağrısı, mitral valv prolapsusu, kardiyak belirteçler



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## INTRODUCTION

Chest pain in children, especially in adolescence, constitutes a significant proportion of presentations to pediatric cardiology and pediatric emergency clinics (1). Chest pain causes restriction of activities and absenteeism from school in children, and anxiety in families, although there is no organic etiology in most cases. Unlike in adults, chest pain rarely relates to cardiac disease in children. However, certain disorders such as myocarditis, hypertrophic cardiomyopathy, and myocardial ischemia that can cause chest pain can lead to sudden death (2,3). Although serious cardiac disorders are rare in children, pediatric patients cannot fully describe and localize their pain, which may lead to the performance of expensive cardiac tests to exclude cardiac chest pain (4). Investigation of cardiac disorders using electrocardiography (ECG), echocardiography (ECHO), telecardiography, and cardiac enzymes may sometimes be exaggerated (5,6). In this study, we retrospectively examined the etiological and epidemiological characteristics of patients with chest pain to determine the respective frequencies of chest pain causes; we also aimed to investigate the importance and the role of echocardiography and markers of myocardial injury, including creatine kinase (CK), creatine kinase myocardial band (CK-MB), and troponin (Tn) levels in making the diagnosis of cardiac chest pain.

## MATERIALS AND METHODS

This study included children with chest pain aged between 10-18 years who were admitted to Kırıkkale University Medical Faculty Hospital Pediatric Cardiology Clinic between 2014-2019. The Kırıkkale University School of Medicine Ethics Committee approved the study (Date: 8.1.2020, Number: 2019.12.07). In practice, almost all patients with chest pain who were referred from the emergency or pediatric polyclinic were seen by a pediatric cardiologist at our hospital. The inclusion criterias were: patients who presented due to chest pain and do not have any pre-existing chronic diseases such as cardiovascular, metabolic, or systemic illnesses. Patients for whom no

other system-related cause could be found to explain chest pain were included in the idiopathic chest pain group. Patients with known cardiac disease and insufficient data were excluded from the study. We recorded the demographic data of the patients, such as age and gender, as well as the results of the tests and studies to evaluate chest pain, including electrocardiography, echocardiography, complete blood count, and biochemical analysis.

Echocardiography was performed using “Vivid 3 Expert” and “Vivid 7 Pro ECO” devices of General Electric Medical Systems (United States) and probes of 3, 5, 7 MHz. All measurements were performed by the same pediatric cardiologist (CS). In the measurements, images were taken in subcostal, parasternal long axis, short axis, apical four-chamber, five-chamber, and suprasternal positions, and hemodynamic functions were evaluated with M-mode, 2-dimensional and Doppler echocardiographic examinations. In addition, a tissue Doppler study was performed. American Society of Echocardiography recommendations were taken as a reference for all measurements (7).

All possible heart conditions such as patent foramen ovale (PFO), patent ductus arteriosus (PDA), myocarditis, pericarditis or valve pathologies were reviewed in echocardiograph

### *Statistical analysis*

SPSS (Statistical Package for the Social Sciences) version 20.0 software (SPSS Inc.) was used to analyze the study data. The categorical variables were expressed as frequency and percentage, and continuous variables as mean and standard deviation (SD). The student's t test was used for data with standard variables to compare means, and the Mann-Whitney-U test was used to compare non-normally distributed pairwise means.

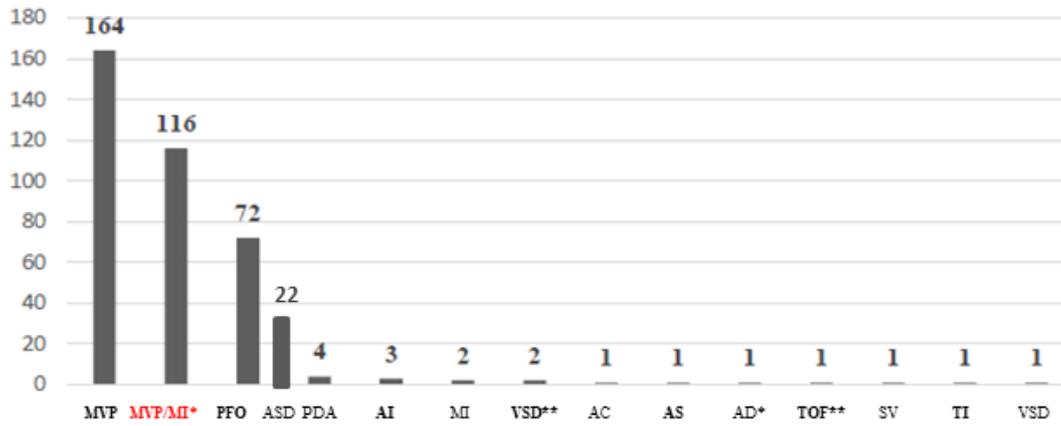
## RESULTS

One thousand hundred sixty-four patients were enrolled in this study. The mean age of the patients was 12.9±2.0 years (range 10-17 years). Fifty-two point six percent of the patients were female. The month with the highest number of patient presentations was February (12.1%) , and July was the month with the lowest number of

