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ORIGINAL ARTICLE

Correlation between the Ankle – Brachial and Toe – Brachial Indexes and Coronary Artery Disease in Patients with Type 2 Diabetes

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Atherosclerotic coronary vascular disease (CVD) is a major cause of mortality and morbidity among diabetic patients. The ankle-brachial pressure index (ABI) is a simple screening procedure used in primary care settings for high risk populations, such as in diabetic patients, in whom medial arterial calcification results in falsely elevated ABI, which complicates?? the value of ABI in predicting CVD. The aim of this study was to determine whether ABI or Toe-brachial index (TBI) abnormalities can be used to identify asymptomatic type 2 diabetic patients with CVD. Materials &Methods: **In this case control study, 91 patients with Type 2 DM were selected. All the patients, who had documented evidence for presence or absence of CVD, completed a questionnaire regarding medical history, following which TBI and ABI were measured using a handheld ultrasound Doppler. ABI values less than 0.9 and TBI less than 0.7 considered abnormal.** Results: **Forty-four persons (patient group) had documented CVD and 47 had normal angiography (control group). ABI < 0.9 was present in 13.6% of the patient group and in 8.5% of control group; TBI < 0.7 was present in 34.1% of the patients group and 23.4% of controls. There was no significant difference between abnormal ABI and abnormal TBI in the patients or and controls. Sensitivity and specificity of abnormal results in prediction of CVD was 13.6% and 91.4% for ABI and 34% and 76.5% for TBI.** Conclusion: **Our study shows lack of sensitivity of ABI and TBI in identifying diabetic patients with CVD due to accelerated atherosclerosis.**

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Introduction

Type 2 diabetes mellitus (DM) is associated with increased cardiovascular risk, mostly due to accelerated atherosclerosis. Recent evidence shows that more aggressive preventive strategies may be effective in high-risk groups, making it ncessary to identify diabetic patients with asymptomatic cardiovascular disease[1].

Ankle-pressure assessment is a simple and inexpensive procedure that can be performed in primary care settings. An Ankle Brachial Index (ABI) value<0.9 is widely acknowledged to indicate an abnormally low level[2]. Low ABI has been associated with increased risk of subsequent mortality in populations with[3] or without[4–8] known cardiovascular disease (CVD); low ABI can predict increased risk of fatal myocardial infarction[9] and increased risk of CVD mortality [4-6,8], independent of conventional risk factors.

Although an ABI abnormality can be used for screening cardiovascular risk, its capacity to identify asymptomatic atherosclerosis in diabetic patients is unknown. In diabetic subjects, ABI measurement is complicated by the presence of medial arterial calcification which results in falsely elevated ABI values in the absence of significant peripheral artery disease. To compensate, we also investigated index measurements involving the toe and brachial systolic pressure (toe-brachial index [TBI]) in our patients. The aim of this study was to determine whether ABI or TBI abnormalities, which are bedside indexes of peripheral artery disease, could identify diabetic patients with obstructive coronary atherosclerosis.

Materials & Methods

In this one-year, case control study, conducted in Mashhad, Iran, 91 consecutive patients with Type 2 DM were selected and recruited between September 2007 and September 2008, from the endocrinology or cardiology in-patient clinics. All of the patients had documented evidence for presence or absence of coronary heart disease. Of these, 44 patients (patient group) had documented CVD (defined as a history of myocardial infarction, coronary artery bypass grafting, or an abnormal coronary angiogram) and 47 who were evaluated for CVD and had normal angiography made up the control group. Smokers and patients with hepatic or renal failure, rheumatologic diseases, peripheral edema, chronic obstructive lung disease and thrombophlebitis were excluded from the study. Participants completed a questionnaire regarding medical history at the Endocrine Research Center. Hypertension was defined as use of antihypertensive medications or blood pressure >130/80 mmHg (mean of 3 measurements). Hyperlipidemia was defined as serum triglycerides>150 mg/dL, low density lipoprotein (LDLchol) > 100 mg/dL or non high density lipoprotein cholesterol>130mg/dL. Height and weight were recorded and body mass index calculated. With the patient placed in a supine position for 15 minutes, Toe Brachial Index (TBI) and Ankle Brachial Index (ABI) were measured using a handheld ultrasound doppler device (Atys Medical – France) by an endocrinologist experienced in this procedure. All measurements were performed in a room, maintained at a temperature of 23–25°C, after at least 30 min of acclimatization. The highest systolic pressure of arm, ankle (tibial or posterior tibial), and toe pressures for each foot, are divided by the highest brachial systolic pressure to obtain the ABI and TBI for each leg. ABI values less than 0.9 and TBI less than 0.7 are considered abnormal.

Data are expressed as the mean ± SD. Data were analyzed by a Student's paired t-test or an unpaired t test. For nonparametric data, differences between groups were analyzed by the Mann-Whitney U test. A p-value <0.05 was considered significant.

Results

The patient group (diabetic patients with documented IHD) included 44 patients (26 females, 18 males) and the control group (diabetic patients with normal angiography) included 47 patients (29 females, 18 males). Mean age of the subjects was 55.5±9.19 years in the patient group and 54.68 ± 6.85 years in the controls. There was no significant difference in mean age, mean body mass indexes (BMI) and durations of diabetes in the patient and control groups (P=0.51) (Table1); 32 patients in the case group and 32 controls had hypertension; 30 patients (case group) and 34 controls had hyperlipidemia. There was no significant difference between the prevalence of hypertension (P=0.63) or hyperlipidemia (P=0.66) between the two groups (Table 1).

