Impact of Type A Behavior on Brachial-Ankle Pulse Wave Velocity in Japanese

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K. and YAMBE, T. Impact of Type A Behavior on Brachial-Ankle Pulse Wave Velocity in
the velocity of a pulse wave traveling a given distance between 2 sites in the arterial sys-
tem, and is a well-known indicator of arteriosclerosis. Brachial-ankle PWV (baPWV) is a
parameter more simple to obtain, compared with the conventional PWV, and is an easy and
effective means of evaluating arteriosclerosis. BaPWV can be obtained by only wrapping
the four extremities with blood pressure cuffs, and it can be easily used to screen a large
number of subjects. Type A behavior has been confirmed as an independent risk factor for
the development of coronary heart disease. To examine the relationship between Type A
behavior and arteriosclerosis, 307 normal Japanese subjects were classified into either a
Type A group (n = 90) or a non-Type A group (n = 217) by using Maeda’s Type A Scale.
BaPWV was evaluated using a PWV diagnosis device. The baPWV in the Type A group
was significantly higher than that obtained in the non-Type A group. The baPWV showed
a positive correlation with age both in the Type A group and in the non-Type A group;
however, the straight-line regression slope of baPWV versus age in the Type A group was
significantly larger than that in the non-Type A group. Therefore, our results suggest that
arteriosclerosis might be promoted earlier in subjects expressing the Type A behavior
pattern. Type A behavior pattern is confirmed as a risk factor for arteriosclerosis, and may
increase the risk of the cardiovascular disease related to arteriosclerosis. ——— Type A
behavior; Brachial-ankle pulse wave velocity; arteriosclerosis

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Type A behavior was first described by Friedman and Rosenman in the late 1950s, and it has since drawn considerable attention as a possible coronary risk factor. This behavior pattern includes impatience, aggressiveness, a sense of time urgency, an intense achievement drive, and a desire for recognition and advancement. In the Western Collaborative Group Study, the Type A behavior pattern was shown to be predictive of the incidence of coronary heart disease independently of the traditional risk factors such as smoking, hyperlipidemia, and hypertension (Buller et al. 1998; Yoshimasu 2001). Type A behavior may enhance the rate of development of coronary arteriosclerosis, and the presence and severity of coronary arteriosclerosis as determined by angiography have been investigated in relation to the presence and severity of Type A behavior (Sparagon et al. 2001). Type A behavior assessed by a questionnaire modified to Japanese characteristics and job strain has been linked to angiographically determined coronary arteriosclerosis (Yoshimasu et al. 2000; Gallacher et al. 2003).

Pulse wave velocity (PWV) is a well known indicator of arteriosclerosis. Many reports have described the relationship between PWV and the development of arteriosclerotic disease. Recent studies have demonstrated that PWV is not only a risk marker of cardiovascular disease, but is also a prognostic predictor (Altun et al. 2004; Fujiwara et al. 2004; Tomiyama et al. 2004, 2005; Woodside et al. 2004).

PWV is the velocity of a pulse wave traveling a given distance between 2 sites in the arterial system. Recently, a new, simple device to measure brachial-ankle pulse wave velocity (baPWV) has been developed using pressure cuffs wrapped around the brachium and ankle. BaPWV has potential as a new marker of cardiovascular risk over conventional markers, as it is easy to obtain and serves as an indicator of either arteriosclerotic cardiovascular risk or severity of arteriosclerotic vascular damage. Thus it can be useful in screening the general population (Yamashina et al. 2003; Yokoyama et al. 2003; Ogawa et al. 2005).

Therefore, we hypothesized that if Type A behavior could be a risk factor of arteriosclerosis, subjects expressing the Type A behavior pattern might show a higher baPWV. The aim of this study was to compare differences of baPWV between subjects showing Type A behavior and those not showing Type A behavior.

