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Relationship Between P Wave Peak Time In Leads II And V1 With Left Ventricle Diastolic Function In Hypertension Patients

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ABSTRACT

Introduction: Left ventricular diastolic dysfunction is common in patients with hypertension. Inadequate management can cause complications such as hypertensive heart disease. Electrocardiography as a tool that is easy to find in health services is known to be able to detect left ventricular diastolic dysfunction. The purpose of this study was to examine the relationship between P wave peak time in leads II and V1 by electrocardiography with left ventricular diastolic function.

Method: This study was a cross-sectional study that was conducted by collecting 111 patients with a history of hypertension at RSUP HAM from October 2021 to November 2022. The P wave peak time was measured in leads II and V1 on the ECG. Diastolic function was assessed using echocardiography. A bivariate test was performed to assess the correlation between the two variables. Furthermore, ROC analysis was performed to assess the P wave peak time as a predictor of left ventricular diastolic function.

Results: **:** Total subjects were 111 hypertensive patients consisting of 49 (31.4%) hypertensive patients with normal diastolic function and 62 (68.6%) hypertensive patients with diastolic dysfunction. In bivariate analysis, a significant difference was found between the P wave peak time in lead II of hypertensive patients with normal diastolic function and hypertensive patients with diastolic dysfunction (65.47± 2.5 vs 68.9 ± 2.7;p = 0.001). Based on the ROC analysis, it was found that the P wave peak time could predict left ventricular diastolic dysfunction in hypertensive patients with AUC = 0.81 in lead II.

Conclusion: The P wave peak time in lead II can be a predictor of diastolic dysfunction in hypertensive patients.

Keywords

Hypertension, P waves, Diastolic dysfunction, Echocardiography

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INTRODUCTION

Hypertension is a global health problem resulting in increased morbidity and mortality rates and health care costs, including in Indonesia. Hypertension is a risk factor for damage to important organs such as the brain, heart, kidneys, retina, large blood vessels (aorta) and peripheral blood vessels. The number of people with hypertension aged 30 - 79 years doubled from 1990 to 2019, from 331 million women and 317 million men in 1990 to 626 million women and 652 million men in 2019. Globally, 59% of women and 49% of men were diagnosed with hypertension in 2019.[1] Basic Health Research (Riskesdas) in 2018 showed an increase in the prevalence of hypertension in Indonesia with a population of approximately 260 million was 34.1% compared to 27.8% in Riskesdas in 2013.[2,3] The increase in the prevalence of hypertension in the previous decades is a challenge so that public awareness and treatment of hypertension must be improved.

A long history of hypertension will eventually develop into hypertensive heart disease and heart failure if no interventions are made such as lifestyle modifications and anti-hypertensive drugs.[4] Hypertensive heart disease is a combination of various abnormalities in the structure and function of the heart, such as: left ventricular hypertrophy, systolic and diastolic dysfunction, and clinical manifestations can include arrhythmias and symptomatic heart failure. The classic paradigm of hypertensive heart disease is that thickening of the left ventricular wall is a response to increased blood pressure and is a compensatory mechanism to reduce pressure in the left ventricle. Changes in the structure of the left ventricular wall and compensatory mechanisms of increased blood pressure can lead to diastolic dysfunction which has a role in the pathophysiology of hypertension and hypertensive heart disease.[5]

There have been many studies of left ventricular diastolic dysfunction associated with electrocardiographic (ECG) examination. Ventricular activation time from ECG results can predict left ventricular diastolic dysfunction and left ventricular stiffness. Other studies with ECG also showed that P wave (P wave terminal force and P wave dispersion) is associated with left ventricular diastolic dysfunction in hypertensive patients. So ECG examination to assess diastolic dysfunction in patients with hypertension can be easily performed.[6,7]

P wave peak time (PWPT), a parameter obtained from a 12-lead ECG, describes the excitation time from the sinoatrial node to the peak point of positive deflection of both atria. An increase in PWPT illustrates the prolongation of intra-atrial or inter-atrial conduction time and illustrates increased pressure in the atria.[8] Burak et al in their study said that PWPT in lead II is associated with an increase in left atrial volume index and left ventricle end diastolic volume (LVEDP) which illustrates left ventricular diastolic dysfunction.[9]

The purpose of this study was to determine whether the PWPT value on a 12-lead ECG has a correlation with diastolic function in patients with hypertension in the outpatient polyclinic of the Haji Adam Malik Hospital Medan.

METHOD

This study was a descriptive analytical study with a cross sectional research design, which assessed the relationship between the peak P wave time from the 12-lead ECG and diastolic function from transthoracic echocardiography examination. P-wave peak time was calculated in units of time (ms) from the ECG, while diastolic function was assessed using transthoracic echocardiography.

