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Correlation between Ambulatory Blood Pressure Profile and Left Ventricular Geometry in Egyptian Hypertensive Patients

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Abstract

Background: LVH is one of the sequelae of uncontrolled hypertension which portends a negative impact on both morbidity and mortality. Some studies evaluated the association between ABPM and LVH but data are still not sufficient whether LV geometric changes can be predicted certain parameters from ABPM or not.

Methodology: 150 adults with primary hypertension attending the hypertension clinic in Suez Canal University were studied. Parameters of ABPM were analyzed and correlated with LVH. LV geometric changes. LVMI was calculated by two different methods, one in relation to the body mass index and another in relation to height 2.7.

Results: Patients were divided two groups, dippers and non-dippers group. Mean age was 48.9 years with 71.3% were females. According to LVM/BSA, 10% had concentric hypertrophy, 2.7% had eccentric hypertrophy and 24.6% with concentric remodeling. LVH was prevalent in the non-dippers. According to LVM/height 2.7, 18.0% had concentric hypertrophy, 22.0% with eccentric hypertrophy and 14.6% with concentric remodeling. LVH was also more in the non-dippers. According to LVM/BSA, and LVM/height 2.7 patients with concentric hypertrophy had the most elevated SBP, patients with eccentric hypertrophy had the most elevated DBP and patients with concentric remodeling had elevated day-time BP. The significant differences in LV geometry were found in 24-hour and day-time SBP.

Conclusion: There was no statistically significant difference between the different LV geometric patterns between dippers and non-dippers by ABPM. Daytime SBP and 24-h systolic BP elevations were associated with significant differences in LV geometric changes in hypertensive patients.

Keywords: Aortic root dilatation; Geometric patterns; Blood Pressure; Left Ventricular Geometry; Right Ventricular Geometry

Introduction

Left ventricular hypertrophy has a strong and independent predictor of all-cause mortality and CV events in hypertensive patients [1-3] because of the associated increase in heart failure, ventricular arrhythmia and death from myocardial infarction, low ejection fraction (EF), aortic root dilatation and cerebro-vascular events [4].

Hypertension is the most common cause of LVH and more than one third of patients at the time of their diagnosis with hypertension show LVH [5]. Prevalence of LVH varies according to the severity of hypertension ranging from<20% in mild hypertension to reach around 100% in severe or complicated hypertension [6]. In 30 studies including around 37,000 subjects, the prevalence rates of echocardiographic LVH were the lowest in population-based studies (10%-19%), intermediate (19%-48%) in untreated hypertensive patients and the greatest in high risk hypertensive subjects (58%-77%), who were hypertensive with (ECG-LVH, severe hypertension, history of previous CV events or refractory hypertension) [7].

Great heterogeneity in the prevalence of LV geometric patterns has been reported in hypertensive patients. Contrary to conventional knowledge, concentric hypertrophy is not the most common pattern. In studies including around 20,600 hypertensive subjects, normal LV geometry was the most common pattern eccentric LVH was almost 25% and around 18% for concentric LVH [8].

Ambulatory blood pressure profile has a better relationship to the LVM in hypertensive subjects with LVH than OBP measurements [8]. Also the regression of LVH associated with improved CV prognosis is more closely correlated to the reductions in ABP than OBP [9-13].

Twenty-four ABPM (24-ABPM) values of average SBP correlate with LVH indices in hypertensive subjects unlike office measurement [14]. Also early structural cardiac changes (increase in septal thickness, decrease in LV ejection time) are related to ABP profile [15].

Although day-time and night-time BP values and their changes with treatment are related to each other [16], the prognostic value of night-time BP is superior [17]. Many studies had concluded that the non-dipping pattern of hypertension may the responsible for the development of the concentric type of LVH [18]. Blood pressure profile without the physiological dipping in the night is believed to promote structural changes in the LV [19]. The rennin angiotensin aldosterone system is most probably responsible for that [20,21].

The non-dipper patients are at higher risk of micro-and macro-vascular complications than dipper patients [21,22] and the non-dipping status is a determinant of cardiac remodeling and LV diastolic dysfunction (LVDD) and may result in a cardiovascular risk independent of the increase in LVM [23] Hypertensive subjects with the non-dipper pattern have more LVM than those with the dipper pattern. Also subjects with the non-dipper pattern have higher risks of cardiac and extra-cardiac morbidity [24,25].

