Introduction

Hypertension (HT), defined by WHO 1999 criteria, is a major public health problem worldwide. In Thailand, the prevalence of HT in 2006 was approximately 19% and the number of hypertensive patients has been increasing. HT is also an important risk factor for systemic atherosclerosis and long standing HT results in many adverse cardiovascular and renal complications such as stroke, left ventricular hypertrophy (LVH), coronary artery disease (CAD), nephropathy and peripheral artery disease (PAD). According to the studies of Peera B. and Murray CJ, the prevalence of cardiovascular death related to HT is predicted to increase up to 77% by the year 2020 (1-4).

Referring to the HT guideline 2007 from the European Society of Cardiology (ESC), hypertensive patients with subclinical target organ damage (TOD) are classified as a high risk group and require aggressive management of HT (3). Many investigations of early TOD are listed and early detection of TOD leads to early effective treatment to stop or slow progression of adverse cardiovascular events. However, performing every test may not be cost effective. It is not mentioned in the latest guidelines how to select appropriate investigations and how frequent to monitor each test in each hypertensive patient (3).

Many studies show that left ventricular mass (LVM) is the best marker for examining LVH. Echocardiography is also a gold standard tool for evaluating LVM and most cardiologists are more familiar with this technique than carotid IMT measurement (5-10). Measurement of carotid intima media thickness (IMT) is a complicated technique which requires skillful operators for accurate numbers. Electrocardiography (EKG) using Sokolow’s precordial...
voltage criteria is an easy and practical method to detect LVH but has low sensitivity (77%) and is not good enough for early detection of LVH and for follow up of HT treatment compared to echocardiography (7-9). Ankle-Brachial Index (ABI), providing information of PAD, is a simple, risk-free, and cost-effective hemodynamic test and it can be widely used as a public screening tool in hypertensive patients (11-13). Until now, the association between left ventricular mass index (LVMI) and ABI has not yet been evaluated. If there is a strong correlation between both parameters, it will be more economical and convenient to use only the ABI in a public screening campaign for HT.

We hypothesized that since HT leads to subclinical end organ damage: LVH by LVMI and peripheral arterial disease (PAD) should have some correlation between the LVMI and ABI in hypertensive patients.

Methods

Patient recruitment

This study was approved by the institutional Ethics Committee. Hypertensive patients who were older than 35 years were recruited from the OPD at the Chest Disease Institute from November 2007 to 31 October 2008. Systolic HT, diastolic HT and isolated HT were defined according to the HT guidelines of the European society and international society of hypertension (3). Exclusion criteria were patients with a history of previous percutaneous coronary intervention (PCI), coronary artery bypass graft (CABG), vascular surgery, significant valvular heart disease (moderate degree and up), mechanical hemodynamic obstruction, serum creatinine more than 1.5 mg/dl and subjects who were unwilling to give consent.

Echocardiography and ABI were performed in every patient. Baseline characteristics, medical profile and routine laboratory results were recorded. LVM was examined by a recommended method of the American Society of Echocardiography (ASE). LVMI was derived from LVM divided by BMI. The calculation of LVM is shown in the following formula:

\[
LV \text{ mass} = (1.04 \times ([LVd + LVPWd + IVSd]^3 - [LVd]^3) \text{ g}) \tag{4-6}
\]

\[
LV \text{ MASS (ASE corrected ; Gram.)} = 0.8 \times (LV \text{ mass}) + 0.6 \text{ Gram (4-6)}
\]

LVd; left ventricular diameter in diastolic phase, LVPWd; left ventricular posterior wall in diastolic phase IVSd; interventricular septum in diastolic phase

ABI was measured with an automatic machine (Vasera model VS-1000) with an oscillometric method. The measurement was made only one time with the patient supine and the single lowest ABI value was used for analysis of correlation.

Statistical Analysis

Discrete data are reported as the percentage, while continuous data are presented as mean value ± standard deviation. A Pearson’s correlation was used for assessing the relationship between the LVMI and ABI. The prevalence of PAD and LVH by LVMI and voltage criteria was calculated.

