ISSN: 0975 -8542

Journal of Global Pharma Technology

Available Online at: www.jgpt.co.in

RESEARCH ARTICLE

The Association Between Brachial Ankle Pulse Wave Velocity and Left Ventric Mass Index In Patients With Hypertension

Dian Fajarwati, Budi Susetyo Pikir*

Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Airlangga, Mayjen Prof. Dr. Moestopo street no 47, Surabaya (60131), Indonesia.

***Corresponding Author: Budi Susetyo Pikir**

Abstract

Background: Arterial stiffness has been considered as a modest method in detecting the arterial burden that can trigger left ventricular hypertrophy in the heart. Increased left ventricle hypertrophy in hypertension patients is a predictor which has impact in the increase of morbidity and mortality. Objectives: We aimed to investigate the association between brachial ankle pulse wave velocity (BaPWV) and left ventricle mass index (LVMI) in patients with hypertension. Material and Methods: This study was conducted by collecting secondary data of 40 hypertension patients aged >40 years old, suffered from hypertension >1 year and have encountered brachial ankle pulse wave velocity test and echocardiography test. Results: There was a significant positive correlation between brachial ankle pulse wave velocity and left ventricle mass index in hypertension patients with r = 0.493 dan p = 0.001. Also, there was a significant correlation between BaPWV and Relative Wall Thickness with r = 0.404 and p = 0.01. There was a significant difference of LVMI value in males and females with the result of (117.78+22.70 and 100.15+16.82, p = 0.008). In contrast, there was no significant difference in BaPWV value in males and females (1865.63+322.29 and 1811.08+350.28). It was also obtained a significant correlation between age factor and systolic blood pressure with LVMI and BaPWV (r = 0.493, p = 0.001). Conclusions: There was significant positive correlation between BaPWV and LVMI in hypertension patients. The arterial stiffness was an indicator of increased left ventricle mass index in hypertension patients.

Keywords: *Brachial ankle pulse wave velocity, Left ventricle mass index, Hypertension, Heart.*

Introduction

Hypertension is considered as an important health challenge for society in the world due to its high frequency and as cardiovascular and kidney disease risk factor. More than a quarter of adult populations in the world suffer from hypertension which was approximately 1 billion people in 2000 and it is presumed to increase into 29% or 1.56 billion people in 2025. In Indonesia, based on the survey of Indonesia Basic Health Research in 2007, the hypertension prevalence was 29,8% [1].

In addition, based on the data of National Health and Nutrition Examination Survey/National Center for Health Statistics (NHANES/NCHS) in 2005-2008, it showed that in hypertension patients aged >20 years old, 79.6% of them was aware of their conditions, 70.9% was in treatment, 47.8% was in controlled hypertension condition while 52.5% was in uncontrolled hypertension condition [2]. Moreover, the data of NHANES in 1999-2006 showed that 11.2% adults aged >20 years old have obtained treatment and been in controlled hypertension situation [3].The increase of after load on hypertension causes increased left vertical wall thickening. This condition increases the cardiovascular disease risks earlier.

In many populations and epidemiology of researches indicated that left ventricle hypertrophy is related in increased morbidity and mortality, including coronary heart disease cases and deaths because of cardiovascular diseases. Echocardiography is used to determine the occurrence of left ventricle hypertrophy by measuring left ventricle mass index. Echocardiography test is required to be conducted by particular

operator that functions as an ideal media to evaluate and more sensitive than electrocardiography [4].Recently, more attention is paid to the relation between arterial stiffness and cardiovascular disease. Arterial stiffness is mainly related to the development of isolated systolic hypertension in elderly and also the increase of mortality and morbidity.

Pulse pressure and pulse wave velocity (PWV) represent arterial stiffness measurement which showed that arterial stiffness increases along with the aging and particular disease condition which is related to increased cardiovascular risk including hypertension, diabetes mellitus, and hypercholesterolemia [5].PWV is an agreed method to measure arterial stiffness noninvasively and it is considered as the golden standard to provide accurate prediction towards mortality and cardiovascular cases. PWV is known as a technique to evaluate the arterial flexibility between two points of arterial branching [6].

PWV is not only able to calculate the amount of blood flow in the arteries but it also provides physiological data involving flow patterns and leg perfusion. PWV functions in evaluating the change of arterial pulse waves in which the result is inversely proportional with arterial flexibility. It is usually higher in PWV correlated with arterial stiffness [7]. The arterial stiffness change can be detected earlier before the occurrence of clinical symptoms and act as the marker of atherosclerosis disease development in the future. It is important to not only reduce blood pressure but to reduce arterial stiffness to increase prognosis in hypertension patients.

