The Study of Cardiovascular and Echocardiographic Parameters Among Young Prehypertension Males

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ABSTRACT

Introduction: Prehypertension, being a precursor of clinical hypertension, is one of the important public health challenge all over the world. It is not only associated with unwanted cardiac morphological and functional remodeling, but also with many other co-morbidities. Hence, the study was planned to evaluate the effect of prehypertension on cardiovascular and echocardiographic parameters.

Material and Methods: 30 prehypertensive males of age group 24.00 ± 2.38 years were included in the study. Another 30 apparently healthy males of age group 23.57 ± 1.83 years served as controls. Relevant medical history and anthropometric variables were taken. Cardiovascular and echocardiographic parameters were recorded for each of the subject.

Results: The prehypertensives were found to have statistically very highly significant higher values of resting SBP, DBP, MAP (mean arterial pressure), heart rate and rate pressure product. They also had statistically very highly significant higher values of interventricular septum thickness, left ventricular posterior wall thickness and left ventricular end systolic diameter.

Conclusions: The study thus showed that prehypertension was associated not only with significant cardiovascular load, but also with abnormal cardiac morphological and functional remodeling.

Keywords: Prehypertension, echocardiography, cardiovascular system remodeling.

INTRODUCTION

Prehypertension is one of the important public health challenges, all over the world. It is responsible for approximately 62% of cardiovascular disease (CVD) and 49% of ischemic heart disease as per WHO.[1] The term prehypertension was coined in 1939 in context of some early studies that linked high blood pressure recorded for life insurance purposes to subsequent mortality and morbidity.[2] The seventh report of the Joint National Committee on prevention, detection, evaluation and treatment of high blood pressure, suggested a new classification for high–normal blood pressure levels-the prehypertension. It is defined as a condition, which heralds hypertension and may be considered as a starting point in cardiovascular disease continuum.[3]

Due to the change in life style patterns and increase life expectancy, the risk of prehypertension, hypertension and cardiovascular diseases is highest in affluent urban population in the developing countries of Asia and Africa. The prevalence of prehypertension is higher in males, in the age group of 30-39 yrs as reported by National Health and Nutrition Examination Survey (NHANES).[4] Also, the prevalence of prehypertension (36%) was highest in the same age group of 30-39 years among the urban young adults in North India.[5]

As compared to normotensive counterparts, prehypertensives have been shown to have significant higher values of resting SBP (systolic blood pressure), resting DBP (diastolic blood pressure), resting MAP (mean arterial pressure), resting pulse pressure, resting heart rate and resting rate pressure product.[7] It has also been reported to have unwanted cardiac morphological and functional remodeling.[8] Individuals with prehypertension has been associated with the development of left ventricular hypertrophy, diastolic dysfunction, and increase in left ventricular thickness, left ventricular mass, increased left atrial size, as compared to individuals with normal blood pressure.[8]

To the best of our knowledge, very few studies have been conducted to evaluate the effect of prehypertension on cardiovascular and echocardiographic parameters, hence the study was planned to evaluate the load and strain on cardiovascular system including structural and functional cardiac remodeling due to prehypertension.

MATERIALS AND METHODS

The study was carried out in the Department of Physiology, Himalayan Institute of Medical Sciences, Swami Ram Nagar, Dehradun over a period of 12 months. Study group was recruited from the students, employees of Swami Rama Himalayan University (SRHU) and residents of Bhaniyawala. Subjects were recruited after taking written and informed consent. A sample size of 30 each for the control and prehypertensive group was obtained using the formula for differences of means at 90% power and α error of 0.05.[9] Following inclusion and exclusion criteria were followed:

a. Control Group (n=30)
   i. Inclusion Criteria
      - Age group: 20 to 40 years
      - Sex: Males
      - Non obese (BMI ≤ 30 kg/m^2)
      - Resting blood pressure:
        Systolic <120 mm Hg
        Diastolic <80 mm Hg

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ii. Exclusion Criteria
- Chronic alcoholic
- Chronic smoker
- Patients with history of medication for Diabetes Mellitus (DM)
- Patients with history of any chronic disease
- History of typical or atypical chest pain

b. Prehypertensive Group (n= 30)

i. Inclusion Criteria
- Age group: 20 to 40 years
- Sex: Males
- Non obese (BMI ≤ 30 kg/m^2)
- Resting blood pressure:
  Systolic 120 - 139 mm Hg
  Diastolic 80 - 89 mm Hg

ii. Exclusion Criteria
- Chronic alcoholic
- Chronic smoker
- Patients with history of medication for Hypertension and Diabetes Mellitus (DM)
- Patients with history of any chronic disease like Tuberculosis (TB), Chronic Obstructive Pulmonary Disease (COPD), Chronic Renal Failure (CRF), Rheumatoid Arthritis (RA)
- History of typical or atypical chest pain

The study was approved by the ethical committee of the institute.

