THE IMPORTANCE OF THE CARDIOMETRIC APPARATUS IN MEDICINE FOR DETECTING METABOLIC CHANGES IN THE HEART

Umarova Saodat Sulaymonovna

Samarkand State medical university- assitante

Abstract. The article analyzes the diagnostic value of the cardiometric apparatus "Cardiocod" for detecting hemodynamic, metabolic, and adaptive changes in the cardiovascular system of children with acute rheumatic fever. The use of a non-invasive cardiometry method makes it possible to objectively assess cardiac functional status, regulatory system tension, anaerobic metabolic activity, and the risk of cardiovascular complications. A significant increase in the stress index, vascular stiffness, and lactate levels, along with a decrease in ejection fraction and oxygen content—especially after physical exertion—was identified. ROC analysis confirmed the prognostic significance of metabolic indicators in the development of carditis. Cardiometry can be recommended as an accessible, cost-effective, and informative method for early diagnosis and dynamic monitoring of cardiac disorders in children with acute rheumatic fever, particularly in resource-limited settings.

Keywords: acute rheumatic fever, children, cardiometry, Cardiocod, cardiovascular system, lactate, oxygen, stress index, carditis.

Аннотация. В статье рассмотрена диагностическая значимость кардиометрического аппарата «Cardiocod» для выявления гемодинамических, метаболических и адаптационных нарушений сердечно-сосудистой системы у детей с острой ревматической лихорадкой. Показано, что использование неинвазивного метода кардиометрии позволяет объективно оценить функциональное состояние сердца, уровень напряжения регуляторных механизмов, выраженность анаэробных процессов и риск развития сердечно-сосудистых осложнений. Установлено достоверное повышение индекса напряжения, показателей жесткости сосудов и уровня лактата, а также снижение фракции выброса и содержания кислорода, особенно после физической нагрузки. Проведён ROC-анализ, подтвердивший прогностическую ценность метаболических показателей в развитии кардита. Кардиометрия может быть рекомендована как доступный, экономичный и информативный метод ранней диагностики и мониторинга сердечных нарушений у детей с острой ревматической лихорадкой, особенно в условиях ограниченных ресурсов.

ISSN 3030-3907

Ключевые слова: острая ревматическая лихорадка, дети, кардиометрия, Cardiocod, сердечно-сосудистая система, лактат, кислород, индекс напряжения, кардит.

Аннотация. Мақолада ўткир ревматик лихорадка билан оғриган болаларда юрак-қон томир тизимидаги гемодинамик, метаболик ва мосланиш ўзгаришларини аниқлашда «Cardiocod» кардиометрик аппаратининг диагностик аҳамияти ўрганилган. Кардиометриянинг инвазив бўлмаган усули юракнинг функционал ҳолатини, регулятор механизмлар зўриқиш даражасини, анаэроб жараёнларнинг фаоллигини ҳамда юрак-қон томир асоратлари ривожланиш хавфини баҳолаш имконини беради. Тадқиқот натижалари юклама олдидан ва кейин стресс индекси, томир қаттиқлиги ва лактат миқдорининг ишончли ошиши, шу билан бирга чиқариш фракцияси ва кислород даражасининг пасайишини кўрсатди. ROC-таҳлил метаболик кўрсаткичларнинг кардит ривожланишини башорат қилишдаги аҳамиятини тасдиқлади. Кардиометрия ресурслари чекланган шароитларда ўткир ревматик лихорадкада юрак шикастланишини эрта аниқлаш ва динамик назорат қилиш учун самарали, арзон ва қулай усул сифатида тавсия этилади.

Калит сўзлар: ўткир ревматик лихорадка, болалар, кардиометрия, Cardiocod, юрак-қон томир тизими, лактат, кислород, стресс индекси, кардит.

