RISK OF CEPHALGIC COMPLICATIONS ACCORDING TO ULTRA SOUND DUPLEX SCANNING OF CAROTID ARTERY IN CHILDREN WITH CHD WITHIN POSTOPERATIVE PERIOD

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Abstract. *This article discusses how to determine the risk of cephalgic complications according to ultrasound duplex examination of the carotid arteries in children with CHD in the long-term postoperative period.*

Keywords: *duplex examination, children with CHD, long-term postoperative period.*

Relevance. European and Russian clinical guidelines indicate the effectiveness of non-invasive ultrasound examinations of the carotid arteries in the stratification of cardiovascular risk in different categories of patients. In the MESA study, atherosclerotic changes in the carotid arteries were independent predictors of cardiovascular events and improved the prediction of the risk of coronary heart disease when added to the risk factors on the Framingham scale in a multinational group of asymptomatic patients

The objective. To determine the risk of cephalgic complications according to ultrasound duplex examination of the carotid arteries in children with CHD in the long-term postoperative period.

Materials and methods of research. Within the period 2019 to 2021 prospective cohort study was conducted on the basis of a multidisciplinary polyclinic in the urban settlement of Khanki, Khorezm region, which included 108 children with an established diagnosis of CHD aged from 1 to 13 years old (average age 7.84±0.8 years old). The control group of the study consisted of 40 practically healthy children of the same age (average age 6.6 ± 0.42 years old). The distribution of children by age in the main and control groups is presented as follows: 1st group – 55 children with CHF-0, in the 2nd group there were 28 children with grade I CHF, and the 3rd group with 25 children with grade IIFC CHF. According to the frequency of occurrence, the 1st place was taken by SVD (66.3% (65)). Pulmonary artery stenosis was observed in 5.1% of cases, triad and tetrad of Fallot in 10 children. Open ductus arteriosus, transposition of magitstral vessels, common atrioventricular canal (complete and incomplete types) occurred with approximately equal frequency in 2% of the cases. To assess the hemodynamic parameters of the vessels, ultrasound duplex scanning of the common carotid arteries was performed using Sonospape SSI-500 ultrasound scanner, Mindray (Holland).

The results of the study and conclusions. Duplex scanning of the extracranial and intracranial sections of the brachiocephalic arteries in children of the control groups, depending on age, revealed a physiological increase in the vascular lumen (diameter of the CCA, ICA and ECA, mm) and, accordingly, a decrease in blood flow velocity (Vps, cm/s) and the resistivity index (RI), which was confirmed by literature data. The study showed that in 4-6 years, the presence of

stage I CHF increases the risk of violations of high–speed hemodynamic parameters by 3.5 (Cass=0.84, p<0.001) times, and in case of IIA CHF - by 7.7 (C_{ass} =0.94, p<0.001) times, in 7-13 years – by 7.5 (C_{ass} =0.92, p<0.001) and 25 (C_{ass} =0.97, p<0.001) times, respectively. Higher values of IMT CCA in children aged 7-13 years old with stage I CHF occur 5.6 times (Cass = 0.89, p < 0.001), and with IIA CHF 14.6 times (Cass =0.95, p <0.001) more often. Duplex examination of the common carotid artery and its branches is a convenient and reliable way of early detection of arterial lesions as target organs in children for the development in the medium and long term of cephalgic complications in the long-term postoperative period in children with CHD with stage I and stage II CHF.

Key words: children, congenital heart disease, duplex ultrasound, carotid arteries, late postoperative period

Relevance. Nowadays, there is no doubt that the processes of adequate blood supply to the brain are extremely important for the body as a whole, since the nature of a person's mental, somatic and visceral functions depends on the quality of the activity of the central nervous system. At the same time, blood supply to the brain is carried out by two interconnected subsystems, namely macro- and microcirculation. Macro circulation, located almost on the surface of the brain, forms a channel for the total cerebral blood flow. Microcirculation supplies blood to the brain substance and forms a vascular bed for local cerebral blood flow. All systems and subsystems of the blood supply to the brain require fundamental careful study to explain the mechanisms of development of cerebrovascular disorders. This can be facilitated by informative methods of studying cerebral blood flow. In this regard, ultrasound duplex scanning of blood vessels is an excellent non-invasive, well-reproducible method. During a duplex study, a two-dimensional image of veins and arteries is obtained, which allows us to judge changes in their structure at the preclinical stage and find out the cause of the problems that have arisen. Also, this method determines the linear velocity and direction of blood flow, which contributes to a more reliable diagnosis of the localization of lesions of the carotid and vertebral arteries [1, 2, 3, 4].

