Internal Medicine
The Japanese Society of Internal Medicine
doi: 10.2169/internalmedicine.9367-17
Intern Med 57: 1371-1374, 2018
http://internmed.jp

【 ORIGINAL ARTICLE 】

Comparison of the Brachial-ankle Pulse Wave Velocity between Patients with Acute Coronary Syndrome and Effort Angina Pectoris

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Abstract:

Objective Coronary artery disease (CAD) is one of the clinical categories of atherosclerotic diseases. There have been reports indicating that the pathological findings of coronary artery plaque differ between acute coronary syndrome (ACS) and effort angina pectoris (EAP). The brachial-ankle pulse wave velocity (baPWV) has been reported to be a good indicator of atherosclerotic disease. However, the baPWV may not be equally effective for evaluating ACS and EAP. In this study, we compared the baPWV in patients with ACS and those with EAP.

Methods Two hundred and seventy patients were enrolled in this study. All patients underwent coronary angiography, and were separated into normal (CONT), ACS and EAP groups according to the clinical and coronary angiographic findings. The baPWV was evaluated and the results were compared among the groups.

Results The baPWV was significantly higher in the EAP group than in the other groups. The baPWV in the ACS group was almost the same as that of the CONT group and was significantly higher in the EAP group than in the ACS group across almost all age groups.

Conclusion The present study showed that the baPWV is high in patients with EAP. In contrast, the baPWV in the ACS group was almost normal and was similar to that of the CONT group. ACS occurs due to plaque rupture induced by atherosis, which may occur independent of sclerosis in the coronary artery. EAP may occur in proportion to systemic arterial sclerosis. The baPWV is suitable for screening for EAP, but not for ACS.

Key words: atherosclerosis, acute coronary syndrome, effort angina pectoris, baPWV

(Intern Med 57: 1371-1374, 2018)
(DOI: 10.2169/internalmedicine.9367-17)

Introduction

Coronary artery disease (CAD) is one of the most important atherosclerotic cardiovascular diseases. It has two major clinical features: acute coronary syndrome (ACS) and effort angina pectoris (EAP). It has been reported that the pathological findings of coronary artery plaque differ between patients with ACS and those with EAP (1-3) even though these two conditions occur due to atherosclerosis. The relationship between systemic atherosclerosis and the clinical features of CAD have not been fully examined. The brachial-ankle pulse wave velocity (baPWV) is a useful marker of arterial stiffness and a good predictor of atherosclerotic diseases (4-7). We examined baPWV to evaluate systemic atherosclerosis and compared the values between ACS and EAP patients.

Materials and Methods

We examined the baPWV in 270 patients who underwent first-time coronary angiography (CAG) at our hospital. The

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Received: April 21, 2017; Accepted: July 28, 2017; Advance Publication by J-STAGE: December 21, 2017
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Table 1. Characteristics of Study Patients.

	CONT (n=20)	ACS (n=156)	EAP (n=94)	p value
Age (yrs)	66.3±9.7	62.1±11.5	67.4±9.2*	p<0.001
M/F (n)	18/2	128/23	73/19	np
BMI (kg/m^2)	22.6±2.2	24.0±3.0	24.2±2.9	np
Hypertension (%)	45.0	52.0	65.2	np
Smoking (%)	40.0	61.1	47.8	np
Diabetes (%)	15.8	33.1	42.4	np
T. chol (mg/dL)	195.0±27.1	188.1±34.3	191.0±30.2	np
Triglyceride (mg/dL)	121.0±63.9	129.3±60.9	141.1±63.4	np
HDL (mg/dL)	56.5±17.9	41.3±13.2**	46.2±12.9***	p<0.0001
LDL (mg/dL)	117.7±22.6	122.3±30.1	119.2±28.1	np
Non HDL (mg/dL)	138.6±26.4	146.6±34.3	144.0±29.5	np
HbA1c	5.23±0.22	5.55±0.63	7.10±7.46	p<0.05
Mean number of vessel diseases	0	1.48	1.74	p<0.01

Data are expressed as n (%) or mean±SD. BMI: body mass index, LDL: low-density lipoprotein, HDL: high-density lipoprotein, RLP: remnant-like particle

