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Regulation of heart rate in pregnant women with infectious risk

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Abstract
Objective - comprehensive study of the functional state of vegetative nervous system (VNS) in pregnant women with latent infection and realized infection. The observation involved 81 women with pregnancy of 28-40 weeks. The studied group included 33 pregnant women with latent infection and 28 realized infection. Parameters of cardiointervalography were studied.
On the basis of findings it can be stated that the changes in the reactivity of the VNS depending on the state and reactivity of the cardiovascular system are diverse on the nature of their manifestation. In pregnant women with physiological course of pregnancy a normal adaptive state was recorded. In pregnant women with latent infection a normal adaptive state was observed in 54.5 %, hyperadaptive - in 27.3 %, hypoadaptive - in 18.2 %, with realized infection - in 0; 49,9 and 57.1 %, respectively. Cardiointervalography is universal marker of adaptive responses. In infections in pregnant women are violated adaptive responses VNS. In pregnant women with latent infection disadaptive condition of VNS observed in 45.5 % of cases, while with realized infection - in 100 % with a slight prevalence of hypoadaptive state over hyperadaptive one.

Keywords: pregnancy, vegetative nervous system, cardiointervalography, latent and realized infection

1. Introduction

Over the years, the prevention and treatment of infectious diseases of the urogenital tract is the actual problem of researchers in the area of basic sciences and medical clinicians of various specialties [2, 6]. Despite significant advances in the diagnosis and treatment of urogenital infections, their frequency has a strong tendency to increase. Infectious pathology takes one of the first places in the structure of perinatal risk factors, recent years their frequency ranges from 6.9 to 13.1%. The average incidence of diseases of the genitourinary system of pregnant women in the last 10 years significantly increased from 8.0% to 11.8% [2, 6]. The presence of urogenital infection during pregnancy presents a real danger both for mother and fetus. It is known that vegetative nervous systems (VNS) is the main regulator of homeostasis and adaptation of the body to changes in the environment [3, 5]. During pregnancy, there is an intensive neuroendocrine change of the body with a predominance of vegetative mechanisms of regulation. Deviations arising in the regulatory systems prior to hemodynamic, metabolic, energy disturbances are early signs of patient's troubles [4, 5]. The heart rate is an indicator of these abnormalities. Universal markers of adaptive responses are the parameters of cardiointervalography (CIG) [1, 3, 4, 5]. With the purpose of integrated assessment of the sympathetic and parasympathetic parts of VNS the analysis of heart rate variability (HRV) is applied [4].
In connection with this the aim of the study was a comprehensive study of the functional state of VNS in pregnant women with latent infection (LI) and 28 realized infection (RI).

Material and methods

The method of CIG — ECG machine Suprodil with a computer program recording and analysis of rhythmocardiograms have been used [1, 3]. The study of regulatory mechanisms and interpretation of data were performed by the method of A.N. Fleyshman [3]. The observation involved 81 women with pregnancy of 28–40 weeks. The studied group included 33 pregnant women with latent infection (LI) (a history of frequent colds, chronic pyelonephritis, chronic endometritis, chronic adnexitis, spontaneous late abortions and premature birth, as well as pregnant women with chronic and acute polyhydramnios) and 28 with realized infection (RI) (acute pyelonephritis, preterm labor infectious genesis, chorioamnionitis, postpartum endometritis). The control group consisted of 20 women whose pregnancy was without complications. The average age of the surveyed pregnant women was 26,5 years. The heart rate has been investigated in II standard lead position in pregnant lying down, during quiet breathing, in a quiet darkened room, which maintained a constant temperature of 20–22°C. Just before the recording the period of adaptation to the conditions of the study for 5 minutes has been observed. In pregnant women the value of the total spectral density of power (Total) of waves of the three components of the spectrum was estimated: very low frequency (VLF) — sympathoadrenal; low frequency (LF) — baro receptor; high frequency (HF) — parasympathetic. In order to determine the balance of VNS regulation mathematical parameters such as (Mo) mode — the duration of the most frequently appearing value of cardio interval; the amplitude of the mode (AMo) — the frequency of the cardio interval appearance, equal to the value of Mo, strain index (SI) of regulatory systems; as well as the secondary data of variation pulsometry: index of vegetative balance (IVB), vegetative parameter of the rate (VPR), the index of regulation process adequacy (IRPA) [1, 3, 7]. The basic statistical parameters were processed by software package Statistics for Windows 6.0. The relative values between the general portions were compared using t — ttest at P = 0.95.

