Original Paper

Blood Pressure Variability and Left Ventricular Mass in Hypertensive Patients

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ABSTRACT: Objectives The purpose of the study is to evaluate 24h blood pressure values by automatic ambulatory monitoring (ABPM) in a group of hypertensive patients already on therapy and to find correlations between different blood pressure parameters and the presence of left ventricular hypertrophy (LVH). Design and method: 39 patients diagnosed with essential hypertension grades 1-3 were enrolled in the study; echocardiography was done and left ventricular mass and mass index were calculated. Based on 24 h ABPM we calculated BP variability estimated as standard deviation (SD) and average real variability (ARV), pulse pressure, dipper profile and morning BP surge. We compared these parameters in pts with and without LVH and calculated correlations with LV mass. Results: Nocturnal diastolic BP variability estimated as SD had significantly higher values in pts with LVH (13,2 vs 9,9 mmHg, p=0,015), ARV/24 hour and ARV during nighttime had higher values in pts with LVH vs those with normal LV mass (12,25 vs 9,7 mmHg and 12,35 vs 9,36 mmHg, p=0,03). Nocturnal diastolic BP variability correlated with LV mass index (r=0,325 for ARV and r =0,327 for SD). Other variables did not correlate with LV mass. Conclusions Nocturnal diastolic BP variability correlates with LVH independently of mean BP value. ABPM offers a valueable analysis of BP and enables the calculation of different parameters- as variability- which predict target organ damage.

KEYWORDS: *variability, blood pressure, left ventricular mass, hypertension*

Introduction

Hypertension (HTN) is the most powerful risk factor for cardiovascular diseases including coronary artery disease, stroke, heart failure and cardiovascular death; it can be modified if early diagnosed and if diet and therapy are prescribed. Ambulatory blood pressure monitoring (ABPM) provides important benefits in the management of hypertensive patients as the large number of readings during 24h offer a clearer assessment than a single measurement. Average blood pressure (BP) value for 24 hour and average values during day and nighttime correlate more strongly to cardiovascular morbidity than single office values. Different summary measures of BP from ABPM have been described and all have evidence of prognostic significance for cardiovascular morbidity beyond average value [1]. Among these are: BP variability (BPV), nocturnal dipping, morning surge and pulse pressure.

BP shows rapid beat to beat oscillation (their analysis implies direct continuous intraarterial recordings), short term variation (minutes to hours, this variability can be estimated by ABPM) and long term variability (days, months, representing large visit to visit BP variation). Rapid and short time BPV are due to interplay between sympathetic nervous system- mainly as a reaction to behavioural changes, baroreceptor reflex, vascular properties: vascular myogenic response, endothelial integrity and release of mediators, various humoral and rheological factors, changes in ventilation [1]. Increased BPV is caused by abnormal neural regulation, impaired arterial baroreflex and altered properties of arteries.

There are many preclinical (animal) and clinical studies who indicated BPV as a risk factor for the following target organ damage: arterial remodelling, left ventricular hypertrophy (LVH), cardiovascular events, cerebrovascular disease and renal damage [1,2,3]

The purpose of the study is to analyse BP profile recorded by ABPM in a group of hypertensive patients on therapy and to find correlations between BP variability calculated as standard deviation (SD) and average real variability (ARV), pulse pressure, nocturnal dipping, morning surge and the presence of LVH.

Material and method

It is an observational study which enrolled 39 patients with grade 1-3 hypertension hospitalized in the Cardiology Department of Craiova County Emergency Hospital between november 2014- january 2015; their hospitalization was necessary to evaluate BP values, target organ damage and to adjust therapy. Approval and informed consent have been obtained from all patients. Exclusion criteria were: significant valvular heart disease,

congenital heart disease, specific cardiomiopathies, heart failure with reduced EF, arrhytmias (atrial fibrillation), pacing. Routine biochemical tests were done: blood glucose, cholesterol, triglyceride, creatinine and estimation of glomerular filtration rate (GFR) using MDRD formula; resting ECG and echocardiography were done with measurement of LV diameters, volumes, calculation of LV mass using Devereux formula, LV mass index, and evaluation of systolic and diastolic function.

All pts had 24h ABPM with a validated device GE Tonoport V; BP measurements were automatically taken every 30 minutes. The original therapy scheme was kept unchanged. The following measures were available from ABPM: average systolic, diastolic BP values over 24h, average values over daytime, nighttime; two different measures of BPV were calculated: SD for systolic, diastolic BP over 24h and selectively during nighttime, ARV as the average of absolute values of differences between two consecutive BP measurements. ARV is a more sensitive BP variability index than SD. We calculated morning surge as the difference between average of 4 consecutive values after waking and average of 2 measures before waking, the last including the lowest nocturnal value.

Statistical analysis

We used Microsoft Excel program (Microsoft Corp. Redmond, WA, USA), together with SPSS Statistics 20.0 (IBM Corporation, Armonk, NY, USA) for data processing. Because most parameters did not have a gaussian distribution we used nonparametric tests for data correlation (Spearman correlation test, Mann Whitney test).