Subjects were asked to report in the department of physiology at 9:00 am. They were asked to take light breakfast in the morning and avoid tea, coffee, heavy exercise, 2 hours before the reporting time. A structured case reporting form was designed to generate required data. Age (years), sex, height (in cm), body weight (in kg), BMI (in kg/m^2), relevant medical history and examination findings were recorded.

Cardiovascular parameters measurement

After a rest of 10 min in sitting position, systolic blood pressure, diastolic blood pressure, mean arterial pressure, pulse pressure, heart rate and rate pressure product were recorded. Rate pressure product or double product was calculated as systolic blood pressure multiplied by heart rate,[10] and heart rate recovery was calculated as heart rate at second minute of exercise minus heart rate after 1 minute of exercise. Blood Pressure Apparatus (model no. EW 254 DC6V) was used.

S. No.	Parameters	Controls (Mean ± SD)	Cases (Mean ± SD)	p-value
1	Age (years)	23.57 ± 1.83	24.00 ± 2.38	0.432
2	Height (cm)	170.93 ± 5.45	170.83 ± 6.28	0.949
3	Weight (Kg)	70.00 ± 4.92	69.97 ± 5.28	0.980
4	BMI (Kg/m^2)	23.97 ± 0.39	23.88 ± 0.37	0.409
p>0.05 -non significant, p<0.05 – significant, p<0.01- highly significant, p<0.001- very highly significant. Unpaired t test.				

Table-1: Comparison of anthropometric parameters among controls and cases (n=30 each)

Echocardiographic parameters measurement

Following parameters were recorded: resting left atrium size, left ventricular end diastolic volume, left ventricular end systolic volume, left ventricular end diastolic diameter, left ventricular end systolic diameter, inter ventricular septum, left ventricular ejection fraction and left ventricular post wall thickness. Echocardiograph (Model Philips HD11XE SNo. US 11270001) was used.

STATISTICAL ANALYSIS

SPSS (Statistical Package for Social Science) version 20 software was used for data analysis. Standard descriptive statistics were determined. Unpaired t test was used for the cardiovascular and echocardiographic parameters comparison between the control and the prehypertensive group. The level of Significance was set at p<0.05.

RESULTS

The anthropometric parameters: age, height, weight and BMI between the controls and the prehypertensives were similar (Table 1).

As compared to controls, the prehypertensives had statistically very highly significant higher values of resting systolic blood pressure, resting diastolic blood pressure, resting MAP, resting pulse pressure, resting heart rate and resting rate pressure product (Table 2).

As compared to controls, the prehypertensives had statistically very highly significant higher values of interventricular septum thickness, left ventricular posterior wall thickness and left ventricular end systolic diameter. They had lower value of left ventricular end diastolic diameter, left ventricular end diastolic volume and left ventricular ejection fraction, but were statistically insignificant. They also had statistically insignificant higher values of left atrial size, left ventricular end systolic diameter and end systolic volume (Table 3).

DISCUSSION

Prehypertensives were found to have statistically very highly significant higher values of resting systolic blood pressure, resting diastolic blood pressure, resting MAP, resting pulse pressure, resting heart rate and resting rate pressure product (Table 2).

S. No.	Parameters	Controls (Mean ± SD)	Cases (Mean ± SD)	p-value
1	Resting SBP (mmHg)	108.97 ± 7.29	128.77 ± 5.88	0.000
2	Resting DBP (mmHg)	69.03 ± 5.99	83.17 ± 3.79	0.000
3	Resting MAP (mmHg)	82.34 ± 6.01	98.37 ± 3.38	0.000
4	Resting Pulse Pressure (mmHg)	39.93 ± 5.03	45.60 ± 6.60	0.000
5	Resting Heart rate (beats per min)	73.00 ± 2.99	85.47 ± 5.68	0.000
6	Resting Rate Pressure Product (mmHg per min)	7950.43± 569.89	11010.03 ± 941.28	0.000
p>0.05 -non significant, p<0.05 – significant, p<0.01- highly significant, p<0.001- very highly significant. Unpaired t test.				

