International Journal of Biomedicine 2(2) (2012) 113-116

INTERNATIONAL JOURNAL OF BIOMEDICINE

Clinical Research

Diagnostic Criteria for Transient Myocardial Ischemia in Newborn Infants with Intrauterine Growth Retardation

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Abstract

Metabolic and hemodynamic disturbances in newborns with intrauterine growth retardation resulting from the transferred intrauterine hypoxia, lead to the development of transient myocardial ischemia. Study included 158 newborn infants with intrauterine growth retardation, 83% of which have the asymmetric and 17% - the symmetric form of IUGR, revealed differences in heart rate due to higher dispersion parameters of cardiac rhythm. It was determined that in infants with intrauterine growth retardation heart rate, respiratory rate accelerated and blood pressure increased in compare with the newborns in the control group. According to the ECG examination results, were revealed the signs of focal changes of ST-T, accompanied by inversion of the ST-T segment below the isoline, which accompanied with the positive and peaked T waves, considered as myocardial ischemia. In infants with intrauterine growth retardation, survived after perinatal damage of the central nervous system, the prolongation of the QRST interval was noted in compare with the control group newborns, which could be an indicator of conjunction of hypoxic and ischemic changes in the myocardium. Clinical manifestations of transient myocardial ischemia followed by pale skin, acrocyanosis, and perioral cyanosis against dullness of heart sounds. Obtained results deepened an understanding of posthypoxic myocardial dysfunction, which is characterized by cardiac rhythm and conductivity disturbances, as well as changes in ventricular complex, and causing the need for electrocardiographic screening in the neonatal period. IJBM 2012; 2(2):113-116.

Key words: *transient myocardial ischemia, newborn infants, intrauterine growth retardation.*

Introduction

The process of postnatal adaptation of newborn infants with intrauterine growth retardation in general and the cardiovascular system in particular, pass with a high stress. The cause of the syndrome of maladjustment of the cardiovascular system can be damage in neonatal brain regulation mechanisms of cardiovascular functioning because of intrauterine or intrapartum hypoxia [3, 5-7].

According to some authors, in the basis of hypoxic encephalopathy are metabolic disorders associated with deficiency of oxygen, death of some cells which accompanied by changes in energy and electrolyte balance, and the accumulation of free radicals [1].

These metabolic disorders involve not only the CNS, but also the cardiovascular system that influence the phasing of formation of hemodynamic parameters in neonates with intrauterine growth retardation in the early neonatal period [2].

In connection with the foregoing, the aim of our study was to determine the clinical and electrocardiographic signs of myocardial damage in newborn infants with IUGR against on background of perinatal hypoxia.

Material and methods

We observed 158 newborns with IUGR. In 131 of them (83.0%) revealed an asymmetric form of intrauterine growth retardation and in 27 (17.0%) - a symmetric form of IUGR. The stage of perinatal CNS lesions in 39 (24.6%) was seen as heavy, in 84 (53.2%) - as average and in 35

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(22.2%) - as easy.

The control group included 158 healthy infants born after 37-38 weeks of gestation.

Condition at birth was determined by Apgar score [8] at 1st and 5th minute of life. Status of newborn child was assessed based on clinical and neurological examination. Biological maturity was assessed on a Ballard scale [9]. Evaluation of physical development of infants and classification of intrauterine growth retardation was carried out according to WHO recommendations. Evaluation of pathology of the nervous system was carried out according to the classification of perinatal lesions of the nervous system in young children, proposed by the Russian Association of Perinatal Medicine Experts (2000).

ECG was carried out by computer 12-channel device "Poly-Spectrum" ("Neurosoft", Russia).

In evaluating of ECG results, the standards designed for infants (MK Oskolkov, OO Kupriyanov, 1986) were used for [4].

Statistical analysis included an assessment of the reliability of measurements of mean values by Student's t with a given level of reliability ($p < 0.05$).

Results and discussion

Surveyed infants were matched by gestational age. Infants with symmetrical form of IUGR have gestational age of 35-36 weeks, infants with asymmetric form have gestational age of 36-37 weeks and newborns in control group have gestational age of 38-40 weeks.

Table 1
Anthropometric parameters of infants with IUGR

Parameters	Control group (n=158)	Main group	
		Symmetrical form of IUGR (n=27)	Asymmetric form of IUGR (n=131)
Body weight (g)	3909.7±27.0	2434.9±73.3***	2372.9±31.3***
Body length (cm)	53.2±0.12	44.9±0.78**	47.1±0.22*
Head circumference (cm)	33.9±0.08	32.4±0.36*	324±0.16*
Chest circumference (cm)	32.7±0.09	31.0±0.46*	30.8±0.21*

Note: ** - the reliability of the data to the control (* - p<0.05, ** - p <0.01, *** - p<0.001)*

According to the data presented in Table 1, in examined children significantly lower rates of weight, body length were revealed, compared with newborns of the control group.

