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NEWBORNS' HEART RHYTHM DISORDERS IN EARLY NEONATAL PERIOD

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Abstract

Heart rhythm and conductivity disorders may occur at different ages. In doctor's practice it is important to determine causative factors, which may lead to newborns' heart rhythm disorder. The research involved examination of 384 newborns at the age of 0-8 days at gestation period of 39.2±1.7 weeks who showed clinical signs of the cardiovascular system (tachy-, bradyarrythmia, systolic murmur, and perioral cyanosis). Thirty seven infants showed heart rhythm disorder.

Evaluation of risk factors, which can occur in perinatal period and potentially affect the development of heart rhythm disorders and conductivity, was performed. The analysis of pregnancy course showed that 83.8% ($p \leq 0.05$) of mothers had fetomaternal disease including hazard of preterm birth in 62.2% ($p \leq 0.05$) of examined mothers, preeclampsia and gestational toxicosis were determined in 37.8%, subcompensated placenta dysfunction in 45.9% and placental abruption in 29.7% of women. Anemia of pregnant women was recorded in 21.6% of expectant mothers. 72.9% ($p \leq 0.05$) of infants were born by Caesarian section. Exacerbation of chronic pyelonephritis at the time of pregnancy was found in 10.8% of women, 10.8% of expectant mothers suffered from phlebeurysm of lower limbs. 17.5% of women had burdened heredity of cardiovascular system represented by heart rhythm and conductivity disorders. There was a domination of sinus bradycardia in 56.8% ($p<0.05$) babies and extrasystole in 32.4% in the heart rhythm disorders. Atrial flutter was observed in one newborn, clinical case is presented; one newborn had QT prolongation syndrome. At the age of 7.2±2.9 days 97.3% ($p \leq 0.05$) of patients had heart rhythm normalization. The development of heart rhythm disorders and conductivity in newborns of mothers suffering from extragenital pathology is affected by different unfavorable ante- and perinatal factors, such as pathological pregnancy and delivery. A baby with arrhythmia firstly found in neonatal period requires mandatory consultation with a cardiologist; it needs further examination in a specialized cardiological center/department, follow-up monitoring in polyclinic.

Keywords: *newborns, arrhythmias, early neonatal period.*

Introduction

Heart rhythm and conductivity disorders may occur at different ages. In doctor's practice it is important to determine causative factors which may lead to newborns' heart rhythm disorder. The first cause is represented by organic congenital abnormalities of the heart anatomy [*Grosse-Wortmann L et al., 2010*], inflammatory and degenerative myocardial diseases, and heart tumors; the second one includes metabolic disorders of homeostasis (hypo- and hyperkalemia, -magnesemia, -calcemia; hypo- or hyperthermia; hyperthyroid conditions and the effect of medications) [*Maulidi H et al., 2012*]. The presence of an arrhythmogenic substrate, hypoxia and morphofunctional immaturity of myocardial tissue is considered to be the principal ethiopathogenetic factors of heart rhythm disorders in babies of early age [*Hoogaars WMH, Tessari A, 2004; Kovalev IA, Usenkov SY, 2013*]. Particularly heart rhythm disorders of posthypoxic

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genesis which developed in newborns after past asphyxia or birth injury are frequently transient and can disappear spontaneously [*Wood CE, 2009; Roos R et al., 2011*]. Autoimmune diseases of connective tissues, diabetes mellitus and thyroid gland diseases in a pregnant woman play an important role in the genesis of arrhythmias [*Kruchina TK, Egorov DF, 2011; Mitchell JL et al., 2012; Yildirim A et al., 2013; Ng O, Shahani SJ 2014*].

Nowadays there are no exact data concerning the prevalence of heart rhythm and conductivity disorders in childhood [*Roos R et al., 2011*]. However, approximately 1% of newborns were found to have heart rhythm disorders during routine screening before discharge from hospital [*Poddar B et al., 2006*]. This problem requires enhanced study of newborns, because some types of arrhythmias may be transient and benign, while others lead to development of newborns' cardiac insufficiency and even to cardiogenic shock and death [*Wood CE, 2009; Safina AI et al., 2010*].

