Short Communication

Myocardial works stress is linked to sympathovagal imbalance in prehypertensives

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Abstract

The link of sympathovagal imbalance (SVI) to rate-pressure product (RPP), the marker of myocardial stress in prehypertension has not been elucidated. Body mass index (BMI), cardiovascular parameters, spectral analysis of heart rate variability, and RPP were assessed in young normotensives (*n* = 58) and prehypertensives (*n* = 58). BMI, heart rate, blood pressure, RPP and low-frequency to high-frequency (LF-HF) ratio were more in prehypertensives compared to normotensives. Pearson correlation revealed a significant association of LF-HF with RPP in prehypertensives, but not in normotensives. Bivariate regression analysis revealed the independent contribution of LF-HF ratio to RPP in prehypertensives. It was concluded that SVI contributed to myocardial work stress in young prehypertensives.

Key words: Myocardial work stress, prehypertension, sympathovagal imbalance

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INTRODUCTION

Recently, prehypertension has been reported to be associated with adverse cardiovascular (CV) events.[1-3] Especially in Asia-Pacific region, the prevalence of ischemic heart disease and stroke in prehypertensive population is comparable to that of hypertension.[4] However, until date no study has evaluated the link of CV dysfunction to the pathophysiological processes that contribute to the genesis of prehypertension. Though the exact mechanisms involved in the causation of prehypertension have not yet been clearly explained, recent reports from our laboratory revealed the role of sympathovagal imbalance (SVI) in the form of sympathetic overactivity and vagal withdrawal in the development of prehypertension.[5-7] Our studies have revealed that prehypertension is more prevalent in males compared to females, and vagal withdrawal is more prominent compared to sympathetic overactivity in male prehypertensives.[8,9] We have reported that body mass index (BMI) and preference for salt are major contributors to the SVI in the causation of prehypertension in Indian population.[10,11] We have also reported that in young prehypertensives, SVI is more intense in offspring of two parents hypertensive compared to that of one parent hypertensive.[12] All these reports of ours establish SVI as the important physiological basis for the genesis of prehypertension. We have observed and analyzed that decreased vagal modulation of cardiac functions and decreased the magnitude of heart rate variability (HRV) are major CV risks in prehypertensives.[13] Though CV risks have been reported in prehypertensives, the pathophysiology of the myocardial work stress in prehypertension has not yet been fully elucidated. Increased rate-pressure product (RPP), a marker of myocardial work stress has been reported to be associated with CV risks.[14] Therefore, in this study we have assessed the link of RPP with SVI in prehypertensives.

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METHODS

After obtaining the approval of Research Advisory Council and Institutional Ethics Committee of Jawaharlal Institute of Postgraduate Medical Education and

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Research (JIPMER), Puducherry, India, 58 prehypertensive subjects were recruited from among the students of medical and paramedical streams of JIPMER, students and staff of central school of JIPMER campus. Eligible participants were explained about their participation and the nature of investigations to be carried out in the project. Informed written consent was obtained from all of them prior to the recordings. The age-matched normotensives served as controls. Prehypertensive and normotensives were grouped based on their level of systolic and diastolic blood pressure (SBP and DBP) as per JNC-7 classification.[15]

- Normotensives (n = 58): Healthy subjects having SBP 100–119 mmHg and DBP 60–79 mmHg
- Prehypertensives (n = 58): Healthy subjects having SBP 120–139 mmHg and DBP 80–89 mmHg.

Subjects on antihypertensive therapy or receiving any medication, with history of smoking and/or alcoholism, with acute or chronic ailments, performing regular sports activities, and known cases of diabetes mellitus, hypertension, cardiac diseases, kidney disease or any endocrinal disorder were excluded from this study.

Laboratory conditions, blood pressure and heart rate variability recordings

Subjects were asked to report to autonomic function testing (AFT) laboratory of the physiology department at about 7.30 am following overnight fast. The temperature of AFT laboratory was maintained at 25°C for all the recordings. After obtaining the informed consent, their age, height, body weight and BMI were recorded. BP of all the subjects was recorded in AFT laboratory. Omron (SEM 1 Model), the automatic BP monitor (Omron Healthcare Co., Ltd., Kyoto, Japan) was used for BP recording. SBP, DBP and basal heart rate (BHR) were noted from the display screen of the equipment. For each subject, SBP, DBP, and BHR were recorded in each arm twice at an interval of 5 min between the recordings, and for each parameter the mean of the four recordings was considered. RPP was calculated using the formula, RPP = SBP × heart rate × 10^{-2}.[13]

After 15 min of supine rest on a couch in AFT laboratory, electrocardiogram was recorded for 5 min for short-term HRV analysis following the standard procedures as practiced in the laboratory. For recording of HRV, the recommendation of the task force on HRV was followed.[16] From frequency domain indices of HRV, the ratio of low-frequency to high-frequency power (LF-HF ratio) was calculated for assessment of sympathovagal balance or imbalance.