This study was conducted on hypertensive patients who sought treatment at the polyclinic of Haji Adam Malik Hospital Medan from October 2021 to October 2022. The target population was subjects with hypertension who visited the outpatient polyclinic at the hospital. Samples in this study were collected using consecutive sampling technique.

Inclusion criteria of this study were subjects with BP $\geqslant$ 140/90 with a minimum of two measurements at rest or patients with normal blood pressure but already diagnosed with hypertension and routinely taking hypertension drugs, and hypertensive patients who were willing to become research subjects. Patients with incomplete medical record data, and ECGs that are difficult to assess, patients who do not have significant coronary artery disease, patients who have impaired left ventricular systolic dysfunction, patients who have reduced left ventricular ejection fraction, patients who have valvular heart disease other than mild degree, patients with congenital heart disease, patients with pulmonary hypertension, patients with pericardial abnormalities, patients with cardiomyopathy, patients with tachyarrhythmias and bradyarrhythmias, patients with chronic renal failure, patients with poor echo window, were included in the exclusion criteria.

Statistical data processing and analysis using the SPSS application. Bivariate analysis using the Chi-square test for categorical data or Fisher's test if the Chi-square test conditions were not met. Bivariate analysis for numerical data using T-independent test if the data were normally distributed and Mann Whitney test for data that were not normally distributed. Correlation between the two variables was calculated by Pearson correlation-regression statistical analysis for normally distributed data and Spearman correlation analysis for non-normally distributed data. Variables were considered significant if the p value was <0.05.

RESULT

This study was conducted at the Department of Cardiology and Vascular Medicine of H. Adam Malik Hospital by collecting data on hypertensive patients from medical records from October 2021 to November 2022. The number of samples that have been collected is 111 patients who have met the inclusion criteria. Then the 111 patients were divided into 2 groups, namely: hypertensive patients without diastolic dysfunction and hypertensive patients with diastolic dysfunction. In the ECG examination, PWPT in leads II and V1 were validated by 2 cardiologists and echocardiographic examination using the results that had been validated by cardiologists in the non-invasive diagnostic section.

Table 1. Characteristics of Research Subjects

Characteristics	n = 111
Age , years	56.15 ±11
Type Sex	
male , n (%)	63 (56.8%)
Female, n (%)	48 (43.2%)
Body mass index, kg/m ^{2}	25.9 (23.5 – 28.7)
DM history, n (%)	15(13.5%)
Smoking History , n (%)	38 (34.2%)
Systolic BP , mm Hg	143.87 ±19.4
Diastolic BP , mm Hg	81 ±11.2
pulse pulse , beats/ minute	80 ±10
Index mass ventricle left , g/m ^{2}	111.1 (89.3 – 131.7)
RWT	0.46 (0.37 – 0.57)
HVK pattern	
Hypertrophic concentric, n (%)	49 (44.1 %)
Remodeling concentric, n (%)	13 (11.7%)
IVAC mL/m ^{2}	28.52 ±3.1
E/A	1.0 ±0.2
e' lateral, m/s	0.10 ±0.3
e' septal, m/s	0.08 ±0.02
E/e'	9.9 ±1.7
TRVmax m/s	2.56 ±0.86
Function diastolic	
Normal, n (%)	49 (31.4 %)
dysfunction diastolic , n (%)	62 (68.6 %)
PWPT leads II (ms)	67.42 ±3.1
PWPT leads V1 (ms)	42.84 ±10.13

Bivariate Analysis of Research Subjects

Bivariate analysis with T-Independent Test, Mann-Whitney Test, Chi-Square Test, and Fisher's Test was conducted to determine whether there was a significant relationship or difference between the characteristics of the study subjects based on left ventricular diastolic function. The study subjects were divided into 2 groups, namely: hypertensive patients with normal diastolic function and hypertensive patients with diastolic dysfunction. Bivariate analysis revealed statistically significant differences ($p < 0.05$) in several parameters such as age, left ventricular mass index, IVAK, E/A ratio, septal e', lateral e', E/e' ratio and PWPT in the second lead.

Table 2. Test-retest Correlation on Intraobserver Reliability Test

Variable	*p-value*	Coefficient Correlation (r)	N
PWPT lead II	<0.001	0.98	111
PWPT leads V1	<0.001	0.98	111

Table 3. Bivariate Analysis of Research Subject Characteristics of Left Ventricular Diastolic Function