European and Russian clinical guidelines indicate the effectiveness of non-invasive ultrasound examinations of the carotid arteries in the stratification of cardiovascular risk in different categories of patients. In the MESA study, atherosclerotic changes in the carotid arteries were independent predictors of cardiovascular events and improved the prediction of the risk of coronary heart disease when added to the risk factors on the Framingham scale in a multinational group of asymptomatic patients [5, 6].

The objective. To determine the risk of cephalgic complications according to ultrasound duplex examination of the carotid arteries in children with CHD in the long-term postoperative period.

Materials and methods of research. Within the period 2019 to 2021 prospective cohort study was conducted on the basis of a multidisciplinary polyclinic in the urban settlement of Khanki, Khorezm region, which included 108 children with an established diagnosis of CHD aged from 1 to 13 years old (average age 7.84±0.8 years old). The control group of the study consisted of 40 practically healthy children of the same age (average age 6.6 ± 0.42 years old).

Criteria for inclusion in the main group of the study were as follows: the age of children from one to 13 years old with an established diagnosis of CHD, the condition after surgical correction of CHD, with CHF-0, IFK CHF I and IIFK CHF IIA degree, and parental consent to the study.

Exclusion criteria from the main study group were: the age of children younger than 1 and older than 13 years old, the condition after surgical correction of CHD, with CHF IIB and III degrees, children from multiple pregnancies, children born with very low and extremely low body weight, children with extracardial pathology in the decompensation stage, and parents' refusal to participate in research.

According to the aim of the study, subgroups were formed in the main group of children depending on the severity of CHF. The severity of CHF was determined based on complaints, anamnestic data and physical examination according to the ACC/ANA classification (American Society of Cardiology/American Heart Association). This classification is similar to the classification of Vasilenko V.H. and Strazhesko N.D. and was used in children of preschool and school age. The functional class of CHF was exposed according to the NYHA (New York Heart Association) classification. For young children, the stages of CHF, taking into account clinical criteria, were determined in accordance with the classification of Belokon N.A. (1978). Functional class in children of early and preschool age was defined according to the Ross classification [7, 8]. The distribution of children by age in the main and control groups is presented as follows: 1st group – 55 children with CHF-0 (among them 8 children aged 1-3 years old, 11 children aged 4-6 years old, and 36 aged 7-13 years old), in the 2nd group there were 28 children with grade I CHF (among them 8 children aged 1-3, 7 aged 4-6, and 13 aged 7-13 years old), and the 3rd group with 25 children with grade IIFC CHF (including7 children aged 1-3 years old, 8 children of 4-6, and 10 aged 7-13 years old). In most cases, the diagnosis of CHD was established before the age of 1 year old (60/55.5%) and surgical correction was carried out in 12.04% (13) of the cases. In the neonatal period, CHD was detected in 15 children (13.9%) and surgical care was provided only in 4.6% (5) cases. In 13 children (12.04%), the diagnosis of CHD was established in the third year of life and in 10 (9.2%) over three years old children. Operation was performed in 35 (32.4%) children before the age of three, 48 (44.4%) and 7 (6.5%) children over the age of 4 were operated on at the age of 3-4. The diagnosis of CHD was established in accordance with the generally accepted classification based on the clinical and instrumental manifestations of the disease. Septal defects were registered most frequently, in 75.5% (74) of the cases. According to the frequency of occurrence, the 1st place was taken by SVD (66.3% (65)). Pulmonary artery stenosis was observed in 5.1% of cases, triad and tetrad of Fallot in 10 children. Open ductus arteriosus, transposition of magitstral vessels, common atrioventricular canal (complete and incomplete types) occurred with approximately equal frequency in 2% of the cases.

