Diagnostic Value of Ankle Brachial Index for Myocardial Ischemia in Asymptomatic Diabetic Patients and Comparison with Myocardial Perfusion Imaging

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Abstract

Objective: The ankle-brachial index (ABI) as a simple test which can detect peripheral arterial disease (PAD). Therefore in this study we try to evaluate the diagnostic value of ABI for silent myocardial ischemia in diabetic patients and compare the results with myocardial perfusion imaging (MPI) results.

Materials and Methods: All 149 diabetic patients in this study were categorized according to different parameters including sex, smoking, cholesterol, familial history, and high blood pressure, level of ischemia, myocardial infraction (MI), left ventricle (LV) volume, ejection fraction (EF), and wall motion. Then the relationship of ABI index and these parameters were investigated.

Results: According to the calculated ABI the data was investigated based on ABI lower and higher than 0.9 .The frequency of ABI> 0.9 was 16 (11%) and< 0.9 was 133 (89%). There was no significant relationship between all the mentioned parameters and ABI index (*P*-value: 0.05).

Conclusion: This study suggests the ABI sensitivity and specificity for diagnose of silent ischemia in asymptomatic diabetic patients is very low and in this case ABI cannot replace MPI by any means.

Keywords: Ankle-brachial index, Diabetes, Myocardial perfusion imaging, Coronary artery disease

Introduction

The ankle-brachial index (ABI) as a simple test can detect peripheral arterial disease (PAD) especially in the lower extremities (1). ABI is equal to the ratio of the ankle systolic pressure to the brachial systolic pressure. In a normal person the ankle pressure is slightly more or close to the brachial pressure; hence ABI is around 1-1.4 (1-3). In PAD patients, the ankle pressure lowers due to the upstream hemodynamic lesions which results in a lower ABI (ABI<1) (4,5). The ABI depends on qualitative and quantitative aspects of other diseases such as atherosclerotic disease. In atherosclerotic disease the serially located lesions additively contribute to decrease distal pressure which enables the ABI to measure the severity and number of atherosclerotic lesions located in the lower extremity (6,7).

On the contrary, the ABI is particularly unreliable in diabetes disease, which is attributed to the stiffness of arterial vessel walls. Theses rigid arteries cause a false positive read by the sphygmomanometer (8,9). Diabetic patients are susceptible to a wide range of other disease including retinopathy (10), obesity (11), resistance to insulin (12), infections (13,14), antonym disorders and most importantly coronary artery disease (CAD) and PAD (15-17). The incidence of silent myocardial ischemia (SMI) and stroke in diabetic patients is 2-7 times higher than non-diabetic patients. Therefore continuous monitoring of diabetic patients could prevent the SMI (18,19).

Myocardial perfusion imaging (MPI) as the gold standard for prognosis and diagnosis of CAD. However, due to ionizing radiation of MPI method encourages finding different and safer methods. In this study we are trying to evaluate the diagnostic value of ABI for SMI in diabetic patients and compare the results with MPI results.

Materials and Methods

Settings and Patients

This study was organized in Fatemeh Zahra Hospital of Sari located in the north of Iran. The subjects of this study were 149 type 2 diabetes who referred to the hospital for MPI. These patients were selected by convenient method during 2015-2016. All the patients were 30-70 years old. We excluded patients who had heart disease from this study. All the demographic information including smoking, type and duration of diabetes, sex, age, blood pressure and etc. were registered for the selected patients.

MPI test

First, a standard dose of ^{99m}Tc-MIBI was injected to the patient and the rest phase image was acquired by a gamma camera (Zemence Company, dual headed gamma camera, Germany 2011). The following day the stress phase image was acquired.

ABI measurement

Before any measurement, the patient should be in the supine position for 5 min. then, the systolic blood pressure of one arm and one ankle were measured. The ABI value was calculated using the following equation:

$$ABI = \frac{\text{systolic blood pressure of the ankle}}{\text{brachial arterial systolic pressure}}$$

Statistical Analysis

P-value <0.05 is considered as a significant difference. In addition, SPSS version 14 software was used for data analysis. Negative predictive value (NPV), positive predictive value (PPV) and overall accuracy (OA) were also calculated.