Table-2: Comparison of cardiovascular parameters among controls and cases (n=30 each)

S. No.	Parameters	Controls (Mean ± SD)	Cases (Mean ± SD)	p-value
1	Left atrial size (cm)	3.05 ± 0.34	3.09 ± 0.26	0.523
2	Interventricular septum Thickness (cm)	0.79 ± 0.06	0.92 ± 0.08	0.000
3	Left ventricular post.wall thickness (cm)	0.82 ± 0.08	0.90 ± 0.09	0.000
4	Left vent. end diastolic diameter (cm)	4.50 ± 0.37	4.43 ± 0.21	0.391
5	Left vent. end diastolic volume (ml)	106.97 ± 7.55	103.60 ±10.83	0.167
6	Left vent. end systolic diameter (cm)	2.86 ± 0.18	3.08 ± 0.25	0.000
7	Left vent. end systolic volume (ml)	40.82 ± 3.31	40.91 ± 5.12	0.932
8	Left ventricular ejection fraction (%)	61.79 ± 2.51	60.37 ± 4.62	0.144
p>0.05 -non significant, p<0.05 – significant, p<0.01- highly significant, p<0.001- very highly significant. Unpaired t test.				

Table-3: Comparison of echocardiographic parameters between the controls and cases (n=30 each)

Similar findings have been reported by Pal GK et al.[7] The finding may be due to sympathovagal imbalance or autonomic dysregulation among prehypertensives.[11] Due to the increased sympathetic activity and decreased parasympathetic activity, they are more liable and prone to hypertension and cardiovascular diseases.[12] Others have also reported autonomic dysregulation among prehypertensives.[13,14]

Since the oxygen demand of the heart has been reported to be higher in prehypertensives and hypertensives, rate pressure product is more among them. Rate pressure product is calculated as the product of systolic blood pressure and heart rate.[10] It is a good estimate of myocardial work or internal work done, and is proportional to myocardial oxygen consumption.[10,15]

The present study has shown that hypertensives had statistically significant higher values of interventricular septum thickness, left ventricular posterior wall thickness and left ventricular end systolic diameter, as compared to controls. They also had higher value of left atrial size and left ventricular end systolic volume than the controls, but the increase was statistically insignificant. The values of left ventricular end diastolic diameter, left ventricular end diastolic volume and left ventricular ejection fraction, were less among prehypertensives as compared to controls, which was statistically insignificant (Table 3).

The increase in interventricular septum thickness and left ventricular posterior wall thickness may indicate increase in left ventricular cardiac muscle mass.[16] The finding of increased left ventricular mass in prehypertensives was also reported by Manios E et al,[17] Di Bello V et al[18] and Stabouli S et al.[19] The increase in left ventricular mass has been reported to be a strong predictor of cardiovascular morbidity in hypertension.[20]

The increase in the cardiac mass is caused by increase in pressure load (primarily due to increase in resistance or after load) and represents an attempt by the heart to normalize myocardial wall stress.[21] Although hypertrophy primarily involves myocytes, the interstitial network also changes. This occurs initially in a perivascular distribution but progressively extends to cause a widespread interstitial fibrosis of the cardiac muscle.[21] In addition, replacement fibrosis may occur to replace necrotic or apoptotic myocytes. This increased interstitial fibrous tissue is probably one of the main causes for increased left ventricular stiffness and cardiac dysfunction seen in hypertension.[21]

The increase in left ventricular end systolic diameter may be due to increase in left ventricular stiffness and reduce contractility.[22] The increase in cardiac stiffness may also account for decrease in left ventricular end diastolic diameter and volume, indicating decreased left ventricular compliance.[23] This may lead to reduction in left ventricular ejection fraction. Prehypertension is associated with increase in left atrial volume,[24] the left atrial volume is an accurate index of left atrial size.[25] In our study as compared to controls, the cases had higher values of left atrial size, which was statistically insignificant (Table 3).

CONCLUSION

The prehypertensives were found to have significant higher cardiovascular parameters, including resting rate pressure product. This indicated that the prehypertensives were having more cardiac load as compared to the normotensives.

The echocardiographic findings indicated that there was unfavorable cardiac remodeling among the prehypertensives due to pathological pressure overloading, and altered hemodynamics, resulting in decrease in systolic as well as diastolic cardiac function.

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REFERENCES

1. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL, Jr., et al. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. JAMA. 2003;289:2560-72.
2. Vasan RS, Beiser A, Seshadri S, Larson MG, Kannel WB, D'Agostino RB, et al. Residual lifetime risk for developing hypertension in middle-aged women and men: The Framingham Heart Study. JAMA. 2002;287:1003-10.
3. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL, Jr., et al. Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. Hypertension. 2003;42:1206-52.