**Materials and Methods**

**Subjects**

Three hundreds and seven normal Japanese subjects participated in this study. The data were collected at Tohoku University, Sendai, Japan. The exclusion criteria were the following: hypertension (defined as systolic blood pressure [SBP] ≥ 140 mmHg, diastolic blood pressure [DBP] ≥ 90 mmHg, or drug treatment for hypertension), endocrine disease, significant renal or hepatic disease, coronary artery disease, arrhythmias, cerebrovascular disease, or use of medication for diabetes mellitus or hyperlipidemia. Written informed consent was obtained from all participants, and the study protocol was approved by the Ethics Committee of Tohoku University, Graduate School of Medicine and School of Medicine, Japan.

**Measurement of the Type A behavior pattern**

Type A behavior was assessed by an abbreviated set of 12 questions developed by Maeda (1991). This assessment is considered to be very practical for epidemiological investigations because of its convenience. Each question is listed in Table 1. The subjects were asked to answer all of the questions. Each question allowed three responses. Two, 1, and 0 points were assigned, respectively, to responses of “always”, “occasionally”, and “hardly” for questionnaire items 1, 2, 3, 4, 7, 8, 10, 11, and 12, and the points were doubled for questionnaire items 5, 6, and 9. A total score of 17 or greater was defined as Type A.

**Measurement of baPWV**

The subjects were examined while resting in the supine position. After at least a 5-minute bed rest, baPWV was recorded using an automated device (VaSeraVS-1000, Fukuda Denshi, Tokyo) (Liu et al. 2005; Watanabe et al. 2005). This device simultaneously records baPWV, blood pressure (BP), electrocardiogram, and heart sounds. Electrocardiogram electrodes were placed on both wrists, and a heart sound microphone was placed on the left sternal border. Cuffs to measure baPWV were wrapped around both upper arms and ankles, and connected to a plethysmographic sensor that
determines volume pulse form. Volume waveforms were stored for a sampling time of 10 s with automatic gain analysis and quality adjustment. This instrument simultaneously records the baPWV on the left and right sides. The highest baPWV on both sides was determined, and subsequent statistical analyses were performed using these values (Liu et al. 2005; Tomiyama et al. 2005).

**Statistical analysis**

Data are expressed as mean ± S.D. All statistical analyses were performed using StatView-5 software (SAS Institute Inc., Cary, NC, USA). Student’s t-test was used to examine statistical difference of baPWV, BMI or SBP between subjects with Type A behavior and subjects without Type A behavior. Multiple linear regression analysis was performed to evaluate the association between baPWV and age, BMI, SBP, DBP, and Type A Scale in the subjects. Pearson’s correlation coefficient analysis was used to assess the relation between baPWV and SBP in subjects with Type A behavior and subjects without Type A behavior and the relation between PWV and Type A Scale in 307 subjects. Partial correlation coefficient analysis was used to describe the correlation between baPWV and age using SBP as covariate. $p < 0.05$ was regarded as statistically significant.

**RESULTS**

**Comparison of baPWV, BMI, and SBP between the Type A group and the non-Type A group**

The subjects’ characteristics are summarized in Table 2. Three hundreds and seven normal Japanese subjects were classified into either the Type A group ($n = 90$) or the non-Type A group ($n = 217$). BaPWV in the Type A group was significantly higher than that in non-Type A group. SBP and BMI were also significantly higher in the Type A group than those in the non-Type A group.

**Table 1. Maeda’s questionnaire for Type A behavior pattern**

<table>
<thead>
<tr>
<th>Questions</th>
<th>Always</th>
<th>Occasionally</th>
<th>Hardly</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Do you have a busy daily life?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Do you feel being pressed for time in your daily life?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Do you easily become enthusiastic over your job or other things?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. When you are absorbed in your job, do you find it difficult to change your mind?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Are you a perfectionist?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Do you have confidence in yourself?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Do you easily feel tense?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Do you easily feel irritated or angry?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Are you punctual with everything?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Are you unyielding?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Do you have an intense temper?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Do you easily become competitive about job or other things?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Each question had three responses. Points 2, 1, and 0 were given to the answers of “always”, “occasionally”, and “hardly” for 1, 2, 3, 4, 7, 8, 10, 11 and 12 nine questions, and the points were doubled for 5, 6 and 9 three questions. A total score of 17 or greater was defined as type A.