The goal of the research is to improve the diagnostics of and to study the pattern of newborns' heart rhythm and conductivity disorders of women suffering from extragenital pathology in early neonatal period.

Materials and Methods

The research involved examination of 384 newborns at the age of 0-8 days in gestation period of 39.2±1.7 weeks who showed clinical signs of the cardiovascular system (tachy-, bradyarrhythmias, systolic murmur and perioral cyanosis). 37 infants showed heart rhythm disorder, among them 72.9% ($p \leq 0.05$) of boys and 27.1% of girls. The age of the babies at the time of observing rhythm disorders was 5.7±4.5 days. The average weight of patients under examination was 3444.2±427.3 *g* which did not differ from control group values ($p \leq 0.05$). The control group was represented by 20 healthy newborns of the same age.

The evaluation of risk factors which may occur in perinatal period and potentially affect the development of heart rhythm and conductivity disorders was performed. The research involved the analysis of obstetric history, gestation and labor course, clinical examination of a newborn, ECG-examination on 12 deflections and Doppler echocardiography. The research was approved by Institutional Bioethics Committee and conforms the principles provided in the Declaration of Helsinki (*Br. Med. J. 1964; p.177*) with further supplements.

The data obtained were processed using the variational statistical method and the Mann-Whitney nonparametric test for equating two independent abnormally distributed samples.

Results and discussion

The research findings demonstrate that infants suffering from heart rhythm disorders were born to mothers whose average age was 28.4±3.4 years old. 32.4% of the children were from the second and subsequent pregnancies, 10.8% of the infants were from multiple pregnancies. The analysis of pregnancy course showed that 83.8% ($p \leq 0.05$) of mothers had fetomaternal disease including hazard of preterm birth in 62.2% ($p \leq 0.05$) of examined mothers, preeclampsia and gestational toxicosis were determined in 37.8%, subcompensated placenta dysfunction in 45.9% and placental abruption in 29.7% of the women. Anemia of pregnant women was diagnosed in 21.6% of expectant mothers. 72.9% ($p \leq 0.05$) of infants were born by Caesarian section due to increasing severity of preeclampsia and occurrence of the signs of fetal disorders and development of dystocia and presence of severe extragenital pathology in mothers. According to anamnestic and clinical laboratory data fetal distress was found in 39.7% of examined mothers that was a consequence of unfavorable conditions of intrauterine growth associated with fetomaternal disease secondary to concomitant somatic pathology in 56.8% ($p \leq 0.05$) of mothers. Somatic pathologies of expectant mothers are as follows: severe endocrine disorders (obesity, primary hypothyroidism (medically compensated); gastrointestinal tract disorders (cholelithiasis, stomach and duodenum ulcer, and abnormal development of bile ducts); urinary system disorders, chronic pyelonephritis, phlebeurysm of lower limbs, and epilepsy. 17.5% of the women were found to have burdened heredity of cardiovascular system repre-

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sented by heart rhythm and conductivity disorders (II grade AV-block), congenital cardiac failure (secondary defect of interatrial septum), vegetative-vascular dysfunction, and hypertonic disease. Exacerbation of chronic pyelonephritis at the time of pregnancy was found in 10.8% of the women, 10.8% of the expectant mothers suffered from phlebeurysm of lower limbs.

Heart rhythm disorders such as tachycardia and episodes of extrasystole were prenatally diagnosed in 10.8% of fetuses. General condition of newborns was considered to be satisfactory. The diagnoses of examined children suffering from heart rhythm disorders included the following: signs of fetal chronic hypoxia in 5.4%, asphyxia in the process of delivery in 10.8%, intrauterine pneumonia in 10.8%, respiratory distress syndrome in 16.2%, hypoxically induced ischemic damage of central nervous system in 29.7% ($p \leq 0.05$) of children, and syndrome of intrauterine growth retardation. Multiple congenital abnormalities were found in one newborn.