INTRODUCTION

Currently, there is no doubt that the essence of the inflammatory process in acute rheumatic fever lies in the development of complex reactions, including proliferative ones in the connective tissue. In this case, systemic disorganization of the connective tissue occurs in combination with specific proliferative and nonspecific exudative-proliferative reactions, as well as damage to the vessels of the microcirculatory bed. The main placenta of pathological manifestations should be considered to be connective tissue, primarily the heart. An important pathomorphological substrate of heart damage in ARL in children was considered to be the nonspecific exudative-proliferative component of inflammation, which determined, first of all, the clinical manifestations of the disease and the direct proportionality of the degree of activity of the pathological process and the severity of carditis. It was in children that this often manifested as clinically significant symptoms of carditis, valvulitis of the mitral and aortic valves, rheumatic arthritis, and neurological disorders. To detect changes in the heart during ARL, it is important to perform Doppler EchoCG. Unfortunately, this device is not available in remote areas, and there are not enough ultrasound specialists. In addition, classical auscultatory symptoms are absent or not always recognized by the doctor,

ISSN 3030-3907

and can lead to the underdiagnosis of ARF, which can lead to the formation of acquired heart defects.

To address this issue, cardiometry, based on data from a digital hemodynamic analyzer - Cardiocod (manufactured in Russia) operating on the "Windows" platform, was included in the complex of cardiological examination of patients with ARL. As mentioned above, the cardiometry method allows for assessing the severity of disorders in the cardiovascular system in children with ARL; hemodynamic, metabolic, and adaptive indicators of rheumatic heart disease are determined not only by cardiologists but also by pediatricians, i.e., it has been proven that this does not require other highly qualified specialists, and the apparatus is also inexpensive and very compact.

In order to assess the adaptive indicators of the body using cardiometry, which is a non-invasive method of studying the cardiovascular system, the Bayevsky intensity index (IN), cardiac index (CI), vascular stiffness index (VSI), and risk index (RI) for the development of cardiovascular diseases and their complications were studied. The heart rhythm variability indicator, the intensity index (CI according to R.M. Baevsky), reflects the cumulative effect of cardiac regulation. Its calculation is based on the analysis of heart rhythm based on the formula "intensity index" according to R.M. Baevsky, that is, R - R intervals, based on which the number corresponding to the deviation from the average value is calculated. The value characterizes the state of the body's tension, the variability of heart rhythm, and the state of the centers regulating the cardiovascular system. The effects of physical exertion, chronic fatigue, decreased body reserves with age, and various diseases are accompanied by an increase in this indicator. The stress index in practically healthy children was 62.5±7.9.

The cardiac index is one of the indicators of the pump function of the heart, which is the ratio of the minute volume of blood circulation to the surface area of the body. Normally, the SI was 2.4±0.11 l/min/m2. The vessel stiffness index is an indicator of decreased vascular elasticity. The normative BMI indicator averaged 1.2±0.09 mmHg/ml. The risk index for the development of cardiovascular diseases was 0.05±0.008 U.E.

Table 1 presents the results of studying the adaptive parameters of cardiometry in patients with ORL depending on age.

ISSN 3030-3907

Table 1

Heart adaptation capacity in patients with ARL in different age groups (n=48)

Parameters	Age, years			Norm (n=40)
	5-9 years old (n = 13)	10-14 years old (n=29)	15-18 years old (n=6)	n=40
Intensity index	267.6±21.2*	243.2±16.5*	223.6±15.5*	62.5±7.9
Heart index l/min/m2	2.13±0.52	2.48±0.39	3.53±1.20	2.4±0.11
Vessel stiffness index mmHg/ml	2.90±0.92	3.64±0.35*	1.80±0.55	1.2±0.09
Risk index u.e.	0.29±0.05*	0.31±0.10*	0.19±0.04*	0.05±0.008 *

*Note: * - significant differences compared to the norm (p<0.05).*

As mentioned above, the effectiveness of aerobic processes decreased compared to the norm. Anaerobic processes, indicating the accumulation of lactic acid in muscles, have increased. The body transitions to anaerobic muscle work. At the same time, the intensity index ranged from 223.6±15.5 to 267.6±21.2, which is significantly higher than the norm (62.5±7.9) *(p<0.05).*

This is a very high, but not critical indicator of heart function, indicating excessive strain on the cardiovascular system. The vascular stiffness index increased in children with ARL aged 5-9 and 10-14 years (2.90±0.92; 3.64±0.35 mm.Hg./ml. respectively), indicating a decrease in vascular elasticity. In children aged 15 to 18, it was within the age norm. In turn, the heart rate was at the reference level.