**Table 2. Characteristics of subjects**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Type A group</th>
<th>Non-Type A group</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>90</td>
<td>217</td>
</tr>
<tr>
<td>Age (years)</td>
<td>34.29 ± 16.54</td>
<td>33.92 ± 14.94</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>21.96 ± 2.94</td>
<td>21.24 ± 2.49</td>
</tr>
<tr>
<td>BaPWV (m/sec)</td>
<td>11.88 ± 2.35</td>
<td>10.96 ± 1.25</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>124.94 ± 8.24</td>
<td>122.27 ± 9.14</td>
</tr>
</tbody>
</table>

Data represent mean ± s.d.

$^*$ $p < 0.05$ (Student’s t-test).
**Correlation of baPWV with age and SBP in the Type A group and in the non-Type A group**

Table 3 shows the results of multiple regression analysis including baPWV and age, BMI, SBP, DBP, or Type A Scale. Age, SBP, and Type A Scale were significantly associated with baPWV, whereas BMI and DBP showed no significant association.

<table>
<thead>
<tr>
<th>Variables</th>
<th>β</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.57</td>
<td>0.001</td>
</tr>
<tr>
<td>BMI</td>
<td>0.01</td>
<td>0.895</td>
</tr>
<tr>
<td>SBP</td>
<td>0.14</td>
<td>0.012</td>
</tr>
<tr>
<td>DBP</td>
<td>0.08</td>
<td>0.102</td>
</tr>
<tr>
<td>Type A Scale</td>
<td>0.29</td>
<td>0.001</td>
</tr>
</tbody>
</table>

After adjusting for SBP, baPWV showed a significant positive partial correlation with age both in the Type A group ($r = 0.72, p < 0.05$) (Fig. 1A) and in the non-Type A group ($r = 0.54, p < 0.05$) (Fig. 1B). Comparisons between straight-line regression slopes were made using an analysis of covariance. The slope of baPWV vs age in the Type A group ($Y = 7.946 + 0.102X$) was significantly larger than that in the non-Type A group ($Y = 10.251 + 0.044X$) ($F = 45.38, p < 0.001$).

BaPWV showed a significant positive correlation with SBP both in the Type A group ($r = 0.41, p < 0.05$) (Fig. 2A) and in the non-Type A group ($r = 0.31, p < 0.05$) (Fig. 2B). The slope of baPWV vs SBP in the Type A group ($Y = -2.831 + 0.118X$) was significantly larger than that in the non-Type A group ($Y = 5.816 + 0.042X$) ($F = 10.99, p < 0.001$).

![Fig. 1. Relations between baPWV and age adjusted for SBP in Type A group (A) and non-Type A group (B).](image)

![Fig. 2. Relations between baPWV and SBP in the Type A group (A) and in the non-Type A group (B).](image)
Correlation of baPWV and SBP with the Type A Scale in 307 subjects

BaPWV showed a significant positive correlation with the Type A Scale in 307 subjects \( (r = 0.34, p < 0.05) \) (Fig. 3A). However, SBP showed no significant correlation with the Type A Scale (Fig. 3B).

**DISCUSSION**

In the present study, we compared the baPWV of subjects with Type A behavior and those without Type A behavior for the first time. Our major finding is that the baPWV of the Type A group had higher values than those of the non-Type A group. Therefore, our results suggest that subjects expressing the Type A behavior pattern have a higher risk for arteriosclerotic diseases than do subjects showing a non-Type A behavior pattern.

