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The Correlation Between P Wave Dispersion and Left Ventricle Mass Index (LVMI) in Heart Failure Patients in H. Adam Malik Central General Hospital Medan

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ABSTRACT

Background: Heart failure is a clinical syndrome that causes impaired ventricular filling. Its progression along with hypertension can cause ventricular enlargement, ventricular diastolic dysfunction, ventricular remodeling resulting in P waves alteration, one of which is P Wave dispersion, and structure of anatomical alterations as evaluated by an echocardiography. However, the examination is still limited to first-level health facilities. Therefore, an easily available and used initial examination is necessary, such as an electrocardiogram (EKG) by assessing the P wave dispersion which describes the left ventricular mass index (LVMI). Thus, this study aims to assess the correlation between P wave dispersion and the left ventricular mass index (LVMI) in heart failure patients at H. Adam Malik Hospital.

Method: This retrospective observational study with a cross-sectional design was conducted in June – December 2023 at H Adam Malik General Hospital, Medan. The sample included all chronic heart failure patients from January – June 2023 at H Adam Malik Hospital Medan who met the inclusion and exclusion criteria. Electrocardiogram and echocardiography data were recorded, then data analysis was carried out.

Results: A total of 60 subjects were included and divided into samples with an average P wave dispersion of ≥36 ms and <36 ms, and left ventricular mass index (LVMI) of 189.2 g/m2 (men) and 172.8 g/m2 (woman). There is a significantly moderate correlation between P wave dispersion and left ventricular mass index (LVMI) ($r= 0.462$, $p = 0.001$).

Conclusion: There is a correlation between P wave dispersion and left ventricular mass index (LVMI) in heart failure patients at H. Adam Malik General Hospital.

Keywords: heart failure. electrocardiography, p wave dispersion, left ventricular mass index.

INTRODUCTION

Heart failure is one of the leading causes of morbidity and mortality worldwide, with its incidence increasing with age and exacerbated by various risk factors.[1] Progressive heart failure with left ventricular hypertrophy is characterized by changes in cardiac impulses leading to alterations in the heart's electrical activation pattern, potentially resulting in decreased cardiac pumping function and increased risk of death.[2]

P waves evaluated from electrocardiograms can detect atrial enlargement, left ventricular hypertrophy, and left ventricular diastolic dysfunction.[3] Anatomical changes or heart structure modifications in hypertensive patients lead to alterations in P waves on electrocardiograms, particularly an increase in P wave duration known as P wave dispersion.[4,5] Previous studies have shown a significant association between P wave dispersion and heart failure.[5] Other research has demonstrated a correlation between P wave dispersion and left ventricular diastolic dysfunction in hypertensive patients, suggesting a relationship between P wave dispersion and left ventricular mass index (LVMI).[6,7]

Evaluating left ventricular hypertrophy in hypertensive patients is crucial as it affects the treatment strategies and guidelines.[8] Echocardiography examination is the gold standard for evaluating left ventricular mass due to its high sensitivity and specificity, although its availability is limited in some healthcare facilities. Given this limitation, healthcare providers are encouraged to utilize electrocardiogram examinations available at primary healthcare centers to provide appropriate management and depict the prognosis of heart failure in patients.[3,4,8]

Thus, this study was conducted to determine the correlation between P wave dispersion and Left Ventricle Mass Index (LVMI) in Heart Failure patients at H. Adam Malik Hospital.

MATERIALS & METHODS

This analytical study with a cross-sectional design was conducted at H. Adam Malik Medan Central General Hospital from January – June 2023 using medical record data. The sample consisted of all patients diagnosed with heart failure with a history of hypertension from January to June 2023 at H. Adam Malik Medan Central General Hospital who met the inclusion and exclusion criteria. Sample size was determined using consecutive sampling technique, with a total of 60 subjects.

Inclusion criteria included age >18 years, diagnosed with heart failure at H. Adam Malik Hospital Medan, having clinical data of heart failure with hypertension with electrocardiogram and echocardiography data. Subjects with incomplete data, a history of cardiac arrhythmias, valvular heart disease, thyroid dysfunction, or end-stage chronic kidney disease were excluded from the study.

