Ambulatory arterial stiffness index derived from 24-hour ambulatory blood pressure monitoring and its relation with left ventricular hypertrophy

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Abstract: Background: Subclinical organ damage represents an intermediate stage in the continuum of vascular diseases and a determinant of overall cardiovascular risks. This study aimed to investigate the associations of ambulatory arterial stiffness index (AASI) with left ventricular hypertrophy (LVH) as a marker of target organ damages (TODs). **Methods:** Forty one subjects were referred to do 24-hour ambulatory BP monitoring from March 2010 to November 2010 in a private outpatient clinic. BP monitoring was evaluated with respect to the relationship of AASI with LVMI as a marker for TOD. **Results:** Ambulatory arterial stiffness index (AASI) was higher with age and correlated with LVMI and hence LVH. AASI was negatively correlated with standard deviation (SD) of diastolic blood pressure. **Conclusions:** AASI is a novel method for assessment of arterial stiffness that can predict subclinical TOD in hypertensive patients.
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Key Words: Ambulatory, stiffness index, hypertrophy, target organ damage.

1. Introduction

Signs of subclinical organ involvement, otherwise called target organ damage (TOD), should be investigated thoroughly in hypertensive patients. Subclinical organ damage represents an intermediate stage in the continuum of vascular disease and a determinant of overall cardiovascular risk. TODs include left ventricular hypertrophy (LVH), impaired coronary flow reserve (CFR), increased intima-media thickness (IMT), elevated levels of microalbuminuria, and cognitive impairment (*1*).

Arterial stiffness represents an independent predictor for all-cause and cardiovascular mortality and morbidity in patients with essential hypertension, diabetes, or end-stage renal disease. Until now, measurements of arterial stiffness require the use of complex ultrasound equipment or applanation tonometry at the level of the peripheral arteries with the subjects in the supine or sitting position. Ambulatory arterial stiffness index (AASI) is a proposed indicator of arterial stiffness that is derived from ambulatory blood pressure measurement (ABPM) (2*)*.

AASI has been shown to strongly correlate with several measures of arterial stiffness including pulse wave velocity (PWV) and augmentation index (*3)*.

In the present study, we aimed to investigate any existing associations between AASI and LVH as a marker for TOD.

2. Subjects and Methods

We studied 41 subjects during the period from March 2010 to November 2010 in a private outpatient clinic. The subjects were referred to do 24-hour ambulatory BP monitoring. Informed consent was taken.

BP measurement: Ambulatory BP was recorded in all individuals using an oscillometric device (Tonoport V, GE Healthcare) that was set to take a reading every 30 min during daytime and every 60 min during nighttime. The monitor was mounted on the non dominant arm and was removed 24 h later. In keeping with JNC7 guidelines, hypertension was a daytime (10:00 AM until 8:00 PM) ambulatory blood pressure averaging ≥135 mm Hg systolic or 85 mm Hg diastolic *(4)*.

Ambulatory arterial stiffness index:

From unedited 24-hour recordings, the investigators computed for each participant the regression slope of diastolic on systolic blood pressure. We did not force the regression line through the origin (intercept=0) because during diastole, when flow dropped to zero, such a phenomenon did not occur for blood pressure. The study defined AASI as 1 minus the regression slope. The stiffer the arterial tree, the closer the regression slope and AASI were to 0 and 1, respectively (2). ABPM profiles were included for further analysis if ≥20 readings per sampling period, and more than 18 continuous hours with valid readings were present.

Echocardiographic examinations were conducted using commercially available ultrasound machine (Sonos 7500, Philips) with S3 adult cardiac phased array probe (2-4) MHz. Recordings and calculations of different cardiac chambers were made according to the recommendations of the American

Society of Echocardiography. In the parasternal long axis view, measurements of left ventricular end diastolic dimension , interventricular septal thickness and posterior wall thickness in diastole according to ASE guidelines were done. **Left ventricular mass (LVM)** in grams was calculated by the Devereux formula. LVM= 0.8 {1.04[([LVEDd + IVSd+ PWd]3 - LVEDd3)]} + 0.6 where LVEDd, IVSd, and PWd represented left ventricular end diastolic dimension , interventricular septal thickness, and posterior wall thickness in diastole, respectively, was derived assuming LV dimensions in centimeters *(5).*
LVM index (LVMI) was then calculated as follows: LVMI = LVM/$m^{2.7}$, where m was the height of the patient in meters. Left ventricular wall thickness was considered normal if LVMI was < 50 g/$m^{2.7}$ and left ventricular hypertrophy if LVMI > 50 g/$m^{2.7}$ (6).