In many studies the nocturnal SBP and the non-dipping status was an independent risk factor for the presence of LVH in hypertensive patients [26] and in a systematic review the nocturnal SBP was a stronger predictor than day-time SBP in hypertensive subjects. The night/day BP ratio and the dipping status were significant predictors of outcome [27]. Some studies showed that isolated nocturnal hypertension was accompanied with higher risks of all CV events and mortality and also isolated day hypertension can predict the fatal and non-fatal CV events and it was found that irrespective the type of the ambulatory hypertension, any rise in the BP is a major risk for CV complications and either isolated nocturnal or day hypertension is not a benign condition [28].

Since LVH is of significant prognostic importance is patient with hypertension and ABPM is now a well-established tool for diagnosing hypertension, this study aimed at clarifying the relationship between LV geometry and ABPM pattern in hypertensive patients regarding to what degree we can predict LV geometric changes from analyzing ABPM.

Methods

The study was a descriptive cross sectional study on 70 adult hypertensive patients attended to Suez Canal University hospital (hypertension clinic). Patients with congestive heart failure, valvular heart disease, history of ischemic heart disease or diabetes mellitus were excluded from the study.

Office blood pressure measurement

Patients were considered hypertensive if they were on anti-hypertensive treatment or they had a resting SBP 140 mmHg or more and/or DBP 90 mmHg or more by using a calibrated and validated BP instrument after at least 5 minutes seated quietly in a chair, with feet on the floor, and arm supported at heart level. An appropriate-sized cuff (cuff bladder encircling at least 80 percent of the arm) was used with at least two measurements were made and the average of them was taken. Systolic BP is the point at which the first of two or more sounds is heard (phase 1), and DBP is the point before the disappearance of sounds (phase 5).

Ambulatory BP monitoring

Ambulatory BP was recorded using an oscillometric device (ABPM50, China) carried by the non-handed arm of the patient. Automatic BP readings were obtained at 60-min intervals during the day-time and night-time. The patient was then sent home with instructions (engage in normal activities but to refrain from strenuous exercise and, at the time of cuff inflation, to stop moving and talking when possible and to keep the arm still with the cuff at the heart level). Day-time and night-time periods were defined individually according to the patient self-reported data of going-to-bed and getting-up times. Interpretation of ABP profile was done according to the recommendations of the British Hypertension Society [29]. Thresholds for Hypertension Diagnosis Based on ABPM were as follows: 24-hour: Average ≥ 130/80 mm Hg.

Awake (day-time): average ≥ 135/85 mm Hg.

Asleep (night-time): average: ≥ 120/70 mm Hg.

Percentage nocturnal BP decline was defined by calculating the percentage of decline in both SBP and DBP during the night, using the following formula: (day time BP-night time BP)/day time BP × 100. A normal dipping pattern (dipper) was diagnosed when the reduction in the average SBP during the night period is>10% of mean SBP during the day. An abnormal dipper pattern (non-dipper) was diagnosed when the night average SBP reduction was <10% with respect to day values [30].

Echocardiography assessment

Echocardiography was done by experienced echo cardiologist using GE vivid 7 machines. Left ventricular mass (LVM) was calculated at end-diastole by using the American Society of Echocardiography (ASE) convention [31] LV mass (ASE): 0.8 × (1.04 × ([LVEDD+PWT +SWT]3-[LVEDD])3)+0.6 g. Where, LVEDD=Left ventricular end-diastolic diameter. (PWT=Posterior wall thickness in diastole and SWT=Inter-ventricular septal thickness in diastole). The indexing of LV mass (LVM) was done by two methods first, by indexing it to the body surface area (BSA) and second, by indexing it to the height.

Calculation of relative wall thickness (RWT) with the formula: RWT=2 × PWT/LVEDD

The reference limits of left ventricular mass and geometry were estimated according to the following Table 1.

	Women	Men
Linear method		
LVM (g)	67-162	88-224
LVMI/BSA (g/m^2)	43-95	49-115
LVMI/height 2.7 (g/m^2)	18-44	20-48
RWT (cm)	0.22-0.42	0.24-0.42
SWT (cm)	0.6-0.9	0.6-1.0
PWT (cm)	0.6-0.9	0.6-1.0
2D method		
LV mass (g)	66-150	96-200
LV mass/BSA (g/m^2)	44-88	50-102

Table 1: The reference limits of left ventricular mass and geometry [32,33].