Ethical considerations

The subjects in this study agreed to contribute in this study and their health were not endanger in this study by any means. All the patients' information will stay confidential. This study was approved by Mazandaran University of Medical Sciences ethical committee. The ethical code for this study is IR.MAZUMS.REC.94-1843.

Results

Descriptive statistics

All 149 patients in this study were statistically analyzes and categorized according to different parameters (table 1). The mean (±SD) age of patients was 61.06 (±9.18) years old.

The mean (±SD) Systolic blood pressure of right brachial was 135.22 (25.35) and right ankle was 156.89 (28.58) for all the 149 patients.

Based on the systolic blood pressure of right brachial and right ankle, ABI was calculated.

Table 1. Descriptive statistics for patients

Parameter	Frequency (%)
Sex	43 (28.86)
Male Female	106 (71.14)
Diabetic	111 (74)
Treatment with peals	29 (19)
Treatment with insulin Treatment with life style	9 (6)
Smoking	6 (4)
Yes No	143 (96)
High cholesterol	116 (78)
Yes No	33 (22)
High blood pressure	110 (74)
Yes No	39 (26)
Familial history	33 (22)
Yes No	116 (78)
Level of ischemia	77 (52)
No	40 (27)
Mild	18 (12)
Moderate Sever	14 (9)
Level of ischemia (bi-level)	77 (52)
Yes No	72 (48)
MI	12 (8)
Yes No	137 (92)
Mixed	18 (12)
Yes No	131 (88)
LV volume	136 (91)
Normal Dilated	13 (9)
EF	130 (87)
Normal Decreased	19 (13)
Wall motion	115 (77)
Normal Decreased	33 (23)

According to the calculated ABI the data was investigated based on ABI lower and higher than 0.9 .The frequency of ABI> 0.9 was 16 (11%) and< 0.9 was 133 (89%)

In order to evaluate the relationship of ABI with ischemia, MI, LV volume, EF and wall motion first we categorized the patients based on ABI values (above 0.9 and under 0.9) for each parameter. Then, we performed Chi-square test to determine whether there is a significant relationship between or not. Based on the data present in table 3 there is no significant relationship between ABI and other parameters (table2).

A receiver operating characteristic (ROC) curve

ROC curve can determine the diagnostic value of ABI. By using this carve different parameter including the area under carve (AUC), p-value and 95% percent confidence interval are provided in table 6. Moreover, diagnostic indicators including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), true negative rate (TNR) and true positive rate (TPR) are calculated (Table 3). This data indicate the low diagnostic value of ABI for prediction of silent ischemia in diabetic patients in comparison with MPI.

Discussion

Most of the patients (71.14%) in this study are

Table 2. Statistical investigation for relationship of ABI and different parameters in diabetic patients

Parameter	Sub-parameter	ABI< 0.9 Number (%)	ABI> 0.9 Number (%)	*P*-value from Chi-square test
Level of ischemia	No	6 (38)	71 (53)	> 0.05
	Mild	5 (31)	35 (26)	
	Moderate	3 (19)	15 (11)	
	Sever	2 (13)	12 (9)	
Level of ischemia (bi-level)	Yes	10 (63)	62 (47)	> 0.05
	No	6 (38)	71 (53)	
MI	Yes	2 (13)	10 (8)	> 0.05
	No	14 (88)	123 (92)	
Mixed	Yes	3 (19)	15 (11)	> 0.05
	No	13 (81)	118 (89)	
LV volume	Normal	16 (1)	120 (90)	> 0.05
	Dilated	0	13 (10)	
EF	Normal	15 (94)	115 (86)	> 0.05
	Decreased	1 (6)	18 (14)	
Wall motion	Normal	11 (69)	104 (78)	> 0.05
	Decreased	5 (31)	29 (22)	