Arterial stiffness is a cause of premature return of reflected waves in late systole, increasing central pulse pressure and the load on the ventricle, reducing ejection fraction, and increasing myocardial oxygen demand (Laurent et al. 2001). The principal outcomes of these changes are left ventricular hypertrophy, aggravation of coronary ischemia, and increased fatigue of arterial wall tissues (Shoji et al. 2001; Blacher et al. 2003). Higher systolic blood pressure and pulse pressure, lower diastolic blood pressure, and left ventricular hypertrophy have been identified as independent factors of cardiovascular morbidity. Arterial stiffness is correlated with atherosclerosis, probably through the effects of cyclic stress on arterial wall thickening (Laurent et al. 2001).

The synergistic effect of hypertension and arteriosclerosis may appear as a higher PWV value. The degree of PWV elevation may correspond to the degree of arteriosclerotic change: a very high PWV may indicate that the arteriosclerotic process is already well established (Ogawa et al. 2003; Yokoyama et al. 2003). Thus, an increased PWV was associated with arteriosclerotic risk factors (Altun et al. 2004; Fujiwara et al. 2004; Tomiyama et al. 2004).

We also examined the correlation between baPWV and age. BaPWV showed a significantly positive correlation with age in subjects both with Type A behavior and in subjects without Type A behavior. The significant positive correlation found between baPWV and age showed that arteries become less elastic with age, and arterial stiffening was observed with increasing age (Oren et al. 2003). Aging induces structural and functional abnormalities such as arterial wall hypertrophy and degeneration or disorganization of the medial layer. These changes increase PWV because of increased arterial stiffness (Tomiyama et al. 2004, 2005).

Moreover, we found that the straight-line regression slope of baPWV vs age was significantly larger in subjects with Type A behavior than in subjects without Type A behavior. These results suggest that the increase of baPWV with age occurred earlier, the development of arterio-
sclerosis was faster, and an overall higher cardiovascular risk was shown in subjects expressing Type A behavior than in subjects not expressing Type A behavior. This trend may be associated with the effects on psychosocial variables of the Type A behavior pattern. A series of recent findings support adverse psychosocial effects relevant to arteriosclerosis under conditions of mental stress. Psychological variables may also impact the course of coronary disease through behavioral mechanisms (Rutledge et al. 2001).

Type A men, irrespective of coronary status, showed larger systolic and diastolic blood pressure response to both mental and physical stress than did Type B men (Sundin et al. 1995). Type A behavior may produce mental overload and stress, while coronary-prone exhaustion is characterized by inappropriate coping with environmental stress and giving up when confronted with life distress. Type A behavior is seen as personality traits, but it may also be a set of reactions to environmental stress and thus easily influenced by life events and working stress (Keltikangas-Jarvinen et al. 1996). Recently, it was reported that there exists a certain relationship between psychological factors and the extent of atherosclerosis measured by coronary angiography (Whiteman et al. 2000). There are few studies investigating the psychosocial factors related to these measures of arteriosclerotic disease processes. Psychosocial factors have been shown to contribute significantly to the development and clinical manifestations of coronary artery disease (CAD) (Whiteman et al. 2000). Type A behavior pattern is predictive of increased risk of coronary arteriosclerosis and might contribute to premature coronary arteriosclerosis and increased risk for CAD (Donker 2000; Yoshimasu et al. 2000, 2001; Sparagon et al. 2001).

Heart rate, lipid profiles and plasma glucose also influence PWV. However, these parameters were not examined in this study. It might be of interest to examine whether Type A behavior influences them.

In summary, the baPWV in the Type A group was significantly higher than that observed in the non-Type A group. The baPWV showed a positive correlation with age both in the Type A and the non-Type A groups. Moreover, the increasing trend of baPWV against age seen in the Type A group had a larger value than that of non-Type A group. Our results suggest that arteriosclerosis might be promoted earlier in subjects showing the Type A behavior pattern. Type A behavior pattern is confirmed as a risk factor for arteriosclerosis, and may promote to increase the risk of the cardiovascular disease related to arteriosclerosis. These findings may be associated with the differences in their psychosocial factors.

**Acknowledgments**

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