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Original Research Article

Heart Rate Variability as a Predictive Marker for Preeclampsia in Pregnancy

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Abstract

Background: Enormous cardiovascular adaptation occurs during Pregnancy as changes in autonomic functions are marked. Heart rate variability (HRV) throws light on these autonomic changes affecting cardiovascular system which is indicated by beat-to-beat variations in RR intervals in ECG.

Objective: Short term HRV of 5 minutes was taken in normal pregnant females of all the three trimesters, compared to control group.

Methodology: We took 50 normal pregnant females and had taken follow up HRV in each trimester. First trimester was considered as control group. Five minutes resting HRV was measured by Kubios Iworx 100 with Labscribe software. Standard protocols were followed to study time-domain & frequency domain parameters. They were further compared between case & control study groups for difference.

Results: Case study groups, second & third trimester's subjects and control group i.e. first trimester were compared. Decreased HRV was found in study group than control group. Statistical significance found in frequency domain & time-domain parameters in 9 subjects between 21 to 30 weeks of gestation. Second and third trimester study group was linked with major decline in HRV parameters.

Conclusion: HRV is generally found to be reduced during pregnancy in all trimesters, may be associated with many factors. Pregnancy itself is a significant risk for PIH with reference to changed cardiac balance. HRV may prove as a decent tool to evaluate these changes.

Keywords: HRV, Preeclampsia, Pregnancy.

Introduction

Preeclampsia, is a leading cause of maternal mortality affecting 2–8% of pregnancies worldwide [1]. Preeclampsia is newly developed hypertension after 20 weeks of gestation in previously normotensive females. Proteinuria and/or end-organ damage may be the alarming clinical presentation [2,3].

Heart rate variability (HRV), reliably reflects Autonomic Nervous System modulations, provides insights into cardio- vascular health [4]. This study evaluates HRV parameters in pregnant women to identify autonomic changes associated with preeclampsia risk.

Methods

After due approval from Institutional Ethics Committee the study was conducted at Jaipur National University Institute of Medical Sciences & Research Center, Jaipur. This study involved HRV of pregnant women across all trimesters. HRV was assessed using ECG recordings, analyzing time-domain (e.g., Mean RR, SDNN, RMSSD) & frequency-domain (e.g., LF, HF, LF/HF ratio) measures (e.g., SD1, SD2) (5; 6). Blood pressure and demographic data were recorded. Spectral analysis emphasized the LF/HF ratio to evaluate sympatho-vagal balance. The institutional ethics committee approved the study.

Results

Case study group's i.e. second & third trimester subjects and control group i.e. first trimester were compared. Fall in HRV was found in study group than control group. Statistically significant changes were found in frequency domain & time-domain parameters in 9 subjects between 21 to 30 weeks of gestation. Second & third trimester study groups were found with decreased HRV parameters.

Primiparous women were found with decreased HRV than multiparous women. Obesity and working status were significantly associated with low HRV in case group. HRV data with high LF/HF ratio associated with elevated blood pressure (SBP 140 mmHg or DBP 90 mmHg) in some participants, suggestive of PIH. Mean RR intervals ranged from 840 ms to 870 ms, and SDNN values varied from 40 ms to 70 ms. Total power (TP) ranged from 3500 ms² to 4000 ms². Subjects with raised LF/HF ratios presented with symptoms such as edema or headache, indicating preeclampsia. Below Table presents HRV data for subjects with raised blood pressure.

Table 1: ANOVA table showing comparison between BMI, HRV parameters of Control group & PIH group

Parameters	Control (Mean±SD)	PIH Group (Mean±SD)	P value
BMI	21.541±1.806	27.6629±2.19	<0.001
TP(ms2)	3965.06±693.655	3587.3333±147.699	0.12
LF/HF ratio	2.6572±0.7084	3.77±0.8707	< 0.001
Mean RR(ms)	944.9±121.5222	854.2222±77.0645	0.036
SDNN(ms)	57.2634±12.9204	53.7±6.7528	0.43
RMSSD(ms)	42.1378±8.3484	40.7522±6.9506	0.64

Discussion

Elevated LF/HF ratios indicate sympathetic predominance, indicating possibility of PIH [1]. Proteinuria may not be present in some cases showing need for alternative diagnostic tools like HRV [3].

The above findings line up with previous studies giving importance to HRV's predictive value showing autonomic changes affecting cardiovascular harmony [7, 8].

Limitations include the lack of longitudinal data to establish definitive predictive thresholds.

HRV analysis could enhance early detection and management of PIH & it's complications, thereby decreasing maternal and fetal morbidity & mortalities [9].

Conclusion

Non-invasive approach to detect autonomic imbalance linked to preeclampsia is better represented by HRV.

Elevated LF/HF ratios and associated HRV parameters provide a promising avenue for early risk stratification. Further studies are needed to validate HRV-based predictive models for hypertensive disorders during pregnancy.

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