Among heart rhythm disorders there was the prevalence of sinus bradycardia in 56.8% ($p \leq 0.05$) of the children, 32.4% suffered from extrasystole, mostly single, nomotopic and atrial. 5.4% of patients were diagnosed with sinus tachycardia; one newborn was found to suffer from atrial flutter and another had QT prolongated syndrome. During the period of monitoring the state of children remained stable, patients did not need antiarrhythmia drug therapy. At the age of 7.2±2.9 days the overwhelming majority of patients, which is 97.3% ($p \leq 0.05$), was found to have heart rhythm normalization. The signs of heart organic damage were found in two children (secondary defect of interatrial septum, aneurism of interatrial septum, and wide open arterial canal).

Thus, the development of heart rhythm and conductivity disorders in newborns of mothers suffering from extragenital pathology is affected by different unfavorable ante- and perinatal factors such as pathological pregnancy and labor. Perinatal damage of CNS hypoxic and ischemic genesis activates the development of 'benign' arrhythmias which do not lead to the damage of central hemodynamics and general state of a child and are transient.

The extract from hospital neonatal record of P., who was born at regional perinatal center of VI pregnancy, II preterm labor at gestation period of 36-37 weeks by Caesarian section (due to development of fetal distress, heart rate (HR) 220 *bpm*), illustrates the above-mentioned data. The patient's medical history reveals that the mother suffered from acute respiratory viral infection during the 35th week of pregnancy. The signs of maternal and fetal infection and congenital abnormality of urinary tract – multicystosis of fetal left kidney were prenatally detected. Mother, who is 28 years old, suffers from congenital abnormality of urinary tract: hydronephrosis of right kidney and chronic pyelonephritis, renal failure 0. A baby was born with the weight of 3200 *g*, height 49 *cm*, head circumference 35 *cm* and chest circumference 34 *cm*. According to Apgar scale, his score was 7/7 grades. The condition was grave at birth; there were signs of respiratory failure, low-pitched crying, and hypomyotonia. Respiration rate was 65-72/*min*. HR was 190-204 *bpm*. Saturation (SaO2) was 88-89%. Heart sounds were rhythmic, soft systolic noise in the second intercostal space to leftward of sternum. Abdomen was soft; liver was enlarged by1.5 *cm* below the costal margin. The values of acid-base balance at birth were as follows: pH 7.33, pCO2 50.0 *mm Hg*, pO2 15 *mm Hg*, HCO2 26.7 *mmol/l*, BE (-0.4). Calcium was 1.4 *mmol/l*. Due to the critical condition the baby was transferred to neonatal intensive care unit, where she was staying for one day.

During the first day of life the general condition remained critical due to respiratory failure, tachycardia with up to 200 *bpm* was still present. Hyporeflexia. Muscle tone and spontaneous motor activity were reduced. Skin was clean, pink and wet. Skin elasticity was normal, turgor was reduced. Subcutaneous fat layer had been sufficiently developed by the gestation period. The edemas were absent. Respiration was spontaneous, rhythmic with the involvement of intercostal spaces. During auscultation, the lung respiration reached all regions from both sides. Respiration rate was 65/*min*. SaO2 97-98%. The borders of deep cardiac dullness were as follows: right – along the right edge of the sternum, upper – II intercostal space,

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1.0 *cm* to the left of the midclavicular line. Auscultation detected rhythmic and dull cardiac sounds. HR was 190 *bpm*. Arterial pressure was 69/36 *mm Hg*, average arterial pressure – 36 *mm Hg*. Abdomen was soft. Liver was enlarged by 1.5 *cm* lower the edge of costal arch. Urination was sufficient (1.5 *ml/kg/h*). Clinical analyses of urine and blood and biochemical blood assay (total bilirubin, electrolytes, albumin, C-reactive protein and blood sugar) are without pathological findings. Creatine phosphokinase-MB: 60.1 *u/l*. Doppler imaging for the first day of life: left ventricular end-diastolic diameter 14.9 *mm*, left ventricular systolic length 12.4 *mm*, left ventricular posterior wall thickness 3.9-5.0 *mm*, interventricular septum thickness 3.9-4.9 *mm*, ejection fraction 62%, ΔD 31%, left atrial length 10.3 *mm*, aorta diameter 8.6 *mm*, pulmonary artery diameter 9.2 *mm*, right ventricular end-diastolic diameter 16.0 *mm*. The average pressure in pulmonary artery trunk was 27 *mm Hg*.