Table1. Characteristics of the patient and control groups

	Patients (44)	Controls (47)
Age (yr)	55.50 ± 9.19*	54.68 ± 6.85
Body mass index (kg/m^2)	27.65 ± 4.26	27.59 ± 3.66
Duration of diabetes (yr)	12.27 ± 8.85	11.12 ± 7.85
Mean ABI	1.091 ± 0.12	1.043 ± 0.12
Mean TBI	0.74 ± 0.11	0.74 ± 0.10
ABI < 0.9 (%)	13.6	8.5
TBI < 0.7 (%)	34.1	23.4

*mean±SD

In 10 persons with abnormal low ABI (in both the case and control groups), 5 had abnormal TBI. In 78 persons with normal ABI, 19 had abnormal TBI. In the remaining 3, ABI was above 1.3; ABI < 0.9 was present in 13.6% of patients group and 8.5% of the controls; TBI < 0.7 was observed in 34.1% of the patient group and 23.4% of the controls. Mean ABI in the patient group was 1.091 ± 0.12, and 1.043 ± 0.12 in the controls. Mean TBI in the patient group was 0.74 ± 0.11, being 0.74 ± 0.10 in the controls. There was no significant difference between abnormal ABI (with cut point of 0.9) (P = 0.26) or abnormal TBI (with cut point of 0.7) (P = 0.46) in patients or controls (Table1). Abnormal ABI results had sensitivity and specificity of 13.6% and 91.4% and abnormal TBI results had sensitivity and specificity of 34% and 76.5% for coronary artery disease.

Discussion

Atherosclerotic coronary vascular disease (CVD) is a major cause of mortality and morbidity among diabetic patients. It is desirable to identify diabetic subjects with coronary atherosclerosis before the onset of angina pectoris or myocardial infarction. Targeting aggressive preventive strategies on the basis of imaging modalities, clinical characteristics and biomarkers can reduce the risk of CVD in high risk population including diabetics [10,11]. One approach involves bedside tests that predict future CVD, and ABI is potentially a useful tool for this purpose [12-15]. Easy and inexpensive, ABI measurement takes less than 10 to 15 minutes, and can be done both in the physician's office and in community settings by a suitably trained nurse or physician[16,17]. Patient acceptability is high because it is noninvasive and causes no discomfort. Variability is comparable with that of routine blood pressure[18,19] and individuals with borderline results may benefit from a repeated measure at a different visit[19]. Recently guidelines published by the American Heart Association and the American College of Cardiology[20], the Transatlantic Inter-Society Consensus Working Group[21] and the Fourth Joint European Task Force[22] suggest that ABI should be considered for the purpose of cardiovascular risk assessment in the general population.

Abnormal ABI results, reported to have sensitivity and specificity of 85% and 77% for 3-vessel or left main coronary artery disease[23], are independent predictors of CVD[12]. Other studies document different results; ABI was normal in some studies in many patients who had atherosclerosis[12,13], suggesting deficiency of ABI in detecting asymptomatic CVD; in a sub study of 414 participants in the Cardiovascular Health Study, Newman et al (24) reported a lack of sensitivity (21%), but moderate specificity (83.5%), of ABI <0.9 in detecting coronary artery calcification scores >400 in an elderly, predominantly non-diabetic sample. In another study by Bagheri et al, associations of ABI abnormalities with coronary artery calcium (CAC), a measure of coronary atherosclerosis, were examined in 589 asymptomatic patients

with type 2 DM. Neither ECG nor ABI changes predicted CAC after adjusting for age, gender, and race, and ABI abnormalities failed to detect patients with subclinical coronary atherosclerosis [25]

ABI interpretation is complicated by the presence of medial arterial calcification and most patients with an ABI >1.3 have been shown to have such calcifications [26]. In diabetic patients medial artery calcification occurs extensively and decreases the value of ABI; in some studies, index measurements involving the toe and brachial systolic pressure (TBI) are advocated in diabetic patients. [26]

However low ABI can independently predict the risk of all cause- and CVD mortality in patients with type 2 DM; in a study from the Netherlands, investigating the association between ABI and TBI and cardiovascular mortality, in diabetic and non diabetic individuals, it was shown that, although an ABI< 0.9 may underestimate the presence of peripheral artery disease in individuals with type 2 diabetes, this measure is a powerful independent predictor of cardiovascular mortality in both diabetic and non-diabetic subjects[27] This result has also been confirmed by similar studies conducted in other countries.[28,29]

Our study compared the ABI values in diabetic patients with documented CVD and with normal coronary vessels. The results showed that the difference between abnormal ABI in diabetic patients with and without CVD was insignificant. The results show lack of sensitivity, but moderate specificity of ABI to assess asymptomatic CVD in patients with diabetes.

Because medial arterial calcification is less frequent in the toe than the ankle, we also measured TBI. The results showed that the difference between abnormal TBI in diabetic patients with and without CVD was insignificant.

To discuss study limitations, first, the small sample size of subjects considerably limits the values of results. Further extensive studies are needed to clarify the relationship between abnormal ABI and CVD. Second, this study is cross sectional and therefore longitudinal inferences cannot be drawn. A prospective study should be undertaken to evaluate role played by high ABI in the development of atherosclerotic disease.

Our study shows lack of sensitivity of ABI and TBI in identifying diabetic patients with CVD, induced by accelerated subclinical atherosclerosis. Abnormal ABI and TBI results had low sensitivity but moderate specificity for coronary artery disease in diabetic patients.

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