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ORIGINAL ARTICLE

Left ventricular hypertrophy in controlled hypertension: Is blood pressure variability blamed?

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KEYWORDS

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Abstract *Background:* Blood pressure (BP) has been shown to exhibit important variations not only in the short term but also over more prolonged periods of time.
Aim: To evaluate the impact of different ambulatory BP variability indices on left ventricular hypertrophy (LVH) in controlled hypertensive patients (Pts).
Patients and methods: Ninety controlled hypertensive Pts (office and ambulatory BP control criteria) with mean age 55.9 ± 8.5 years were enrolled. Pts were classified into two groups: Non-LVH group including 75 Pts with normal LV mass index and LVH group including 15 patients with LV mass index > 134 g/m^2 in men and > 110 g/m^2 in women. Mean BP and BP load values were obtained for the full 24 h and day-time and night-time periods. Similarly Standard Deviation (SD) and Average Reading Variability (ARV) were calculated in all pts.
Results: Regarding office BP, Dipping status and average ambulatory BP, there was no statistically significant difference between both groups. Meanwhile, SD of BP readings and ARV showed a significant difference. After step-wise regression, ARV of systolic BP 24 h was the most powerful variability index that was associated with LVH ($R2$ = 0.944). The ROC curve analysis showed that the discriminative power was best at more than 14.23 mmHg with sensitivity and specificity 100% and 96% respectively for prediction of LVH.
Conclusion: The adverse cardiovascular consequences of hypertension not only depend on mean BP values but may also depend on BPV, which independently adds to CV risk over elevated mean BP levels.

1. Introduction

Hypertension has a serious harmful effect on the physiological and biochemical functions of heart that end with the appearance of cardio-vascular diseases.[1] Blood pressure is characterized by large spontaneous variations from time to time in a hypertensive patient during the day and between days, months and seasons so called blood pressure variability (BPV).[2] It is an independent predictor of progression of subclinical organ damage (i.e., increased left ventricular mass index or carotid intima-media thickness)[3] and cardiovascular (CV) mortality.[4]

Accordingly, the purpose of the present work was to evaluate the impact of different ambulatory BP variability indices on left ventricular hypertrophy (LVH) in controlled hypertensive patients (Pts).

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2. Patients and methods

This prospective study included 90 hypertensive pts who presented to Minia University hospital outpatient cardiology clinic, during the period from May 2013 to May 2014 for regular follow up of blood pressure.

All included pts had a history of hypertension for at least 3 years, and were compliant on antihypertensive treatment for at least the last year and their office blood pressure (BP) and ambulatory blood pressure monitoring (ABPM) represented controlled hypertension (i.e. $<140/90$ mmHg office BP readings and $<135/85$ mmHg average 24 h ABPM readings respectively). Smoking, Diabetes Mellitus, renal impairment, Impaired LV systolic function (LVEF 45%), valvular heart disease, coronary artery disease, atrial fibrillation and obesity were the exclusion criteria.

The studied pts were subjected to the following:

1. Full detailed clinical evaluation including blood pressure measurements at morning hours in sitting position after at least 5 min of rest. An average value of 3 measurements was obtained. BMI (kg/m^2) and BSA (m^2) were calculated and Local cardiac examination was performed.
2. Laboratory investigations: including fasting blood sugar and Serum creatinine.
3. 24-h ambulatory BP monitoring: Pts were fitted with an ABPM device (Contec model ABPM 50, China).

The device was programmed to obtain BP readings at 15-min interval during the day (07:00–23:00 h) and at 30-min intervals during the night (23:00–07:00 h). Mean systolic BP (SBP), Diastolic BP (DBP), Mean arterial pressure (MAP) and BP load values were obtained for the full 24 h, day-time and night-time periods.

I Calculation of blood pressure variability indices:

- *Dipping status:* Normal dippers are defined as those with average night BP decreasing 10–20% of the average daytime BP. Non-dippers are those with average night BP decreasing 0–10% of the average daytime BP. Extreme-dippers are those with average night BP decreasing $>20\%$ of the average daytime BP. Meanwhile, reversed dippers are those with average night BP higher than the average daytime BP.
- Standard Deviation (SD) and Average Reading Variability (ARV) of 24 h BP, daytime BP and nighttime BP (systolic & diastolic) were calculated

i. Standard Deviation (SD)[3]:

$$\text{Standard Deviation (SD)} = \sqrt{\frac{\sum(X - X^{\wedge})}{N-1}}$$

(N) Number of valid BP measurements – (X) denotes each single ABPM reading ($X^{\wedge}$) average of ABPM readings – ($\sum$) denotes that we sum across the values.

ii. Average Reading Variability (ARV)[3]:

$$\text{ARV} = \frac{1}{N-1}\sum_{K=1}^{N-1}|\text{BP}k+1 - \text{BP}k|$$

(N) Number of valid blood pressure (BP) measurements – (K) ranges from 1 to $N-1$ – ($\sum$) denotes that we sum across the values.

I Trans-thoracic echocardiography.

- Echocardiography examination was performed by using General Electric Vivid 3 ultrasound with simultaneous ECG tracing. The measurements represent a mean of 3 consecutive cardiac cycles.
- Left ventricular mass (LV Mass) was calculated by Devereux's formula.[5] as follows:
- LV mass $= 0.8$ $[1.04\{(\text{IVSd} + \text{LVEDd} + \text{PWTd})^3 - \text{LVEDd}^3\}] + 0.6$ g.
- BSA is calculated by Mosteller square root method[6]
- BSA = Height (m) × Weight (kg)/36 (m^2).
- LV mass Index (LVMI) = $\frac{\text{LV}_{\text{mass}}}{\text{BSA}}$ (g/m^2).

According to this formula, LVMI is increased if >134 g/m^2 in men and >110 g/m^2 in women.[5]

3. Statistical methodology

The Statistical Package of SPSS version 16 for windows was used for data entry and analysis. Standard descriptive statistics were done and all values were given as mean ± SD.

Correlations were done by Pearson correlation coefficient test. Correlation was considered significant if its P value was <0.05.

Multivariate stepwise regression analyses were done for all ABPM indices that showed significant correlation with LVMI. Roc curve analysis was done for the most powerful ABPM index detected by multivariate stepwise regression analysis.

4. Results

Based on echocardiographic measurement of LV mass index (g/m^2), patients were classified into two groups:

A – Non-LVH group. This group included 75 patients.

B – LVH group (where LV mass index is >134 g/m^2 in men and >110 g/m^2 in women). This group included 15 patients.

There was no statistically significant difference between Non-LVH group and LVH group as regard age, sex and duration of hypertension. (Table 1).

Table 1 Comparing Non-LVH group and LVH group regarding age, sex and hypertension duration.

	Non-LVH ($n = 75$)	LVH ($n = 15$)	P value
Age (y) mean ± SD	55.75 ± 8.76	57.07 ± 7.02	0.585
Sex prevalence (male/female)	32/43	3/12	0.100
Duration of hypertension diagnosis (y) mean ± SD	4.75 ± 2.99	5. 24 ± 3.61	<0.07

LVH = left ventricular hypertrophy.