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Correlation of Hypertension and Hypertensive Heart Disease in Mae Fah Luang University Medical Center Hospital

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Abstract:

Background: Ambulatory blood pressure (ABPM) can monitor blood pressure by obtaining multiple readings over the 24-hours, capturing the blood pressure variability, and an important predictor of cardiovascular outcomes in a hypertensive population.

Objective: To determine the correlation of hypertension and hypertensive heart disease by using ABPM.

Material and Methods: The present study was a cross-sectional study. 30 participants were assigned for detected left ventricular hypertrophy (LVH) using echocardiography and detected hypertension using ABPM.

Result: Participants who were diagnosed with hypertensive heart disease (HHD) by echocardiography found 26 samples (86.67%) and diagnosed with hypertension by ABPM found 20 samples (66.67%). The proportion of silent hypertension and HHD was found to be statistically correlated ($p< 0.002$). SBP significant correlation with LVH ($r = 0.53$, p-value $= 0.001$). Systolic blood pressure (SBP) was positively correlated with age ($r = 0.40$, p-value $= 0.014$), triglyceride ($r = 0.32$, p-value $= 0.042$), and low density lipoprotein (LDL) levels ($r = 0.31$, p-value 0.050).

Conclusion: This study found a high proportion of silent hypertension as measured by ABPM in participants who were diagnosed with HHD. Silent hypertension is also correlated with LVH. Moreover, age had been an important factor that correlated with increased systolic blood pressure and HHD.

Keywords: Incidence, Hypertension, Hypertensive heart disease

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Introduction

Hypertensive heart disease (HHD) refers to a group of changes in the left ventricle, left atrium, and coronary arteries caused by chronically high blood pressure.[1] Hypertension, also known as high blood pressure (BP), is diagnosed when systolic blood pressure is higher than 120 mmHg or diastolic blood is more than 80 mmHg.[2] The fiscal year in Thailand was from 2015 to 2017, new cases of hypertension of 50,000 to 70,000 are diagnosed each month.[3] Hypertension is a silent disease and is known as a "silent killer" because most people with high blood pressure do not know it. Most of the time, the symptoms are minimal or absent in their early stage.[4] Uncontrolled high blood pressure increases the workload on the heart, causing structural and functional changes in the myocardium. These changes include left ventricular hypertrophy (LVH) or LV systolic and diastolic dysfunction, which can lead to heart failure. In addition, hypertensive heart disease also causes cardiac arrhythmias, and sudden cardiac death.[5]

According to World Health Organization (WHO) statistics in 2020, cardiovascular disease is the leading cause of death worldwide, with an estimated 17.9 million deaths from the disease.[6] In 2018, cardiovascular disease was one of the top three causes of mortality among Thai people. According to the survey, the death rate from stroke and ischemic heart disease is on the rise. The mortality rates were 47.1 and 31.8 deaths per 100,000 people, respectively.[7] In Thailand, 45% of people with hypertension either never knew of it or knew but were not aware of it. Although they may have previously had their blood pressure measured because there are frequently no symptoms, a lack of trust in the system, and the accuracy of blood pressure measurement.[8]

Electrocardiography (ECG) and echocardiography are the primary tools used by cardiologists to diagnose hypertensive heart disease. ECG is the recommended test for the initial evaluation of hypertensive heart disease due to its high specificity but low sensitivity. The echocardiogram is an investigation to confirm HHD.[9] Ambulatory BP monitoring (ABPM) and home BP monitoring (HBPM) are the primary methods for measuring out-of-clinic BP to diagnose hypertension. HBPM is less expensive than ABPM. However, HBPM does not measure BP during routine daily activities and sleep. Thus, HBPM may have the potential for measurement error and incorrect classification of BP status, especially in people having high nocturnal BP.[10] ABPM is more useful than HBPM in monitoring BP by obtaining multiple readings over the 24-hours, capturing the blood pressure variability, and an important predictor of cardiovascular outcomes in a hypertensive population.[11,12]

Despite this recommendation, there is published data about people with silent hypertension and HHD. This study is to determine correlation of hypertension and hypertension heart disease by ABPM at the Mae Fah Luang University (MFU) Medical Center Hospital.

Materials and Methods

Participants

The present cross-sectional study was conducted between October 1, 2020, and January 30, 2021. The population in this study were all person who came to the clinic for a normal health checkup at the MFU Medical Center Hospital, Chiang Rai, Thailand. The author enrolled participants who were aged more than 18 years, had never been diagnosed with hypertension, followed a health check-up protocol with ECG, and were willing to participate in the study. The

exclusion criteria were participants who had been diagnosed with valvular heart disease equal to or higher than level 3, had not received ECG in the health check-up protocol, and had been diagnosed with hypertension.

The sample size was calculated using the infinite population proportion formula, considering the 15% prevalence of patients who receive health check-ups at MFU Medical Center Hospital, a total of 1138 cases were found to have been examined. There were 291 echocardiograms, 44 of which were diagnosed with left ventricle hypertrophy, with a 99% confidence interval (CI), and a 20% precision error. The study required 22 participants based on the calculations. To avoid missing data, the author increased the number of participants. As a result, the samples of 30 participants were gathered using a consecutive sampling technique.