Comprehensive examination of the children was conducted using standardized research methods. The analysis of the features of the anamnesis vitae and morbi was carried out on the basis of interviewing children and their parents, as well as studying medical documentation (f-111, f-25-u).

Laboratory and instrumental studies were carried out on the bases of the Republican Specialized Scientific and Practical Center of Cardiology and Cardiac Surgery of the Aral Sea region. To assess the hemodynamic parameters of the vessels, ultrasound duplex scanning of the common carotid arteries was performed using Sonospape SSI-500 ultrasound scanner, Mindray (Holland). The study was carried out according to a standard technique in B-mode with spectral analysis of blood flow and color Doppler mapping. The thickness of the intima-media complex (IMT) was measured in longitudinal section at the level of the bifurcation of the common carotid arteries (CCA) along the posterior wall of the vessel: from the interface between intima and the

vessel lumen to the border between the media and the adventitia of the artery with the calculation of the average. The Vps parameters such as the maximum systolic blood flow rate in sm/s, the diameter of the internal (ICA) and external carotid artery (ECA) in mm, Pi -the index of peripheral resistance (index Purselo) were studied.

The results of the study and their discussion. The average indicators of hemodynamics and the diameter of the extracranial left and right brachiocephalic arteries had no significant differences, and therefore we present the values of the right sections of the CCA depending on the studied groups in the age aspect. Duplex scanning of the extracranial and intracranial sections of the brachiocephalic arteries in children of the control groups, depending on age, revealed a physiological increase in the vascular lumen (diameter of the CCA, ICA and ECA, mm) and, accordingly, a decrease in blood flow velocity (Vps, cm/s) and the resistivity index (RI), which was confirmed by literature data [9].

Statistical processing of the duplex study data made it possible to detect similar changes in the above-listed parameters in the children of the 1st group in the age aspect without significant differences in relation to the control.