Results and discussion

In overwhelming majority of 18 (54.5 %) pregnant women with LI an increase in rate of heart beats (RHB) within normal limits up to 81.2 ± 1.3 ($P < 0.1$) was observed. At the same time, a slight decrease of Mo from 0.76 ± 0.01 to 0.71 ± 0.01 ($P < 0.01$) was observed, the activity of the sympathetic regulation link of AMO was 48.4 ± 2.5 ($P > 0.05$) at a normal rate of 43.3 ± 1.8, and the activity of the central mechanisms of regulation over the autonomous, SI increased up to 179.8 ± 27.1 (131.0 ± 14.7) ($P > 0.05$). At the same time on the background of sympathetic nervous system activity the functional activity of the sinus knot IRPA is increased from 57.7 ± 2.9 to 68.4 ± 3.0 ($P < 0.05$). A slight decrease in total absolute level of activity of Total regulatory systems from 673.9 ± 80.3 to 555.6 ± 62.2 ($P > 0.05$) was observed, VLF was slightly decreased from 234.2 ± 31.0 to 229.1 ± 33.8 ($P > 0.05$), LF was the same and made 202.3 ± 25.9 ($P > 0.05$) (202.6 ± 30.9), HF decreased up to a considerable value of 24.3 ± 23.5 ($P < 0.01$) (237.1 ± 36.6) respectively. In this case, the IVB increased and made 254.6 ± 38.2 ($P > 0.1$) (norm is 193.3 ± 19.5), and the VPR increased and was 6.880 ± 0.702 ($P > 0.05$) (5.6 ± 0.4). Such condition is treated as normal adaptive state.

In 9 (27.3 %) pregnant women with LI an increase in RHS was determined normal up to 102.70 ± 2.43 ($P < 0.01$), the value of IRPA increased from 57.7 ± 2.9 to 98.9 ± 11.1 ($P < 0.01$) against a background of the activity of the sympathetic nervous system, AMO increased up to 55.00 ± 5.35 ($P > 0.05$) at a norm of 43.3 ± 1.8, SI increased from 131.0 ± 14.8 to 383.6 ± 110.4 ($P < 0.01$) respectively, a decrease of Mo up to 0.560 ± 0.013 ($P < 0.01$) at a norm of 0.76 ± 0.01, indicating a functional stress of adaptation mechanisms and centralization of regulation. In this case, the IVB has increased from 193.3 ± 19.5 at a norm of up to 414.8 ± 97.9 ($P < 0.01$), and the VPR from 5.7 ± 2.9 to 12.30 ± 2.43 ($P < 0.5$). According to the spectral analysis was revealed: a decrease of Total from 673.9 ± 80.3 to 368.2 ± 117.3 ($P > 0.05$), VLF decreased slightly from 234.2 ± 31.0 to 217.3 ± 67.3 ($P > 0.05$), LF decreased from 202.6 ± 30.9 to 113.2 ± 46.0 ($P > 0.05$), decrease of the quantities of HF 37.7 ± 21.8 ($P < 0.01$) at a norm of 237.1 ± 36.6 was observed. The value of LF/HF increased up to 5.83 ± 1.85 ($P < 0.05$) at a norm of 1.49, i.e., there is a slight increase in reactivity of regulatory systems against a background of significant reduction in the activity of the parasympathetic nervous systems. This condition is regarded as hyperadaptive.

In 6 (18.2 %) women with LI decrease in RHS within 61.50 ± 1.63 ($P < 0.01$), with this an increase of Mo up to 0.970 ± 0.033 ($P < 0.01$) is noted, and AMO dropped up to considerable values — from 43.3 ± 1.8 to 31.20 ± 1.96 ($P < 0.01$), SI decreased from 131.0 ± 14.8 to 38.68 ± 6.20 ($P < 0.01$). In this case, against a background of moderate activity of parasympathetic nervous system tone the functional activity of the sinus knot of IRPA decreased from 57.7 ± 2.9 to 32.6 ± 2.7 ($P < 0.01$). A reduction of the IVB from 193.3 ± 19.5 to 74.2 ± 10.6 ($P < 0.01$) was revealed, i.e. there is a decrease of reactivity of the cardiovascular system on the background of the activation of the parasympathetic nervous system. An increase of the Total up to significant values 1463.8 ± 387.3 ($P < 0.05$) (673.9 ± 80.3) was revealed with a slight increase of VLF from 234.2 ± 31.0 to 360.0 ± 97.6 ($P > 0.05$) and LF from 202.6 ± 30.9 to 450.8 ± 159.4 ($P > 0.05$). An increase of HF from 237.1 ± 36.6 to 653.0 ± 173.1 ($P = 0.05$) and a decrease in LF/HF up to 0.98 ± 0.40 ($P > 0.05$) at a norm of 1.49 ± 0.30 were observed.

