

Study of Cardiovascular Parameters and Heart Rate Variability (Frequency Domain Analysis) in 1st Trimester of Normal Pregnant Women and Pregnant Women with Risk Factors for PIH in Western Rajasthan

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Abstract

Background: The role of sympathovagal imbalance (SVI) and CV risk in pregnancy-induced hypertension (PIH) has been reported, and their association during early trimesters of gestation in PIH has not been studied. Therefore, in the present study, we have investigated the maternal cardiovascular parameters and frequency domain indices of Heart rate variability (HRV) between normal pregnant women and women with risk factors for PIH in their 1st trimester of gestation.

Methods: Two hundred twenty subjects each (220 of normotensive pregnant women i.e., control group and 220 of pregnant women with risk factor for PIH i.e., study group) of 1st trimester of gestation were recruited from the obstetrics & gynecology department of Umaid hospital, associated with Dr. S. N. Medical College, Jodhpur, Rajasthan. Physical examination was done and anthropometric measurement like height & weight were taken. The collected data was statistically analyzed using HRV analysis software.

Results: Significant difference in body mass index was observed between the two groups. Systolic blood pressure, Diastolic blood pressure, Pulse pressure, Rate pressure product and Mean arterial pressure of study group was significantly higher than control group. Values of LF and LF/HF ratio components of frequency domain analysis of HRV were significantly increased but HF component is non significantly decrease in 1st trimester of the pregnant women with risk factor for PIH than normal pregnant women.

Conclusion: The present study indicates that the cardiovascular parameters in 1st trimester of pregnant women with risk factor for PIH were increased highly significantly than the normal pregnant women. The highly significant (HS) ($p < 0.000$) increase in the LF (nu) & LF/HF ratio and non significant (NS) ($p < 0.552$) decrease in HF (nu) of pregnant women with risk factors for PIH was observed than normal pregnant women this indicate that sympathetic tone was increased in 1st trimester of pregnant women with risk factor for PIH. Vagal withdrawal and sympathetic exaggeration may be the possible cause of PIH in pregnant women with its risk factors.

Keywords: PIH, Heart Rate Variability, pregnancy, autonomic nervous system

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Introduction

Severe HTN during pregnancy raises the risk of heart attacks, cardiac failure, cerebrovascular accidents, and renal failure in the mothers ⁽¹⁾. In India, the incidence of PIH is reported to be 8-10% among

pregnant women. According to a study, the prevalence of PIH was 7.8% with preeclampsia is 5.4% of the study population in India.

The exact pathophysiology of PIH is not known but low circulating volume and high vascular resistance is well established characteristics of this disease^(2,3)

Impairment of the autonomic nervous system functions may be the cause of PIH.⁽⁴⁾ Although there is still a debate regarding whether PIH is associated with disturbances in the sympathetic and parasympathetic functions of the autonomic nervous system⁽⁵⁾ Heart Rate Variability (HRV) analysis test can be used to evaluate changes in ANS during different pathophysiological conditions.

In recent year heart rate variability (HRV) is powerful tool for quantitative assessment of cardiac autonomic function, as an indicator of autonomic nervous activity and index of cardiac autonomic regulation.⁽⁶⁻⁸⁾ It is well established that high-frequency (HF) of HRV is mediated by parasympathetic nervous system (PNS) modulation⁽⁹⁻¹¹⁾ whereas low-frequency (LF) reflects both sympathetic nervous system (SNS) and parasympathetic nervous system (PNS) autonomic influences.^(12,13) The ratio of low-frequency power to high-frequency power (LF/HF) has been used to reflect cardiac sympathetic modulation (SNS indicator)^(13,14)

Decreased HRV is a marker of cardiovascular autonomic dysfunction and a predictor for cardiovascular risk and increased mortality^(15, 16); it can be used as a sensitive tool in the early detection of PIH in pregnant women with risk factors for PIH. But very few studies have been done on it, thus the main objective of our present project was to compare the maternal HRV (frequency domain parameters) changes between normal pregnancy and pregnancy with risk factors for PIH.

Material & Method

The present study was conducted in the Upgraded department of Physiology in Dr. S. N. medical college and hospitals, Jodhpur. Subjects (control group and study group) were recruited from the out-patient unit of the Obstetrics and Gynecology Department of UMAID hospital associated with Dr. S. N. Medical College. Before starting study all ethical consideration for the subjects were taken in accounts and written permission was obtained from institutional ethical committee. A written consent was obtained from each subject. Sample of the 440 women (220 normal pregnant women and 220 pregnant women with risk factor for PIH) were collected during the October 2019 to December 2019.

