



HEART RATE VARIABILITY AS A MARKER OF AUTONOMIC MALADAPTATION IN PREGNANT WOMEN WITH THREATENED MISCARRIAGE

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Abstract

The aim of the study was to assess heart rate variability (HRV) in pregnant women with threatened miscarriage (TM) as a marker of autonomic maladaptation and a predictor of adverse gestational outcomes. Seventy-two pregnant women at 8–22 weeks of gestation were examined: 42 patients with clinical signs of TM and 30 women with physiological pregnancy. HRV was recorded by 5-minute cardiointervalography. Patients with TM demonstrated a significant decrease in SDNN, RMSSD, HF, and pNN50 with a simultaneous increase in the LF/HF index, reflecting predominance of sympathetic activation and suppression of vagal control. HRV may be considered an accessible and informative method for early identification of pregnant women at high risk.

Keywords: Heart rate variability, threatened miscarriage, autonomic dysfunction, sympathetic activation, adaptation.

Introduction

Threatened miscarriage remains one of the leading causes of reproductive losses and perinatal morbidity. Neurohumoral and autonomic disturbances accompanied by hyperactivation of the sympathoadrenal system, impaired uteroplacental blood flow, and reduced adaptive reserves of the maternal organism play an important role in the pathogenesis of TM. Heart rate variability is a recognized non-invasive method for objective assessment of autonomic regulation and the overall adaptive potential of the organism. However, data on HRV application in pregnant women with threatened miscarriage remain limited, which determines the relevance of this study.

Aim of the Study. To assess HRV parameters in pregnant women with threatened miscarriage and to determine their prognostic significance.

Materials and Methods

Seventy-two pregnant women at 8–22 weeks of gestation were examined. The TM group included 42 women, while the control group (physiological pregnancy) consisted of 30 women. HRV was recorded using 5-minute cardiointervalography at rest. Time-domain and spectral parameters were



analyzed: SDNN, RMSSD, pNN50, HF, LF, VLF, and LF/HF ratio. Statistical analysis was performed using the Mann–Whitney U test; differences were considered significant at $p<0.05$.

Results

Analysis of heart rate variability parameters revealed pronounced and statistically significant differences between pregnant women with physiological pregnancy and patients with threatened miscarriage (Table 1).

Table 1. Heart rate variability parameters in pregnant women

Parameter	Control	TM	p
SDNN (mc)	52,4±4,1	31,7±3,5	<0,001
RMSSD (mc)	46,1±3,9	24,6±2,8	<0,001
pNN50 (%)	18,3±2,1	7,2±1,4	<0,001
HF (%)	41,6±3,8	21,5±3,1	<0,001
LF/HF	1,4±0,3	3,2±0,4	<0,001

In the control group, high values of total heart rate variability were observed, reflecting preserved adaptive potential and adequate parasympathetic activity. SDNN in the control group was 52.4 ± 4.1 ms, whereas in TM patients it was significantly reduced to 31.7 ± 3.5 ms ($p<0.001$), indicating a pronounced decrease in total HRV and functional reserves.

RMSSD, characterizing vagal influence on the sinus node, was also significantly lower in pregnant women with TM (24.6 ± 2.8 ms) compared with the control group (46.1 ± 3.9 ms; $p<0.001$), indicating suppression of parasympathetic activity and decreased cardiovagal adaptation.

A similar trend was observed for pNN50: $18.3\pm2.1\%$ in the control group versus $7.2\pm1.4\%$ in TM patients ($p<0.001$), reflecting reduced short-term HR oscillations and impaired regulatory stability.

Spectral analysis revealed a significant decrease in the high-frequency component (HF) in TM patients ($21.5\pm3.1\%$) compared with controls ($41.6\pm3.8\%$; $p<0.001$), indicating suppression of vagal regulation.

At the same time, the LF/HF ratio was significantly higher in TM patients (3.2 ± 0.4) than in controls (1.4 ± 0.3 ; $p<0.001$), reflecting pronounced sympathetic predominance and formation of sympathetic tonic autonomic regulation.

Thus, pregnant women with threatened miscarriage demonstrate significant reduction in total HRV, marked suppression of parasympathetic regulation and predominance of sympathetic activity, reflecting autonomic maladaptation and depletion of adaptive reserves. LF/HF values above 3 indicate pronounced sympathetic tonus and exhaustion of adaptive resources, which may represent a key pathogenetic mechanism in progression of threatened miscarriage and placental insufficiency.

Conclusion

HRV is an informative, accessible and non-invasive method for assessing functional status in pregnant women with threatened miscarriage. Decreased SDNN, RMSSD and HF with simultaneous increase in LF/HF may serve as early markers of high-risk gestational course.



Practical Recommendations. HRV screening should be performed in the first and second trimesters in women with TM. When $LF/HF > 3$, intensified monitoring and preventive interventions are recommended. HRV should be used for therapy effectiveness monitoring.

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