Instrument and procedure

The Mae Fah Luang ethics committee on human research provided its approval (COA no. 202/2020) before the study began. Participants went through a normal health checkup routine after enrolling, following which patient information was collected from hospital records, and a direct patient interview was conducted. The findings of the sample group's ECG were read by the cardiologist. All participants had echocardiography to verify the LVH. The author employed an ABPM to collect blood pressure measurements for 24 hours, for a total of 30 samples. After removing the apparatus, the cardiologist read the results.

All analyses were performed at MFU Medical Center Hospital, Chiang Rai, Thailand. ECG was measured using the GE Healthcare MAC 800 version. Echocardiography was measured using the echocardiogram Epiq7c version. Blood pressure was measured using the ABPM GE tonoport version. This laboratory was regularly audited for international standard quality controls.

LVH was defined by LV concentric geometry greater than 0.43.[13] According to the 2017 American Cardiology Association/ American Heart Association recommendations, hypertension is defined as systolic blood pressure higher than 120 mmHg or diastolic blood pressure of more than 80 mm Hg.[2] HHD was defined as having LVH and a systolic blood pressure of more than 130 mmHg.[1,14]

Statistical analysis

The data was analyzed using the IBM SPSS statistics, version 26. The general characteristic data were analyzed using descriptive statistics as frequency, percentage, mean and standard deviation. Univariate analysis was performed to demonstrate various possible associated factors among patients by using Pearson's correlation coefficient, Spearman rank correlation coefficient, and the Chi-square test. The p-value of less than 0.05 was considered statistically significant.

Results

A total of 30 participants participated in this study. Most of them were female (56.67%), over 60 years old (56.67%), and overweight (63.33%), with dyslipidemia as the underlying disease (33.33%). None of the participants had ever smoked before. Twenty percent of the individuals drank alcohol, and 56.67% took an NSAID. The result of the participants' laboratory. The most of them were FBS< 100mg/dL (76.67%) (mean ± SD = 97.87 ± 20.32), Cholesterol level < 200 mg/dL (70.00%) (Mean ± SD = 189.93±51.30), triglyceride level < 150 mg/dL (63.33%) (mean ± SD = 162.20 ± 121.94), high HDL level (53.33%) (mean ± SD = 53.6 ± 14.4), low LDL level (63.30%) (mean ± SD = 105.03 ± 43.24).

The results of the clinical data analysis found six samples were detected in LVH from ECG (20.00%). Participants who were diagnosed with HHD by echocardiography found 26 samples (86.67%). However, those who were diagnosed with hypertension by ABPM found 20 samples (66.67%), as shown in table 1.

Table 1 The characteristics of clinical data (n = 30)

Characteristics	N	%
ECG result		
Yes (LVH)	6	20.00
No	24	80.00
Echocardiographic result		
HHD	26	86.67
Normal	4	13.33
ABPM result		
HT	20	66.67
Normal	10	33.33

Hypertension (HT) among HHD patients were found to be significantly higher than normal blood pressure (p-value = 0.002). Participants who were diagnosed with HHD had a statistically significantly higher proportion of HT as measured by ABPM than participants who were not diagnosed with HHD, as shown in table 2

Table 2 Comparison of blood pressure among HHD patients (n=30)

Diagnosis	ABPM result		p-value
	HT (N, %)	Normal (N, %)	
HHD	20 (76.89)	6 (23.11)	0.002
Normal	0 (0)	4 (100)	

Table 3 shows the correlation between HT as measured by ABPM and LVH. Systolic blood pressure (SBP) revealed a direct and positive correlation with LVH ($r = 0.53$, p-value = 0.001). As a result, high SBP than normal range (>130 mmHg) was correlated with LVH.

Table 3 The correlation between silent hypertension and blood pressure as measured by ABPM and LVH (n = 30)

HT measured by ABPM	Mean	SD	LVH	
			Correlation coefficient	P-value
SBP	139.93	15.10	0.53	0.001*
DBP	78.46	9.06	0.13	0.251

**p-value < 0.05*

Table 4 shows the correlation between variables and SBP as measured by ABPM. SBP was positively correlated with age, triglyceride, and LDL levels (r = 0.40, 0.32, and 0.31, p-value 0.05, respectively).

Tabel 4 The correlation between variables and SBP as measured by ABPM (n = 30)

variables	Mean	SD	SBP (mmHg)	
			Correlation coefficient	P-value
Age	61.73	12.91	0.40	0.014*
BMI	23.93	3.04	0.03	0.436
FBS	97.86	20.32	-0.06	0.386
Cholesterol level	189.93	51.30	0.27	0.075
Triglyceride level	162.20	121.93	0.32	0.042*
HDL level	53.60	14.40	-0.23	0.110
LDL level	105.03	43.25	0.31	0.050*

**p-value < 0.05*

Table 5 shows the comparison between the characteristics of patients with and without HHD. It was found that age was significantly different between the two groups. Most patients with HHD were around 40-60 years old. On the contrary, BMI, FBS, cholesterol level, triglyceride level, HDL level, and LDL level found no difference between HHD and normal patients.