Figure 1. Population Classified by Stage of HT
Table1. Demographic and baseline characteristic data.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Male (54)</th>
<th>Female (52)</th>
<th>All genders (106)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr.)</td>
<td>58 ± 10</td>
<td>62 ± 11</td>
<td>60 ± 11</td>
</tr>
<tr>
<td>Age &lt; 46 yr (n)</td>
<td>6</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Age 46-60 yr (n)</td>
<td>26</td>
<td>24</td>
<td>50</td>
</tr>
<tr>
<td>Age &gt; 60 yr (n)</td>
<td>22</td>
<td>26</td>
<td>48</td>
</tr>
<tr>
<td>DLP (n, %)</td>
<td>15</td>
<td>20</td>
<td>35 (33%)</td>
</tr>
<tr>
<td>DM (n, %)</td>
<td>6</td>
<td>19</td>
<td>24 (24%)</td>
</tr>
<tr>
<td>Hx of Stroke (n, %)</td>
<td>1</td>
<td>1</td>
<td>2 (2%)</td>
</tr>
<tr>
<td>Smoking (n, %)</td>
<td>27</td>
<td>2</td>
<td>29 (27%)</td>
</tr>
<tr>
<td>Fx. of CAD (n, %)</td>
<td>8</td>
<td>6</td>
<td>14 (13%)</td>
</tr>
<tr>
<td>BMI</td>
<td>26 ± 4</td>
<td>25.9 ± 3.8</td>
<td>26 ± 4</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>160 ± 31</td>
<td>160 ± 25</td>
<td>160 ± 29</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>89.0 ± 15</td>
<td>83.0 ± 13</td>
<td>86.5 ± 14</td>
</tr>
<tr>
<td>GFR</td>
<td>75.8</td>
<td>64.8</td>
<td>71 ± 24</td>
</tr>
<tr>
<td>Hct (%)</td>
<td>40.7</td>
<td>37.2</td>
<td>39 ± 3.9</td>
</tr>
<tr>
<td>LVH by EKG (n)</td>
<td>11</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>ABI &lt; 0.9 (n)</td>
<td>10</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>LVH by LVMI (n)</td>
<td>20</td>
<td>34</td>
<td>54</td>
</tr>
</tbody>
</table>

BMI = body mass index (kg/m²), DLP = dyslipedemia (LDL>150mg/dl), DM = diabetic mellitus, SBP = systolic blood pressure, DBP = diastolic blood pressure, GFR = glomerular filtration rate, Hct = hematocrit, LVH by LVMI defined by LVMI more than 150 g/m² in male and 120 g/m² in female.

Results

Patient characteristics

Of the 138 subjects recruited, only 106 patients were enrolled in the study. The rest of 32 subjects were excluded due to the inability to achieve good image quality and missing blood chemistry data. Baseline characteristics are shown in Table1. The mean age was 60 ± 11 years and 51% were men. Dyslipedemia, smoking and diabetes were identified in 33%, 27% and 24% respectively. The mean BMI was 26 in both genders. Nearly half of the patients were categorized in stage I of hypertension (Figure 1).

Outcomes

The correlation between LVMI and 1-ABI is illustrated in Figure 2. An absence of a relationship between the two markers were demonstrated (R = 0.19). Prevalence of PAD by the ABI criteria (<0.9) was 15%. LVH by LVMI was detected in 51% whereas Sokolow’s precordial voltage criteria could demonstrate LVH in only 12%.

Discussion

The prevalence of PAD in our study was not different from a previous survey (14,15). In the Netherlands, the combined prevalence of symptomatic and asymptomatic PAD in the population of those 55 years and older was 19% (14). In the United States, different prevalence values for PAD have been reported, ranging from 4% in patients 40 years and older to 29% in patients either older than 70 years or aged 50 to 59 years with a10-pack year history of smoking or the prevalence of diabetes mellitus (15).

Electrocardiographic criteria should not be used to rule out LVH in patients with hypertension (9). We could find LVH in hypertensive patients using LVMI approximately three times higher than those detected by EKG criteria. LVH is a precursor for left ventricular diastolic dysfunction and can turn into heart failure with preserved systolic function (HFPSF) which has the same
natural history and carries the similar prognosis as systolic heart failure. Until now, no definite regimen has been recommended for treating patients with HFPSF. Therefore, early detection of LVH for early treatment of LVH to prevent HFPSF should be the best strategy (3,16).