Data collected included demographic information, weight and height, results of 12-lead EKG examination, and echocardiography. Echocardiography data included Left Ventricle End-Diastolic Dimension (LVSD), Interventricular Septal Thickness at end-diastolic (IVSd), and Posterior wall thickness at end-diastolic (PWd). Left Ventricle Mass Index was measured using the formula for calculating Left Ventricle Mass Index (LVMI) in units of g/m2.

STATISTICAL ANALYSIS

Data analysis was conducted with bivariate analysis using Pearson's test to determine the relationship between P wave dispersion and LVMI in normally distributed data or Spearman's test for non-normally distributed data. The strength of correlation was assessed using correlation coefficient (r). Data analysis was performed using IBM SPSS (Statistical Product and Service Solutions) version 22 software.

RESULT

A total of 60 subjects were included in this study, consisting of 63.3% males and 36.7% females. Most subjects were over 50 years (83.3%). Regarding P wave dispersion results, most subjects had ≥36 ms (70%). Table 1 shows the characteristics of the study subjects.

Table 2 below shows the results of Left Ventricle Mass Index (LVMI) examination. Most male and female subjects had abnormal LVMI results (65.8% and 77.3% respectively).

Tables 3 and 4 below show the mean P wave dispersion and LVMI. The mean

values of P wave dispersion and LVMI were 36.33 (± 11.927) and 183.25 (± 90.785), respectively.

Table 5 shows the results of Spearman correlation analysis between P wave dispersion and LVMI. The results showed a p-value of 0.001 and an r-value of 0.462. These results indicated a moderate, positive correlation; supporting the hypothesis that there is a correlation between P wave dispersion and Left Ventricle Mass Index (LVMI) in Heart Failure patients at H Adam Malik Medan Central General Hospital.

Table 1. Subjects' characteristics.

Characteristics	N	%
Age		
< 50-year-old	10	16,7
> 50-year-old	50	83,3
Gender		
Man	38	63,3
Woman	22	36,7
Body Mass Index		
<18.5	1	1,7
18,5-24,9	26	43,3
25-29,9	26	43,3
≥30	7	11,7
Height(cm)		
150 – 154	8	13,3
155 – 159	12	20,0
160 – 164	17	28,3
165 – 169	11	18,3
170-174	11	18,3
≥ 180	1	1,7
Weight (Kg)		
40 – 49	2	3,3
50 – 59	11	18,3
60 – 69	21	35,0
70 – 79	15	25,0
80 – 89	7	11,7
90 – 99	2	3,3
≥100	2	3,3
P Wave Dispersion		
<36 ms	18	30
≥36 ms	42	70

Table 2. The left ventricle mass index results.

		n (%)	
		Man	**Woman**
LVMI	**Normal**	13 (34.2)	5 (22.7)
	Abnormal	25 (65.8)	17 (77.3)

Table 3. Mean P Wave Dispersion results.

	Total Subjects (n=60)	Abnormal (n=42)	Normal (n=18)
P Wave Dispersion	36.33±11.927	39.05±10.777	30.00±12.367

Table 4. Mean Left Ventricle Mass Index results.

	All subjects		Abnormal		Normal	
	Man	**Woman**	**Man**	**Woman**	**Man**	**Woman**
LVMI (mean±SD)	189.29 ±92.249	172.82± 89.343	223.48±74.776	185.65±82.097	123.54±89.089	129.20±108.944

Table 5. The correlation between P Wave Dispersion and LVMI.

Analysis	P	r
The correlation between P Wave Dispersion and LVMI	**0.001***	0.462

Measured using the Spearman correlation test. r : coefficient correlation; *statistically significant.