Left ventricular geometric patterns were determined as follows [31-34]:

Normal geometry, normal LVM+normal RWT

Concentric hypertrophy………………….…….. high LVM+high RWT

Eccentric hypertrophy…………………….….. high LVM+normal RWT

Concentric remodeling………………………. normal LVM+high RWT

LVH was calculated once according to BSA and another time in relation to height 2.7 and analysis was done separately according to each method (Table 2).

Geometric type/BSA	Dippers 51 (34%)	Non Dippers 99 (66%)
N (%)	N (%)	N (%)
Normal		
94 (62.7%)	30 (58.9%)	64 (64.8%)

Concentric hypertrophy		
15 (10%)	6 (11.7%)	9 (9.0%)
Eccentric hypertrophy		
4 (2.7%)	0 (0%)	4 (4.0%)
Concentric remodelling		
37 (24.6%)	15 (29.4%)	22 (22.2%)
p value>0.05; BSA: body surface area.		

Table 2: Different left ventricular geometric patterns according to LVM/BSA of the study groups.

Statistical Analysis

The data was analyzed using SPSS version 19 (SPSS Inc., Chicago, IL, USA). All data were expressed as percentages, means and standard deviation. Differences between variables were assessed using parametric test. Mean values for dipper and non-dipper patients were compared using Student's t-test for independent samples. Differences between groups were assessed by analysis of variance (ANOVA). χ^2 test was used to compare categorical variables between groups. Differences were considered to be statistically significant if p value<0.05. Pearson's correlation was used to investigate the correlation between ABP profile and LVM indexed to both BSA and height.

Results

A total of 150 hypertensive patients where included in the study and divided into 2 groups according their nocturnal decline in SBP (the dipping status): dippers and non-dippers group. The mean age in all patients was 48.9 ± 12.23 years (range: 25-71 years) comprising 43 (28.7%) males and 107 (71.3%) females. There were no significant differences as regard age, weight, height, BMI, BSA, average day SBP and DBP (Table 3).

Geometric type/height 2.7 N (%)	Dippers 51 (34%) N (%)	Non dippers 99 (66%) N (%)
Normal		
68 (45.4%)	21 (41.1%)	47 (47.6%)
Concentric hypertrophy		
27 (18.0%)	12 (23.5%)	15 (15.1%)
Eccentric hypertrophy		
33 (22%)	9 (17.6%)	24 (24.2%)
Concentric remodeling		
22 (14.6%)	9 (17.6%)	13 (13.1%)
p value:>0.05, LVM/height 2.7: left ventricular mass indexed to height to the allometric power 2.7		

Table 3: Different left ventricular geometric patterns according to LVM/height 2.7 of the study groups.

Ambulatory blood pressure parameters of the study population

The ABP parameters of the 2 groups are showed no significant differences between the 2 groups except for the average night SBP which showed an increase in the non-dippers group (p value=0.02) upon which patients were classified into the two groups.

Left ventricular geometric patterns distribution in the study groups

The distribution of the different LV geometric patterns according to LVM/BSA was as follows: 94 patients (62.7%) with normal geometric pattern and 56 patients (37.3%) with abnormal geometry in the form of 15 patients (10%) with concentric hypertrophy, 4 patients (2.7%) with eccentric hypertrophy, and 37 patients (24.6%) with concentric remodeling. The patients with LVH were more in the non-dippers group (8.6% vs. 4.0% of total population) and total patients with abnormal LV geometry including the concentric remodelling were more in the non-dippers group (23.3% vs. 14.0% of total population).

The the distribution of the different LV geometric patterns according to LVM/height 2.7 reveealed that 68 patients (45.4%) had normal geometric pattern and 82 patients (54.6%) had abnormal LV geometry in the form of 27 patients (18.0%) with concentric hypertrophy, 33 patients (22.0%) with eccentric hypertrophy, and 22 patients (14.6%) with concentric remodelling. The patients with LVH were also more in the non-dipper group (26.0% vs. 14.0% of total population) and total patients with abnormal LV geometry including the concentric remodeling were also more in the non-dipper group (33.3% vs. 20% of total population).