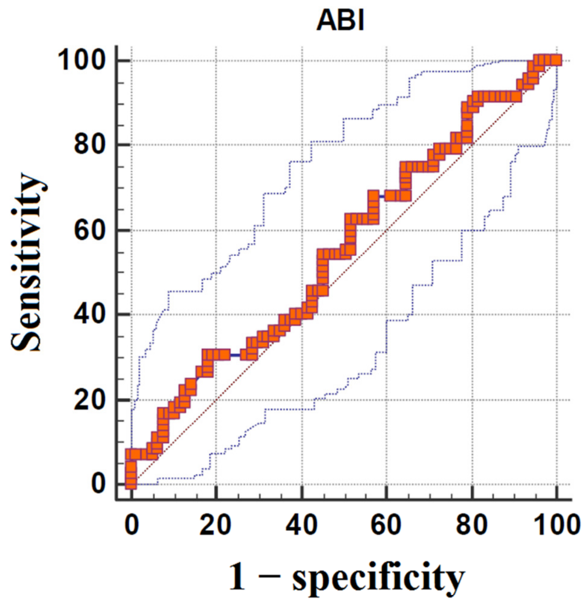

Figure 1. ROC caurve for ABI diagnostic value

female. The administration of insulin is the most common treatment for these patients, and most of them possess high level of cholesterol which is very common for diabetic patients. The calculation of ABI for this papulation indicates a normal distribution for the most part. However, different studies suggest that diabetic patients have low ABI and they are very susceptible to CAD and PAD (20-24).

The relationship between ABI and different level of ischemia was also investigated. Even though the findings suggested that mild, moderate and sever ischemic diabetic patients ABI are lower than normal ABI, but these difference were not statistically significant. It is noteworthy that the increment in the population of patients may change the results. Likewise the relationship of ABI and MI was also not statistically significant which agrees with other studies (22). However some studies suggested that patients with low ABI are 2-3 times more susceptible to heart stroke (25). Diabetic patients with low ABI are highly at risk of CAD in previous studies (26-28). This contradictory can be due to the small patient population of our study.

For good measures we also investigated the relationship between heart function (EF, wall motion and LV function) and ABI. The data indicates that there was no significant relationship between ABI and neither EF nor wall motion and LV function which is in parallel with other studies (29).

Finally, ROC curve displayed a very low diagnostic value for ABI in ischemic diabetic patients in comparison with MPI. According

Table 3. the ROC extarcted data for diagnostic value of ABI

Diagnostic test	Value
AUC	0.552
Standard error	0.0474
95% percent confidence interval	0.468 and 0.633
Z-score	1.094
p-value	0.274
Sensitivity (at 95% percent confidence interval)	68.06 (56.0, 78.6)
Specificity (at 95% percent confidence interval)	42.86 (31.6, 54.6)
TPR (at 95% percent confidence interval)	1.19 (0.9, 1.5)
TNR (at 95% percent confidence interval)	0.75 (0.5, 1.1)
PPV (at 95% percent confidence interval)	52.7 (42.1, 62.1)
NPV (at 95% percent confidence interval)	58.9 (45.0, 71.9)

our findings ABI cannot replace MPI by any means in the case of ischemia in diabetic patients. On the contrary, Chang et al. suggested that sensitivity, specificity, PPV and NPV for ABI in diabetic and non-diabetic patients is significantly different and diabetic patients with vessel calcification and ischemia possess significantly lower ABI. They also expressed that the ABI is a useful and noninvasive method to evaluate the CAD even in diabetic patients which does not correlate with our study (30).

Dachun et al. performed a systematic review on sensitivity and specificity of ABI in PAD. They implied that for ABI≤ 0.9 the precision and specificity are 89.2-92.1% and 83.3-99%, respectively. However, the sensitivity of ABI in this study was very variant (15-79%) and more interestingly sensitivity and specificity of ABI for elderly diabetic patients was lower (29).

Conclusions

This study suggests the ABI sensitivity and specificity for diagnose of silent ischemia in asymptomatic diabetic patients is very low and in this case ABI cannot replace MPI by any means. However it is noteworthy that more profound studies with a larger patient population (especially above 55 years old) is needed to shed light upon this topic.

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Conflict of Interest

The authors declared no conflict of interest.

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