Thus, on the basis of findings it can be stated that the changes in the reactivity of the VNS depending on the state and reactivity of the cardiovascular system are diverse on the nature of their manifestation. In a normadaptive state the activity of sympathetic and parasympathetic nervous system, as well as humoral mechanisms of regulation the parameters of CIG remained within normal limits, but were relatively in high level, with a predominance of the central regulation circuit. In hyperadaptive states the reactivity of the sympathetic nervous system and humoral regulation with the centralization of control, with a reduction of the reactivity of the parasympathetic nervous system were mobilized. In hypoadaptive state against a background of the decrease of the reactivity of sympathetic nervous system and humoral regulation mechanism, the prevalence of autonomous components with the presence of parasympathetic part of VNS was revealed; the activity of the sinus knot was decreased.

In RI in 12 (42.9 %) pregnant women an increase in rate of heart beats above the norm up to 108.20 ± 3.64 beats/min ($P < 0.01$) was revealed, decrease in the level of functioning of the cardiovascular system — Mo up to 0.53 ± 0.02 (0.76 ± 0.01) ($P < 0.01$); increase in the activity of sympathetic link of regulation — AMO from 43.3 ± 1.8 % to 60.10 ± 3.87 % ($P < 0.05$) and respectively the degree of predominance of the activity of the central mechanisms of regulation over the autonomous SI from 131.1 ± 14.8 increased and made 476.6 ± 100.0 ($P < 0.05$). At the same time the functional activity of the sinus knot of IRPA increased from 57.7 ± 2.9 to 117.3 ± 9.9 ($P < 0.001$) on the background of the activity of the sympathetic nervous system. IVB has increased from 193.3 ± 19.5 to 471.1 ± 87.0 ($P < 0.05$), as well as the VPB from 5.65 ± 0.40 to 14.60 ± 2.55 ($P < 0.01$). According to the spectral analysis a slight decrease in total absolute level of the activity of regulatory systems was revealed — Total from 673.9 ± 80.3 at a norm of up to 409.0 ± 115.6 ($P > 0.05$), metabolichumoral and relative level of the activity of the sympathetic nervous system VLF decreased from 234.2 ± 31.0 to 191.6 ± 44.6 ($P > 0.05$), the relative level of activity of the vasomotor center LF from 202.6 ± 30.9 to 177.7 ± 71.2 ($P > 0.05$) also decreased, a decrease in the relative level of activity of the parasympathetic regulation up to considerable values of HF — from 237.1 ± 36.3 to 40.6 ± 19.1 ($P < 0.05$) respectively was observed. The ratio of LH/HF significantly increased from 1.47 ± 0.30 to 16.8 ± 7.9 ($P < 0.05$). Relationship in terms of the spectral analysis of wave power is as following. VLF waves were 46.7 %, LF 43.4 %, HF was 9.9 % (at a norm of 15–30, 15 to 40 and 15–25 %, respectively) that indicates a sharp predominance of sympathetic activity.

The results obtained on the parameters of cardiointervalography in pregnancy with infectious risk are shown in table 1.

