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The Potential of Holter Monitoring in Pediatric Practice, Depending on the Gender, Age of Children and the Study of the Circadian Rhythm of the Child's Body

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Resume: Arrhythmia in children is a fairly widespread condition and a serious disease. Holter monitoring (HM) makes it possible to identify the entire spectrum of arrhythmias in children and diagnose ischemia by analyzing changes in the ST segment and evaluate the circadian heart rate profile based on the calculation of the circadian index (CI), analyze heart rate variability (HRV) and heart rate turbulence (TSR).

Key words: children , Holter monitoring, ECG , circadian rhythm, arrhythmias.

Relevance. According to the World Health Organization (WHO), 5% of deaths among pediatric patients are due to sudden cardiac death (SCC). It is assumed that this is related to the occurrence of arrhythmia. Most cases of sudden cardiac death in children are caused by life-threatening arrhythmias. A pressing task in pediatric cardiology is to identify hidden heart rhythm disorders, which can be a factor in sudden death in children.

Holter ECG monitoring is one of the most important methods for diagnosing heart rhythm disorders in children, where ECG is recorded continuously for a long time (24 hours or more). The duration of Holter's ECG monitoring has important diagnostic significance in pediatric practice, as a significant portion of arrhythmic events can only be detected during prolonged ECG monitoring.

Holter ECG serves as the gold standard for determining the circadian index (CI). Thus, when assessing heart rate (HR) in CM, not only the average daily value is considered, but also the ratio of the average daily HR to the average night HR. CI is a stable indicator of the organization of circadian heart rhythm, with an average value of 1.33 + 0.05. A decrease in the circadian index below 1.2 is observed in diseases associated with vegetative "denervation" of the heart and is associated with a poor prognosis and a high risk of sudden death in children from the risk group (prolonged QT interval syndrome, progressive heart failure, diabetic vegetopathy, etc.). An increase in the circadian rhythm profile (increase in the circadian index above 1.5) is associated with increased sensitivity to sympathetic stimulation and is observed in patients with idiopathic supraventricular and ventricular tachycardia, primary pulmonary hypertension, and several other diseases.

Purpose of the study: to study the results of daily ECG monitoring in children aged 3 to 18 years to identify life-threatening arrhythmias, as well as to assess the importance of Holter ECG monitoring in children depending on the sex and age of patients and to determine the circadian index.

Materials and methods of research. A retrospective analysis of the Holter monitoring results for the period from 2017 to 2024 was conducted on the basis of the pediatric cardioreumatology department of the Bukhara Regional Children's Multidisciplinary Medical Center. 250 children aged 3 to 18 years were included, who underwent examination and treatment in the pediatric cardioreumatology department. The reasons for hospitalization were the child's and their parents' complaints at the syncope, unexplained heartbeat, and recorded heart rhythm changes during the ECG. CM was conducted around the clock using the SCHILLER MEDILOG AR4 plus device. To improve the effectiveness of the study, patients or their parents were recommended to keep a diary that noted: complaints, waking and sleeping hours, physical activity, and medication intake.

To assess the significance of arrhythmia, both the number of ventricular extrasystoles and, in mandatory order, the qualitative characteristics of ventricular rhythm disorders are taken into account. The method is especially important for diagnosing types of arrhythmias that manifest themselves only at night or early morning hours, which is the most dangerous for children's lives. Such disorders include: transient WPW phenomenon (syndrome), sinus node weakness syndrome (asistolic pauses higher than age norms and their number throughout the day), ventricular and supraventricular tachycardia paroxysms, atrial flutter and flutter episodes, which are especially important for the child's life against the background of the WPW phenomenon. Based on greater (>90%) presentation in different periods of the day, at night, and mixed circadian types of arrhythmias are distinguished in CM.

Results. During the period from 2020 to 2025, 251 children hospitalized in the cardiorheumatology department were examined using the "SCHILLER MEDILOG AR4 plus device at the Children's Cardiorheumatology Center. By sex, children were represented by 110 (43.8%) girls and 141 (56.4%) boys (Figure 1).

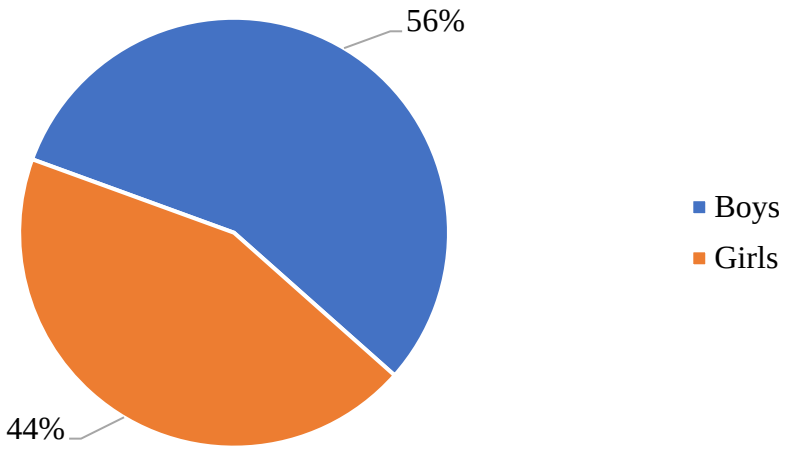

Fig.1. Sex distribution of childhood patients

The age composition of the examined children was studied, and 3 groups reflecting the conditional periods of biological age were identified:

1. 3–7 years - preschool age;
2. 8–12 years - primary school age;
3. 13–17 years - adolescence.