Study has shown that in infants with IUGR heart rate tended to increase during the first day. The most commonly sinus tachycardia was recorded in 93 (70.9%) infants with asymmetric IUGR, while at the same time in 28 (62.9%) newborns with the symmetric form the slowdown of heart rate was occurred.

To study the characteristics of heart rate we used the coefficient of dysrhythmia (Kd) represents the ratio of the spread of heart rate (HR) to the average heart rate [3].

$$K_d = \frac{HR_{max} - HR_{min}}{HR_{mean}} \times 100$$

The mean values of heart rate, heart rate dispersion and coefficient of dysrhythmia are presented in Table 2.

Table 2.
The values of heart rate in newborns

Parameter	Studied group		
	Control group (n=158)	Main group (n=158)	p
HRmean, per minute	155.24±8.6	168.78±0.75	<0.01
HRmax - HRmin, per minute	8.66±0.54	7.13.±0.27	<0.01
Kd, %	5.68±0.37	4.22±0.79	<0.05

Obtained results show the differences in the values of dysrhythmia coefficient in the examined newborns. These differences are due to higher dispersion parameters of heart rate in the examined infants. In infants with symmetric form of intrauterine growth retardation revealed hypokinetic type of central hemodynamics, manifested by lower values of cardiac index, stroke and cardiac output and ejection fraction.

In the first days after birth in 43 (27.2%) revealed an increasing of blood pressure up to 70 mm Hg, which is statistically not different from children of the control group (37 (23.4%)) (p>0,05).

On the 3-4 days the frequency of high blood pressure occurrence was significantly higher in infants with IUGR (70 (44.3%) vs 18 (11.4%), p<0.001).

Tachycardia in main group infants was accompanied by tachypnea (RR≥60 min), and occurred significantly more frequently on the 3-4 days after birth in compare with newborns in control group (74 (46.8%) vs 40 (25.3%), p<0,001). Frequency of tachypnea occurrence during the first 4 days in infants with IUGR remained stable, whereas in newborns of the control group it`s frequency decreased by the end of the early neonatal period. Therefore, in infants with IUGR heart and respiratory and blood pressure increased in compare with the control group infants. However, in infants with symmetric form of IUGR there was a tendency to hypokinetic type of central hemodynamics.

The study of adaptive capacity of the cardiovascular system of newborn infants with IUGR showed (Table 3) that the structure of the electrical systole (QRST), and the phase of ventricles excitation (Q-TI) on the first day of observation in the newborns in study and control groups significantly differ (0.123±0.001 vs 0.134±0.008 s, p<0.05). On the 2-3 days of life length of Q-TI interval in newborns in the main group decreased in compare with the infants in the control group (0.105±0.003 vs. 0.141±0.005 s, p<0.001). It also was found that the shortening of the Q-TI interval length in newborns of the main group, identified on the first day, was due to the shortening of the QRS interval length (0.033±0.003 vs 0.046±0.001 s, p<0.001), whereas at 2-3 days of life - due to the segment ST-T shortening (0.067±0.002 vs. 0.104±0.006 s, p<0.001).

Table 3.
Dynamics of electrocardiographic parameters in neonates with IUGR

Parameters	Days of observation and study groups							
	Day 1		Day 2		Day 3		Day 4	
	Main group	Control group	Main group	Control group	Main group	Control group	Main group	Control group
RR, s	0.741±0.003	0.445±0.006	0.441±0.003**	0.476±0.013	0.461±0.003	0.474±0.012	0.469±0.003	0.471±0.008
QT, s	0.123±0.001*	0.134±0.008	0.105±0.003***	0.141±0.005	0.110±0.002	0.125±0.006	0.118±0.002	0.113±0.002
QRS, s	0.033±0.003***	0.046±0.001	0.040±0.005	0.033±0.004	0.038±0.003	0.035±0.005	0.038±0.002	0.036±0.005
ST-T, s	0.084±0.001	0.090±0.004	0.067±0.002***	0.104±0.006	0.075±0.001	0.090±0.003	0.077±0.003	0.078±0.002
T1-T	0.144±0.002**	0.137±0.002	0.135±0.003	0.142±0.003	0.146±0.003	0.131±0.002	0.163±0.007***	0.125±0.002

