

## Original article

# Determining the Relationship of Foot-brachial Index with Silent Ischemia in Myocardial Perfusion Imaging in Diabetic Patients without Clinical Symptoms of Heart Ischemic Referred to Nuclear Medical Center of Shahid Sadooghi Hospital in Yazd for Myocardial Perfusion Imaging

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### Abstract

**Objective:** about 70% of diabetic patients mortality is due to cardiac events. The risk of cardiac death in diabetic patients is 3 times more than non-diabetics. The coronary artery disease among diabetic patients is more severe which is caused by silent ischemia. But it is not determined who need cardiac screening and about 41% of diabetic patients with silent ischemia are missed. The ankle brachial index is an independent, simple and noninvasive method in peripheral vascular disease diagnosis. The aim of this study was to evaluate the association of ABI and silent myocardial ischemia in diabetic patients.

**Methods:** this was an analytic cross-sectional study. The convenient sampling was used. About 204 patients with diabetics and without CAD history were included. For all of patient's myocardial perfusion scan and ankle brachial index was done. All of statistical analysis was done by STATA-10.

**Results:** totally 204 diabetic patients without coronary artery disease symptoms. about 63.3% (127) were female and 37.7% were male. The mean age of patients was  $57.39 \pm 10.62$  years old. About 60.8% (124) of patients were normal and 39.2% had silent myocardial ischemia. The mean of ABI was  $1.0165 \pm 0.14$ . there were significant differences of ABI between normal and silent ischemic patients (p-value: 0.000)

**Conclusion:** our findings showed that ABI is significantly different between patients with and without ischemia. ABI is a simple, noninvasive, and inexpensive test that can be used to identify individuals who are at high risk of developing cardiovascular disease (diabetic patients).

**Keywords:** ankle brachial index, silent ischemia, myocardial perfusion scan, diabetic.

### Introduction

Coronary artery disease (CAD) is the leading cause of death in patients with diabetes type 2 (1) which is often asymptomatic (2) and could be with warning sign of acute myocardial infarction (AMI), heart failure, arrhythmia or sudden death (3). Also, many studies have shown that macrovascular diseases such as peripheral vascular disease and cerebrovascular disease are strongly associated with CAD (4). The overall prevalence of coronary artery disease has been reported using a range of diagnostic methods. The prevalence of this disease

among the patients with diabetes and general population has been estimated to be 55% and 2-4%, respectively (5). Clinical spectrum of this disease varies from silent ischemia to stable chronic angina, unstable angina, acute myocardial infarction, ischemic cardiomyopathy, and sudden cardiac death (6).

Given the high risk of cardiovascular conditions and high prevalence of silent myocardial ischemia in patients with diabetes, screening for coronary artery disease in asymptomatic diabetic patients is

highly concerned. Screening of silent myocardial ischemia can reduce the mortality caused by coronary heart disease in people with diabetes. In this regard, there is no consensus on the ideal and interpreted screening methods (7). In February 1998, American Diabetes Association (ADA) issued an agreed statement on the diagnosis of coronary artery disease in patients with diabetes. According to this statement, it has been recommended that asymptomatic diabetic patients with at least two risk factors for coronary artery disease to be screened for this disease (8). Population screening for diagnosis of silent ischemia is not possible, but, however, diabetics at high risk of silent ischemia should be identified and examined. In this regard, there are still discussions on the selection of the best strategy for screening of patients (2). In general, a screening test should be able to make the difference between high and low risk patients. In fact, selection of the diagnostic method is dependent on the disease likelihood. For example, perfusion imaging, due to its ability in risk stratification and identifying the patients who suffer from revascularization, is preferred for patients with a high probability of coronary artery disease (9). Some clinical symptoms of patients with mellitus diabetes which are helpful in identifying people at high risk for stroke or cardiac death include evidence of atherosclerosis, microalbuminuria, Chronic Kidney Disease, ECG of abnormal rest, diabetic complications such as autonomic neuropathy and retinopathy, age, gender, unexplained asthma, and other risk factors (10).