Objective

This study tries to investigate the correlation between brachial ankle pulse wave velocity and left ventricle mass index in patients with hypertension.

Methods

Subjects

The samples were 40 hypertension patients in Outpatient Cardiology Unit Taman Husada General Hospital Bontang, Kalimantan Island, Indonesia on August 2012 until October 2012. The subjects fulfilled inclusion criteria including patients had the hypertension history of 1 year or more, aged > 40 years old, had examination data of brachial ankle pulse wave velocity and echocardiography. The data was collected by random sampling method. The brachial ankle pulse wave velocity measured by using OMRON VP-2000/1000 type 230 Non-invasive vascular screening device BP-203RPE II (Omron Healthcare, Kyoto, Japan).

On the other hand, the echocardiography equipment employed was Siemens ACUSON X500 Ultrasound Imaging System (Siemens Healthcare GmbH, Erlangen, Germany) [8]. The study protocol was approved by the Ethical Commission of Taman Husada General Hospital Bontang, Indonesia. Both of dependent and independent variable data were analyzed analytically by using Spearman correlation test or Pearson correlation test. The results of the analysis were presented in graphics. All the data analysis process was processed by using a SPSS software version 20 [9].

Results

Table 1: Subjects Characteristics

Characteristics	Statistics/Category	Result
Age (year)	Mean ± SD	52.92 ± 9 . 50
	Range	40-82
Age (categorization)	40 – 49 years old	18 (45%)
	50- 59 years old	16 (40%)
	≥60 years old	6 (15%)
Gender	Male	16 (40%)
	Female 24 (60%)	
Systolic blood pressure	Mean ± SD	151.47 ± 17 . 55
	Range	119 – 188
Diastolic blood pressure	Mean ± SD	86.2 ± 11 . 55
	Range	65 – 122
Pulse	Mean ± SD	82.93 ± 17 . 34
	Range	57-129

Body Mass Index	Mean ± SD	26.12 ± 4 . 73
	Range	19. 5 - 38 . 9
Obesity	Yes	7 (17.5%)
	No	33 (82.5%)
Smoking	Yes	14 (35%)
	No	26 (65%)
Dyslipidemia	Yes	30 (75%)
	No	10 (25%)
Hyperuricemia	Yes	13 (32.5%)
	No	27 (67.5%)
Diabetes mellitus	Yes	13 (32.5%)
	No	27 (67.5%)
Anti hypertension therapy		
Calcium Channel Blocker		25 (62.5%)
ACE inhibitor		23 (57.5%)
Angiotensin Receptor Blocke r		16 (40%)
ß- blocker		19 (47.5%)
Diuretic		7 (17.5%)

Hypertension patients in this study consisted of 16 subjects of males and 20 subjects of females. The average age of the patients was 52.92 ± 9.50 years old. The youngest patient was 40 years old and the oldest one was 82 years old. The most frequent patients were aged 40-49 (45%) and followed by patients aged 50-59 years old (40%). Patients' average systolic blood pressure in this study was 151.47 mmHg±17.55 while the average diastolic blood pressure was 86.2 mmHg±11.55. The average of patients' body mass index was 26.12 ± 4.73. The subjects were also suffering from several other diseases such as obesity occurred in 7 patients (17.5%), smoking occurred in 14 patients (35%), dyslipidemia occurred in 30 patients (75%), hyperuricemia occurred in 13 patients (32.5%) and diabetes mellitus occurred in 13 patients (32.5%). Moreover, the anti hypertension drugs that were consumed by the subjects were Calcium Channel Blocker consumed by 25 patients (62.5%), ACE Inhibitor consumed by 23 patients (57.5%), Angiotensin Receptor Blocker consumed by 16 patients (40%), ß-blocker consumed by 19 patients (47.5%), and diuretic consumed by 7 patients (17.5%).

Table 2: The basic characteristics of echocardiography

Echocardiography data	**Mean ± SD**
EF by Teich (%)	69.75 ± 6.89
Cardiac Output (L/ minute)	4.83 ± 1.38
Cardiac Index	2.86 ± 0.67
LVIDd (mm)	44.01 ± 4.89
LVIDs (mm)	26.76 ± 4.06
IVST (mm)	10.73 ± 1.85
PWT (mm)	11.93 ± 1.90
RWT	0.527 ± 0.10
LA (mm)	29.24 ± 5.12
LVM (gram)	209.01 ± 355.85
LVMI (gram/ m^2)	107.20 ±21.01
E/A	0.99 ± 0.30
Left ventricle geometry	
Normal	8 (20%)
Concentric Remodeling	10 (25%)
Concentric Hypertrophy	21 (52.5%)
Eccentric hypertrophy	1 (2.5%)

The basic data of echocardiography in hypertension patients in this study showed that the average ejection fraction was 69.75% ± 6.89. The average cardiac output was 4.83 L/minute ± 1.38 and cardiac index 2.86 ± 0.67. The normal left ventricular geometry occurred in 8 subjects (20%), concentric remodeling occurred in 10 subjects (25%), concentric hypertrophy occurred in 21

subjects (52.5%) and eccentric hypertrophy occurred in 1 subject (2.5%).