Note: ** - p<0.05, ** - p<0.01, *** - p<0.001 statistically significant within the group.*

The study of adaptive capacity of the cardiovascular system of newborn infants with IUGR showed (Table 3) that the structure of the electrical systole (QRST), and the phase of ventricles excitation (Q-TI) on the first day of observation in the newborns in study and control groups significantly differ (0.123±0.001 vs 0.134±0.008 s, p<0.05). On the 2-3 days of life length of Q-TI interval in newborns in the main group decreased in compare with the infants in the control group (0.105±0.003 vs. 0.141±0.005 s, p<0.001). It also was found that the shortening of the Q-TI interval length in newborns of the main group, identified on the first day, was due to the shortening of the QRS interval length (0.033±0.003 vs 0.046±0.001 s, p<0.001), whereas at 2-3 days of life - due to the segment ST-T shortening (0.067±0.002 vs. 0.104±0.006 s, p<0.001).

The structural segment QRST, referred to as "termination of excitation phase" in ventricles (TI-T) in neonates of the main group lengthened on first day of life in compare with infants of the control group (0.144±0.002 vs 0.137±0.002 s, p<0.001). This interval also is further extended to a 4 day of life in the main group, compared with the control one (0.163±0.007 vs 0.125±0.002 s, p<0.001). In connection with these shifts, the Q-TI/QRST ratio over the entire period of observation in main group infants is less (45.1%, 44.6%, 43.2% and 41.4%) than in children of control group (49.6 %, 50.5%, 51.4% and 46.9%, p<0.05 - <0.01), and the TI-T/QRST is more (54.9%, 55.4%, 56.7% and 58.6%, 50.4% vs. 49.5%, 47.8% and 53.1%, p<0,01-0,01). Consequently, the Q-TI/QRST ratio in neonates in the main and in the control group decreases with age, whereas the TI-T/QRST ratio increases and its severity significantly higher in infants of the main group.

We studied the frequency of repolarization changes (ST-T and T) in the examined infants. At the same time, it was found an inversion (shift down) of the ST-T segment below the isoline more than -2.0 mm (-3.15±0.19 mm on average) in 30.9% of neonates in the main and in 16.7% infants of control group (p<0.01). ST-T change in 11.3% in main and in 3.33% in control group (p<0.05) was associated with positive and peaked T waves in precordial leads V3-V6.It could indicate the subendocardial ischemia of the front or anterior-lateral wall of the left ventricle [4].

In newborn infants in 9.3% the main and in 6.7% of control group (p>0.05) revealed an elevation (upward shift) of ST-T segment by more than +2 mm (+3.53±0.40 mm on average) which combined with peaked negative T

waves in leads V1-V4, only in 3 (3.1%) infants in the main and in only 1 (3.3%) child in the control group infants ($p>0.05$). It is well known, that the first of these ST-T changes are interpreted as a sign of ischemia of subendocardial layer of the anterior and lateral walls of the left ventricle, and the second - as the ECG signs of ischemic damage of this layer of the heart [5]. Therefore, in infants with perinatal CNS damage observed the subendocardial ischemia of the left ventricle.

The interpretation of ischemic changes was based on the status that isolated changes of the T wave was considered as a sign of ischemia, and ST-T changes - as ischemic myocardial injury [7]. Therefore, in isolated ischemia (without damage) disturbance of repolarization phase occurred (TI-T), and in its combination with ischemic lesions the phase of ventricular depolarization (QRS, ST-T) is also involved in the process. Herewith, in infants with perinatal CNS damage at the 4th day of their lives the interval QRST is lengthened (0.280 ± 0.002 vs. 0.239 ± 0.002 s in control group, $p<0.001$) and a segment of TI-T (0.163 ± 0.007 vs. 0.125 ± 0.002 s in controls, $p<0.001$), which could indicate the large conjugation of ischemic (hypoxic) changes in the myocardium with its injuries.

According to obtained results revealed the following manifestations of heart rhythm disturbances and transient myocardial ischemia:

- Coefficient of dysrhythmia can be a sign of morphological and functional maturity of the cardiovascular system;
- Changes in the ST-T interval, which were registered on the ECG in the early neonatal period disappeared during the first 2 weeks after birth;
- Ischemic changes of the QRS complex with the heart rhythm and conduction were observed from the first day of life and during the all neonatal period;
- Transient focal changes of the initial part of ventricular complex QRS.

The appearance in infants with IUGR, survived after perinatal hypoxia, against the overall several condition, clinical signs such as skin pallor, acrocyanosis, and perioral cyanosis on the background of muted or dull cardiac tones could serve an indication for the ECG examination.

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