Assessment of the Correlation between Ambulatory Blood Pressure Thresholds and Echocardiographic Indices of Left Ventricular Size and Function.

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Abstract:

Introduction: **Hypertension is a leading cause of stroke, coronary artery disease, heart failure and premature death around the world. Ambulatory blood pressure monitoring (ABPM) calculates the average of BP readings over a set period of time, and its values have been proven to be more closely related to the left ventricular mass (LVM) .** ***Aim:*** **This study aimed at finding ambulatory Blood pressure thresholds at which Echocardiographic indices of Left Ventricle Size and function start to be affected .** ***Material & Methods.*** **This study was conducted on seventy eight patients visiting cardiology clinic of Suez Canal hospital .** ***Results.*** **This cross-sectional study included 78 patients , the mean age was 55 years(from 21 to 70 years). Subjects with significantly higher systolic BP averages found with dilated left atrium , significant higher average SBP found with impaired GLS compared with those with normal SBP readings who were found to have normal GLS . There was a strong correlations between ambulatory BP readings and Echocardiographic changes including LVH , Left atrial dilatation and impaired GLS , correlations were more stronger in GLS impairment rather than LVH and LA dilatation (correlation coefficient: 0.772,P<0.001). Systolic blood pressure averages showed stronger correlations with LVH, LA dilatation and GLS impairment than diastolic averages . The determined optimal ABPM threshold in this study at which cardiac changes (LVH, LA dilatation or GLS impairment) occur is > 140 mmHg for 24-hour SBP. Conclusion. Higher ambulatory BP thrersholds were significantly associated with hypertension, LA dilatation, LV hypertrophy and impaired GLS in subjects with normal LVEF. The thresholds at which these cardiac changes start to manifest are higher than the established ABPM normal values, which was found to be > 140 mmHg in 24-SBP.**

Keywords: Ambulatory Blood Pressure , Left ventricle indexed volume , Speckle tracking echocardiography , Left atrium indexed volume.

Introduction:

Ambulatory blood pressure monitoring (ABPM) provides the average of BP readings over a defined period, usually 24 hours. The average BP values are usually provided for daytime, night-time, and 24 hours. A diary of the patient's activities and sleep time can also be recorded . Ambulatory blood pressure (BP) values have been shown to have a better relationship to the left ventricular mass (LVM) of hypertensive patients with LVH than conventional office BP measurements [1]. Similarly, the regression of LVH associated with improved cardiovascular prognosis may be more closely correlated with reductions in ambulatory BP than office blood pressure. Day-time and night-time blood pressure values and their changes due to treatment are related to

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each other [2].The most significant risk factor in the process of changing LV contractility and relaxation from normal structure/geometry to LV remodeling is systemic hypertension, which causes myocyte hypertrophy and interstitial fibrosis. The basis of the so-called hypertensive heart disease is these morpho-functional changes; specifically, LV hypertrophy (LVH), which is frequently evaluated by electrocardiography or, more precisely, echocardiography, is the key biomarker of subclinical cardiac damage [3].

Patients & Methods

Study population

This cross sectional study was conducted on seventy eight patients visiting cardiology clinic of Suez Canal hospital with the following criteria: Males and females aging > 18 years old , patients presenting for ambulatory BP monitoring for the following indications**:** suspected White coat HTN, suspected masked HTN , assessment of nocturnal BP and dipping status , patients who have previously been diagnosed with hypertension but in whom this diagnosis is uncertain (e.g. due to persistently normotensive or hypotensive readings on only low-dose antihypertensive medication). Exclusion Criteria included Patients with Valvular heart disease , patients with Ischemic heart disease,patients with congestive heart failure and Patients with secondary HTN.

The study protocol & the informed consent were in accordance were approved by the Bioethics Committee of Suez Canal University of Medical Sciences.

All patients assessed in the following variables:

1.A questionnaire: Includes questions about demographics, symptoms and risk factors such as: age, sex, BMI, smoking status, and presence of chronic illnesses: diabetes, hypertension, dyslipidemia.

2.Ambulatory BP monitoring: Ambulatory BP device (model : DMS 300-4A) is present in cardiology department of Suez canal university , patients can take the device with them , it was attached to their arms for 24 hrs and it was used to assess Day time systolic BP , Night Time systolic BP , Day Time Diastolic BP , Night Time Diastolic BP , 24hr average systolic BP , 24h – average Diastolic BP and 24h- Mean arterial BP.

3.Conventional echocardiography: Standard echocardiography was performed using a commercially available Philips EPIQ 7C system. All the measurements were analyzed taking the average of three cardiac cycles. The left atrium volume index was determined by the biplane-area-length method. Two-dimensional measurements of LV wall thickness was assessed in parasternal long-axis views. LVEF was calculated by the biplane Simpson method. As measures of global LV diastolic function peak velocities at the early (peak E) and late (peak A) diastole, their ratio and deceleration time of the E wave were assessed by pulsed-Doppler with the sample volume placed at the mitral valve leaflet tips and at the aortic outflow. Finally, by pulsed tissue Doppler, peak early diastolic velocity on the septal part of the mitral annulus were measured (e′) and E/e′ ratio was calculated.