4. Wang Y, Wang QJ. The prevalence of prehypertension and hypertension among US adults according to the new joint national committee guidelines: new challenges of the old problem. Arch Intern Med. 2004;164:2126-34.
5. Yadav S, Boddula R, Genitta G, Bhatia V, Bansal B, Kongara S, et al. Prevalence and risk factors of pre-hypertension and hypertension in an affluent north Indian population. Indian J Med Res. 2008;128:712-20.
6. Qureshi AI, Suri MF, Kirmani JF, Divani AA, Mohammad Y. Is prehypertension a risk factor for cardiovascular diseases? Stroke. 2005;36:1859-63.
7. Pal GK, Pal P, Nanda N, Lalitha V, Dutta TK, Adithan C. Sympathovagal imbalance in young prehypertensives: importance of male-female difference. Am J Med Sci. 2013;345:10-7.
8. Marilyn B, Lawrence W, Richard B. Association of prehypertension by Joint National Committee 7 criteria with left ventricular structure and function-the strong heart study. Journal of the American College of Cardiology. 2004;17:1142-83.
9. Chrysant SG. Current evidence on the hemodynamic and blood pressure effects of isometric exercise in normotensive and hypertensive persons. J Clin Hypertens (Greenwich). 12:721-6.
10. Hanjabam B, Kailashiya J. Effects of addition of sprint, strength and agility training on cardiovascular system in young male field hockey players: An echocardiography based study. IOSR Journal of Sports and Physical Education. 2014;1:25-9.
11. Pal GK, Pal P, Nanda N, Amudharaj D, Adithan C. Cardiovascular dysfunctions and sympathovagal imbalance in hypertension and prehypertension: physiological perspectives. Future Cardiol. 2013;9:53-69.
12. Dogru MT, Simsek V, Sahin O, Ozer N. Differences in autonomic activity in individuals with optimal, normal, and high-normal blood pressure levels. Turk Kardiyol Dern Ars.;38:182-8.
13. Doğru M, Güneri M, Tireli E, Sahin O, Celik T, Iyisoy A. QT interval and dispersion differences between normal and prehypertensive patients: effects of autonomic and left ventricular functional and structural changes. Anadolu Kardiyol Derg. 2009;9:15-22.
14. Erdogan D, Gonul E, Icli A, Yucel H, Arslan A, Akcay S, et al. Effects of normal blood pressure, prehypertension, and hypertension on autonomic nervous system function. Int J Cardiol. 2011;151:50-3.
15. Gobel FL, Norstrom LA, Nelson RR, Jorgensen CR, Wang Y. The rate-pressure product as an index of myocardial oxygen consumption during exercise in patients with angina pectoris. Circulation. 1978;57:549-56.
16. Perrault H, Turcotte RA. Exercise-induced cardiac hypertrophy. Fact or fallacy? Sports Med. 1994;17:288-308.
17. Manios E, Tsivgoulis G, Koroboki E, Stamatelopoulos K, Papamichael C, Toumanidis S, et al. Impact of prehypertension on common carotid artery intima-media thickness and left ventricular mass. Stroke. 2009;40:1515-8.
18. Di Bello V, Talini E, Dell'Omo G, Giannini C, Delle Donne MG, Canale ML, et al. Early left ventricular mechanics abnormalities in prehypertension: a two-dimensional strain echocardiography study. Am J Hypertens. 2010;23:405-12.
19. Stabouli S, Kotsis V, Rizos Z, Toumanidis S, Karagianni C, Constantopoulos A, et al. Left ventricular mass in normotensive, prehypertensive and hypertensive children and adolescents. Pediatr Nephrol. 2009;24:1545-51.
20. Devereux RB. Echocardiographic insights into the pathophysiology and prognostic significance of hypertensive cardiac hypertrophy. Am J Hypertens. 1989;2:186S-95S.
21. Mayet J, Hughes A. Cardiac and vascular pathophysiology in hypertension. Heart. [Review]. 2003;89:1104-9.
22. Borlaug BA, Lam CS, Roger VrL, Rodeheffer RJ, Redfield MM. Contractility and Ventricular Systolic Stiffening in Hypertensive Heart DiseaseInsights Into the Pathogenesis of Heart Failure With Preserved Ejection Fraction. Journal of the American College of Cardiology. 2009;54:410-8.
23. Lorell BH, Carabello BA. Left ventricular hypertrophy: pathogenesis, detection, and prognosis. Circulation. 2000;102:470-9.
24. Akturk E, Ermis N, Yagmur J, Acikgoz N, Kurtoglu E, Cansel M, et al. Early Left Atrial Mechanics and Volume Abnormalities in Subjects with Prehypertension: A Real Time Three-Dimensional Echocardiography Study. Echocardiography. 2012 Aug 29.
25. Anwar AM, Soliman OI, Geleijnse ML, Nemes A, Vletter WB, ten Cate FJ. Assessment of left atrial volume and function by real-time three-dimensional echocardiography. Int J Cardiol. 2008;123:155-61.

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