The ambulatory blood pressure profile of the different LV geometric patterns in the study groups

It was noticed that according to LVM/BSA, patients with normal LV geometry had the lowest and the most controlled BP, with average 24-hour BP, day-time BP and night-time BP around 129/77, 132/79, and 124/73 mm Hg respectively. Patients with concentric hypertrophy had the most elevated SBP (24-hour, day-time and night-time, around 146, 150 and 140 mm Hg respectively). Patients with eccentric hypertrophy had the most elevated DBP (24-hour, day-time and night-time, around 86, 89 and 89 mm Hg respectively). Patients with concentric remodeling had elevated day-time BP around 141/89 mm Hg. The significant differences were found in 24-hour and day-time SBP (p value<0.009) with near significant differences in 24-hour and day-time DBP (p value=0.06) and no significant differences in night-time BP (Table 4).

	Normal	CH	EH	CR	p value
24-hour systolic	129.02 ± 11.87	146.57 ± 6.45	134.00 ± 26.87	138.06 ± 18.74	0.009*
24-hour diastolic	77.45 ± 9.82	86.14 ± 6.89	86.00 ± 18.39	84.82 ± 16.02	0.067
Day systolic	132.02 ± 10.90	150.71 ± 6.92	136.50 ± 26.16	142.18 ± 20.06	0.003*
Day diastolic	79.95 ± 9.97	88.00 ± 6.93	89.50 ± 14.85	87.76 ± 16.35	0.063

Night systolic	124.36 ± 16.07	140.29 ± 9.95	131.00 ± 25.46	130.35 ± 16.77	0.088
Night diastolic	73.70 ± 12.06	83.14 ± 8.38	84.00 ± 19.80	78.06 ± 14.98	0.191
Nocturnal BP decline	6.84 ± 5.97	6.94 ± 6.49	4.00 ± 0.00	8.80 ± 7.19	0.627
CH: concentric hypertrophy, EH: eccentric hypertrophy, CR: concentric remodeling, SBP: systolic blood pressure, DBP: diastolic blood pressure. (*) statistically significant.					

Table 4: Blood pressure levels in correlation with LV geometric patterns according to LVM/BSA.

When it comes to the results according to LVM/height 2.7, patients with normal LV geometry had the lowest and the most controlled BP (24-hour, day-time and night-time, around 128/77, 131/80 and 123/72 mm Hg respectively). Patients with concentric hypertrophy had the most elevated BP (24-hour, day-time and night-time, around 141/85, 1145/88 and 130/72 mm Hg respectively). The significant differences were found in 24-hour and day-time SBP (p value<0.03) and non-significant differences in the other parameters (Table 5).

	Normal	CH	EH	CR	p value
24-hour systolic	128.34 ± 11.01	141.85 ± 11.01	132.87 ± 15.84	137.40 ± 22.23	0.03*
24-hour diastolic	77.72 ± 9.50	85.92 ± 8.06	79.80 ± 13.24	82.40 ± 18.80	0.197
Day systolic	131.75 ± 9.47	145.77 ± 12.30	134.93 ± 16.03	141.90 ± 23.57	0.018*
Day diastolic	80.44 ± 9.55	88.38 ± 9.35	81.87 ± 13.13	85.40 ± 18.73	0.21
Night systolic	123.00 ± 15.18	130.81 ± 19.57	128.92 ± 19.57	130.00 ± 19.28	0.199
Night diastolic	72.81 ± 10.66	78.06 ± 12.17	77.31 ± 16.48	75.00 ± 16.48	0.31
Nocturnal BP decline	7.38 ± 6.01	7.43 ± 6.34	5.37 ± 5.27	9.40 ± 8.11	0.471
CH: concentric hypertrophy, EH: eccentric hypertrophy, CR: concentric remodeling, SBP: systolic blood pressure, DBP: diastolic blood pressure, (*) statistically significant.					

Table 5: Blood pressure levels in correlation with LV geometric patterns according to LVM/height 2.7.

Discussion and Conclusion

In this study, there were no significant differences between the dippers and non-dippers on LV geometry. The effect of the non-dipping status on LV geometry has been controversial. Some studies showed that there was a significant echocardiographic difference between the dippers and non-dippers and others failed to show any difference.

Ersoylu et al. [35] evaluated 78 hypertensive patients who were underwent ABPM and TTE examination and grouped them as dippers and non-dippers. Non-dippers patients had higher incidences of LVH (p=0.03), LV diastolic dysfunction (p=0.003), increase in aortic root diameter (p=0.001), SWT (p=0.002) and PWT (p=0.03).