4.Speckle tracking echocardiography (STE): 2Dspeckle tracking echocardiography was performed using the Philips EPIQ 7CaCMQ strain package. Measurements of LV GLS were performed in the 2, 3, and 4chamber apical views. The endocardial border was traced manually at end-systole. Tracking was adjusted to include the entire myocardial wall from the endocardium to the myo-epicardial border.

Data management:

A Microsoft Excel sheet containing the patient's data was used for data entry, & version 25.0 of the Statistical Package for Social Sciences software was used for analysis. P values of less than (0.05) were deemed statistically significant (At 95% level of confidence) when statistical significance tests were employed. For quantitative variables, descriptive statistics were shown as (Means ± Standard Deviation), & for qualitative variables, as (Percent). For quantitative variables, the significance of the difference was tested using the Student t test. The Chi square test was applied to examine relationships between qualitative variables. After gathering information on patients, physicians, & imaging studies, as well as researching the relationships between various aspects, the management outcomes were displayed in tables & graphs.

Results

This study included 78 patients visiting cardiology clinic in Suez Canal University Hospital. Table 1 shows the counts and percentages of the qualitative variables in the study. The study population is roughly balanced in terms of gender distribution. Only around a third of patients were known hypertensive, since ABPM is typically ordered for undiagnosed patients. A similar proportion were diabetics. Around a quarter of patients complain of dyspnea and/or headache, with fewer patients having other complaints such as chest pain, palpitations, and/or orthopnea. The mean age was around 55 years ranged from 21 to 70 years old with some overall obesity (mean BMI approximately 30 kg/m2).

Table 2 compares ambulatory blood pressure averages between patients with LVH (LVMI > 115 g/m2 male or > 95 g/m2 female) and those without. As expected, all average blood pressure readings are significantly higher in patients with LVH.

Table 3 shows Pearson correlations between 24-hour blood pressure readings and several important echocardiographic parameters. As might be expected, most measures of LV mass and ventricular filling/atrial pressure correlated significantly with both systolic and diastolic blood pressure averages, with the strongest correlations exhibited by GLS, LVMI and LAVi with GLS impairment having the strongest correlation compared to LVH and LD dilatation (correlation coefficient : 0.772 _ P<0.001). Interestingly, systolic blood pressure readings showed stronger correlations with these parameters than diastolic readings.

Table 4 shows area under the curve and optimal cutoffs. All SBP average showed the highest AUC for detecting cardiac changes (0.93), followed closely by day SBP (AUC 0.927). In accordance with the previous observation SBP was superior to DBP and day BP was superior to night BP at differentiating the presence of cardiac changes. The determined optimal ABPM thresholds at which cardiac changes (LVH, LA dilatation or GLS impairment) occur are 140 mmHg for 24-hour SBP.

Table 1: Basic demographic and clinical data of the study participants (n=78).		
	N	%
Age (years) mean±SD	54.5±11.3	
range	21-70	
Gender Male Female	 38 40	 48.7% 51.3%
Comorbidities (%)		
Smokers	25	32.1%
Hypertension	27	34.6%
DM	24	30.8%
Dyslipidemia	22	28.2%
Complaint (%)		
Dyspnea	21	26.9%
Chest pain	13	16.7%
Orthopnea	2	2.6%
Palpitations	6	7.7%
PND	3	3.8%
Headache	18	23.1%
BSA	2.0±0.2	
BMI (kg\2)	29.7±5.7	
Abbreviations : DM; diabetes mellitus, PND; Paroxysmal nocturnal dyspnea, BSA; body surface area, BMI; body mass index		

Table 2: Comparison of blood pressures between patients with LVH and those without			
	No LVH	LVH	P value
SBPD (mmHg)	133.6±15.2	157.2±15.2	<0.001
DBPD (mmHg)	79.4±9.9	92.7±9.9	<0.001
SBPN (mmHg)	123.6±14.2	144.7±14.7	<0.001
DBPN (mmHg)	72.2±10.7	84.3±9.7	<0.001
SBP 24h (mmHg)	128.5±14.3	152.3±13.3	<0.001
DBP24h (mmHg)	75.6±9.5	89.2±8.7	<0.001
Dipping (mmHg)	12.0±5.6	9.8±6.2	0.11
*Student t test used. *Statistically significant as p<0.05.Abbreviations :SBPD : systolic blood pressure at day , DBPD : day diastolic blood pressure , NSBP : night systolic blood pressure , NDBP : night diastolic blood pressure , LVH : left ventricular hypertrophy*			

Table 3: Correlation between 24-hour blood pressure readings and pertinent echocardiographic parameters											
		LVEF	LVM	LVMI	LA diameter	E/A	E/e'	DT	sPAP	LA IV	LVGLS
All SBP average	R	0.112	0.627	0.649	0.553	0.057	0.435	-0.174	0.545	0.625	-0.772
	P value	0.330	<0.001	<0.001	<0.001	0.624	<0.001	0.127	<0.001	<0.001	<0.001
All DBP average	R	0.076	0.572	0.602	0.497	0.086	0.336	-0.287	0.390	0.501	-0.618
	P value	0.506	<0.001	<0.001	<0.001	0.455	0.003	0.011*	<0.001	<0.001	<0.001

*Pearson correlation test used. *Statistically significant as p<0.05.Abbreviations : SBP : Systolic Blood pressure , DBP : Diastolic Blood pressure , LVEF : left ventricular ejection fruction , LVM : left ventricular mass , LA : left atrium , DT : deceleration time , GLS : global longitudinal strain, PAP : pulmonary artery pressure , LAIV : left atrium indexed volume.*

Table 4: Validity of optimal thresholds of ambulatory blood pressure for the detection of any cardiac change (LVH, LA dilatation, and impaired GLS).