Results

Demographic characteristics, risk factors incidence and target organ damage

Patients age varied between 34-86 yrs, average value being 60,71 yrs, women representing 61,53%. Duration since HTN was diagnosed varied between 1- 30 yrs, average value being 7,89 yrs. Diabetes mellitus (DM) was found in 9 pts (23%), LDL cholesterol value > 115 mg/dl was present in 23 pts (58,97%), HDL cholesterol value <50 mg/dl in 19 pts (48,71%) and triglyceride value >150 mg/dl in 11 pts (28,2%).

Demographic characteristics and values of major biological tests in patients with and without LVH are shown in Table 1.

Table 1. Demographic characteristics and values of major biological tests for the study group

parameter	entire group	group without LVH	group with LVH	p Mann-Whitney
women (%)	61,53	12,82	48,71	
age (yrs)	60,11± 11,29	58,55± 11,28	61,629 ± 11,40	NS
HTN duration (yrs)	7,89± 7,32	7,06 ±8,77	7,97 ±6,83	NS
DM (%)	9	5	4	NS
LDL cholesterol (mg/dl)	128,02± 43,45	117,73 ±34,73	132,07 ± 46,38	NS
HDL cholesterol (mg/dl)	50,92± 13,4	53,55 ± 12,76	49,89 ±13,73	NS
triglycerides (mg/dl)	145,92± 100,45	113 ± 40,46	158,86 ± 113,94	NS
GFR(ml/min/1,73m^2)	89,32± 32,34	102,27 ±28, 94	84,24 ± 32,67	NS

Target organ damage was found in the following percentages: stable angina or previous unstable angina/ myocardial infarction in 15 pts (38,64%), chronic kidney disease evaluated as GFR< 60ml/min/1,73m^2 on repeated measurements in 5 pts (12,82%), stroke in 4 pts (10,25%).

Patients were on antihypertensive therapy, most often with more classes of which: diuretics, β- blockers, Ca channel blockers, angiotensin I converting enzyme inhibitors (ACEI), angiotensin receptor blockers (ARB). 7 pts (17,94%) were on 4 antihypertensive drugs, 14 pts (35,89%) were on 3 drugs, the same percentage on 2 drugs, 3 pts (7,69%) on only 1 drug and 1 patient (2,56%) was free of therapy.

LV mass

LVH is considered if LV mass index value is over 95g/m^2 in women and over 115 g/m^2 in men. LV mass values ranged between 123-410g; the average value was 231,94± 59,11 g. LV mass index ranged between 72- 211g/m^2, with an average value of 118,46± 28,69 g/m^2. LVH was found in 71,79% of patients of which

DOI: 10.12865/CHSJ.42.01.07

19 women (79,6% of all women) and in 9 men (60% of all men).

Average BP value, nocturnal dipping and BP variability

Average BP value obtained by 24h monitoring for the entire group was 135,18 /79,63 mmHg. 20 pts (51,28%) had average systolic BP/24h over 135 mmHg and 14 pts (35,89%) had average diastolic BP/24h over 85 mmHg. Pulse pressure (PP) had an average value of 55,55 mmHg and 17 pts (43,58%) had pp values> 53 mmHg, threshold value which indicates increased arterial stiffness. Average nocturnal dipping was -5,74% for systolic and -9,17% for diastolic BP. 9 pts (23,07%) had a favourable profile with more than 10% nocturnal decrease in systolic BP, while 20 pts (51,28%) had the same decrease in nocturnal diastolic BP.

BP variability calculated as standard deviation (SD) was 15,13/ 11,66 mmHg for 24h period and 13,13/11,17 during nighttime. ARV was 13,28/10, 68 mmHg for 24h period and 12,49/10,51 mmHg during nighttime. Average BP values and different BP variability parameters in the two groups with and without LVH are shown in Table 2.

Table 2. Average BP values and different BP variability parameters in the two groups with and without LVH

parameter	entire group	group without LVH	group with LVH	p Mann Whitney
average SBP	135,18± 14,75	131,68 ± 12,39	136,56± 15,57	NS
average DBP	79,63 ± 8,47	80,45± 7,69	79,31 ± 8,88	NS
pp	55,55 ± 12,60	51,24 ± 9,34	57,25 ± 13,44	NS
nocturnal dipping SBP	-5,74 ± 5,96	-6,2± 8,19	-5,56 ± 5,01	NS
nocturnal dipping DBP	-9,17 ± 8,07	-8,98 ±11,03	-9,25 ±6,83	NS
24h variability SBP (SD)	15,13 ± 3,9	14,48±3,71	15,4 ±4,01	NS
24h variability DBP (SD)	11,66± 3,85	10,93± 2,52	12,82 ±5,25	NS
nocturnal variability SBP (SD)	13,13 ±4,63	12,92 ± 4,92	13,22 ± 4,61	NS
nocturnal variability DBP (SD)	11,17 ± 4,2	9,9 ±3,13	13,2 ± 4,95	**0,015**
ARV 24h SBP	13,28 ± 4,2	13,02 ±4,97	13,38 ±3,96	NS
ARV 24h DBP	10,68 ± 3,83	9,7 ± 3,13	12,25 ± 4,41	**0,032**
nocturnal ARV SBP	12,49 ± 4,2	11,76±3,77	12,78 ± 4,39	NS
nocturnal ARV DBP	10,51 ± 4,46	9,36 ± 3,66	12,35 ± 5,11	**0,030**
morning surge	10,73± 7,18	11,51± 7,44	10,44 ± 7,2	NS

SBP- systolic blood pressure, DBP- diastolic blood pressure, SD- standard deviation, ARV- average real variability

Parameters reflecting diastolic BP variabilityfor 24 hour and during nighttime (SD, ARV) had significantly higher values in pts with LVH. PP and morning surge did not have statistically significant differences.

