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Adaptive capabilities of the circulatory system in children diagnosed with glomerulonephritis

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Abstract

Introduction.Glomerulonephritis (GN) is characterised by a polysystemic lesion and early involvement of the cardiovascular system (CVS) in the overall pathological process. Cardiovascular lesions in patients with GN are primarily going with the presence of arterial hypertension syndrome and varying degrees of circulatory failure.

Aim of the study. Determination of the peculiarities of circulatory system adaptation in children with GN with nephrotic syndrome (NS) using ultrasound with doppler assessment of intracardiac flow.

Materials and methods of research. 50 children were diagnosed with acute GN (AGN) with NS, and 100 patients were diagnosed with nephrotic form (NF) of chronic GN (CGN). The control group consisted of 30 practically healthy children. Echocardiography was performed on a combined ultrasound system GE with a special cardiological programme for cardiac examination in M-, B- and Doppler modes using a mechanical sectoral transducer of 3.5 MHz. Echocardiography was performed from the parasternal position along the long axis of the heart. In this case, the transducer was placed to the left of the sternum in 3 to 4 intercostal spaces and the central ultrasound beam was directed perpendicular to the surface of the chest.

Echocardiography was used to determine the main haemodynamic parameters: ejection fraction (EF), minute blood volume (MBV), cardiac index (CI), velocity parameters of transmitral (TMK) and transaortic (TAK) blood flows according to the standard method [1]. The echocardiography method was used in 150 children. The average age of the subjects was 8.2 ± 1.3 years.

Results. Hypokinetic and hyperkinetic circulation types were found with equal frequency (42.8%) in 12 patients with AGN. In CGN, a different picture was observed: 11 patients had a normokinetic type of blood circulation (40.7%), while hypokinetic was found in 9 patients (33.3%) and hyperkinetic in 7 patients (26%). The normokinetic type of hemodynamics at the second stage was observed in 4 patients (19.1%) with AGN and in 19 patients (51.4%) with CGN. The percentage of patients with a hypokinetic type of hemodynamics decreased in the case of AGN from 42.8% to 33.3%; in the case of CGN - from 33.3% to 16.2%. In 36 patients with chronic GN after completion of GC and CS therapy, the predominant type of haemodynamics was normokinetic, which was observed in 22 patients (61.2%), hypokinetic and hyperkinetic types of circulation were diagnosed in 14 patients (19.4%, respectively).

Conclusion: In case of CGN, before treatment, hyperkinetic and hypokinetic types of haemodynamics prevail, and after treatment discontinuation, the hypokinetic type slightly prevails, and hyper- and normokinetic types of haemodynamics occur with equal frequency, indicating heterogeneity of adaptive reactions of the cardiovascular system.

Key words: acute glomerulonephritis; chronic glomerulonephritis; echocardiography; hypokinetic; normokinetic; hyperkinetic hemodynamic

Introduction.Glomerulonephritis (GN) is characterised by a polysystemic lesion and early involvement of the cardiovascular system (CVS) in the overall pathological process [2]. Cardiovascular lesions in patients with GN are primarily going with the presence of arterial

hypertension syndrome and varying degrees of circulatory failure. The course of the pathological process mainly depends on the level of adaptation of the circulatory system in the conditions of renal parenchyma damage. There are several data in the literature on haemodynamic types of circulation using traditional methods of functional diagnostics (ECG, ultrasound etc). These methods have been used to obtain data on the prevalence of hypokinetic hemodynamics in chronic GN (CGN) [3] and hyperkinetic hemodynamics in acute GN (AGN) [3]. On the basis of the data obtained, the authors concluded that circulatory failure in AGN is not due to myocardial damage but is a response to fluid overload.

At the same time, there are no data in the literature on dynamic observations of the level of CVS adaptation in GH with nephrotic syndrome (NS) in children under the conditions of glucocorticoids (GC) and cytostatics (CS) using ultrasound method - ultrasound with doppler assessment. GCs and CSs in maximum doses can contribute to CVS damages and worsen renal function [5], so these issues are of great practical importance for paediatric nephrology.