Table 3: the comparison between gender and left ventricle mass index value

	n	Mean	SD	Min.	Max.	
Male	16	117.78	22.70	69.90	149.80	
Female	24	100.15	16.82	80.30	141.50	T = 2.823
Total	40	107.20	21.01	69.90	149.80	p = 0.008*

Note: *it was significant in α= 0.05 (based on Independent t-test)

Left ventricle mass index in hypertension patients was 69.90-149.80 gram/m^2 with the average of 107.20 gram/m^2 ± 21.01.

The average LVMI in male patients was 117.78 gram/ m2 ± 22.70 with minimum value of 69.90 gram/m^2 and maximum value of 149.80 gram/m^2. The average LVMI in female patients was 100.15 gram/m^2 ± 16.18 with the minimum value of 80.30 gram/m^2 and maximum value of 141.50 gram/m^2.

The value of LVMI in hypertension male patients and female patients was considered significantly different statistically (p = 0.008).

Table 4: the correlation between LVMI and patients characteristics

Characteristics	R	P
Age	0.518	0.001*
Systolic blood pressure	0.370	0.019*
Diastolic blood pressure	0.127	0.435
Pulse	0.040	0.806
Body Mass Index	0.131	0.420

Note: *it was significant in α= 0.05 (based on correlation test

This study obtained that there was a correlation between LVMI and the patient characteristics in which the value of LVMI showed statistically significant association with age and systolic blood pressure. However, there was no statistically significant association between LVMI value in patients who smoked, with diabetes mellitus, dyslipidemia, and hyperuricemia compared to those who had no risk factors.

Table 5: The comparison of patient characteristics towards LVMI

Characteristics	Category	LVMI		Comparison test
		Mean	SD	
DM	Yes	116.42	16.98	t = - 1.997
	No	102.77	21.59	p = 0.053
Smoking	Yes	115.48	22.58	t = - 1.887
	No	102.75	19.09	p = 0.067
Dyslipidemia	Yes	107.07	22.55	t = 0.054
	No	107.52	16.55	p = 0.957
Hyperuricemia	Yes	115.83	23.53	t = -1.858
	No	103.05	18.75	p = 0.071

Tablel 6: the comparison of gender towards BaPWV value

N		Mean	SD	Min.	Max.	
Male	16	1865.63	322.29	1421	2675	
Female	24	1811.08	350.28	1139	2571	t = 0.498
Total	40	1832.90	336.22	1139	2675	p = 0.622

Table 6 shows that the brachial Ankle Pulse Wave Velocity (BaPWV) was 1139-2675 cm/second with the average of 1832.90 cm/second±336.22. The average BaPWV in male patients was 1865.63 cm/second ±322.29 with the highest value of 2675

cm/second and the lowest value of 1421 cm/second. On the other hand, the average BaPWV in female patients was 1811.08 cm/second±350.28 cm/second with the lowest value of 1139 cm/second and the highest value of 2571 cm/second. There was no statistically significant difference in BaPWV value between males and females (p = 0.622).

Table 7: The correlation between BaPWV and patient characteristics

Characteristics	r	p
Age	0.658	0.000*
Systolic blood pressure	0.314	0.049*
Diastolic blood pressure	0.140	0.390
Pulse	0.006	0.972
Body Mass Index	-0.306	0.055

Note: *it is significant in α= 0.05 (based on correlation test)

Table above shows statistically significant correlation between BaPWV and subject characteristics including age and systolic blood pressure (r = 0.658, p = 0.000 and r = 0.314, p = 0.049).

Table 8: The correlation between Brachial Ankle Pulse Wave Velocity and left ventricle mass index

Correlation	The correlative coefficient (r)	p
BaPWV – RWT	0.404	0.01*
BaPWV – LVMI	0.493	0.001*

Note: *it is significant in α= 0.05 (based on Pearson correlation test)

The analysis result of Pearson correlation in table 8 shows that there was a significant correlation statistically between BaPWV and Relative Wall Thickness (RWT) as well as BaPWV and left ventricle mass index. The result of BaPWV and RWT correlation was r = 0.404 and p = 0.01. On the other hand, the result of BaPWV and left ventricle mass index correlation was r = 0.493 and p = 0.001 which showed moderate positive correlation.