Characteristics	Normal n = 49 (31.4%)	Diastolic Dysfunction n = 62 (68.6%)	*P-value*
Age, years	52.90 ±11	58.73 ±10	0.005 [3]
Gender, n (%)			
Man	29 (27.8%)	34 (35.2%)	
Woman	20 (21.2 %)	28 (26.8 %)	0.790 [1]
Body mass index, kg/ m^2	25.3 (23.6 – 28.1)	25.9 (22.8 – 28.8)	0.833 [4]
DM history, n (%)	9 (6.6%)	6 (8.4%)	0.294 [1]
Smoking History, n (%)	18 (16.8%)	20 (21.2%)	0.770 [1]
Systolic blood pressure, mm Hg	142 ±16	144 ±21	0.565 [3]
Diastolic blood pressure, mm Hg	80 ±10	81 ±11	0.847 [3]
Left ventricular mass index, g/m^2	93.9 (77.5 – 105)	128.5 (119 – 144)	0.001 [4]
IVAK, mL/m^2	26.6 ±2.4	29.9 ±2.9	0.001 [3]
E/A ratio	1.1 ±0.1	0.9 ±0.2	0.001 [3]
e' septal, m/s	0.08 ±0.02	0.07 ±0.02	0.039 [3]
e' lateral, m/s	0.11 ±0.02	0.09 ±0.02	0.001 [3]
E/e ratio'	9.4 ±1.4	10.3 ±2	0.012 [3]
TRVmax , m/s	2.2 ±0.2	2.6 ±0.9	0.592 [3]
PWPT lead II , ms	65.47 ±2.5	68.9 ±2.7	0.001 [3]
PWPT leads V1 , ms	41 ±9	44.3 ±10	0.079 [3]

[1]Chi-Square; [2]Fisher Exact; [3]T-independent; [4]Mann-Whitney

Correlation Analysis of P Wave Peak Time in Taps II and V1

To determine the correlation of the time of peak P wave in leads II and V1 to left ventricular diastolic function parameters on echocardiography, Pearson correlation analysis was performed with normally distributed data. The results obtained were significant results with a positive correlation between the peak time of the P wave in lead II and IVAK (r = 0.916; p value <0.001), with a strong correlation strength. Significant correlations were also found between the time of peak P wave in lead II and age, E/A ratio, and E/e' but with weak correlation strength.

Table 4. Correlation Analysis of P Wave Peak Times in Leads II and V1

Variable	Correlation Test	Age	IVAK	E/A	E/e'
PWPT lead II	p-value	0.004	<0.001	0.008	0.008
	r	0.272	0.916	- 0.251	0.292
PWPT leads V1	p-value	0.375	0.006	0.773	0.212
	r	0.088	0.260	- 0.028	- 0.119

ROC Analysis of P Wave Peak Time in Leads II and V1 against Left Ventricular Diastolic Function.

ROC analysis was performed to assess the accuracy of the P wave peak time in both lead II and lead V1 in predicting left ventricular diastolic dysfunction. Diastolic function was categorised into patients with normal diastolic function and patients with diastolic dysfunction. The results obtained area under the curve (AUC) of lead II was 81% and V1 lead was 59%. The AUC value in lead II was classified as strong while the AUC value in lead V1 was classified as weak.

Table 5. Point cut off time peak P waves in leads II and V1 against function diastolic ventricle left

Parameter	AUC	p-value	cut off	Sensitivity	Specificity
PWPT lead II	81 %	0.00 1	66.5	80%	34 %
PWPT leads V1	59 %	0.089	45.5	26 %	61 %

The cut off point of the P wave peak time in lead II is 66.5 ms with 80% sensitivity and 34% specificity. The cut off point for the peak time of the P wave in lead V1 is 45.5 ms with a sensitivity of 26% and a specificity of 61%.