Aim of the study. The aim of our study was to determine the peculiarities of circulatory system adaptation in children with GN with NS using ultrasound with doppler assessment of intracardiac flow.

Materials and methods. Echocardiography was performed on a combined ultrasound system GE with a special cardiological programme for cardiac examination in M-, B- and Doppler modes using a mechanical sectoral transducer of 3.5 MHz. Echocardiography was performed from the parasternal position along the long axis of the heart. In this case, the transducer was placed to the left of the sternum in 3 to 4 intercostal spaces and the central ultrasound beam was directed perpendicular to the surface of the chest.

Echocardiography was used to determine the main haemodynamic parameters: ejection fraction (EF), minute blood volume (MBV), cardiac index (CI), velocity parameters of transmitral (TMK) and transaortic (TAK) blood flows according to the standard method [1]. The echocardiography method was used in 150 children. The average age of the subjects was 8.2 ± 1.3 years. 50 children were diagnosed with acute GN with NS, and 100 patients were diagnosed with nephrotic form (NF) of chronic GN. The control group consisted of 30 practically healthy children. The distribution of patients depending on the form of GN and gender is presented in Table 1.

Boys predominated among the children studied. The ratio between boys and girls was 1.5 : 1,0. The duration of the disease ranged from 3 to 8 months in case of acute GN, and from 2 to 5 years in case of chronic GN. A typical clinical picture of emergency was observed in 41 children (82%) with AGN and 69 children (69%) with CGN: significant edema, daily proteinuria of

more than 3 g, hypo- and dysproteinemia, hypercholesterolaemia. In 14 patients (28%) with AGN, there was a tendency to a prolonged course of the disease (more than 3 months).

Table 1

Distribution of patients depending on the form of GN and gender

Clinical groups of patients	Number of patients		Total	
	Male	Female	abs.	%
Acute GN with NS	32	18	50	33,4
Chronic GN, nephrotic form	67	33	100	66,6

We determined the clinical presence of cardiovascular changes in 133 patients (87.3%) with GN. Children mainly complained of pain in the aria of heart, palpitations and shortness of breath. Physical changes in the cardiovascular system in children with GN are presented in Table 2.

Pathogenetic therapy was carried out according to the unified guidelines of the Institute of Urology and Nephrology of the Academy of Medical Sciences of Ukraine using GC and CS.

Table 2

Frequency of changes in the cardiovascular system in children with GN

(physical data)

Physical data	Clinical form of GN			
	Acute (n=50)		Chronic (n=100)	
	abs.	%	abs.	%
Expanding the boundaries of the heart	8	16	15	15
Weakening of heart sounds during auscultation	12	24	25	25
Systolic murmur at the apex of the heart	18	36	25	25
Hypertension	12	24	30	30

Depending on the stage of treatment, all patients were divided into 3 clinical groups:

1. Before treatment (against the background of advanced clinical manifestations of CGN or exacerbation of CGN).
2. The stage of completion of the maximum doses of GC and CS (discharge from the hospital).
3. After treatment (from 1 till 3 years).

The data on the distribution of patient groups depending on the stage of treatment are presented in Table 3. 42 children (28%) were studied in the dynamics at all stages of treatment.

Table 3

Distribution of patient groups depending on the stage of treatment

Stage	Clinical form of GN	
	Acute	Chronic
1	14	27
2	21	37
3	15	36

Obtained results and their discussion. Different hemodynamic types of blood circulation were observed at the stages of emergency treatment in children. Thus, in the period of edema on the background of extensive clinical manifestations, hypokinetic and hyperkinetic circulation types were found with equal frequency (42.8%) in 12 patients with AGN. In CGN, a different picture was observed: 11 patients had a normokinetic type of blood circulation (40.7%), while hypokinetic was found in 9 patients (33.3%) and hyperkinetic in 7 patients (26%).

At the same time, children with CGN with a hypokinetic type of circulation at the time of the examination were on cyclical GC and maintenance doses of CS, so they completed treatment, but had a relapse of the disease against the background of intercurrent infection and were prescribed repeated treatment with maximum doses of medicines.