SPSS version 13 (SPSS Software Inc., Chicago, IL, USA) and GraphPad InStat software (GraphPad Software Inc., San Diego, CA, USA) were used for statistical analysis. All the data were expressed as mean ± standard deviation. Normality of data was tested by Kolmogorov-Smironov test. For parametric data, the level of significance between the groups was tested by Student's unpaired t-test and for nonparametric data, the Welch's corrected t-test was used. The association of LF-HF ratio with RPP was assessed by Pearson correlation analysis. Independent association of RPP with LF-HF ratio was assessed by bivariate regression analysis. The P value < 0.05 was considered statistically significant.

RESULTS AND DISCUSSION

In the present study, BMI, BHR, SBP, DBP, mean arterial pressure and RPP were significantly more in prehypertensives compared to the normotensives [Table 1]. Also, there was a significant increase in LH-HF ratio in prehypertensives. LF-HF ratio is a sensitive measure of sympathovagal balance and increase in this ratio indicates increased basal sympathetic activity and decreased parasympathetic activity.[16] Higher LH-HF ratio in prehypertensives indicates SVI. It has been reported that SVI in prehypertensive could be due to high BMI, insulin resistance, dyslipidemia, retrograde inflammation, and oxidative stress.[17]

RPP is an indirect measure of myocardial workload and oxygen consumption, is considered as a potential CV risk especially in hypertensives.[15] In the present study, RPP was significantly high in prehypertensives compared to normotensives [Table 1]. Also, LF-HF ratio was significantly correlated with RPP in prehypertensives (r = 0.315, P = 0.007) but not in normotensives (0.098, P = 0.872). Further, on regression analysis, LF-HF ratio had an independent contribution to RPP [Table 2]. Thus,

Table 1: Comparison of age, BMI, cardiovascular parameters and LF-HF ratio between NT and PHT population

Parameters	NT (n=58)	PHT (n=58)	P
Age (years)	20.56±2.75	21.60±3.47	0.095
BMI (kg/m^2)	21.92±3.70	27.23±3.83	<0.001
CV parameters			
BHR (per min)	70.05±6.76	78.50±9.93	<0.001
SBP (mmHg)	103.30±7.60	130.74±5.50	<0.001
DBP (mmHg)	66.80±6.42	84.08±3.41	<0.001
MAP (mmHg)	78.90±6.55	99.63±3.88	<0.001
RPP (mmHg/min)	72.36±8.85	102.64±9.25	<0.001
LF:HF	0.66±0.37	1.76±0.75	<0.001

Data expressed as mean±SD. Statistical analysis was done by Student's unpaired t-test. P<0.05 was considered statistically significant. NT: Normotensive, BMI: Body mass index, BHR: Basal heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MAP: Mean arterial blood pressure, RPP: Rate pressure product, LF:HF ratio: Ratio of low-frequency to high-frequency power of heart rate variability, PHT: Prehypertensive, BMI: Body mass index, SD: Standard deviation, CV: Cardiovascular

Table 2: Bivariate regression analysis of LF-HF ratio (as dependable variable) with RPP (as independent variables) in the PHT population (*n*=58) adjusted for age, gender and BMI

Independent variables	Exp (B)	95% CI		*P*
		Lower bound	Upper bound	
RPP	0.453	0.003	0.905	0.012

P<0.05 considered significant. BMI: Body mass index, CI: Confidence interval, RPP: Rate pressure product, PHT: Prehypertensive, LF:HF: Ratio of low-frequency to high-frequency power of heart rate variability

myocardial energy expenditure could be linked to SVI and the risk of CV dysfunctions in prehypertension may possibly be linked to the level of RPP in prehypertensives. In the present study, as the prehypertensives were age-matched with control subjects, the effects of age on SVI and cardiac works stress were nullified. The limitation of the study are that we have not assessed cardiac functions in these subjects, and we have not correlated cardiac dysfunctions (if present) in prehypertensives with SVI.

CONCLUSION

Findings of the present study suggest that SVI is linked to increased RPP in prehypertensives, which in turn increases the risk of CV dysfunction in these subjects by increasing their myocardial enery expenditure.

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