Conclusion

Moderate dilatation of right chambers. Aneurism of interatrial septum, wide oval opening, diameter 4.7 *mm*, intensive left-right bypass. Open arterial duct, diameter 3.1 *mm*, pressure gradient of aorta/pulmonary artery 17 *mm Hg*. Cardiac arrhythmia, HR 113-190 *bpm*. Blood flow in abdominal aorta was pulsating.

Under the influence of post syndrome therapy the signs of respiratory failure had been reduced by the 2nd and 3rd days of life, the baby was transferred to the general unit. However tachycardia was still present (HR 200-220 *bpm*) in the absence of hemodynamic disorders, thereat Doppler imaging was performed, cardiologist's consultation was recommended. The results of Doppler imaging by the third day of life (Fig. 1): left ventricular end-diastolic diameter 13.9 *mm*, right ventricular end-diastolic diameter 16.0 *mm*, right atrial end-diastolic diameter 15.0 *mm*, ejection fraction 56%, left atrial length 10.3 *mm*, aorta diameter 8.6 *mm*, pulmonary artery diameter 9.2 *mm*. The average pressure in pulmonary artery trunk was 27 *mm Hg*.

Conclusion: Moderate dilatation of right chambers, wide oval opening with intensive left-right by-

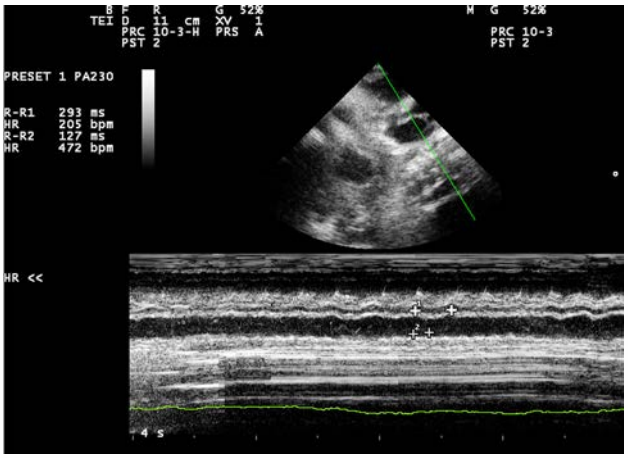

Figure 1. *Doppler imaging (M-mode) of a newborn P. (girl), third day of life.*
Note: *Atrial contraction with the rate of 472 bpm, see mark "2" in echogram of the left atrium; left ventricles deflate rate 205 bpm, see mark "1" at aorta root.*

pass through interatrial septum. Open arterial duct 2.4 *mm* (Doppler color flow mapping mode downstream in pulmonary artery trunk with diameter). Tachycardia. Blood flow in abdominal aorta was pulsating. Investigation in M-mode showed non-compliance of aortic root HR and left atrium in the ratio 1:2 with the aorta deflate rate 190-200 *bpm*, atria 350-400 *bpm* (irregularly), which allowed diagnosing heart rhythm disorders – atrial flutter.

ECG examination showed characteristic atrial waves F which have a specific saw-tooth form that determined the presence of heart rhythm disorder - atrial flutter (Fig. 2). Clinical signs of cardiac failure were not detected.

To normalize baby's HR she was prescribed antiarrhythmic therapy (cordaron with the dosage of 5 *mg/kg/d*). The normalization of heart rhythm was recorded in 20 hours (Fig. 3).

Holter monitoring of ECG during the day detected sinus rhythm (Fig. 4).