The first group included 68 patients (27%), the second - 102 children (40.8%), and the third - 81 children (32.2%).

As a result of HM research in 251 children, it was possible to identify heart rhythm disorders in 246 (99%) children. No pathology was detected in 5 preschool children. Of the hospitalized patients, 69 (27.4%) had heart rhythm disturbances, 1 (0.4%) had WPW syndrome, paroxysmal tachycardia 23 (9.2%), SVD 7 (2.8%), complete AV blockade 6 (2.4%), extrasystole 50 (19.9%), syncope 31 (12.4%), and bradycardia 64 (25.5%). In 52 (20.7%) children, ECG changes were identified, which are manifestations of normal variants for children, namely sinus arrhythmia, rhythm driver migration, single ventricular and supraventricular rhythm disorders.

When analyzing the HM data in 245 (99%) children, the following heart rhythm disorders were identified, which at the time of examination did not pose a threat to the child's life, but required further observation: sinus arrhythmia (which is a variant of the norm in children) - in 130 (52%) children, supraventricular rhythm disorders - in 94 (37.6%) children, ventricular rhythm disorders - in 63

(25.2%) children, WPW syndrome - in 1 (0.4%), single pauses of atrioventricular blockade - in 6 (2.4%) patients. In 247 (99%) children, combined heart rhythm disturbances were observed, which did not pose a threat to the child's life.

In the analysis of HM data and in the calculation of CI, a deviation from the norm was noted in 241 children. Of these, 16 (6.6%) children had a CI index of 0.36 to 1.0, 28 (11.6%) children from 1.01 to 1.20, 153 (63.4%) children from 1.21 to 1.40, 44 (18.25%) children from 1.41 to 1.80. According to the results of the examination, all children with life-threatening conditions were treated according to the diagnosis to prevent sudden cardiac death syndrome. These patients were registered with a pediatric cardiologist for dynamic observation and treatment adjustment depending on age.

Discussion. The CM of 251 children examined at the cardiologic center revealed heart rhythm disorders in 245 (99%) children, including life-threatening conditions. Paroxysmal tachycardias in 23 children; including 11 boys: 1 child aged 4-7 years; 6 children aged 12-15 years, 5 children over 16 years old; 12 girls: 2 children aged 4-7 years, 8-11 years old – 2 children, 12-15 years old – 2 children, over 16 years old – 6 children. Pathological ventricular activity, namely ventricular extrasystole in an amount exceeding 10% of all recorded complexes for the entire period of ECG HM, ventricular tachycardias, and ventricular rhythms in 43 children. A total of 30 boys: 1 child aged 1-3 years, 5 children aged 4-7 years, 5 children aged 8-11 years, 8 children aged 12-15 years, and 11 children over 16 years old; 13 girls: 1 child aged 1-3 years, 3 children aged 4-7 years, 1 child aged 8-11 years; 12-15 years old – 3 children and over 16 years old – 5 children. Atrioventricular block of the II stage in 6 boys: 2 children aged 4-7 years, 2 children aged 8-11 years, and 2 children over 16 years old. 1 boy at the age of 12 has WPW syndrome. Among the identified threatening heart rhythm disorders in children, the following were more often detected: pathological ventricular activity – in 11 children (4.4%), ST – in 7 children (2.8%), AV block of the 2nd stage – in 6 children (2.4%). According to the CI index, 241 children had deviations from the norm of CI – 16 (6.6%) children had no CI from 0.36 to 1.0, 28 (11.6%) children had a CI from 1.01 to 1.20, 153 (63.4%) children had a CI from 1.21 to 1.40, and 44 (18.25%) children had a CI from 1.41 to 1.80.

The result of the study allows you to make the correct diagnosis and prescribe the right treatment (therapeutic or surgical) in the shortest possible time. This method is of particular importance in saving the lives of children. Thanks to CM, 33.4% of children out of 251 pediatric patients examined in the Department of Pediatric Cardiorheumatology

Conclusion

In terms of gender, boys prevailed over girls in the studied group of pediatric patients by 1.5 times.

Cardiac problems occurred more often in the examined children of primary school age, 102 (40.6 %) children.

In 99% of the examined pediatric patients with complaints of dizziness, syncope, interruptions in the work of the heart, rapid heartbeat of unknown origin, heart rhythm and conduction disorders were found.

In 241 (96%) pediatric patients examined using Holter ECG monitoring, there were changes in circadicity. 245 (99%) children had arrhythmias characteristic of the normal variant, which do not require therapy at the moment, but indicate the need for dispensary observation of children by a pediatrician.

Among life-threatening conditions in children, pathological ventricular activity (17.2%) and paroxysmal tachycardia (9.2%) prevailed.

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