Also Aydin et al. [36] studied 25 hypertensive dipper patients and matched them with another 25 hypertensive non-dipper patients and noticed an increase in LVMI, LVEDD, SWT and PWT and more decrease in EF in the non-dippers group than the dipper one.

Ivanovic et al. [37] as well showed in their cross sectional study on 376 hypertensive patients who were divided into 4 groups according their dipping status (extreme dippers, dippers, non-dippers and reverse dippers) that IVS, RWT, LVMI and the left atrium showed a statistically significant differences by comparing the dippers and the non-dippers as a whole with no significant differences in EF and LV dimensions between the groups. Matova et al. [38] followed up 120 hypertensive patients over 10 years and divided them into dippers and non-dippers groups. They found an increase in LVMI, RWT and LA diameter and a decrease in the EF with more diastolic function deterioration and all these finding were more prominent in the non-dippers group (p value<0.05).

Balci et al. [39] studied the LV geometric changes of 60 hypertensive patients with TTE according to the dipping status by ABPM, they found that LVMI was higher in the non-dipper hypertensive patients as compared with the dipper hypertensive patients (p value<0.04).

Cuspidi et al. [40] studied the cardiac alterations in hypertensive patients and examined 355 hypertensive untreated patients by ABPM and TEE and found that there were non-significant increases in LVEDD, SWT, PWT, LVM/BSA and LVM/height 2.7 in the non-dippers than the dippers and significant increases in LA diameter and the aortic root diameter (p value<0.01).

In accordance with our results, Modan et al. [41] in their study analyzed data of 76 hypertensive patients and 25 control group who underwent TEE and ABPM examination and divided them into two groups according to the dipping status, they found that there were no statistically significant differences between the dippers and non-dippers groups as regards more increase in LVM, LVMI, LA diameter, LVEDD, SWT, or PWT and more decrease in EF and E/A ratio in the non-dippers than the dippers.

In the present study it was clear that indexation of LVMI/height 2.7 identified more than two-fold higher prevalence of LVH when compared with indexation of LVM/BSA (40% vs. 12.9% respectively). This difference may be due to the fact that LVM/BSA may reflect hypertension related LVH but LVM/height 2.7 may detect both obesity and hypertension related LVH. Clinically, we noticed that the patients categorized as having LVH by LVM/BSA were having higher values in all ABP parameters than those categorized as having LVH by LVM/height 2.7. It may reflect that the LVH in the first group due to BP load mainly but the second group due to the combined effect of hypertension and obesity.

The thing that also noticed by Cuspidi et al. [42] who studied the LV geometry, ABP and extra-cardiac organ damage in 669 hypertensive patients and categorized them into four groups according to their LV geometry by indexing the LVM to both BSA and height 2.7 and the patients were underwent ABPM and TTE examination, they noticed that there was a two-fold increase in LVH when LVM indexed to height 2.7 when compared with LVM indexication to BSA. The prevalence rates of the normal LV geometry was 54.8%, LV concentric remodeling 14.8%, LV eccentric hypertrophy 21.1% and LV concentric hypertrophy 9.3% by indexing LVM to height 2.7 and normal LV geometry was 65.8%, LV concentric remodelling 19.8%, LV eccentric hypertrophy 10.3% and LV concentric hypertrophy 4.1% by indexing LVM to BSA.

Cuspidi et al. [43] also studied 299 hypertensive patients to see if controlled BP in non-dippers patients had an effect on the LV structure or not. All patients had ABPM and TTE and LVM indexed to both BSA and height 2.7. They grouped them into 3 groups; controlled hypertensive patients, uncontrolled clinic but controlled home BP and finally refractory hypertensive patients whose BP elevated both clinic and home. The prevalence of non-dipping was around 40% in groups 1 and 2 and 60% in group 3 (p <0.01). The prevalence of LVH according to LVM/BSA and LVM/height 2.7 was respectively as follows: group 1: (10.3% to 24.1%), group 2 (31.9% to 43.1%), group 3 (60.6% to 67.7%). Eccentric hypertrophy was the most common type of LVH in groups 1 and 2 and the concentric hypertrophy was the most common one in group 3.

Bahattin et al. [39] examined 60 consecutive hypertensive patients with TTE examination and ABPM then divided them into four groups according to their LV geometric pattern based on LVM/BSA. The LV concentric hypertrophy pattern was the most common pattern (33.3%), and both LV eccentric hypertrophy and concentric remodeling had equal percentages (23.3%). The dippers patients showed concentric hypertrophy most frequently (23.3%, p=0.1) and the eccentric hypertrophy was the most frequent (20% p=0.1) LV geometric pattern in non-dipper patients.