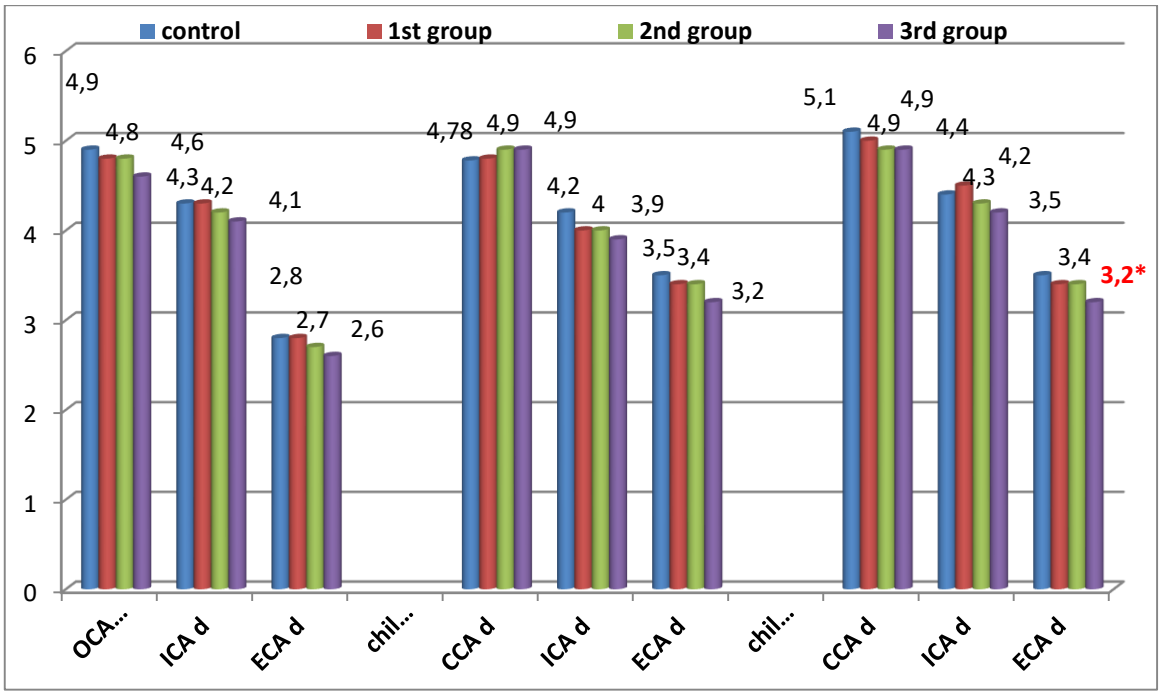

Figure 1. Mean values of CCA, ICA and ECA diameters of children in the analyzed groups dependently on the age

It was found that in children of the 2nd and 3rd groups, the diameter values of the right CCA and its intra-extracranial branches tended to decrease compared to the control without significant differences, and only the diameter index of the ECA ($p<0.05$) at 7-13 years of age in the children of the 3rd group was significantly lower than in the control (Fig. 1).

The averaged values of hemodynamic velocity parameters (CVPs, CVPs and HCVPS) of children of the 2nd and 3rd main groups tend to increase, but the diameter sizes of the ICA and ECA tend to flatten with an increase in RI parameters in the age ranges of 1-3 and 4-6 years old in comparison to the control and the 1st group without significant differences. Only the blood flow rate in the ECA (ECA Vps, $p<0.001$) in children aged 4-6 years old of the 3rd group significantly differed compared to the control (Fig.2).

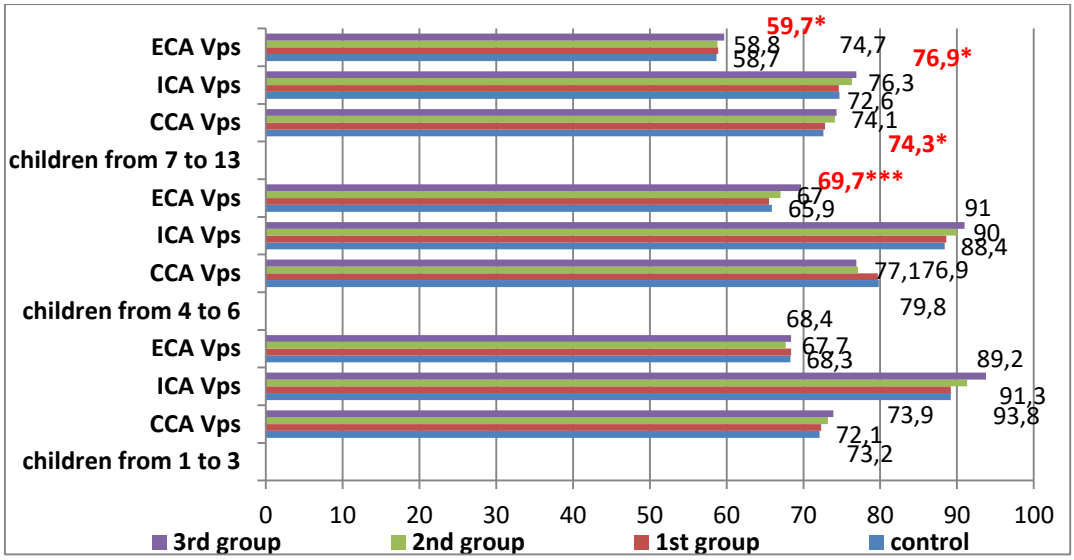

Figure 2. Mean values of hem dynamic velocity indicators (CCAVps, ICAVps and ECAVps) in the children of the analyzed groups

At the age of 7-13 years, children of the 2nd and 3rd groups had low values of the diameters of the CCA, ICA and ECA and significantly increased blood flow rates (CCAVps, $p<0.05$; ICAVps, $p<0.05$; ECAVps, $p<0.05$) in children of the 3rd group in relation to the control with high RI values for CCA, ICA and the ECA, without significant differences (Fig.2).