patient presentations (5.3%). The rate of admission to the pediatric emergency service due to chest pain was 0.84%. Echocardiographic evaluation was performed in 1023 of 1164 patients (87.9%). In 769 patients (75.2%) there was no cardiac abnormality. Mitral valve prolapse (MVP) was detected in 164 (16.0%) patients. Out of these patients, 116 (11.3%) had also mitral insufficiency (MI). In addition, 72 (7.0%) patients had patent foramen ovale (PFO), 22 (2.1%) patients had atrial septal defect (ASD), and 4 (0.4%) patients had patent ductus

arteriosus (PDA) (Figure 1). The remaining disorders found in the patients were aortic insufficiency (n=3), isolated mitral insufficiency (n=2), operated ventricular septal defect (n=2), aortic coarctation (n=1), aortic stenosis (n=1), operated aortic dilation (n=1), operated Tetralogy of Fallot (n=1), single ventricle (n=1), tricuspid insufficiency (n=1), and ventricular septal defect (VSD) (n=1). The majority of those who had MVP were female (117/164, 71.4%).

**Figure 1:** Distribution of the echocardiography findings



MVP: Mitral valve prolapse, MI: Mitral insufficiency PFO: Patent foramen ovale, AI: Aort insufficiency, VSD: Ventricular septal defect, AC: Aort coarctation, AS: Aort stenosis AD: Aort dilatation, TOF: Tetralogy of Fallot, SV: Single ventricle, TI: Tricuspid insufficiency

\*Patients who had MVP and MI

\*\*Operated

Patients with normal echocardiography findings (n=769, 75.2%) were compared with patients with MVP+MI (n=116, 11.3%) with respect to mean hemoglobin (Hb), mean corpuscular volume (MCV), CK, CK-MB,

troponin, Pro-BNP, and CRP levels (Table 1). There was no significant difference between these groups with respect to these parameters.

**Table 1:** Comparison of laboratory finding of MVP/MI and normal patients

Parameter	Patients with MVP/MI (N=116)	Patients with without cardiac origin (N=769)	p
Mean Hb*	13.6±1.2	13.8 ±1.2	0.156
Mean MCV*	85.3±5.8	83.3 ±5.4	0.070
Median ProBNP** (min-max)	34.9 (6.2-499.7)	37.2 (5-704)	0.442
Median Troponin I** (min-max)	0.01 (0.003-0.103)	0.005 (0.003-35.3)	0.501
Median CK-MB** (min-max)	18 (7.6-100)	20.2 (3.3-274)	0.140
Median CK** (min-max)	87.2 (34-5.294)	99 (25-2.967)	0.080

Hb: Hemoglobin, MCV: Mean corpuscular volume, ProBNP: Pro-B-type natriuretic peptide, CK: Creatine kinase

\*Student's t test

\*\* Mann Whitney U test

**Table 2:** Distribution of the etiologies of chest pain

Etiologies of chest pain	N (%)*
<b>Non cardiac</b>	1000 (85.9)
<b>Idiopathic</b>	485 (41.7)
<b>Musculoskeletal system pain</b>	168 (14.4)
<b>Psychogenic</b>	110 (9.5)
<b>Respiratory system</b>	157 (13.5)
<b>Gastrointestinal system</b>	80 (6.9)
<b>Cardiac origin (MVP)</b>	164 (14.1)
<b>MVP/MI</b>	116 (9.9)

\*n/Total patient number (1164)

MVP: Mitral valve prolapse, MI: Mitral insufficiency

## DISCUSSION

Although parents of children presenting with chest pain may be excessively concerned about cardiac causes, chest pain in children is usually caused by non-cardiac causes (8). In contrast to the known relationship between chest pain with angina pectoris and myocardial infarction in adult patients, previous studies have shown that heart-related disorders are seen in as low as 1-5% of the pediatric patients (9-12).

When the previous studies were examined, it was seen that the rates of admission to the pediatric emergency service with chest pain ranged from 0.25% to 5.2% (13,14). In our study, the rate of admission to the pediatric emergency service with chest pain was 0.84%. Since children who present with chest pain are often referred to pediatric cardiology outpatient clinics without a detailed evaluation, to relieve families' concerns and mitigate the malpractice risk, the frequency of admission to pediatric cardiology outpatient clinics for chest pain has gradually increased (15,16). Sudden deaths in athletes, which have increased in recent years, cause anxiety in both families and physicians. Therefore, the evaluation of chest pain requires further testing, which may lead to excessive and unnecessary use of resources (17). In addition the psychological effect of unnecessary testing or long-term follow-up for inconsequential diagnoses is another handicap.

Studies have shown that the incidence of chest pain is generally equal in male and female genders, which is in accordance with our findings (13,14). Studies have also

shown that chest pain is more common in the pubertal period (18,19). Aygün et al. found a mean age of 7.82 years for patients with chest pain, as opposed to 12.02±3.16 years in our study (20). Psychological problems during puberty may be the reason for chest pain. They also found that there was an increase in patient admissions during the winter months, as we demonstrated in our study. We believe that infections in winter and during the semester break may lead to an increased admission rate.