DISCUSSION

Increased P wave dispersion occurs in patients with left ventricular diastolic dysfunction. This is caused by the hypertensive effect on the atrial myocardium, leading to uneven contractions, prolonged electrical activation, left atrial stiffness, increased left atrial

pressure, and cardiac remodeling.[6] The mean value of P wave dispersion in this study was 36.33 ms (±11.927). The P wave dispersion value in healthy individuals is known to be 33.46 ms, with a maximum value of 36 ms.[9,10] P wave dispersion of nearly 40 indicate a pathological scenario depicting heterogeneous electrical conduction activity in the heart, which may predict the occurrence of atrial arrhythmias, particularly atrial fibrillation (AF).[11,12] Additionally, it is known that P wave dispersion also increases in ischemic heart disease and hypertension. According to Gunduz et al., the mean P wave dispersion in patients with ischemic heart disease is 53 ± 8 ms, and in patients with left ventricular hypertrophy and heart failure, it is 52 ± 9 ms. The research conducted by Gunduz et al. showed that the duration of P waves or P wave dispersion is significantly longer in patients with systolic dysfunction.[6]

Based on the LVMI result, the mean values of abnormal LVMI for males and females were 223.48±74.776 and 185.65±82.09, respectively, with the overall mean LVMI for all male and female subjects being 189.29±92.249 and 172.82±89.343, respectively. In a study by Markus et al. in Brazil, it was found that the mean LVMI of heart failure patients was higher in males (175.7 g/m^2) compared to females (165.7 g/m^2).[13] Similarly, another study by Fuster et al. in Spain, involving 392 patients with diastolic ventricular dysfunction and low ejection fraction, also showed that the mean abnormal LVMI was higher in males compared to females (196.84 g/m^2 vs.187.86 g/m^2).[14] Differences in values between males and females are influenced by factors such as larger body surface area in males compared to females.[8] Another study by Yano et al. also showed that LVMI in males is larger than in females (115 g/m^2 vs. 95 g/m^2).[14]

Based on the normal LVMI result, this study also showed that normal LVMI in males is higher than in females (129.20±108.944 vs. 123.54±89.089). In the Southeast Asian population, it is known that the normal LVMI value for females is 96 g/m^2, and for males, it ranges from 49 to 106 g/m^2. Factors influencing this difference include height, weight, ethnic groups, and geographical variations. However, the ESC guidelines in 2016 suggest that the normal LVMI cutoff in heart failure patients is >115 g/m^2 for males and ≥ 95 g/m^2 for females to evaluate the risk and prognosis of patients.[14,15]

In this study, a significant moderate correlation (p 0.001, r 0.462) was found between P wave dispersion and Left Ventricle Mass Index (LVMI) in Heart Failure patients. P wave dispersion can reflect atrial conduction disturbances and the risk of atrial fibrillation, especially in patients with hypertension. This was demonstrated by a study reporting mean values of 38.29±8.02 ms for patients with hypertension and 32.11±4.72 ms for the control group ($p < 0.001$). [9] P wave dispersion has been shown to correlate with increased left ventricular mass index and diastolic development in hypertensive patients. [7]

Another study by Tosu et al. showed that P wave dispersion is not associated with clinical parameters such as age, gender, heart rate, echocardiographic parameters like left atrial diameter and E/A ratio, but there is a significant correlation with LVMI (r=0.412, p=0.011), IVRT (r=0.290, p=0.009), DT (r=0.210, p=0.052), and interventricular septum thickness (r=0.230, p=0.04). Compensatory hypertrophy of the ventricular wall due to increased pressure load in systemic hypertension leads to prolonged relaxation and ventricular flexibility as well as diastolic dysfunction. Increased end-diastolic pressure can directly cause atrial pump dysfunction in diastolic dysfunction. This pathophysiological condition leads to increased volume and tension in the atrium. Increased atrial tension stimulates collagen synthesis in atrial myocytes, leading to fibrosis and hypertrophy. Hypertrophy and fibrosis exacerbate arrhythmic symptoms and diastolic heart failure.[7]

CONCLUSION

In conclusion, there is a significantly moderate correlation between P wave dispersion and left ventricle mass index in heart failure patients in H. Adam Malik Medan Central General Hospital.

Declaration by Authors

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