Ten studies were included in a systematic review involving 1722 hypertensive subjects and the aim was to define the different Left ventricular geometric patterns based on LVM/BSA in hypertensive Nigerians. The median prevalence of LVH was 36.4% (17.5% for LV eccentric hypertrophy pattern and 18.4% for LV concentric hypertrophy pattern), 28.3% for LV concentric remodeling pattern and 36.9% for LV normal geometry [44].

Like our results, Ajayi et al. [45] found in their study that the prevalence of LVH was 20% and the abnormal LV geometry was 48.4%. Sixty eight patient (51.6%) had normal LV geometry, 38 patients (29%) had LV concentric remodeling, 12 patients (9.7%) had LV concentric hypertrophy and 12 patients (9.7%) had LV eccentric hypertrophy.

Unlike our results, Monika et al. [41] also showed in their study that the concentric hypertrophic pattern was the commonest one (57%) and concentrated mainly in the non-dippers group with no statistical significance in the echocardiographic characteristics between the two groups.

Adeoye et al. [46] studied 156 newly diagnosed hypertensive patients to identify the relationship between gender and LV geometric structure in these category of patients by using LVM/height 2.7 and they found that the normal LV geometric pattern was the most prevalent one (61%) then the LV concentric remodeling pattern (36%) then LV the eccentric hypertrophy pattern (30%) and finally the LV concentric hypertrophy pattern (18%).

On the contrary with all previous studies Dike et al. [47] in their study on 133 hypertensive patients found that the LV concentric hypertrophic pattern was the commonest pattern (41.4%) then the LV eccentric hypertrophic pattern (30.8%) then the LV concentric remodeling pattern (14.3%) and finally the LV normal geometric pattern (13.5%).

Also we found that by using LVM/BSA the patients with normal LV geometry had the lowest and the most controlled BP, patients with concentric hypertrophy had the most elevated 24-hour BP, day-time SBP and night-time DBP with significant SBP of 24-hour and day-time (p value=0.009) and near significance other parameters (p value=0.088), But when LVM/height 2.7 was used, the results for patients with LV normal geometry was the same and patients with LV concentric hypertrophy had the most elevated BP in the study population with significant SBP of 24-hour and day-time (p value=0.03) and non-significant other parameters.

Ajayi et al. [45] studied 123 hypertensive patients to get the relation between the LV geometry based on LVM/BSA and the ABP profile. They found that patients with normal LV geometry had the most controlled BP (day-time, night-time and 24-hour), patients with LV eccentric hypertrophy geometry had the highest SBP (day-time, night-time and 24-hour), and patients with LV concentric remodeling had the highest DBP (day-time and 24-hour).

Cuspidi et al. [48] in their study to define the LV geometry, ABP and extra-cardiac organ damage in hypertensive patients also showed that patients with LV normal geometry had the lowest and the most controlled ABP profile and the LV concentric hypertrophy had the highest ABP profile (p=0.02) when indexing the LVM to both BSA and height 2.7.

So, our study, although there was no significant difference between the dippers and non-dippers regarding LV geometry, it detected a significant correlation between both LVM/BSA and LVM/height 2.7 and the ABP levels during ABPM.

Also it was clear that indexing the LVM to BSA underestimated the prevalence of LVH and ignored the effect of obesity which was respected by indexing it to height 2.7.

Patients with normal LV geometric pattern had a controlled ABP profile and the patients with LV concentric hypertrophic pattern had the most elevated one. Left ventricular concentric hypertrophy was the most prevalent pattern in males and the LV eccentric hypertrophy and the concentric remodeling were more prevalent in females. Finally the non-dippers hypertensive patients had more LV diastolic dysfunction than the dippers hypertensive patients.

Limitations

Our study was a cross sectional one so, the ABPM parameters were measured only once and there were no serial echocardiographic assessment and follow-up for LV geometric patterns, the thing that had an impact on our results which showed that there was only an association between the ABP parameters and LVMI but didn't show its direction over time.

Small sample size which limited us to find the effect of the non-dipping status on LVMI. Majority of patients were already on treatment limited the categorization and staging of their hypertensive status.

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