It is known that the process of vascular remodeling in children with CHD in the postoperative period includes stages of functional and morphological changes that lead to a violation of the main vascular functions, an increase in carotid artery IMT and a decrease in arterial elasticity. Structural changes in the middle carotid artery membrane (media) are directly dependent on increase in the level of CRPhs and endothelin in blood plasma, which confirms the role of ED in the formation and progression of vascular remodeling processes. The study of IMT makes it possible to assess the risk of developing complications in the postoperative period in children with CHD in the medium and long term.

According to the results of our study, in children of the 3rd group, the average value of IMT was higher by 9.2%, 12.5% and 10.3% in children in the age ranges of 1-3, 4-6 and 7-13 years old, respectively, in relation to the control (Fig. 3).

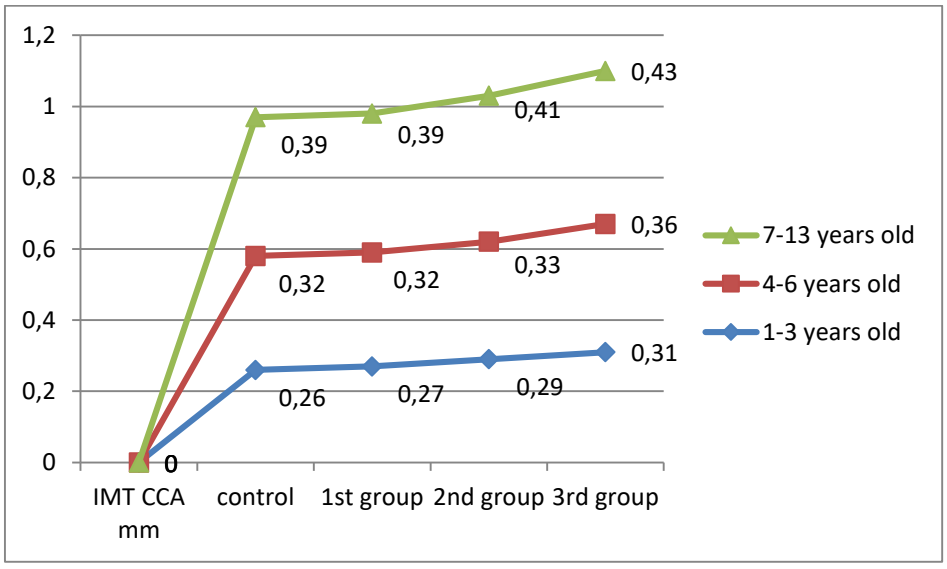

Figure 3. Average values of IMT CCA in children in the analyzed groups

This indicates that these markers of impaired vasomotor function and IMT CCA are manifested much earlier in the development of cephalgic complications compared with other parameters in the post-correction period in children with CHD.

Conclusions. Duplex scanning of the extracranial and intracranial sections of the brachiocephalic arteries in children of the control groups, depending on age, revealed a physiological increase in the vascular lumen (diameter of the CCA, ICA and ECA, mm) and, accordingly, a decrease in blood flow velocity (Vps, cm/s) and the resistivity index (RI), which was confirmed by literature data.

Duplex examination of the common carotid artery and its branches is a convenient and reliable way of early detection of arterial lesions as target organs in children for the development in the medium and long term of cephalgic complications in the long-term postoperative period in children with CHD with stage I and stage II CHF. The study showed that in 4-6 years, the presence of stage I CHF increases the risk of violations of high–speed hemodynamic parameters by 3.5 (C_{ass}=0.84, p<0.001) times, and in case of IIA CHF - by 7.7 (C_{ass} =0.94, p<0.001) times, in 7-13 years – by 7.5 (C_{ass} =0.92, p<0.001) and 25 (C_{ass} =0.97, p<0.001) times, respectively. Higher values of IMT CCA in children aged 7-13 years old with stage I CHF occur 5.6 times (C_{ass} = 0.89, p < 0.001), and with IIA CHF 14.6 times (C_{ass} =0.95, p <0.001) more often.

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