Statistical Analyses: Data were presented as mean ± standard error of mean (SD). We used SPSS software, version 16.0 (SPSS, Chicago, IL). Pearson's correlation coefficients were used to explore associations between examined continuous variables with parametric distribution. Statistical significance was determined by *P*-level < 0.05.

3. Results

Table (1): Study population characteristics.

Characters	Value
Age (years)	50.12±14.96
Gender	25 (61%) males 16 (39%) females
Average systolic blood pressure (mmHg)	140.00±17.80
Standard deviation of systolic blood pressure (mmHg)	15.01±2.72
Average diastolic blood pressure (mmHg)	85.42±12.66
Standard deviation of diastolic blood pressure (mmHg)	13.65±3.17
Average heart rate (b/min)	79.42±9.49
Standard deviation of heart rate (b/min)	15.33±5.03
Presence of left ventricular hypertrophy	27 (65.9%)
LVMI (g/$m^{2.7)}$	51.98±4.57
Ambulatory arterial stiffness index (AASI)	0.30±0.18

Table (2): Correlations of AASI*.

Parameters	***r*****	***P value***
Age (years)	0.308	0.050
Standard deviation of diastolic blood pressure (mmHg)	-0.413	0.007
Presence of left ventricular hypertrophy	0.367	0.018
LVMI (g/$m^{2.7)}$	0.322	0.040

*Values are expressed as mean± standard deviation
****r** = Spearman correlation coefficient

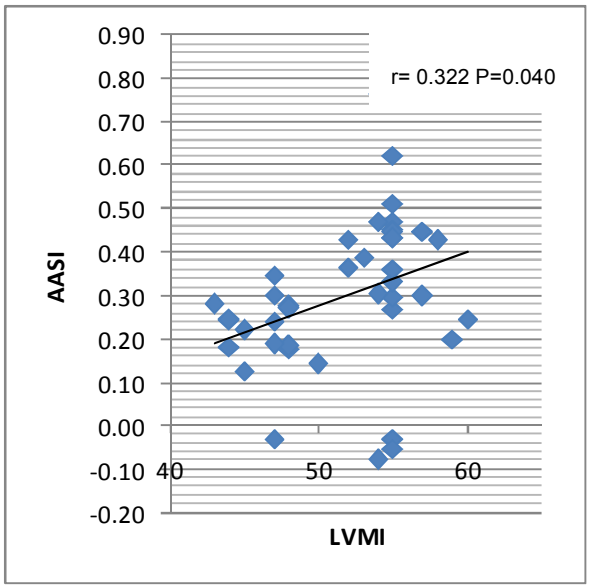

Figure (1): Correlation between AASI and LVMI.

The baseline demographic characteristics of the study population were shown in (Table I).

The mean age ± standard deviation (SD) was 50.12 ±14.96(years), males represented 61% of studied populations; The calculated average systolic blood pressure was 140.00±17.80 (mmHg) while the calculated standard deviation of systolic blood pressure measurement was 15.01±2.72 (mmHg), the calculated average diastolic blood pressure was 85.42±12.66 (mmHg) while the calculated standard deviation of diastolic blood pressure measurement was 13.65±3.17 (mmHg), the average heart rate was 79.42±9.49 (b/min) while the standard deviation was 15.33±5.03 9b/min), left ventricular hypertrophy present in 61% of the studied population, the mean left ventricular mass index was 51.98±4.57*(*g/$m^{2.7)}$ and finally the calculated Ambulatory arterial stiffness index (AASI) of the studied populations was 0.30±0.18.

In studying the correlation between AASI and the parameters : the study found positive correlation with AASI and : age, presence of LVH by echocardiography and LVMI and negative correlation with standard deviation of diastolic blood pressure {Table (2) and figure (1)}.

4. Discussion

Arterial compliance plays an important role in the pathogenesis of adverse cardiovascular events. So there is increasing interest in developing noninvasive methods that can easily be applied in clinical practice to measure arterial compliance.

ABPM is used more and more in clinical practice for the diagnosis and management of hypertension (1*)*.

AASI is a non invasive method for estimating arterial stiffness based on ABPM. Untreated hypertensive patients with left ventricular hypertrophy showed higher ambulatory arterial stiffness index as compared with those without it. Strong evidence exists from cross-sectional analysis and prospective cohort studies that AASI predicts cardiovascular risk within the normotensive and hypertensive range (3*)*.

AASI may be associated with signs of subclinical target organ damage (TOD) in patients with hypertension.

In the present study the investigators studied AASI and found it 0.30±0.18.

Arterial stiffening is deemed to reflect widespread atherosclerosis as *van Popele et al., 2001* stated and the correlation the investigators of this study found between AASI and age is in keeping with this notion (7).