Table 1: Parameters of cardiointervalography in pregnant women with realized infection (M±m)

Parameter	Physiological pregnancy	RI (hyperadaptive)	RI (hypoadaptive)
RHB (beats/min)	76.53±1.07	108.17±3.64*	60.94±2.13
MODE (s)	0.76±0.01	0.53±0.02*	0.83±0.02
AMO (%)	43.29±1.78	60.11±3.87*	35.19±1.74*
IVB (%/s)	193.33±19.54	471.13±27.32*	97.27±7.97*
VPR (s^2)	5.65±0.43	14.56±2.56*	3.34±0.42
IRPA (%/s)	57.70±2.94	117.28±9.90*	43.06±2.73*
SI (%/s^2)	131.05±7.76	476.58±25.01*	61.37±5.62*
Total (ms^2)	673.93±8.31	409.83±23.12*	1765.06±112.74*
VLF (ms^2)	234.20±21.04	191.58±14.59*	473.75±30.18*
LF (ms^2)	202.57±8.68	177.67±11.15*	498.31±34.42*
HF (ms^2)	237.17±11.50	40.58±3.15*	794.44±80.41*
LF/HF	1.49±0.26	16.81±1.87*	1.12±0.24

Note: * - *P<0.05 as compared with the norm.*

In pregnant women with realized infection in 16 (57.1 %) of pregnant women there was a decrease in rate of heart systoles up to 60.9 ± 2.1 (P < 0.01), with the help of CIG an increase of the level of sinus knot function against a background of the increase of parasympathetic reactivity was revealed; index of Mo increased from 0.76 ± 0.01 to 0.83 ± 0.02 a (P < 0.05), there is a decrease of the reactivity of sympathetic link of regulation — AMO from 43.3 ± 1.8 to 35.20 ± 1.74 (P < 0.01), autonomous mechanisms of regulation predominated over the central — SI increased slightly from 43.3 ± 1.8 % to 61.40 ± 9.62 (P < 0.01). At the same time IRPA reduced up to 43.10 ± 2.73 (in physiological pregnancy 57.7 ± 2.9) (P < 0.01) on the background of the increase of the reactivity of the parasympathetic nervous system.

According to the secondary indicators of pulsometry variation: index of vegetative balance IVB decreased from 193.3 ± 19.5 to 97.3 ± 13.9 (P < 0.01). Vegetative index VPR significantly decreased from 5.65 ± 0.40 to 3.34 ± 0.42 (P < 0.01).

According to the spectral analysis a significant increase in Total up to 1765.1 ± 232.7 (673.9 ± 80.3) (P < 0.05) was revealed, which indicates the imbalance of regulatory system, disrupting of the functional reserves, work of the system in autonomous mode; metabolichumoral and relative level of the activity of the sympathetic nervous system VLF increased from 234.2 ± 31.0 to 473.8 ± 50.1 (P < 0.05), an increase of the relative level of the activity of the vasomotor center LF from 202.6 ± 30.9 to 498.3 ± 94.4 (P < 0.05) and the relative level of the activity of the parasympathetic regulation of HF from 237.1 ± 36.3 to significant values 794.4 ± 80.4 (P < 0.05) is observed. Power ratio in absolute LH/HF terms was 1.12 ± 0.24 (1.47 ± 0.30) (P > 0.1), but this parameter is not statistically significant. In percentage terms on the parameters of the spectral analysis of waves power are as follows: VLF waves were 26.8 %, LF — 28.2 %, HF makes 45.0 %.

Conclusions

In pregnant women with physiological course of pregnancy a normadaptive state was recorded.

1. In pregnant women with LI a normadaptive state was observed in 54.5 %, in 27.3 % hyperadaptive, in 18.2 % hypoadaptive state were revealed. In RI in 12 (42.9 %) hyperadaptive and in 16 (57.1 %) hypoadaptive state were revealed. Normal adaptive state in the group was not revealed.
2. The more severe the infection, the greater violation indicators of adaptive mechanisms in the reactivity of the VNS is revealed. At a rate of heart beats higher than normal in the centralization of regulatory systems over the autonomous on the background of the activation of the sympathetic nervous system, an effect of the sympathetic nervous system, an increase of the reactivity of the sympathetic humeral sympathetic nervous regulation, an activation of vasomotor regulation with decreasing of the parasympathetic regulation predominated, all testifies hyperadaptive reactivity of the body (with LI 27.3 %, with 42.9 % of the RI).
3. In a group of pregnant women in a rate of heart beats within the lower limits, a tone of parasympathetic nervos system with centralized vasomotor center of regulation is predominated, metabolichumoral mechanisms of regulation are exhausted, the activity of the vasomotor center and activity level of the parasympathetic nervous system are increased, which promotes the development of hypoadaptive state in the body in LI 18.2 %, in RI 57.1 %.

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