Test Result Variable(s)	AUC	Optimal cutoff	Sensitivity	Specificity
All SBP average	0.930	140	85.3%	86.4%
Day SBP	0.927	145	82.4%	88.6%
Night SBP	0.884	131	88.2%	75.0%
Day DBP	0.853	87	76.5%	88.6%
All DBP average	0.851	83	76.5%	88.6%
Night DBP	0.783	79	64.7%	81.8%

*Pearson correlation test used. *Statistically significant as p<0.05. Abbreviations : AUC : area under the curve, SBP : Systolic Blood pressure , DBP : Diastolic Blood pressure.*

Discussion

In this current study, ambulatory systolic blood pressure averages were (157.2±15.2 mmHg / 24hr SBP) in patients with LVH , these averages were significantly higher than those without LVH (133.6±15.2 mmHg /24hr SBP) (P< 0.001). This is expected, as the presence of LVH is a more conclusive indicator of the presence of hypertension [(4)]. This is in agreement with another study correlating ambulatory blood pressure profile with left ventricular geometry in group of hypertensive patients, they found that mean ambulatory BPs were significantly higher in patients with LVH compared with those without LVH [(5)]. Comparing ambulatory blood pressure averages between patients with LA dilatation and those without, showed that patients with dilated left atria had significantly higher blood pressure averages, (P<0.001). This is attributable to the fact that increase in LV diastolic filling pressure and LV stiffness in hypertensive hearts leads to increase left atrial pressure and left atrial dilatation [(6)]. Similarly, Su et al., found that left atrium enlargement was noted in 195 hypertensive patients (57.2%) in the study group [(7)].

In the current study we found a significant difference in ambulatory readings between patients with impaired GLS (<18%) versus patients with normal GLS, with the former having significantly higher ambulatory readings (P<0.001), This can be explained by the high level of end-systolic wall stress in hypertension, as well as the hypertrophic myocardium itself playing a pathophysiological role in reducing the subendocardial longitudinal-oriented myocardial fiber shortening in hypertensive patients [8]. In agreement with our study Narayanan et al., also reported that significantly impaired GLS was observed only in hypertensive patients with extreme LV hypertrophic remodeling (LV mass >190g) [9].

In This study there was strong correlation between ambulatory BP readings and Echocardiographic changes such as LVH , Left atrial dilatation and impaired GLS, with GLS impairment having the strongest correlation compared to LVH and LA dilatation (correlation coefficient: 0.772, P<0.001). This is agreement with a study by Santos et al., that highlights the role of GLS in early prediction of cardiac changes in even mild cases of hypertension. Their findings showed lower GLS in patients in the beginning of the hypertensive spectrum (stage I HTN) compared with prehypertensive patients, demonstrating that a mild difference in BP (around 10 mm Hg in SBP and DPB) can affect longitudinal systolic function [10]. In our study, systolic blood pressure readings showed stronger correlations with LVH, LA dilatation, impaired GLS than diastolic readings.Also Similar to our results, Aparicio et al., conducted a study with a mixed population (either receiving or not receiving antihypertensive treatment), consisting of more than 900 patients, and showed that 24 h systolic ABPM, was more associated with LVMI than DBP ($p < 0.01$) [11].

The determined optimal ABPM thresholds in this study at which cardiac changes (LVH, LA dilatation or GLS impairment) occur was > 140 mmHg for 24-hour SBP (AUC 0.93) , this is agreement with Cuspidi et al., who found that the risk of developing LVH, as well as cardiovascular outcomes, has been shown to depend on the severity of hypertension, that is, to progressively increase as blood pressure increases from the upper normal limit of 140/90 mm Hg [12].

Conclusion

In conclusion, ambulatory blood pressure averages were higher in known hypertensives versus patients without history of hypertension although a significant degree of overlap was observed, calling into question the reliability of using office BP measurements for diagnosis of hypertension. Higher ambulatory BP readings were significantly associated and correlated with LV hypertrophy, LA dilatation and impaired GLS in subjects with normal LVEF, independent of the presence or absence of other cardiovascular risk factors. The threshold at which cardiac changes start to manifest, namely LVH, LA dilatation, and GLS impairment, was found to be > 140 mmHg in 24-SBP, which is somewhat higher than the established ABPM normal values. In addition, systolic blood pressure readings showed stronger correlations with these parameters than diastolic readings.

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