In this study, a positive correlation between AASI and age was found where AASI increased with age this is in agreement with Lee *et al.,* (8) who studied 418 untreated hypertensive patients, Muxfeldt *et al.,* (9) who studied 391 resistant hypertensives, Leoncini *et al*., (10) who studied 188 hypertensive patients and Li *et al.,* (11) who studied arterial stiffness in 348 randomly recruited Chinese.

In our study, a positive correlation between AASI and left ventricular mass index in agreement with Wang *et al.,* (12) who studied 583 chronic kidney disease patients and Lee *et al.,* (8). Also with Leoncini *et al.,* (10) but the correlation between AASI and LVMI, even in the presence of a positive linear trend, did not reach statistical significance may be due to small aged patients 47.3±9.7 (years) compared to 50.12±14.96 (years) in our study.

In our study, a negative correlation between AASI and Standard deviation of diastolic blood pressure in agreement with Lee *et al.,* (8) and Leoncini *et al.,* (10).

In conclusion, the determination of AASI is easier than that of aortic stiffness, since "ABPM is implemented in most hospitals," whereas measurement of arterial stiffness "requires special equipment and trained observers." AASI is considered as a novel index of arterial stiffness which can be easily measured under ambulatory conditions is increased with age and correlated with LVMI and predictor of LVH. AASI is negatively correlated with standard deviation of diastolic blood pressure.

Study limitations

One of the limitations of this study is the relatively low number of patients. Because hypertension has a high prevalence in population, a greater number of patients should be necessary in order to generalize the results of this study in untreated hypertensives or treated hypertensives with medications that affect arterial stiffness calculation. Additionally, AASI and its relation to other arterial stiffness indexes as pulse wave velocity (PWV) could be studied and with other items of target organ damage (TOD).

Declaration of interest

The authors reported no conflict of interest. All of the authors had substantial contributions to conception and design, acquisition of data, analysis and interpretation of data, drafting and revising the article critically with final approval of the version to be published. The research was funded by the authors.

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References

1. Mancia G, De Backer G, Dominiczak A *et al.* (2007): Management of Arterial Hypertension of the European Society of Hypertension; European Society of Cardiology. 2007 guidelines for the management of arterial hypertension: The Task Force for the Management of Arterial Hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). J Hypertens, 25:1105–1187.
2. Li Y, Wang JG, Dolan E *et al.* (2006): Ambulatory arterial stiffness index derived from 24-hour ambulatory blood pressure monitoring. Hypertension, 47:359–364.
3. Dolan E, Thijs L, Li Y *et al.* (2006): Ambulatory arterial stiffness index as a predictor of cardiovascular mortality in the Dublin Outcome Study. Hypertension,47:365–370.
4. Aggoun Y, Szezepanski I and Bonnet D.(2005): Noninvasive assessment of arterial stiffness and risk of atherosclerotic events in children. Pediatr Res, 58:173–178.
5. Devereux RB, Alonso DR, Lutas EM *et al.* (1986): Echocardiographic assessment of left ventricular hypertrophy: comparison to necropsy findings. Am J Cardiol,57:450-458.

6. Schillaci G, Verdecchia P, Porcellati C *et al.* (2000): Continuous relation between left ventricular mass and cardiovascular risk in essential hypertension. Hypertension,35:580-586.
7. van Popele N, Grobbee D, Bots M *et al.* (2001): Association between arterial stiffness and atherosclerosis: the Rotterdam Study. Stroke, 32: 454–460.
8. Lee H.T., Lim Y.H., Kim B.K *et al.* (2011): The relationship between ambulatory arterial stiffness index and blood pressure variability in hypertensive patients. Korean Circ J, 41:235–240.
9. Muxfeldt E, Fiszmann R, Castelpoggi C and Salles G. (2008): Ambulatory Arterial Stiffness Index or Pulse Pressure: Which Correlates Better with Arterial Stiffness in Resistant Hypertension? Hypertension Research,31: 607–613.
10. Leoncini G, Ratto E, Viazzi F *et al.* (2006): Increased Ambulatory Arterial Stiffness Index Is Associated With Target Organ Damage in Primary Hypertension. Hypertension,48: 397-403.
11. Li Y, Wang J, Dolan E *et al.* (2005): P-21: Ambulatory arterial stiffness index derived from 24-hour ambulatory blood pressure monitoring. Am J Hypertens,18 (S4): 16A.
12. Wang C, Zhang J, Li CC *et al.* (2013): The ambulatory arterial stiffness index and target-organ damage in Chinese patients with chronic kidney disease. BMC Nephrol,14(1):257.

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