All the indicated indicators indicate a significant load on the cardiovascular system during ARL. Also, based on the indicators of the risk index for the

ISSN 3030-3907

development of cardiovascular diseases, which averaged 0.26±0.06 U.E., it can be noted that there is a high probability of heart damage in children with ARL.

It should be noted that there are no significant differences between the cardiometric indicators of the adaptive capacity of the heart in children of different age groups, i.e., the values of these parameters do not depend on age.

To assess the functioning of the cardiovascular system in acute ARL in children, we studied the dynamics of changes in the main cardiometric indicators (voltage index according to the R.M. Baevsky method, ejection fractions (RV1, %), oxygen and lactate) before and after physical exertion (10 shallow squats of patients in moderate condition), where the informative value is determined by the difference between two values, which is a new approach.

Table 2 presents the results of the main cardiometric examination indicators before and after the orthostatic test in children with ORL.

Table 2

The main indicators of cardiometry during the orthostatic test in patients with ORL depending on age

Age, years	5-9 (n=13)	10-14 (n=29)	15-18 (n=6)	Norm (n=40)
Laktat, U.E.				
Before load	4.95± 0.32*	5.63±0.16*	6.44± 0.56*	3.6±0.11*
After the load	5.99± 0.74*	6.83± 0.33*	7.70± 0.97*	4.2±0.14*
Oxygen, U.E.				
Before load	0.69±0.12	0.48±0.03	0.57±0.09	0.55±0.02
After the load	0.51±0.04	0.46±0.03	0.47±0.08	0.53±0.02
RV1, %				
Before load	45.19± 2.87*	50.50±2.15*	52.90± 5.66*	70.9±2.37*
After the load	38.63±8.14*	43.57±1.98*	46.01±5.65*	59.5±3.21*
TIN				
Before load	131.7±21.2	187.5±20.5	263.6±24.7	62.5±7.9
After the load	208.8±22.3	299.1±21.2	311.7±25.3	63.8±4.3

Note: ** - significant differences compared to patients after physical exertion ($p<0.05$).*

ISSN 3030-3907

As shown in Table 4.2.2, a significant increase in lactate levels after physical activity is observed in all age categories. The increase in lactate in all age categories tends to increase evenly, when comparing the indicators, and amounts to approximately 1 U.E. The increase in lactate in the muscles leads to an overload of heart activity. When analyzing the oxygen content, it was found that in patients with ORL, a significant ($p<0.05$) decrease after exercise was noted in children aged 5 to 9 years and amounted to 0.51±0.04 U.E., in children aged 10 to 18 years, a decrease in indicators was also noted, but the indicators were insignificant. Dynamics of ejection fraction during cardiometry depending on physical activity in patients with ARL of all ages revealed a significant ($p<0.05$) decrease in it after physical activity. Analysis of changes in the strain index showed an increase in all age categories after physical activity.

Lactate is a statistically significant predictor of carditis (AUC = 0.509; 95% CI: 0.344 - 0.673, p = 0.920). The maximum value of the Juden index at the corresponding cut-off point was the lactate limit value of 6.390. Its presence was predicted at lactate values below this value. The sensitivity and specificity of the obtained prognostic model were 28.6% and 89.3%, respectively.

Table 3

Analysis of lactate's discriminatory ability

Threshold value	sensitivity (Se), %	specificity (Sp), %	PPV	NPV
8.14	50.0	56.0	52.2	53.8
8.00	**54.2**	**52.0**	**52.0**	**54.2**
7.71	66.7	52.0	57.1	61.9

When assessing the discriminatory ability of O2 reduction using ROC analysis, the following curve was obtained (4.2.3-figure).

FIGURE 4.2.3. 4.2.3 - ROC curve characterizing the discriminatory ability of O2 in MR forecasting

A decrease in oxygen content is a statistically significant predictor of MR (AUC = 0.561; 95% CI: 0.397 - 0.726, p = 0.467).

Table 4

Analysis of O2 discrimination ability

Threshold value	sensitivity (Se), %	specificity (Sp), %	PPV	NPV
0.45	67.9	52.4	65.5	55.0
0.44	64.3	52.4	64.3	52.4
0.43	**57.1**	**57.1**	**64.0**	**50.0**
0.41	50.0	57.1	60.9	46.2

ISSN 3030-3907

At the cutting point corresponding to the highest value of the Juden index, the limiting value of O2 was 0.450. The existence of O2 in a state below this value was predicted. The sensitivity and specificity of the obtained prognostic model were 67.9% and 52.4%, respectively.