Discussion

Increased hypertension cases are related to age that are caused by structural change and arterial functions along with the aging process. The role of arterial stiffness is essential in hypertension patients. Several methods have been developed to measure arterial stiffness; one of them is PWV. PWV test is recommended by European Society of Cardiology in detecting asymptomatic target organ damage in hypertension patients [10].

This study was an observational analytic study by using cross sectional approach that aimed to correlate the value of BaPWV and left ventricle mass index in hypertension patients. This study involved 40 patients that consisted of 16 males (40%) and 24 females (60%).

This study revealed that there was significant correlation between left ventricle mass index with age and systolic blood pressure. Hypertrophy occurs because of cardiomyocyte response to excessive hemodynamic load which turns into myocardium remodeling [10]. Cardiomyocyte hypertrophy that causes ventricle wall thickness and increases left ventricle mass index is a primary mechanism to reduce stress on left ventricle wall due to excessive pressure load [4]. Based on the study conducted by Rosendorff, et al. who analyzed 179 male subjects aged more than 75 years old with the average age of 81.8±4.3, they obtained the average systolic blood pressure was 136.5±18.3 mmHg and the left ventricle mass index was 136.5±39.2 g/m2.

Their study showed that there was a significant correlation between systolic blood pressure and LVMI with the value of r = 0.246 dan p = 0.001. This study shows that there is a significant correlation between brachial ankle PWV with age and systolic blood pressure in hypertension patients.

The increased hypertension prevalence is associated with structural change and arterial functions along with the aging process [4]. Large blood vessels will be stiffer that can increase blood pressure. Reduced arterial dispensability can be detected with the occurrence of clinical manifestations such as increased pulse pressure and isolated systolic hypertension [1]. A study conducted the correlation between arterial stiffness

indicator and left ventricle stiffness in 78 subjects with hypertension and normotensive aged 18-91 years old. They found that there was a strong significant correlation between heart femoral PWV and age with the value of $r = 0.72$ dan $p < 0.001$. In addition, there was a strong significant correlation between heart femoral PWV and systolic blood pressure. It can be concluded from Minesh, ET al.

Study that there was a strong significant correlation among age, systolic blood pressure, arterial stiffness and left ventricle stiffness [11]. Based on the result of Pearson correlation test that measured the relation between brachial ankle PWV and RWT in this study, there was a positive correlation with the value of $r = 0.404$ dan $p = 0.01$. It is accordance with the study in 237 hypertension patients who had not undergone therapy aged 18-88 years old.

They indicated that there was a positive correlation between aortic PWV and RWT in patients aged 40-59 years old and > 60 years old while there was no significant correlation in patients aged < 40 years old. It showed that if the patients were aged less than 40 years old, the lesser their chance in facing arterial stiffness [12].

On the other hand, in middle and older age, increases aortic impedance had bigger effect towards the occurrence of concentric remodeling without any significant increased left ventricle mass index. Along with the aging process, aortic PWV is the main determinant of the occurrence of large arterial stiffness and related to the occurrence of left ventricle concentric remodeling [10].

This study aims to elaborate the correlation between the value of brachial ankle pulse wave velocity and left ventricle mass index in hypertension patients. Brachial ankle PWV is one of the test alternatives to find out arterial stiffness accurately, quickly and easily. The left ventricle mass index was obtained by echocardiography test in hypertension patients [13]. The results of two types of test were analyzed and it was found the positive correlation with the value of $r = 0.493$ dan $p = 0.001$. A study conducted the correlation between arterial stiffness and systolic and diastolic functions in hypertension patients who had not undergone anti hypertension therapy.

There were 200 subjects in their study that consisted of 61% males and 39% females [14]. The average systolic blood pressure was 165.96 ± 10.41; the average carotid femoral PWV was 7.96 ± 1.49; also, the average LVMI was 14 ± 12.72. Moreover, the result showed that there was a significant positive correlation between carotid femoral PWV and LVMI, negative correlation between carotid femoral PWV and ejection fraction and negative correlation between carotid femoral PWV and E/A [15]. Another study by Zhou, *et.,al* (2018) investigate the correlation between heart femoral PWV and left ventricle mass index in controlled hypertension patients.