*p<0.001 vs. ACS ** p<0.01 vs. CONT ***p<0.01 vs. ACS

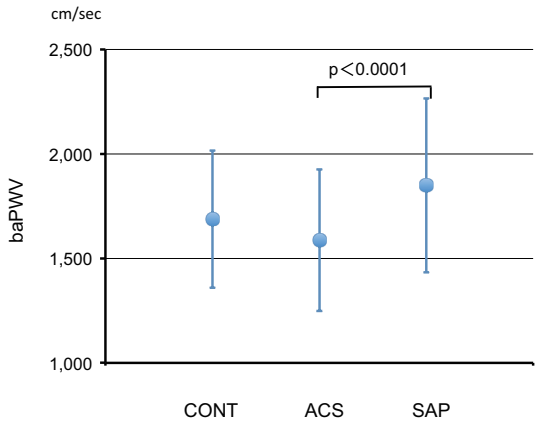

Figure 1. A comparison of the baPWV among the CONT, ACS and EAP groups. The baPWV was significantly higher in the EAP group than in the ACS group. baPWV: brachial-ankle pulse wave velocity

patients were divided into three groups: those with ACS, those with EAP and those without significant stenosis of coronary arteries (CONT). One hundred and fifty-six patients with ACS were diagnosed based on chest pain coupled with ST segment changes on electrocardiography (ECG) and angiographically significant coronary artery stenosis or occlusion with thrombus. Ninety-four patients with EAP were diagnosed based on chest tightness on effort and ≥75% coronary artery stenosis on angiography according to the American Heart Association standards. The remaining 20 patients, placed in the CONT group, were suspected to have CAD, but CAG did not reveal significant stenosis. None of the patients had a history of intermittent claudication or treatment for peripheral artery disease.

For ACS patients, blood samples were obtained after 12 hours of fasting and baPWV was measured when the clinical status was stable, i.e. approximately 2 weeks after admission. For EAP and CONT patients, blood samples were obtained after 12 hours of fasting on the second day of admission and baPWV was measured on the day after admission. The baPWV was assessed after about 20 minutes of bed rest, as the value can be influenced by blood pressure. The baPWV was automatically measured and calculated using form pulse wave velocity (PWV)/ankle brachial index (ABI) (OMRON COLIN, Tokyo, Japan). This device can calculate the ABI simultaneously. The patients with an ABI under 0.9 were excluded from the study, as the baPWV is inaccurate if the ABI is under 0.9.

It has been reported that the baPWV increases with age. Therefore, we compared the baPWV between the patients with ACS and those with EAP according to different age groups.

We separated the patients into four age groups: younger than 60 years old (<60), 60 to 69 (60s), 70 to 79 (70s) and 80 and above (≥80). All study protocols conformed to the requirements of the Declaration of Helsinki.

Statistical analysis

Statistical results are expressed as the mean ± standard deviation. The data were analyzed using Student's *t*-test for comparisons between two groups and an analysis of variance for comparisons between multiple groups. The chi-squared test was used for all rate comparisons. The relationships between the clinical variables and the baPWV were evaluated using univariate linear regression analysis, and the variables that correlated with baPWV ($p<0.1$) were tested for independence using multivariate linear regression analysis. A p value of <0.05 was considered statistically significant. Statistical analyses were performed using the JMP10 software program for Macintosh (SAS Institute, Cary, USA).

Table 2. Univariate and Multivariate Regression Analysis of BaPWV.

	Univariate		Multivariate		
	r	p value	β	SE	p value
Age	0.561	<0.0001	0.495	1.939	<0.0001
BMI	-0.053	0.393			
Digagnosis	0.280	<0.0001	0.186	33.66	0.0003
Hypertension	0.184	0.003	0.069	40.01	0.1724
Smoking	-0.248	<0.0001	-0.076	41.48	0.145
Diabetes	0.159	0.01	0.129	41.08	0.01
T.chol	-0.008	0.891			
Trigriceride	-0.058	0.355			
HDL-cholerterol	0.049	0.434			
LDL-cholesterol	-0.052	0.407			

Variables with p value<0.1 on univariate analysis were incorporated into the multivaliate models
(adopted factors: Age, Diagnosis, Hypertension, Smoking, Diabetes). BMI: body mas index, LDL: low-density lipoprotein, HDL: high-density lipoprotein, RLP: remnant-like particle