Table 5 Comparison between characteristics of patients with and without of HHD (n = 30)

Variables	Diagnosis		p-value
	HHD (N, %)	Normal (N, %)	
Sex			
Female	15 (57.69)	2 (50.00)	0.773
Male	11 (42.31)	2 (50.00)	
Age (year)			
≤ 40	0 (0.00)	1 (25.00)	0.005*
40 – 60	9 (34.62)	3 (75.00)	
≥ 60	17 (65.38)	0 (0.00)	
BMI			
< 18.5	2 (7.69)	0 (0.00)	0.800
18.5 – 22.9	8 (30.76)	1 (25.00)	
23.0 – 24.9	16 (61.55)	3 (75.00)	
Fasting blood sugar (FBS)			
< 100	20 (76.92)	3 (75.00)	0.778
101 – 125	4 (15.39)	1 (25.00)	
> 126	2 (7.69)	0 (0.00)	
Cholesterol level			
< 200	17 (65.38)	4 (100.00)	0.160
≥ 200	9 (34.62)	0 (0.00)	
Triglyceride level			
< 150	15 (57.69)	4 (100.00)	0.102
≥ 150	11 (42.31)	0 (0.00)	
HDL level			
Low level	12 (46.15)	2 (50.00)	0.886
High level	14 (53.85)	2 (50.00)	
LDL level			
Low level	16 (61.5)	3 (75.00)	0.603
High level	10 (38.5)	1 (25.00)	

* *p-value < 0.05*

Discussion

The current study found that most ECG results were not found to be LVH in participants. Several ECG criteria have previously been proposed to diagnose LVH in the past.[15] However, criteria for the diagnosis of LVH had relatively low sensitivity, and high specificity.[16] ECG indices and subsequent poor diagnostic performance of these indices in the elderly.[17,18] Similar to the results in this study, most participants with HHD were found in the age groups 40-60 and over 60. Most likely, the age-related counterclockwise turn of the frontal QRS axis is primarily responsible for the reduced magnitude of LVH.[19] Therefore, echocardiography should be considered a screening device for the detection of LVH in the elderly. Hypertension is regarded as the most important trigger of LVH development that adversely affects the left ventricular structure.[20] Many early hypertensive patients have no symptoms and are unaware of their condition. As a result, early detection of hypertension remains a challenge, especially in the subclinical population. In this study, ABPM was used as a reference standard to assess blood pressure, avoid possible false readings, and predict cardiovascular outcomes in a hypertensive population.[2,13]

According to the findings of the present study, participants with HHD reported a statistically significantly larger proportion of HT as determined by ABPM than those who were not diagnosed with HHD. Age was a variable that showed significant correlation with SBP by using ABPM. Moreover, age was significantly different between patients with and without HHD. An explanation for this finding, that aging is associated with ventricular remodeling, is likely related to the coupling of ventricular and vascular stiffening processes that can occur over a lifetime.[21,22]

In vasculature studies, in elderly subjects without atherosclerosis, arterial wall media thickens, smooth muscle cell hypertrophy, extracellular matrix accumulation, and calcium deposition were found. Intimal-medial thickness (IMT) was nearly three times greater than that of those aged 20 and 90 with normal blood pressure. This factor affects the increase in blood pressure in older people.[23,24] A study of myocardial thickening. In younger adults, the heart is composed of approximately 25% cardiomyocytes and a complex structure of connective tissue, unlike in the elderly; with aging, there is a decrease in the total number of cardiomyocytes, likely due to apoptosis, as well as an increase in their size. The cardiac MRI study shows age-related declines in both LV diastolic and systolic volumes and an increased LV mass/volume ratio in both sexes.[23]

Study limitations

The small number of participants in this study constituted a limitation. Further research involving a greater number of healthy persons will contribute to the identification of risk factors that potentially predict HHD.

Conclusion

This study found a high proportion of HT as measured by ABPM in participants who were diagnosed with HHD. HT in the participants who had never been diagnosed with hypertension before was also correlated with LVH. Moreover, age has been an important factor that is correlated with increasing SBP and HHD.

What is already known on this topic?

Among people with HHD, this study discovered a significant incidence of silent hypertension as evaluated by ABPM. Echocardiography should be considered a screening device for the detection of LVH in the elderly.

What this study adds?

Echocardiography should be regarded as a screening tool for detecting LVH in the elderly. Furthermore, many people with high blood pressure have no abnormal symptoms. By utilizing a more sensitive tool to do a health check-up, early detection of hypertension can help to prevent consequences from high blood pressure.

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Conflicts of interest

There are no conflicts of interest for the authors to disclose.

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