According to what was said and given the fact that cardiovascular disease is the leading cause of death in diabetic patients, the use of an inexpensive, available, non-invasive, and reliable method as the screening test is recommended. Foot-brachial index of less than 0.9 in diabetics indicates the need for controlling the cardiovascular complications and its associated risk factors. Also in the case of unfavorable values of this index, it is recommended that asymptomatic vascular complications in these patients such as carotid involvement and coronary arteries to be examined in order to prevent severe vascular complications in organs such as the brain and heart. Therefore, since foot-brachial index is an independent, non-invasive, simple, and accurate measure for early diagnosis of peripheral vascular disease and is used as an index for prediction of cardiovascular diseases events and also due to the high prevalence of silent ischemia and diabetes in Iran and existence of no similar studies in Iran on this subjects, the present study seems necessary to be carried out.

## Method

The present research was a cross-sectional, analytic study which was carried out on asymptomatic type-II diabetes patients referred to Nuclear Medical Center of Shahid Sadooghi Hospital in Yazd for myocardial perfusion imaging. Sampling was done based on availability method. Given the number of patients, the sample size was considered to be 200. In the case of withdrawal or lack of entry of each of the sample member, they were replaced. Inclusion criteria were as follows: ages between 18 and 75, under exercise stress or dipyridamole, asymptomatic diabetics without confirmed ischemia, without the record of open-heart surgery, and without the history of percutaneous intervention. If any of these items did not apply to patients, they were excluded from the study.

First of all the patients were examined by a cardiologist. Preparation of patients for scanning was the same as items for preparation of patients for exercise test which include physical readiness and cutting the use of some heart interfering drugs that inhibit the increased activity of the heart during exercise (such as beta blockers or calcium channel blockers), at a given time interval before exercise test under the supervision of a physician (these drugs were already introduced in the scanning preparation sheet). The first phase of myocardial perfusion imaging was performed with training on exercise test or dipyridamole stress. Blood pressure and ECG were repeatedly measured and recorded at the beginning and in later stages of the test.

Foot-brachial index calculation: Systolic blood pressure was measured in all four upper and lower extremities patients. The ratio of systolic blood pressure of foot in every leg to the highest systolic blood pressure of hands was calculated and the obtained value was recorded as the foot-brachial index in each leg. Depending on the indication intensity, the patients were treated with exercise stress or Pharmaceutical stress.

Exercise stress: In this type of stress, depending on the age of the patient, a certain amount of exercise and the maximum heart rate that the patient should achieve (calculated according to age-220 formula) is determined for each patient and the test will be continued until reaching this heart rate, unless abnormal changes occur in clinical status or ECG. At the end of the exercise, the radioactive substance (the drug related to heart imaging) is administered to the patient (through the IV) and one minute later, the treadmill is slowed down to gradually stop.

Imaging with dipyridamole: This imaging method is used as an alternative to exercise stress in patients who are not able to take part in exercise or exercise test would cause contraindication in

them. This imaging can be also done without exercise, because some drugs such as dipyridamole have an effect life exercise on the heart and reveal the cold spots in imaging.

The first stage of heart imaging (scanning): In this stage which lasts 20 minutes, the body should be in a motionless state. Moving, shaking the hands, coughing, and even deep breathing, because of moving the heart in the chest, would tarnish the final image of the heart and cause diagnostic errors. During imaging, the revealer device in a 180-degree orbit captures an image of the heart in approximately 5 degree for 35 seconds, providing a total of 32 images of the heart from different angles. The thickness of each cut is a few mm. As a result, even the smallest and most hidden parts of the heart, if having any defect in blood circulation (ischemia), will be shown incompletely or paler than usual. As imaging is finished, the first stage of scanning will end and the next day the patient should refer for myocardial perfusion at rest at the determined time.

The second stage of heart scanning (scanning at rest): In this stage, there is no test or exercise. At first, the radioactive substance is intravenously administered and after a delay of about 1 and sometimes 2 hours (in some patients with a slow liver metabolism), heart imaging is repeated with the same conditions.

The obtained data were recorded in checklists and analyzed in STATA 10 software. In descriptive analysis, drawing tables and graphs and descriptive methods were used and in analytic part, t-test, correlation, Chi-square, and ANOVA tests were used. Analysis of data related to each patient was done according to the received treatment protocol.

### Results

In this study, 200 diabetic patients without clinical signs of cardiac ischemia were studied. 127 subjects (63.3%) were female and 77 subjects (37.7%) were male. Among the subjects, 121 patients (59.3%) were afflicted with hyperlipidemia and 127 patients (63.3%) had hypertension (Figure 2 and Figure 3). Among the patients, 32, 129, and 43 subjects were treated with lifestyle change, oral medications, and insulin (Figure 4).