The hypokinetic type of hemodynamics was accompanied by reduced values of EF to 58.5±1.3%, MBV to 3.5±0.2 l/min, HI to 3.9±0.2 l/min/m2 and velocity parameters of transaortic (80.2±1.8 cm/s) and transmitral (74.9±1.6 cm/s) blood flows.

Patients with hypokinetic type of hemodynamics subsequently had the transition of the acute form of the disease to NF of CGN. The duration of therapy with maximum doses of prednisolone in this group of patients ranged from 8 to 12 weeks. The hyperkinetic type was characterised by increased values of MVB (5.3±0.4 l/min) and HI (4.8±0.3 l/min/m2). Left ventricular EF in this group of patients was within 72%, and the velocity parameters of TAC and TMC remained low and were 90.4±1.7 cm/s and 86.4±1.5 cm/s, respectively.

The normokinetic type was accompanied by normal or slightly elevated values of MBV (4.2±0.1 l/min), HI (4.5±0.2 l/min/m2), EF (68.0±0.8%) and TAC (102.8±1.6 cm/s) and TMC (96.7±1.5 cm/s).

The administration of maximum doses of GC and the consistent inclusion of CS drugs in the treatment had a positive effect on the pumping function of the heart and improved the

parameters characterising the state of central hemodynamics. Thus, the percentage of patients with a hypokinetic type of hemodynamics decreased in the case of AGN from 42.8% to 33.3%; in the case of CGN - from 33.3% to 16.2%. In turn, the number of patients with hyperkinetic circulation increased: in case of AGN from 42.8% to 47.6% and in case of CGN from 26% to 32.4%, which can be explained by the effect of GC on the myocardial receptor apparatus and an increase in its contractility.

The normokinetic type of hemodynamics at the second stage was observed in 4 patients (19.1%) with AGN and in 19 patients (51.4%) with CGN. In this group of patients with a normokinetic type of hemodynamics (23 patients), during the treatment of GC and CS, complete clinical and laboratory remission was documented in 16 patients and clinical and partial laboratory remission in 7 patients, which was considered a good effect of pathogenetic treatment. Observation of this group of children after treatment for 3 years allowed us to state the absence of relapses and stability of haemodynamic parameters.

We considered the preservation of the hypokinetic type of blood circulation in 5 patients with AGN at the second stage of treatment as a prognostically unfavourable sign. In all patients of this observation group, a relapse of the disease and the formation of NF of CGN (4 patients), as well as a less favourable mixed form of the disease (1 patient) were subsequently recorded.

Echocardiographic observation of 15 patients with AGN after completion of treatment revealed a slight predominance of the hypokinetic type of hemodynamics, which was observed in 6 patients (40%) over the hyper- and normokinetic types, which were found in 5 (33.3%) and 4 patients (26.7%), respectively. In 36 patients with chronic GN after completion of GC and CS therapy, the predominant type of haemodynamics was normokinetic, which was observed in 22 patients (61.2%), hypokinetic and hyperkinetic types of circulation were diagnosed in 14 patients (19.4%, respectively).

Conclusions. Thus, the studies have shown that the type of blood circulation depends on the duration of the disease and the stage of treatment of GN in children. Thus, in CGN, before treatment, normokinetic and hypokinetic types of blood circulation dominate, which are less favourable for the functioning of the cardiovascular system in conditions of fluid overload. After treatment for CGN, the normokinetic type prevails, which is a consequence of prolonged adaptive restructuring of the cardiovascular system in response to a chronic pathological process. In CGN, before treatment, hyperkinetic and hypokinetic types of haemodynamics prevail, and after treatment discontinuation, the hypokinetic type slightly prevails, and hyper- and normokinetic types of haemodynamics occur with equal frequency, indicating heterogeneity of adaptive reactions of the cardiovascular system. The data obtained should be

taken into account at the stages of treatment of GN in children and, in the presence of unfavourable prognostic signs (preservation of the hypokinetic type of circulation at all stages of treatment), corrective cardiotropic therapy should be prescribed.

Conflict of interest. There are no conflicts of interest of any kind concerning commercial, financial, copyright relations, relations with organizations or individuals that could be related to the research in any way, and the relationship between the co-authors of the article.

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