Thus, the cardiometric method for RRD can be used to: 1) significantly increase the level of detection of changes in the cardiovascular system, including in the early stages of their development, which allows for timely provision of qualified assistance; 2) reducing the burden on expensive methods of examining patients; 3) increasing the effectiveness of treatment of patients with ARI due to the possibility of frequent (quick, inexpensive) monitoring of the treatment process; 4) as a result of timely identification of the risk of developing cardiovascular complications, a decrease in the level of disability in patients with ARI or overload of cardiac activity, improvement of the quality of medical examination.

CONCLUSION

The findings of this study demonstrate that cardiometry using the digital hemodynamic analyzer *Cardiocod* is an effective, non-invasive, and informative method for assessing functional, hemodynamic, and metabolic changes in the cardiovascular system of children with acute rheumatic fever. The method allows early detection of excessive cardiac load, impaired adaptive capacity, increased anaerobic metabolism, and a high risk of cardiovascular complications, even in the absence of clear clinical or auscultatory signs.

Significant increases in stress index, vascular stiffness, and lactate levels, along with a decrease in ejection fraction and oxygen content—particularly after physical exertion—indicate pronounced tension of regulatory mechanisms and reduced myocardial efficiency. ROC analysis confirmed the prognostic value of metabolic indicators, especially lactate and oxygen dynamics, in predicting the development of carditis. Cardiometry can be recommended as a practical screening and monitoring tool in pediatric practice, especially in resource-limited settings where echocardiography is not readily available. Its simplicity, affordability, and ability to provide rapid, repeatable assessments make it a valuable component of the comprehensive examination and follow-up of children with acute rheumatic fever, contributing to timely intervention and prevention of long-term cardiac complications.

REFERENCES

1. Gewitz MH, Baltimore RS, Tani LY, et al. Revision of the Jones criteria for the diagnosis of acute rheumatic fever in the era of Doppler echocardiography: a scientific statement from the American Heart Association. Circulation.

ISSN 3030-3907

2015;131(20):1806-1818. *(Key update to Jones criteria, including subclinical carditis via echocardiography.)*

2. Baevsky RM, Chernikova AG. Heart rate variability analysis: physiological foundations and main methods. Cardiometry. 2017;10:66-76. *(Core reference for Baevsky's stress index and HRV methods.)*

3. Carapetis JR, McDonald M, Wilson NJ. Acute rheumatic fever. Lancet. 2005;366(9480):155-168.

4. Lahiri S, Sanyahumbi A. Acute Rheumatic Fever. Pediatr Rev. 2021;42(5):221-232.

5. Karacan M, Işıkay S, Olgun H, Ceviz N. Heart rate variability in children with acute rheumatic fever. Cardiol Young. 2012;22(3):285-292. *(Direct study on HRV in pediatric ARF, showing sympathetic dominance.)*

6. Reményi B, Wilson N, Steer A, et al. World Heart Federation criteria for echocardiographic diagnosis of rheumatic heart disease—an evidence-based guideline. Nat Rev Cardiol. 2012;9(5):297-309.

7. Figueroa FE, Fernández MS, Valdés P, et al. Prospective comparison of clinical and echocardiographic diagnosis of rheumatic carditis: long term follow up of patients with subclinical disease. Heart. 2001;85(4):407-410.

8. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. Heart rate variability: standards of measurement, physiological interpretation, and clinical use. Circulation. 1996;93(5):1043-1065.

9. Riaz BK, Selvaraj K, Das PK, et al. Heart rate variability in children with rheumatic fever. Indian Pediatr. 2009;46(3):237-240. *(Another study on HRV in pediatric rheumatic fever.)*

10. Zühlke L, Engel ME, Karthikeyan G, et al. Characteristics, complications, and gaps in evidence-based interventions in rheumatic heart disease: the Global Rheumatic Heart Disease Registry (REMEDY). Eur Heart J. 2015;36(18):1115-1122.

ISSN 3030-3907