Frequency of different types of ischemia according to the findings of perfusion scanning in diabetic patients without clinical symptoms of cardiac ischemia is shown in Figure 5. According to this figure, 60.8% of subjects (124) were normal and without affliction with silent ischemia and 39.2% of them (80) were afflicted with silent ischemia.

Mean of foot-brachial index among the subjects was  $1.0165 \pm 0.14$ . Mean of foot-brachial index among patients with different degrees of ischemia has been presented in analytic analysis part.

Table 1: Frequency of different types of ischemia according to the findings of perfusion scanning in diabetic patients without clinical symptoms of cardiac ischemia

Percentage	Number	Result of heart perfusion scanning
%60/8	124	Normal
%6/9	14	Low ischemia
%13/2	27	Moderate ischemia
%15/2	31	Severe ischemia
%3/9	8	Myocardial infarction

The mean foot-brachial index based on degrees of ischemia in patients is shown in Table 2. In addition, the difference between groups was studied by variance analysis and shown in the table as level of significance.

After classification of foot-brachial index into two groups of normal (0.9 to 1.4) and non-normal (less than 0.9 and greater than 1.4), the difference of ischemia degrees with normal and non-normal values of foot-brachial index was studied using Chi-square test. This difference was found to be significant at a significance level of 0.000 (Table 3).

Table 2: Foot-brachial index difference between patients on the degree of ischemia

Myocardial infarction	Severe ischemia	Moderate ischemia	Low ischemia	Normal	Mean foot-brachial index	Standard deviation	Significant level of normal group	Significant level of low ischemia group	Significant level of moderate ischemia group	Significant level of severe ischemia group
0/817	0/928	1/017	1/02	1/05						
0/140	0/156	0/214	0/162	0/086						
<u>0/000</u>	<u>0/000</u>	0/829	0/973	-						
<u>0/013</u>	0/259	1	-	-						
<u>0/007</u>	0/15	-	-	-						
0/329	-	-	-	-						

Table 3: The difference of ischemia degrees with normal and non-normal values of foot-brachial index

Foot-brachial index		Result of myocardial perfusion scanning
Non-normal	Normal	
116(%93/5)	8 (%6/5)	No ischemia
8(%57/1)	6 (%42/9)	Low ischemia
15 (%55/6)	12 (%44/4)	Moderate ischemia
17 (%54/8)	14 (%45/2)	Severe ischemia
5 (%62/5)	3 (%37/5)	Myocardial infarction

### Discussion

The results of the present study showed that mean value of foot-brachial index is significantly lower among patients with severe ischemia and silent myocardial infarction than in those with a normal scanning result. A number of studies have confirmed silent myocardial ischemia in diabetic patients and according to studies, the prevalence of silent ischemia in diabetic patients varies from 6% to 59% (2-5). This is completely consistent with the findings which indicate that the prevalence of silent ischemia in diabetic patients referred for cardiac scanning was equal to 39.2%. In asymptomatic diabetes patients, diagnostic value of silent ischemia using stress myocardial perfusion imaging has been estimated to be 6-59% in different studies. This wide diagnostic range of prevalence of silent ischemia depends on the way of selection of the patients, the stress method, and imaging techniques (2). In this study, prevalence of ischemia by perfusion scanning has been estimated to about 40%. However, one of the main constraints of the present research was inconsistency between data and angiographic findings. Peripheral artery disease (PAD) is a common systemic atherosclerotic disease with a high mortality rate due to cardiovascular complications (11) and high prevalence of silent myocardial ischemia is observed among the patients (12).

In terms of diagnosis, PAD is easily and accurately diagnosed among the patients using the ankle-brachial index (ABI), which the ratio of the systolic blood pressure of ankle (measured by Doppler ultrasound device) to higher systolic blood pressure in the brachial arteries (13). The index is the diagnostic and prognostic indicator of atherosclerosis (14) and its association with the involvement of coronary, cerebrovascular, and peripheral arteries has been proven in many studies (15). In the present study, the relationship of this index with the severity of cardiac ischemia in

asymptomatic diabetic patients was also confirmed, which is fully consistent with the findings on patients presenting symptoms of cardiovascular diseases.

### Conclusion

Foot-brachial index is an inexpensive, non-invasive, simple, and acceptably sensitive method. Consistency of the results obtained from this test with silent ischemia makes the mentioned features good candidate for screening in diabetic patients without clinical symptoms of cardiac ischemia.

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