When no explanation is found for chest pain it is called idiopathic chest pain. Although, in our study, the rate of idiopathic chest pain was consistent with the literature, Saleeb et al. showed a lower rate (1%) of cardiac origin of chest pain in 3700 pediatric patients (21). The rate of non-cardiac pain etiologies was as follows: 52.1% idiopathic, 36.4% musculoskeletal, 6.5% respiratory, 0.9% psychogenic, 2.9% gastrointestinal (21). We thought that the difference could be attributed to varying lifestyles and living conditions in these two different societies, especially in terms of their impact on psychogenic, gastrointestinal and musculoskeletal systems. The relatively high number of cardiac origin pain in our study compared to the Saleeb study could be attributed to the high rate of application to clinic in their study.

The relationship between pain with meals and an epigastric indigestion history should be questioned. Previous studies prospectively showed that 33.3% of the patients who were admitted to the cardiology outpatient clinic due to chest pain had also epigastric tenderness (22,23). Ninety-three point two percent of these patients had positive endoscopic findings, including various degrees of gastritis (23).

Chest pain was classified as psychogenic unless an organic cause could be identified. Psychogenic chest pain can occasionally result from anxiety or a conversion disorder triggered by stress factors (24). Aygün et al. found that psychogenic causes of chest pain constitute 28.4% of all chest pain episodes (20). Therefore, it should be first questioned whether there is any stress factor in a patient. However, since our study

was retrospective, Beck depression scale and anxiety scales could not be performed for anxiety disorder, attention deficit hyperactivity disorder, and behavioral disorders. We found a rate of 9.5% for psychological causes using patient history alone.

Respiratory system disorders causing chest pain are mainly pneumonia, asthma, pneumothorax, pulmonary embolism, and pleural effusion, among others (25). In a previous study, the prevalence of respiratory disorders in patients with chest pain was 12% (26). In our study, the corresponding figure was similar, i.e. 13.5% when patients with fever, cough and abnormal respiratory findings were excluded.

Cardiac disorders are the most feared causes of chest pain in children. Studies have shown that cardiac problems are a rare cause of chest pain in childhood, with a prevalence of 1-5% (9-12). Unlike previous studies on the subject, our study included patients with MVP, resulting in a higher rate of cardiac disease among our patients compared to the literature. Although the true frequency of MVP is unknown, it has been reported as 0.3-21% (27). Like previous studies, there was a female preponderance in MVP patients. MVP should be considered especially in female patients who present with complaints of chest pain and palpitation (28). The diagnostic criteria we based on for MVP, include the late systolic posterior displacement on M-mode, bulging into the left atrium on 2D long-axis view, and thickening of the mitral leaflets (29). However postmortem data showed that the sensitivity and specificity of echocardiography in diagnosing MVP was 88 percent and 82 percent, respectively (30).

The most common complication of MVP is mitral regurgitation. Chest pain associated with MVP+MI reportedly causes more frequent pain. In a study, 67.3% of patients with MVP also had mitral insufficiency (31). Similarly, 70.7% of our MVP patients had MI. Patients with MVP do not need routine antibiotic prophylaxis for bacterial endocarditis; however, it should be considered for patients who also have MI (32). Systolic murmur (midsystolic/pansystolic) is an important physical examination sign for MVP/MI (33). Therefore, a careful

auscultation at the first stage of the evaluation of a patient with chest pain is an important criterion for patient referral to a pediatric cardiologist.

Biochemical tests (cardiac enzymes) are requested from patients presenting with chest pain, and such patients are usually referred to a pediatric cardiologist for echocardiography without a detailed evaluation. As shown in our study, most chest pain episodes are of non-cardiac origin. However, cardiac enzymes did not rule out or in cardiac disease. As we showed in our study there was no significant difference between normal patients and patients with MVP/MI regarding the mean cardiac enzyme level. The prevalence of MVP in the general population is 4 to 5% (33). Thus, compared to the normal population, our patient population had a higher prevalence of MVP/MI (11.3%) but with chest pain.

Our study had some limitations. The first of them is its retrospective nature, and the second one is the inaccessibility of the information about the chest pain characteristics and the status of murmur presence. In addition, the high rate of MVP in comparison to the literature may be caused by the high rate of echocardiographic examination for chest pain. Besides fear of malpractice accounts for the increased use of echocardiography in our study. In addition myocarditis which is an important cause of chest pain, was not encountered in our cases, since most of the patients were outpatients.

In this study, we showed that the rate of chest pain associated with the heart is low in children (9.9%) and we found that MVP/MI was the most common cause of cardiac related chest pain in our study population. Therefore, especially chest pain with physical examination findings, such as a murmur, should be evaluated by a pediatric cardiologist, ideally by echocardiography.

*Conflict of Interest:* The authors have indicated no conflicts of interest regarding the content of this article.

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EBC; Data Collection: CS, EBC; Writer: CS, EBC, YK; Critical Review: CS, EBC, YK; Approver: CS, EBC, YK

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