Subjects of study group included pregnant women who had risk factors for PIH so inclusion criteria for the study group included established risk factors for PIH such as

1. family history of preeclampsia,
2. preeclampsia in previous pregnancy,
3. extremes of reproductive age, and
4. BMI \geq 30.

Subjects of control group included pregnant women who had none of above mentioned risk factors for PIH. All the subjects were examined and detailed personal history was taken with reference to smoking, alcohol intake, family history of hypertension, socioeconomic status, place of residence etc. All subjects had to fill a proforma. Physical examination was done and anthropometric measurements like height and weight were taken and BMI was calculated.

The subject was advised to take complete bed rest in supine position for 10 minutes in a cool and calm environment and not to take and perform any physical or mental activity. Blood pressure was recorded using mercury sphygmomanometer. The recording of short

term HRV was done according to recommendation of the task force. After 10 minutes of supine rest in Polygraph laboratory of physiology department which was established in OPD of Obs. & Gyne. Department of UMAID hospital, all leads of HRV was placed over the subject in requisite position. Lead II of ECG was recorded for 5 minutes during supine rest using Physio Pac Digital Polygraph- Physiograph PL-2008, Medicaid 6 channel Systems, Chandigarh.

The data was transferred from Medicaid machine to window based computer with HRV analysis software. Frequency domain indices such as low frequency (LF), high frequency (HF) and LF/HF

ratio (ratio of low frequency and high frequency) of HRV were calculated. In the frequency domain, LF power indicates a mixture of action of sympathetic and parasympathetic components on heart rate with a predominance of sympathetic ones, whereas HF power reflects parasympathetic modulation of heart rate^(17, 18).

Statistical analysis of data:

SPSS version 13 (SPSS Software Inc., Chicago, IL, USA) was used for statistical analysis. All data were expressed as mean \pm SD. We used Student's unpaired t-test for the level of significance between the two groups.

Result

Table 1: The comparison of the cardiovascular parameters between normal pregnant women and pregnant women with risk factors for PIH.

Cardio vascular parameters (mm Hg)	1st trimester of Normal pregnant women (control group)	1st trimester of Pregnant women with risk factor for PIH (study group)	Normal v/s PIH risk factors women
	Mean \pm S.D	Mean \pm S.D	P value
SBP	104.99 \pm 5.89	120 \pm 9.913	<0.000 \uparrow
DBP	65.30 \pm 3.12	78.49 \pm 7.67	<0.000 \uparrow
MAP	78.53 \pm 3.50	92.32 \pm 7.78	<0.000 \uparrow
RPP	82.28 \pm 5.55	101.23 \pm 13.8	<0.000 \uparrow
PP	39.68 \pm 5.10	41.52 \pm 7.15	<0.000 \uparrow

The data presented are Mean \pm S.D. P value<0.01 was considered statistically highly significant

Table 1 is showing the comparison of SBP (mm of Hg), DBP (mm of Hg), MAP (mm of Hg), PP (mm of Hg) & RPP between the normal pregnant women and pregnant women with risk factors for PIH in their

1st trimester. The result shows the highly significant (HS) (p<0.000) increase in the SBP (mm of Hg), & DBP (mm of Hg), MAP (mm of Hg), PP (mm of Hg) & RPP of pregnant women with risk factors for PIH.

Table 2: Comparison of Frequency domain parameters between normal pregnant women and pregnant women with risk factors for PIH.

Frequency domain analysis	1st trimester of Normal pregnant women (control group)	1st trimester of Pregnant women with risk factor for PIH (study group)	Normal v/s PIH risk factors women
	Mean±S.D	Mean±S.D	P value
LF (nu)	30.55±4.91	39.27±5.8	<0.000↑
HF (nu)	33.37±9.88	32.84±8.8	<0.552↓
LF/HF	0.99±0.31	1.29±0.43	<0.000↑

The data presented are Mean±S.D. P value<0.01 was considered statistically highly significant.

Table 2 is showing the comparison of LF (nu), HF (nu) & LF/HF ratio between the normal pregnant women and pregnant women with risk factors for PIH in their 1st trimester. The result shows the highly significant (HS) ($p<0.000$) increase in the LF (nu) & LF/HF ratio and non significant (NS) ($p<0.552$) decrease in HF (nu) of pregnant women with risk factors for PIH.