To our knowledge, the association between LVMI and ABI has not been reported. Unfortunately, we found no correlation of both parameters so, in terms of cost-effectiveness, it is not possible to use only a single tool for detecting subclinical organ damage among hypertensive patients. There are some possible explanations. First, the main pathology of generating an abnormal ABI is related directly to atherosclerosis while the severity of HT and the abnormal renin-angiotensin system is associated with the degree of LVH (16-19). HT with other risk factors is more likely to develop atherosclerosis and PAD than patients with HT alone. Less than one third of our hypertensive patients had other risk factors for atherosclerosis. Second, most of the study population had mild HT (stage I). The correlation may be presented in a more advanced stage of HT.

There are some limitations in our study. The number in our study population was relatively small. The data for the duration of hypertension was not available and white coat hypertension could not be entirely excluded from the study.

Conflict of Interest
None

References

Figure 2. Correlation between LVMI and 1-ABI

![Correlation between LVMI and 1-ABI](image_url)


16. Maciver DH. Heart failure with normal left ventricular ejection fraction may be due to systolic dysfunction. J Am Coll Cardiol 2009; 54: 488.


การศึกษาหาความสัมพันธ์ระหว่างค่าดัชนีความหนาตัวของห้องทรวงอกล่างซ้าย (Left Ventricular Mass Index) และค่าความแข็งตัวของหลอดเลือดแดงส่วนปลาย (Ankle-Brachial Index) ในผู้ป่วยความดันโลหิตสูง

นิติภัทร ตั้งธัญพุธุ, เภริยวัชสร สำรินทร์, อริยพร อัตตัณฑนทิพย์, บุญจง แซ่จิง

บทคัดย่อ
วัตถุประสงค์: การตรวจพบภาวะ subclinical organ damage (OD) ในผู้ป่วยโรคความดันโลหิตสูงมีความสำคัญในการชี้ถึงการพยายามโรคและส่งผลต่อการล่าอาชญาที่ควบคุมให้ความดันโลหิตสูงได้ตามเป้าหมายอย่างมีประสิทธิภาพ

วิธีการศึกษา: ระหว่างเดือนพฤศจิกายน 2550 ถึงตุลาคม 2551 ผู้ป่วยที่มีภาวะความดันโลหิตสูงณแผนกผู้ป่วยนอกของสถาบันโรคทรวงอกจะได้รับการตรวจภาวะค่าความแข็งตัวของหลอดเลือดแดงส่วนปลายและค่าดัชนีความหนาตัวของห้องทรวงอกที่มีการเก็บข้อมูลพื้นฐานและข้อมูลทางคลินิก มีการนำข้อมูลของค่าABIและLVMIมาศึกษาถึงความสัมพันธ์และมีการคำนวณถึงความชุกชุมของภาวะLVHโดยอาศัยคลื่นไฟฟ้าหัวใจเพื่อเปรียบเทียบกับการใช้คลื่นเสียงสะท้อนหัวใจ และความชุกชุมของการแข็งตัวของหลอดเลือดแดงส่วนปลาย

ผลการศึกษา: มีจำนวนผู้ป่วยที่เข้าร่วมการศึกษาจำนวน 106 ราย อายุเฉลี่ย 60 ปี เป็นเพศชาย 54 ราย พบความชุกชุมของการแข็งตัวของหลอดเลือดแดงส่วนปลายร้อยละ 15 และความชุกชุมภาวะLVHร้อยละ 12 แต่ความชุกชุมภาวะLVHโดยอาศัยคลื่นเสียงสะท้อนหัวใจ 51 ไม่พบว่ามีความสัมพันธ์ที่มีนัยสำคัญทางสถิติ

สรุป: การศึกษานี้ไม่พบความสัมพันธ์ระหว่างค่าความแข็งตัวของหลอดเลือดแดงส่วนปลายและค่าความหนาตัวของห้องทรวงอกล่างซ้าย การตรวจพบภาวะLVHด้วยคลื่นเสียงสะท้อนหัวใจไม่มีความไวมากกว่าการตรวจคลื่นไฟฟ้าหัวใจ