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Relation of Ankle Brachial Index to Left Ventricular Ejection Fraction in Non-Diabetic Individuals

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ABSTRACT

Introduction: Peripheral arterial disease is associated with an excessive risk for cardiovascular events and mortality. Peripheral arterial disease is usually measured with ankle brachial index (ABI). It is previously shown that the ABI would reflect LV systolic function, as well as atherosclerosis; however, these results are not shown in non-diabetic individuals. In this study, we aim to evaluate this relation in non-diabetic individuals.**Methods**: In a prospective study, 73 non-diabetic individuals (38.4% male with mean age of 59.20±14.42 years) referred for ABI determination who had had the left ventricular ejection fraction determined using trans-thoracic echocardiography were studied. Participants were compared in normal and low ABI groups. ***Results***: The mean left ventricular ejection fraction (LVEF) was 52.34±7.69, mean ankle brachial index for the right leg was 1.08±0.13, and the mean ankle brachial index for the left leg was 1.07±0.12. Low ABI incidence was 12.32%. Individuals with low ABI significantly were older ($p<0.001$) and had lower left ventricular ejection fraction ($p<0.001$). ABI had significantly inverse correlation with LVEF ($r=-0.53$, $p<0.001$) and positive correlation with age ($r=0.43$, $p<0.001$). The ABI correlated inversely with LVEF in the patients with ($r=-0.52$, $p=0.008$) and without ($r=-0.55$, $p<0.001$) IHD. ***Conclusion***: Results showed that ankle brachial index would be influenced by left ventricular ejection fraction in non-diabetics and to evaluate and monitor cardiovascular risk in patients these should be considered together.

Introduction

The ankle brachial index (ABI), which is the ratio of systolic pressure at the ankle to that in the arm, is fast and easy to quantify and has been applied for many years in vascular practice to verify the diagnosis and evaluate the severity of peripheral artery disease in the legs. The ABI usually measured the systolic blood pressure in the posterior tibial and/or the dorsalis pedis arteries either in both legs or one leg chosen at random (using a Doppler probe or alternative pulse sensor), with the lowest ankle pressure then divided by the brachial systolic blood pressure. In addition to peripheral artery disease, the ABI also is an indicator of generalized atherosclerosis due to the fact that lower levels have been associated with upper rates of concomitant coronary and cerebrovascular disease, and with the attendance of cardiovascular risk factors.[1, 2] Atherosclerosis is a generalized process involving different arterial territories; therefore, it is not surprising that the presence of flow-limiting lesions in a peripheral artery indicates disease in coronary, renal, and carotid arteries. [3] The presence of ABI less than 0.9 identifies the presence of peripheral arterial disease (PAD) [4] and advanced atherosclerotic burden. It is remarkable that low ABI has been identified as an independent predictor of coronary heart disease (CHD) and mortality. [5-7] ABI normal values generally range from 1.2 to 1.4. [8] The ratio is >1.0 because the shape of the arterial wave form changes from the central aorta to the periphery, with the systolic blood pressure increasing at peripheral sites owing to arterial waveform reflection and summation. [9] It is previously shown that the ABI would reflect left ventricular (LV) systolic function, as well as atherosclerosis[10]; however, these results are not shown in non-diabetic individuals. In this study, we aim to evaluate this relation in non-diabetic individuals.

Materials and methods

Patients

In cross-sectional study, we included 73 non-diabetic individuals. Exclusion criteria were diabetes mellitus,

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acute cardiovascular, cerebral, infectious or other active disease in the time of study, history of deep vein thrombosis, severe and non tolerable lower limb pain, PAD calcification which was considered in ABI>1.4.

All patients signed informed consent form. In addition, the study was done in accordance with the principles of the Helsinki Declaration (Edinburgh Amendment, 2000). All patients undergone ABI determination and had transthoracic echocardiographic studies within 14 days without clinical events or a known change in clinical status. After the participants had rested in the supine position for at least 10 minutes, the systolic ankle blood pressures were measured at the right and left brachial, dorsalis pedis, and posterior tibial arteries by trained technicians using a Doppler ultrasound instrument (Huntleigh). The right and left ABI rates were measured by dividing the right and the left ankle pressure by the higher of the two brachial systolic blood pressures. We used the greater of the dorsalis pedis and posterior tibial artery pressure. Participants were divided into two groups: low ABI if either leg had an ABI of ≤1 and normal ABI if both legs had an ABI ≥1 but <1.40.

Transthoracic echocardiography was performed in all participants and interpreted by experienced echocardiographer blinded to the ABI results. The LV dimensions were measured from M mode images according to the American Society of Echocardiography standards. Two-dimensional images were used when the scanning axis was not perpendicular to the axis of the heart. Left ventricular ejection fraction was measured either by echocardiography using the Simpson or eye ball method.

A normal left ventricular ejection fraction (LVEF) was defined as ≥50%. Clinical data were obtained from the vascular database and patient medical records. The clinical variables included age, body mass index, hyperlipidemia, hypertension, current cigarette smoking, and known coronary artery disease (CAD), defined as previous documented myocardial infarction, abnormal stress test results, or ≥50% stenosis by coronary angiography. Hyperlipidemia and hypertension were defined as a documented diagnosis obtained from either chart review or current treatment with medication.

Statistical analysis

Continuous data with normal distribution are given as mean± standard deviation, otherwise as median, Student's t-test for testing the significance of mean for independent continuous scale data, Chi-squared or Fisher's exact test for testing the significance of percentages. Multivariate analysis by logistic regression was done considering significant parameters. A p value of 0.05 or less was considered significant. Statistical analyses were performed using the Statistical Package for Social Sciences, version 13.0 (SPSS Inc, Chicago, IL, USA).

