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European International Journal of Multidisciplinary Research and Management Studies

TYPE Original Research
PAGE NO. 149-153
DOI 10.55640/eijmrms-05-02-29

Clinical and Instrumental Features of Minor Cardiac Anomalies in Children

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OPEN ACCESS

SUBMITTED 24 December 2024
ACCEPTED 26 January 2025
PUBLISHED 28 February 2025
VOLUME Vol.05 Issue02 2025

Abstract: Currently, a new term, Connective Tissue Dysplasia (CTD), has been introduced in pediatric disease clinics, which influences the child's health in the long term. Among these conditions are minor cardiac anomalies (MCA), which involve anatomical changes in the architecture of the heart and major vessels that do not lead to severe dysfunction of the cardiovascular system (1,3,5,10).

Keywords: Connective Tissue Dysplasia (CTD), heart rhythm disorders.

Introduction: Currently, a new term, Connective Tissue Dysplasia (CTD), has been introduced in pediatric disease clinics, which influences the child's health in the long term. Among these conditions are minor cardiac anomalies (MCA), which involve anatomical changes in the architecture of the heart and major vessels that do not lead to severe dysfunction of the cardiovascular system (1,3,5,10).

To date, studies on CTD have led to the conclusion that cardiovascular pathology is the most common disorder in individuals with CTD. Cardiovascular dysfunctions are among the leading causes of reduced life expectancy in these patients (2,6). The frequency of detecting heart rhythm disorders in individuals with CTD ranges from 18% to 91%, according to the literature (3,8,9,13). Although arrhythmic syndrome in MCA is not life-threatening, it negatively affects the patient's quality of life.

There are only a few studies dedicated to examining the functional characteristics of the cardiovascular system in MCA in children. However, a comprehensive assessment of cardiovascular system changes would allow for better prognosis and early diagnosis of heart rhythm disturbances in MCA patients. This, in turn, would improve quality of life and delay the onset of

disability (7,11,12).

Changes in Cardiovascular Pathology in Children Over the Last Decade: A Focus on Minor Cardiac Anomalies

Over the past decade, the structure of cardiovascular pathology in children has undergone significant changes. There has been an increase in the prevalence of arrhythmias, cardiomyopathies, and congenital heart defects. In recent years, conditions associated with connective tissue dysplasia (CTD) and its impact on the heart have gained increasing attention.

Among cardiovascular pathologies, functional disorders and conditions linked to minor cardiac anomalies (MCA) play an important role. When specifically searched for, ultrasound methods detect MCA in 97-99% of children. There are approximately 30 different types of microanomalies in heart development. On the one hand, these anomalies may appear relatively "harmless"; on the other hand, they can lead to various disturbances in cardiovascular function and significantly impact intracardiac hemodynamics. It is now widely accepted that MCA is pathogenetically linked to CTD syndrome, which is a generalized and progressively worsening condition over time. Therefore, each microstructural anomaly of the heart requires an individual prognostic assessment.

Objective of the Study

Given this, the objective of the present study is to analyze the clinical and functional manifestations of MCA in children and to identify the functional characteristics of the cardiovascular system associated with this pathology.

METHODS

We examined 52 pediatric patients aged 3 to 15 years with MCA, all of whom were receiving treatment in the cardiorheumatology department of a medical center. A control group of 30 healthy children was included for comparison.

The diagnosis of MCA was established based on:

- Medical history,
- Objective clinical data,
- Findings from clinical and paraclinical investigations,
- Echocardiographic (ECG) parameters.

The clinical examination involved:

- A detailed history, including early antenatal developmental indicators,
- Health status of the mother, pregnancy conditions, and childbirth history,
- Information on the child's postnatal development.

Assessment of exercise tolerance in children with MCA was conducted using the Shalkov test.

An electrocardiogram (ECG) was recorded at rest using a three-channel electrocardiograph in 12 standard leads. The ECG analysis focused on:

- Duration of waveforms and intervals,
- Presence of rhythm and conduction disturbances,
- Repolarization abnormalities,
- Signs of cardiac overload,
- Evaluation of electrical systole (QT interval), calculated as the difference between the expected QT and the actual QT, adjusted for age**.

Ultrasound examination of the heart was performed using one-dimensional and two-dimensional scanning, combined with Doppler studies in pulsed-wave mode. Structural analysis of the heart was conducted from standard imaging positions, utilizing:

- Parasternal access,
- Apical access,
- Subcostal access,
- Suprasternal access.