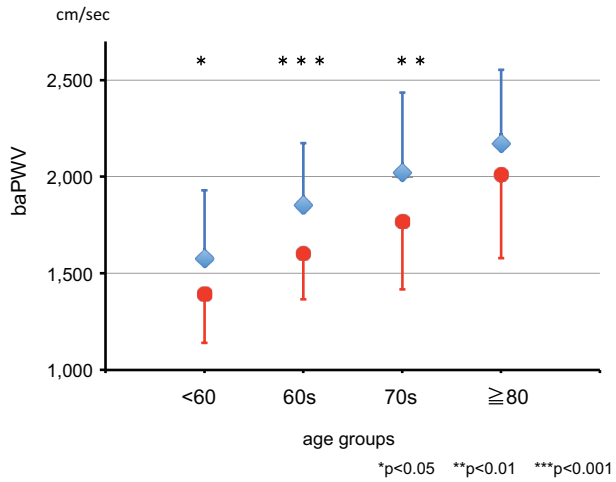

Figure 2. A comparison of baPWV between the ACS and EAP groups for the four age groups. The baPWV was significantly high in the EAP group for patients in the <60, 60s and 70s age group. *: p <0.05 **: p <0.01 ***: p <0.001. baPWV: brachial-ankle pulse wave velocity

Results

The clinical characteristics of the patients are shown in Table 1. No significant differences were identified among the groups in terms of gender, body mass index, rate of hypertension, diabetes and smoking status. However, the age was significantly higher in the EAP group than in the other groups. Significant differences were observed in the lipid levels, including remarkably different triglyceride and high-density lipoprotein-cholesterol levels. The mean number of vessel diseases was significantly high in the EP group than in the other groups.

Fig. 1 shows the results for the baPWV, which were significantly higher in the EAP group than in the ACS group (p <0.0001). Table 2 showed the results of univariate and multivariate regression model analysis. Age was the most influencial factor for the baPWV, so we compared the baPWV between the ACS and EAP groups for the four age groups, with the results shown in Fig. 2. For the patients in the <60, 60s, and 70s age groups, the baPWV was significantly higher in the EAP group than in the ACS group (p<0.05, p< 0,001, p<0.01, respectively).

Discussion

ACS and EAP are different not only in clinical findings but also in pathological findings for the coronary artery. Coronary artery plaque in ACS patients is known as vulnerable plaque and is characterized by lipid pooling, a thin fibrous cap (1, 2) and inflammatory cell infiltration (3). A rupture of coronary artery plaque is the trigger for ACS (4, 5). Therefore, systemic atherosclerosis may differ between these two conditions.

baPWV is one of the most widely used methods for evaluating aortic stiffness. There have been reports that the baPWV is a good predictor of cardiovascular disease (6-9) and that coronary artery calcium in patients with high baPWV progresses rapidly (10). In the present study, we compared the baPWV among CONT, ACS and EAP groups. The baPWV was significantly higher in the EAP group than in the other groups. The baPWV in the ACS group was almost normal and was similar to that of the CONT group. However, the CONT patients in this study are not normal control patients. They were suspected of having CAD and underwent coronary angiography, because they had some coronary risk factors and chest pain. These findings indicate that the systemic artery in patients with ACS is not excessively stiff or sclerotic.

The age was significantly higher in the EAP group than in the other groups. Since the baPWV increases with

age (11), we compared the values between the ACS and the EAP groups across different age groups. In both disease groups, the baPWV increased with age; however, the baPWV in the EAP group was significantly higher in almost all age groups than in the ACS group. In the patients over 80 years of age, there were no statistical differences between the two groups, but the EAP group had higher values. The baPWV in the ACS group in patients younger than 60 years of age was within the normal range. Therefore, baPWV measurement was not useful for the prediction of ACS in the younger patients.

ACS patients underwent baPWV about two weeks after admission. The start of medication, rehabilitation and diet for ACS patients was not constant. It has been reported that several medications or treatments improve the baPWV (12-15). However, because these treatment would have over two months to induce any improvement, we believe that the influence was small.

The baPWV is influenced by sclerosis and calcification of the arterial media (16), and atherosis of the arterial intima plays an important role in the onset of ACS (17). Given the present findings, we believe that atherosis and sclerosis do not necessarily develop simultaneously. These results suggest that coronary atherosclerosis or stenotic changes in EAP patients occur as systemic arterial stiffness develops.

However, in ACS patients, vulnerable plaque development is not concurrent with systemic artery stiffness. In EAP patients, chest symptoms appear when the coronary artery stenotic lesion exceeds 75% of the artery, but in ACS, it occurs when coronary artery stenosis is under 50% (18-20). The significant difference in the baPWV between the two groups may be influenced by the difference in coronary artery stenosis. We concluded that the baPWV is a good predictor for EAP, but not for ACS.

ACS occurs suddenly, and progresses rapidly, often causing sudden death. At present, it is difficult to predict and detect ACS before its occurrence. We believe that measuring the baPWV is an effective method of predicting EAP. However, the early detection and adequate treatment of coronary risk factors may be even more effective for preventing ACS.

The authors state that they have no Conflict of Interest (COI).

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