Results

Low ABI incidence was 12.32%. The patient characteristics are listed in Table 1. Two groups were similar except for age, which was higher in individuals with low ABI (p<0.001). There were significant differences between groups in ejection fraction and left and right ABI (p<0.001).

Table 1. Demographic and clinical parameters in all patients and two groups

	Low ABI (<1) (n=9)	Normal ABI (>1) (n=64)	All (n=73)	P
Age (yr)	76.75±8.32	57.01±13.52	59.20±14.42	<0.001
Gender (Male)	4 (44.4%)	24 (37.5%)	28 (38.4%)	0.72
Hypertension	8 (88.9%)	50 (78.1%)	58 (79.5%)	0.67
Hyperlipidemia	2 (22.2%)	25 (39.1%)	27 (37%)	0.47
Current smoking	2 (22.2%)	9 (14.1%)	11 (15.1%)	0.61
IHD	4 (44.4%)	20 (31.2%)	24 (32.9%)	0.46
Ejection fraction	41.66±8.66	53.84±6.28	52.34±7.69	<0.001
Normal ejection fraction (≥50%)	2 (22.2%)	58 (87.5%)	58 (79.5%)	<0.001
Right ABI	0.84±0.18	1.11±0.09	1.08±0.13	<0.001
Left ABI	0.86±0.17	1.10±0.09	1.07±0.12	<0.001

ABI had significantly inverse correlation with LVEF (r=-0.53, p<0.001), which in lower ABI, LVEF<50% was higher (77.8% versus 12.5%). ABI was also positively correlated to age (r=0.43, p<0.001), indicating that lower ABI is higher in higher age. In addition, the ABI correlated inversely with LVEF in the patients with (r =-0.52, p=0.008) and without (r=-0.55, p<0.001) IHD. Regression analysis showed that both age [OR=1.14, CI (1.03-1.27), p=0.01] and LVEF [OR=0.06, CI (0.008-0.50), p=0.009] were related to ABI.

Discussion

The ankle-brachial index has been used as an important indicator for diagnosis of peripheral arterial disease, particularly in studies of elderly populations with a high incidence of clinically significant atherosclerotic disease. [11] A low ABI is also associated with higher risk of cerebrovascular disease [12], more severe coronary artery disease [13-15], improved prediction of acute coronary events [6], higher prevalence of atherosclerosis [16,17], higher risk of arterial disease in people with diabetes [18], and greater decline in renal function over time. [19]

In this study, we evaluated relation of ABI to LVEF in non-diabetic individuals. We found that in non-diabetic individuals, ABI was associated with LVEF; compared with subjects with a normal ABI, those with a low ABI had a lower LVEF.

Price and coworkers [20] in the study of 28,980 individuals reported low ABI in 10.9%. In our study population, low ABI incidence was 12.32%, which was lower than Mo-

rillas *et al.* [21] study including 42.6% and Rizvi and coworkers [10] study including 52%. These could be due to exclusion criteria, in which we excluded diabetic patients. Morillas *et al.* [21] reported higher diabetes in patients with low ABI. Moreover, Resnick *et al.* [22] reported that diabetes was more prevalent in individuals with low ABI (60.2%) than normal ABI (44.4%). These results support this theory.

The mean ABI would have been affected by the age, sex of the population and method of measurement but was comparable to that found in other studies. [2, 23,24] Fowkes and coworkers [25] either reported that low ABI increased by age. Results of current study showed that age and LVEF are related to low ABI. Cantú-Brito and colleagues [26] observed that ABI ≤ 0.9 was associated with age, arterial hypertension, diabetes, current smoking, dyslipidemia and previous vascular events. The decreasing ABI with age is also universally observed and is compatible with an increase in the prevalence and severity of atheroma with age.

There are also some reports that low ABI is related to female gender. [20, 27] We observed no difference between male and female in ABI incidence.

It is shown that the ABI is influenced by LV systolic function, independent of coronary disease. [10] Similar to our study, Rizvi and coworkers [10] found that mean LVEF significantly increased from low ABI to normal and high ABI. ABI was independently related to LVEF. [10] Likewise, Ward *et al.* [28] in the study of 204 patients with symptomatic PAD found that LVEF less than 55% among patients with low ABI is more common than normal ABI. Also in the study by Santo Signorelli *et al.* [29] LVEF <50% had higher prevalence in patients with ABI≤0.9.

Two other studies showed different results. Thatipelli *et al.* [30] studied 395 patients referred for dobutamin stress echocardiography and ABI determination and observed that there was no relation between ABI and left ventricle wall motion index score at rest or after stress. Maldonado *et al.* [31] found ABI to be inversely correlated with LV mass and systolic function. The disparate results among these studies likely resulted from the differing patient populations and LV function measures.

Although the mechanism of the relation between ABI and LVEF remains uncertain, CAD and IHD is unlikely to be a confounding factor. Rizvi and coworkers [10] reported similar correlations between LVEF and ABI in patients with and without IHD. Similarly, in our study there were similar correlations between ABI and LVEF in patient with or without IHD. However, unlike their study, we observed no significant differences between low and normal ABI in IHD prevalence. It could be due to their diabetic patients that in diabetes cardiovascular disease are more prevalent.

Conclusion

Results of current study showed that ankle brachial index would be influenced by left ventricular ejection fraction in non-diabetics and to evaluate and monitor cardiovascular risk in patients these should be considered together.

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Ethical issues

The Ethical Committee of Tabriz University of Medical Sciences, Tabriz, Iran, approved the study. We kept personal information of patients as confidential. In addition, patients signed informed consent form before launching of the study.

Conflict of interests

No conflict of interest to be declared.

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