This comprehensive diagnostic approach is essential for identifying early rhythm disturbances and evaluating the impact of MCA on cardiac function, ultimately improving long-term prognosis and quality of life in affected children.

RESULTS AND DISCUSSION

Among the 52 children diagnosed with minor cardiac anomalies (MCA), the most frequently detected condition was mitral valve prolapse (MVP), which was observed in 23 (42.2%) of the cases. Anomalous chords of the left ventricle (ACLV) were found in 19 (36.5%) of the children, while combined MCA (MVP associated with intraventricular formations) was identified in 10 (19.2%) of the patients.

Gender Differences: MVP was more common in girls than in boys, with 64.3% of cases occurring in females and 35.7% in males.

Prenatal and Perinatal History:

- Among children with MVP, 56.5% were born after complicated pregnancies and deliveries.
- 17.4% of mothers had a history of threatened miscarriage, while 30.4% had early or late gestosis.
- Acute respiratory infections and maternal inflammatory diseases of the urogenital tract were found in 39.1% of cases.

- Among children with ACLV, 54.1% had perinatal complications, the most common being weak labor activity (20.8%) and premature rupture of membranes requiring operative delivery (12.5%).
- Premature birth, post-term deliveries, and premature rupture of membranes were observed in 52.3% of children with MVP.
- In the combined MCA group, 21.05% (18 patients) had a history of premature birth and umbilical cord entanglement, which was significantly higher than in the control group ($p<0.01$).

Clinical Symptoms and Variants of MCA

The clinical presentation of MCA in children varied and was influenced by autonomic instability, including:

- Cardiac symptoms: Chest pain (cardialgia) and palpitations
- Neurological symptoms: Headaches (cephalalgia) and dizziness
- Abdominal syndrome
- Joint pain (arthralgia)
- Increased fatigue

There were no significant differences in clinical symptoms between healthy children and those with isolated MCA. However, in the combined MCA group, cardiac syndrome (chest pain, palpitations, $p<0.01$) and fatigue were more common than in the healthy children.

Variants of MVP

Two clinical forms of MVP were identified:

1. Mildly symptomatic MVP (5 children, 21.7%)
   - o No complaints from patients
   - o Detected accidentally during echocardiography
   - o Auscultatory signs included soft systolic murmurs (48.2%) and isolated clicks (27.7%)
   - o Degree of valve prolapse ranged between 4-6 mm, with no mitral regurgitation
2. Clinically significant MVP (18 children, 78.2%)
   - o Palpitations (74.4%)
   - o Chest pain (28.2%)
   - o Headaches (32.3%)
   - o Dizziness (29.8%)
   - o History of syncope (14.7%)

Exercise Tolerance

Assessment of exercise tolerance using the Shalkov test revealed functional impairment in the MVP group:

- In 72.2% of children, blood pressure and heart rate returned to normal only by the 7th–8th minute after the 5th and 6th test stages, indicating cardiac dysfunction.
- Auscultatory findings showed isolated systolic clicks and systolic murmurs in 93.7% of cases.

Phenotypic Features of Clinically Significant MVP

Children with clinically significant MVP were more likely to have:

- Asthenic body type (28.2%)
- Low body weight (32.3%)
- Joint hypermobility (55.5%)
- Flatfoot deformities (44.4%)

These phenotypic markers of connective tissue dysplasia (CTD) were significantly less frequent in children with mildly symptomatic MVP.

Echocardiographic and Electrocardiographic Findings

- Mitral regurgitation was detected in 54.8% of children with clinically significant MVP.
- Arrhythmias were found in 53 (82.8%) of children with MCA, which was significantly higher than in the control group (11 children, 36.6%).
- Comparison of groups showed that children with MVP+ACLV had a higher prevalence of ventricular extrasystole, prolonged QT interval, and a tendency for multiple types of arrhythmias, compared to isolated ACLV cases.
- Supraventricular ectopic rhythms and QT prolongation were also more common in the MVP+ACLV group compared to isolated MVP cases.

CONCLUSION

The findings suggest that:

- MVP and ACLV are the most common types of MCA in children.
- Prenatal and perinatal complications play a significant role in the development of MCA.
- Clinically significant MVP is associated with higher rates of cardiac symptoms, autonomic dysfunction, and exercise intolerance.
- Arrhythmias, mitral regurgitation, and structural heart abnormalities are more frequent in children with combined MCA (MVP+ACLV) than in isolated cases.
- Early diagnosis and comprehensive monitoring of MCA in children are essential for preventing complications and improving quality of life.