After examination the aim of which was to exclude intrauterine infection, myocarditis, consultation with heart surgeon the baby was discharged in

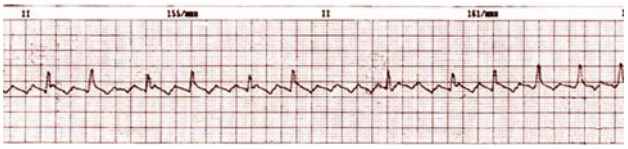

Figure 2. *ECG, of a newborn P (girl), third day of life. Atrial waves F which have a specific "saw-tooth" form.*

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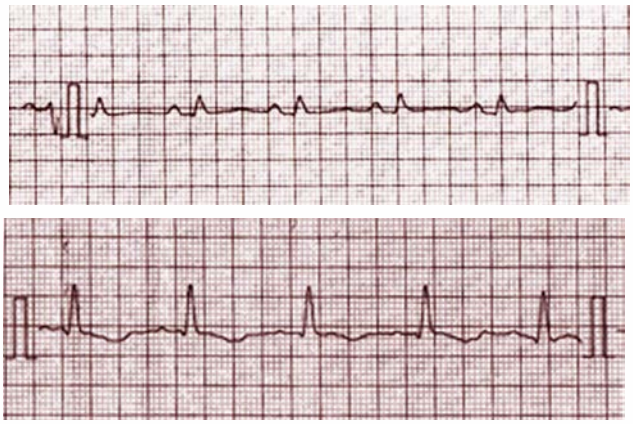

Figure 3. *ECG of a newborn P (girl), fourth day of life (after administration of amiodarone (cordaron). Sinus rhythm. HR is 148 bpm.*

satisfactory condition to be further supervised by pediatrician at the place of residence with diagnosis: rhythm disorders of the heart: atrial flutter. Heart failure (HF0). Patent foramen ovale, functioning patent ductus arteriosus. Abnormal trabecula of left ventricle. Congenital disorder of urinary system: multicystosis of the left kidney. Renal failure 0. During the first month of life the condition was satisfactory, episodes of tachycardia were not recorded, parents did not ask for doctor's help. Routine examination and follow-up monitoring at the regional children's cardiological center during the year is recommended.

ST episode Ch.1. Total number of episodes 10.
Total duration 00:28:18. Heart rate: 171 bpm.

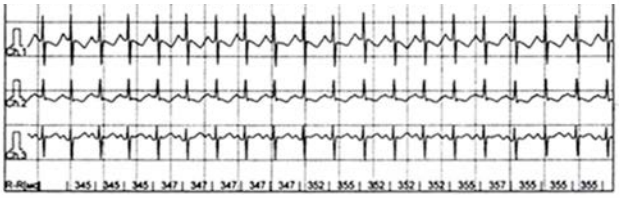

Figure 4. *Holter monitoring of ECG, 12 days of life. Sinus rhythm. HR is 150-171 bpm. Isolated supraventricular premature beats (time of observation 23 hours 53 minutes).*

Given clinical case demonstrates that it is possible to conclude that atrial flutter in newborn may develop in early neonatal period as the result of right atrial overload with the volume associated with actively functioning fetal communications (wide oval opening with left-right bypass, open arterial duct). To the extent of the stabilization of extrauterine hemodynamics, normalization of pulmonary artery pressure, associated with undertaken therapy, atrial flutter was reduced, and the baby was discharged in a satisfactory condition.

Neonatologist and children's cardiorheumatologist should exclude a significant number of diseases of baby and mother to determine the genesis of arrhythmia. The specification of frequency of development and range of fetal and perinatal heart rhythm and conductivity disorders, the investigation of cause-and-effect interactions of their formation, possible consequences, indications and algorithms of medical or surgical treatment will promote reduction of the perinatal and neonatal morbidity rates and have significant clinical, social and economic effects.

A baby with the arrhythmia detected for the first time in the neonatal period requires mandatory consultation of a cardiologist. Later on, it is in need of further examination in a specialized cardiological center/department, follow-up monitoring in an out-patients' clinic.

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