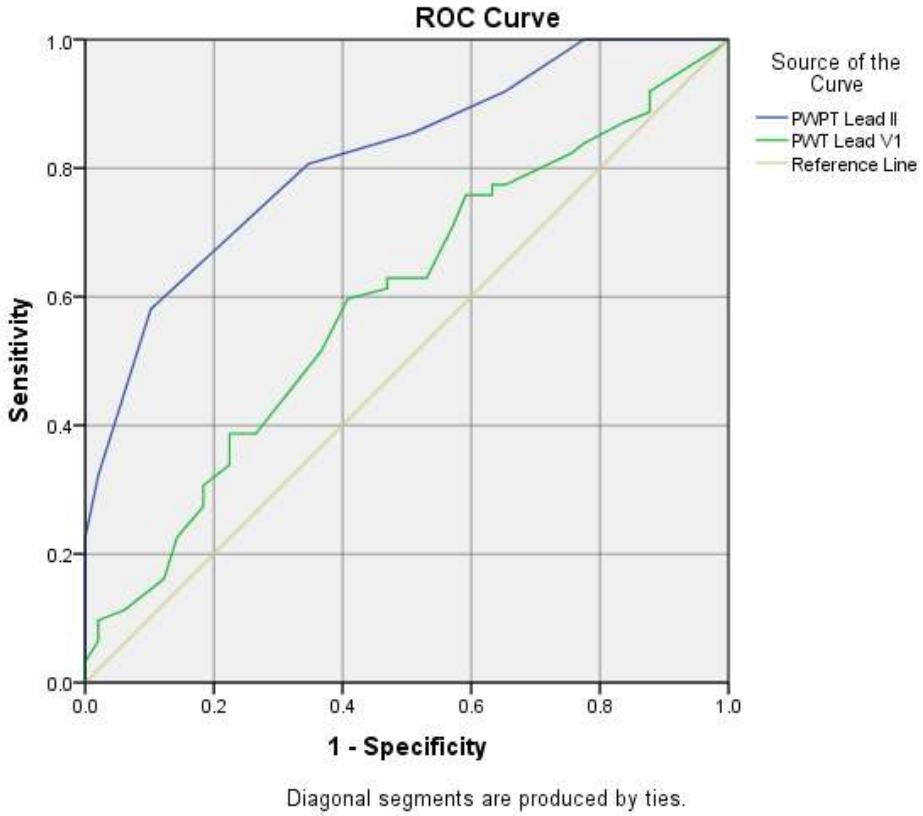

Figure 1. ROC analysis of P Wave Peak Time in Taps II and V1 against left ventricular diastolic function.

DISCUSSION

This study is a cross-sectional study on hypertensive patients at the Haji Adam Malik Central General Hospital which was conducted from October 2021 to November 2022. This study aims to assess the relationship or correlation between P wave peak time and left ventricular diastolic function in hypertensive patients. In this study, it has been found that there is a strong relationship or correlation between the time of peak P wave in tap II and left ventricular diastolic function in hypertensive patients.

Left ventricular diastolic dysfunction is characterised by decreased diastolic filling of the left ventricle, as well as impaired myocardial relaxation and distensibility as a consequence of HVK and myocardial fibrosis.19 Decreased diastolic filling of the left ventricle can lead to pathological changes in mitral flow and tissue Doppler velocities, which can be examined using echocardiography. The initial stage of diastolic dysfunction is impaired left ventricular relaxation, decreased E/A ratio and prolonged deceleration time. In the next stage, the complement of the left ventricle is disturbed and the filling pressure increases, so that the E/A and E/e' ratios increase and tissue Doppler velocities increase.6 In this study, a lower E/A ratio was found in hypertensive patients with left ventricular diastolic dysfunction. On examination of tissue Doppler velocities, the velocities of the septal e' and lateral e' were lower in patients with diastolic dysfunction. E/e' ratio values were higher in patients with diastolic dysfunction than in patients with normal diastolic function.

In hypertensive patients, the dimension of the left atrium increases due to increased filling pressure of the left ventricle, which is associated with worsening cardiovascular events, atrial fibrillation and diastolic dysfunction.[10,11] In this study, IVAK was found to be greater in hypertensive patients with diastolic dysfunction than patients without diastolic dysfunction.

ECG examination is the most accessible examination modality in healthcare. ECG can also be used for evaluation in all patients with hypertension. In this study, there was a strong positive correlation between the time of peak P wave in the second lead and IVAK. In a previous study by Burak et al, there was also a strong correlation between peak P wave time in lead II and IVAK.[9] It is known that increased pressure in the left atrium can cause prolongation of inter- and intra-atrial conduction time, prolonged increase in left atrial pressure can cause dilatation and fibrosis of the left atrium.[12] In this study, there was also a significant difference in IVAK in hypertensive patients with normal diastolic function and hypertensive patients with diastolic dysfunction.

In this study, it has been analysed with the ROC curve to determine the cut-off point of the P wave peak time in lead II and found a cut-off point at 66.5 ms with a sensitivity of 80% and specificity of 34%. This is slightly different from the results of the research of Burak et al, found a cut point at the second lead of 64.8 ms with a sensitivity of 68.7% and specificity of 91.3%.[9] In this study there was a strong correlation between the time of the P wave peak with diastolic dysfunction in hypertensive patients with diastolic dysfunction.

CONCLUSION

There is a strong positive correlation between the time of peak P wave in lead II and IVAK (r = 0.916; p value: 0.001). P wave peak time in lead II can well predict diastolic dysfunction in hypertensive patients. (AUC = 81%).

DECLARATIONS

Ethics approval and consent to participate. Permission for this study was obtained from the Ethics Committee of Universitas Sumatera Utara and Haji Adam Malik General Hospital.

CONSENT FOR PUBLICATION

The Authors agree to publication in Journal of Society Medicine.

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COMPETING INTERESTS

None.

AUTHORS' CONTRIBUTIONS

All authors significantly contribute to the work reported, whether in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas. Contribute to drafting, revising, or critically reviewing the article. Approved the final version to be published, agreed on the journal to be submitted, and agreed to be accountable for all aspects of the work.

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