Also, on the electrocardiogram (ECG) of the examined patients, nonspecific changes in the terminal part of the

ventricular complex were identified in the form of a decrease in the amplitude of the T waves in standard and left precordial leads in 38.9% of patients, as well as a downward shift of the ST segment in 33.3% of patients. Heart rhythm and conduction disturbances based on standard ECG data were detected in 47.8% of children with clinically significant MVP and were represented by extrasystole in 36.4% of patients, pacemaker migration in 18.2% of patients, secondary QT interval prolongation over 440 ms in 18.2% of patients, and sinus tachycardia in 27.3% of patients.

The study of clinical and laboratory signs in anomalously located chords of the left ventricle (ACLV), classified as additional structures in the left ventricular cavity, revealed an equal frequency in boys (52.3%) and girls (47.6%). Among 84% of patients with ACLV, complaints were noted of poor tolerance to physical exertion in 63.2% of patients, cardialgia in 26.3%, headaches in 21.0%, "respiratory neurosis" in 15.8% of patients, as well as syncope in 10.5% of patients. Auscultatory examination in ACLV revealed a characteristic systolic murmur of the “chordal squeak” type, most frequently registered in the apex of the heart, without extracardiac conduction.

In children with additional structures in the left ventricle, the following phenotypic signs of connective tissue disorders were significantly more common than in children with MVP: asthenic constitution in 47.4% of patients, skin hyperelasticity in 57.8% of patients, myopia in 31.6% of patients. Patients with ACLV had three or more phenotypic signs of connective tissue dysplasia. Assessment of exercise tolerance using the Shalkov test in 68.4% of patients revealed a decrease, manifested as the restoration of heart rate and blood pressure at the 8th-9th minute after performing the 6th and 7th tests.

ECG changes in 63.2% of patients with ACLV included heart rhythm disturbances in the form of supraventricular extrasystole registered in 21.0% of patients with this anomaly, ventricular extrasystole in 36.8% of patients, pacemaker migration in 36.8% of patients, shortened PQ interval in 10.5%, and sinus tachycardia and bradycardia in 15.8% of patients.

In children with combined MCA, where both MVP and ACLV and other types of MCA were identified, complaints were more often associated with cardiac syndrome (cardialgia, palpitations) in 7 (70%) patients, headaches and dizziness in 4 (40%) patients, abdominal syndrome in 1 (10%) patient, and increased fatigue in 6 (60%) patients.

Phenotypic signs of connective tissue dysplasia were significantly more frequent, including asthenic constitution in 30% of patients, joint hypermobility in 40% of patients, skin hyperelasticity in 20% of patients, posture disorders in 10%, and myopia in 30% of patients. A systolic murmur of varying intensity, changing with body position, was found in 100% of patients in this group.

Comparison of the studied groups revealed that cardiac syndrome was more characteristic of children with combined structural heart abnormalities than in children with isolated ACLV ($p<0.05$) and isolated MVP ($p<0.01$).

Thus, the study of the prevalence of minor heart anomalies (MHA) in children aged 3 to 15 years revealed that mitral valve prolapse (MVP) with significant clinical manifestations was the most common, occurring in 23 (42.2%) children with MVP, followed by anomalously located chords of the left ventricle (ALCLV) in 19 (36.5%) cases, and combined MHAs in 10 (19.2%) cases. According to our research, the genesis of various types of MHA is influenced by pregnancy and childbirth pathologies, maternal age, and the number of pregnancies in mothers of children with MHA.

In children with MHA, physical changes in the heart were frequently detected, and ECG studies revealed nonspecific changes in the terminal part of the ventricular complex, as well as disturbances in heart rhythm and conduction. The assessment of the functional state of the cardiovascular system through exercise tolerance and ECG parameters showed significant changes in the group of children with clinically significant MVP and combined MHA.

It is important to note that phenotypic signs of connective tissue dysplasia (CTD), which also indicate the presence of MHA, include asthenic constitution, joint hypermobility, skin hyperelasticity, posture disorders, and myopia.

The study of ECG parameters in patients with combined MHA (MVP, ALCLV) revealed a high frequency of arrhythmias. Notably, in this group, 10 patients were diagnosed with prolonged QT syndrome, which can lead to life-threatening cardiac arrhythmias. The frequency of detected heart arrhythmias increases with the combination of microanatomical anomalies.

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