The sample are 20 controlled hypertension patients with the average age of 67.8 ± 9.3 and 55% of them had consumed two or more types of anti-hypertension drugs underwent heart femoral PWV test and echocardiography test. It revealed that there was positive correlation between heart femoral PWV and LVMI. However, there was no significant correlation between augmentation index and LVMI [7].

Conclusion

There was significant difference of left ventricle mass index in males and females. In addition, there was a significant positive correlation between the value of brachial ankle pulse wave velocity and left ventricle mass index with two variables which were age and systolic blood pressure. Furthermore, there was a significant positive correlation between brachial ankle pulse wave velocity and left ventricle mass index in hypertension patients.

References

1. Athiyah Umi, Subarniati R, Yuda Ana. Medication Adherence in Elderly Patients with Hypertension. Asian J. Pharm. Clin Res., 10(8):165-70.
2. Putri Aps, Hidajah Ac (2019) Indicator of Dyslipidemia For Ischemic Stroke in Elderly with Hypertension. Indian J Public Heal Res Dev., 10: 3.
3. Sayogo S, Siregar P (2017) Plasma Potassium Levels In Healthy Prehypertension Subjects and the Role of A High Potassium Drink. Curr. Hypertens

Rev., 13(1):65-70.

4. Tsao T-M, Tsai M-J, Hwang J-S, Su T-C (2019) Health Effects of Seasonal Variation In Cardiovascular Hemodynamics Among Workers in Forest Environments. Hypertens Res., 42(2):223.
5. Zhu Z-Q, Chen L-S, Wang H, Liu F-M, Luan Y, Wu L-L, Et Al (2019) Carotid Stiffness And Atherosclerotic Risk: Non-Invasive Quantification with Ultrafast Ultrasound Pulse Wave Velocity. Eur. Radiol., 29(3):1507-17.
6. Tomiyama H, Koji Y, Yambe M, Shiina K, Motobe K, Yamada J, Et Al (2005) Brachial-Ankle Pulse Wave Velocity Is A Simple And Independent Predictor Of Prognosis In Patients With Acute Coronary Syndrome. Circ. J., 69(7):815-22.
7. Zhou Y, Chen Z, Kuang C (2008) Relationship Between Brachial Ankle Pulse Wave Velocity And Hypertensive Retinopathy. Int. Eye Sci., 18(1):130-2.
8. Widiyanti P, Paramadini Aw, Jabbar H, Fatimah I, Nisak Fnk, Puspitasari Ra (2016) Morphology Characterization And Biocompatibility Study of Plla (Poly-L-Llactid-Acid) Coating Chitosan As Stent For Coronary Heart Disease. In: Aip Conference Proceedings. Aip Publishing, 60008.
9. Miftahussurur M, Yamaoka Y (2016) Diagnostic Methods Of Helicobacter Pylori Infection For Epidemiological Studies: Critical Importance Of Indirect Test Validation. Biomed Res Int., 2016.
10. Milan A, Zocaro G, Leone D, Tosello F, Buraioli I, Schiavone D, Et Al (2019) Current Assessment Of Pulse Wave Velocity: Comprehensive Review of Validation Studies. J. Hypertens.
11. Yamashina A, Tomiyama H, Takeda K, Tsuda H, Arai T, Hirose K, Et Al (2002) Validity, Reproducibility, And Clinical Significance Of Noninvasive Brachial-Ankle Pulse Wave Velocity Measurement. Hypertens Res, 25(3):359-64.
12. Lee Sw, Han Sh, Yoo Th, Chung W, Park Sk, Chae Dw, Et Al (2018) Relationship Between Brachial-Ankle And Heart-Femoral Pulse Wave Velocities and the Rapid Decline of Kidney Function. Sci. Rep., 8(1):821.
13. Yamashina A, Tomiyama H, Arai T, Hirose K, Koji Y, Hirayama Y, Et Al (2003) Brachial-Ankle Pulse Wave Velocity As A Marker Of Atherosclerotic Vascular Damage And Cardiovascular Risk. Hypertens Res, 26(8):615-22.
14. Akbar Mia, Adibrata Ma, Aryananda Ra, Angsar Md, Dekker G (2019) Maternal and Perinatal Outcome Related to Severity of Chronic Hypertension in Pregnancy. Pregnancy Hypertens.
15. Cermakova P, Ding J, Meirelles O, Reis J, Religa D, Schreiner Pj, Et Al (2019) Carotid Intima-Media Thickness And Markers Of Brain Health In A Bi-Racial Middle-Aged Cohort: Cardia Brain Mri Sub-Study. Journals Gerontol Ser A.