Discussion

In the present study, the blood pressure measurement in the present study, had a highly significant increase in Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Mean Arterial Pressure (MAP), Rate Pressure Product (RPP) and Pulse Pressure (PP) in the study group compared to the control group, which suggest that subjects having risks of developing PIH have altered CV parameters even in the early part of pregnancy, this may be due to their increased sympathetic discharge as PIH is first and foremost a state of sympathetic overactivity. So the cause of elevated blood pressure in PIH risk factor women in our study is may be sympathetic activation. This observation was supported by the study of

Chaswal M. et al. (2018)⁽¹⁹⁾, Subha et al (2014)⁽²⁰⁾ & G. K. Pal et al. (2011)⁽²¹⁾.

The variables analyzed among the “Frequency Domain Measures” included in our study are “LF, HF, and LF/HF Ratio”. As expected “Frequency Domain” variable LF which reflect both sympathetic and parasympathetic influence show highly significant ($p<0.01$) increase in 1st trimester of gestation of study group compared to control group, where as HF which mainly reflect parasympathetic influences was non significantly ($p>0.05$) lower in 1st trimester of gestation of study group compared to control group. “LF/HF Ratio” marker of sympathovagal imbalance (mainly depicts sympathetic dominance) was significantly high ($P<0.01$) in 1st trimester of gestation of study group compared to control group.

The current investigation likewise shows that in study group, patients have higher LF/HF ratio segments of “Frequency Domain Indices” which for the most part measures the sympathovagal balance to heart reflecting an increase in sympathovagal nerve action in PIH patients in starting of their pregnancy. The LF/HF ratio has been proposed to be a precise

proportion of the general sympathovagal balance of the autonomic nervous system in which higher values demonstrate an all the more sympathetically driven cardiovascular system. Same results were obtained by the study of Chaswal M. et al. (2018)⁽¹⁹⁾, A. Hossen et al. (2013)⁽²²⁾ G. K. Pal et al. (2011)⁽²¹⁾. The changes occurs in preeclampsia is not fully understood but few studies observed that some biologically active factors like cytokines or reactive oxygen species from placenta which inhibit vascular relaxation pathway or facilitates vascular smooth muscle contraction, may be responsible for hypertension in pregnancy.

Reports from various studies indicate that these placental factors cytokines and reactive oxygen species⁽²³⁻²⁵⁾ released peripherally cross the blood-brain barrier and influence activities of various brain centers and their estimation may be helpful for further research. Although no intervention has yet proven effective for the prevention of PIH, early identification of women at risk for PIH may improve maternal and perinatal outcome. Screening for PIH is believed to be most relevant during the first trimester because preventive interventions (such as anti-platelet agents, calcium and antioxidants) are more likely to be effective if initiated early in pregnancy when pathogenic mechanisms may be modified. Further confirmation of the risk of future PIH based on HRV may enable closer prenatal monitoring, earlier diagnosis and prompt and appropriate management.

Conclusion

The present study conducted with the objective to compare maternal cardiovascular and HRV changes (frequency domain analysis) between normal pregnant women & pregnant women with risk factor for PIH it clearly indicates that the sympathetic activation may be the cause of elevated blood pressure in preeclamptic pregnant women of Jodhpur district. This study adds further evidence for the dominant cardiac sympathetic modulations in patients with risk factors for PIH compared with normal pregnant

women, probably due to parasympathetic withdrawal in the study group. The frequency domain analysis of heart rate variability proved as a good tool in the study of preeclampsia. Significant increase in the LF and LF/HF ratio component of frequency domain indices was observed in pregnant women with risk factor for PIH than normal pregnant women this indicates that sympathetic tone was increased in study group. Our study on frequency domain analysis suggested that vagal withdrawal and sympathetic exaggeration may be the possible cause of PIH in pregnant women. Our study could have been better if this study would be conducted in different trimester of pregnancy. Further this study could be better if we estimate the levels of placental factors cytokines and reactive oxygen species in both the groups along with the level of proteinuria.

Ethical Clearance: Research involves human participants so ethical approval is obtained from Institutional ethics committee of Dr. Sampurnanand Medical College and Hospital, Jodhpur-. (IEC No.-18/15753).

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Conflict of Interest: Nil

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