Correlations

There is a significant correlation between LV mass index and nocturnal diastolic BP variability (correlation coeficient for ARV: r=0,325, p=0,044, correlation coeficient for SD: r= 0,372, p= 0,020) as shown in Fig.1 and 2. Also LV mass index correlates with diastolic ARV/24h (r= 0,372, p=0,02).

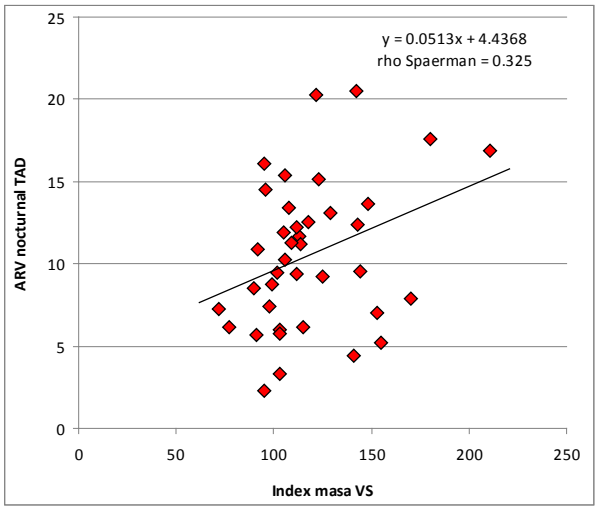

Fig.1. Correlation of LV mass index and nocturnal diastolic ARV

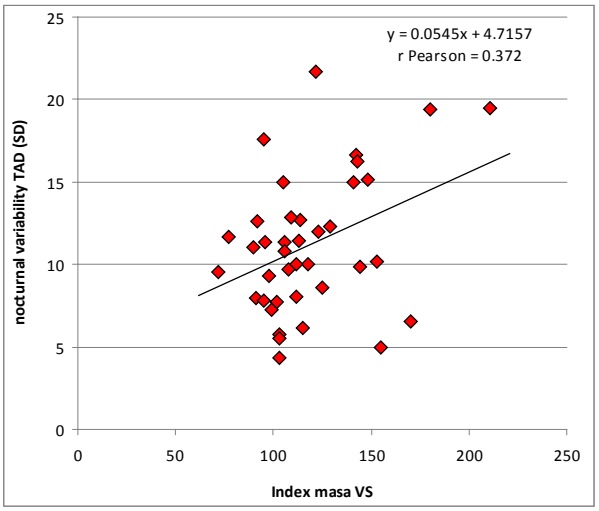

Fig.2. Correlation of LV mass index and nocturnal BP variability calculated as SD

Other parameters as average BP/24h, nocturnal dipping and morning surge did not correlate with LV mass. Older age correlates with increasing pulse pressure (r= 0,33, p=0,04) but not with BP variability. Increasing average BP values is accompanied by increasing BP variability, correlation ranged from 0,33 for systolic BP to 0,43 for diastolic BP. BP variability does not correlate with LDL cholesterol, other lipid fractions or with DM presence.

Discussion

The study calculated BP variability and other parameters derived from 24 hour ABPM and looked for correlations with LV mass. We obtained a significant correlation of LV mass index with nocturnal diastolic BP variability expressed as SD and ARV. The last one is a more accurate marker of variability being less dependent on the number of measurements. Other indexes like average BP value did not have significant correlation with LV mass. Most pts were on therapy which changed BP profile. Medication schedule might have influenced less BP values during nighttime, so nocturnal BP variability became a stimulus for hypertrophy. BP variability is closely linked to arterial stiffness and autonomic dysfunction.

There are studies that show a direct association between BP variability and LVH. A study made by R. Sega [4] found a correlation between LV mass index and both systolic (r=0,38) and diastolic BPV (r=0,88) in pts without therapy. In the study made by A. E. Schutte [5] systolic BP variability correlated with LV mass calculated by Cornell index (r =0,37) again in pts without medication. In C. Podoleanu [6] study only systolic variability (ARV) measured for daytime, nighttime and 24 hour was significantly increased in pts with LVH. Although variability is a recognised risk factor for target oragan damage, there is no single parameter or a threshold value beyond which complications occur more often.

Conclusions

ABPM provides important information in hypertensive patients; nocturnal BP variability is a stimulus for LV hypertrophy. Medication can mask the contribution of different BP parameters to LVH.

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 DOI: 10.12865/CHSJ.42.01.07