The Association of Carotid Intima-Media Thickness and Ankle Brachial Index with SPECT Myocardial Perfusion Imaging in Asymptomatic Diabetic Patients

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Introduction

Diabetes mellitus (DM) is an independent risk factor of cardiovascular disease (CAD) (1-3). CAD is the leading cause of death in DM patients (4). Myocardial infarction (MI), Angina and sudden death rates in diabetic patients are higher than normal population (5).
Also silent ischemia and CAD prognosis are more severe in diabetic patients (6). Silent myocardial infarction (SMI) is defined as “the presence of objective evidence of myocardial ischemia in the absence of chest discomfort or other angina equivalent symptom” (7-8). Diabetic patients are at risk of SMI about 2-4 times more than normal population (9-11). The prevalence of SMI in diabetic patients is 10-20% but in non-diabetic population is 1-4% (12-16).

In 1998, American Diabetes Association (ADA) recommended that diabetic patients with at least two cardiovascular disease risk factors need cardiovascular screening (20). Non-invasive techniques for cardiovascular screening in diabetic patients are more recommended, such as (21): Exercise tolerance testing (ETT), myocardial perfusion imaging (MPI), Stress echocardiography, Single photon emission computer tomography (SPECT), Electron beam computed tomography (EBCT), Magnetic resonance angiography (MRA), Multislice computed tomography (MSCT) and Ankle-Brachial Index (ABI) (20-24).

CIMT is a surrogate marker of atherosclerosis (25-27). CIMT is a marker of CAD and further cardiovascular events (28). A marked association between CIM and cerebrovascular or coronary artery disease is showed in recent studies. Carotid ultrasonography revealed carotid wall and lumen surfaces which is quantified severity of atherosclerosis. Carotid IMT is non-invasive and inexpensive diagnostic surrogate test for CAD and CIMT could useful for prediction of CAD. (26-27)

ABI is a non-invasive method used to diagnose peripheral artery disease (PAD) but suggested as a CAD screening method in diabetic patients (29-30). The screening tests should be available, acceptable, non-invasive, inexpensive, reliable and valid (31). ABI fulfills the screening tests criteria. ABI lower than 0.9 in diabetic patients indicates CAD and cerebrovascular disease (CVD) risk (32).

The aim of this study was to evaluate the association of CIMT and ABI in prediction of SMI in MPI in Asymptomatic diabetic population.

**Materials and Methods**

This was an analytic cross-sectional study conducted in Shaheed Sadoughi hospital on 104 diabetic patients during 2015-2016. All patients received information about the study and signed an informed consent. The study inclusion criteria was: type 2 diabetes mellitus and no history of CAD, Percutaneous coronary intervention (PCI) and no symptom of CAD. Exclusion criteria was: Lower limb trauma, Deep vein thrombosis (DVT), Amputation or surgery, Foot ulcers, lower limb swelling, Type I diabetes mellitus.

For assessing of CIMT, the study was down in supine position and mildly head hyperextension. By B-mode ultrasonography 7.5-10 MHz linear transducer, with an automatic boundary detection system, the carotid arteries were evaluated. The origins of the common carotid arteries, internal and external carotid arteries as well as carotid sinus were scanned. Mean CIMT was evaluated throughout 10-mm segments. The mean of four segments was used to determine mean CIMT.

ABI was calculated with continuous wave Doppler using a hand-held sensor Smartart model 450 Hz instrument for all patients. Duplex Colour Doppler and blood pressure was measured in all four limbs at brachial and posterior tibial artery. ABI was calculated as ankle pressure/ brachial pressure and the lower ratio amongst the two was chosen. All patients were examined by physician. Selected patients were included. The ABI and dipyridamole or Exercise stress test were done for all patients. Finally Myocardial Perfusion SPECT was done and the ischemic findings in Myocardial Perfusion SPECT were correlated by ABI.

All statistical analysis was done by the SPSS software (Statistical Package for the Social Sciences, version 20; SPSS Inc, Chicago, Illinois). The normal distribution of data was checked. Mean, standard deviations (SD), minimum and maximum were calculated.
Analysis of variance (ANOVA) and Pearson correlation were used. The statistical significances considered as 0.05.

**Results**
Totally 114 patients were studied. About 66.7% of patients were female and 33.3% were male. The baseline characteristics of patients were presented in table 1.

Differences between the group means of continuous variables were tested for significance by ANOVA. In post hoc ANOVA analyses, the mean CIMT, ABI, age and diabetes duration values were significantly associated within groups with moderate to severe ischemia in SPECT but in groups with normal MPI and mild ischemia no statistically significant mean deference was noticed. Also between groups with Mild ischemia and moderate to severe ischemia significant mean deference was not seen. Table 2 shows differences between the group means of CIMT, ABI, age, Diabetes duration with MPI results.

Spearman's correlation coefficients revealed statistically significant correlation between CIMT, ABI, and age and diabetes duration. But In this partial Spearman's correlation analysis (adjusted for age), correlations between CIMT with ABI and diabetes duration was not still statistically significant. (table 3).

**Discussion**
SPECT prognostic values were confirmed in diabetic patients (41). But, the important question remains exactly how diabetic patients without symptom of ischemic heart disease should be excluded in general diabetic population. Our findings showed that age, CIMT and ABI are significantly different between patients with and without ischemia. The previous studies suggested, diabetic patients suffer from SMI and the prevalence of SMI differs from 6-59% (2-5). The prevalence of SMI in our study was 48.5%.

The validity of SPECT in patients without

**Table 1. The baseline characteristics of patients**

<table>
<thead>
<tr>
<th>Variable</th>
<th>No ischemia</th>
<th>Mild ischemia</th>
<th>Moderate to severe ischemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (Female/male %)</td>
<td>66.7/33.3</td>
<td>71.4/28.6</td>
<td>57.7/42.3</td>
</tr>
<tr>
<td>Age (Mean ± SD)</td>
<td>53.87 ± 8.6</td>
<td>58.82 ± 8.7</td>
<td>60.81 ± 9.2</td>
</tr>
<tr>
<td>Hypertension (%)</td>
<td>41.7</td>
<td>71.4</td>
<td>91.3</td>
</tr>
<tr>
<td>Hyperlipidemia (%)</td>
<td>46.7</td>
<td>75</td>
<td>69.2</td>
</tr>
<tr>
<td>Diabetes duration (Mean ± SD)</td>
<td>5.1 ± 4.3</td>
<td>7.3 ± 5.7</td>
<td>8.3 ± 6.6</td>
</tr>
<tr>
<td>Mean IMT</td>
<td>0.85 ± 0.18</td>
<td>0.96 ± 0.18</td>
<td>1.06 ± 0.23</td>
</tr>
<tr>
<td>ABI (Mean ± SD)</td>
<td>1.01 ± 0.06</td>
<td>0.96 ± 0.12</td>
<td>0.91 ± 0.16</td>
</tr>
<tr>
<td>MPI (%)</td>
<td>52.5</td>
<td>25</td>
<td>22.8</td>
</tr>
<tr>
<td>Smoking (%)</td>
<td>14</td>
<td>16</td>
<td>19</td>
</tr>
</tbody>
</table>

**Table 2. Mean age, ABI, diabetes duration and CIMT in patients with normal myocardial perfusion scan, Mild ischemia and moderate to severe ischemia (analysis of variance)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>MPI</th>
<th>Mean Difference</th>
<th>Std. Error</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Normal</td>
<td>Mild ischemia</td>
<td>-4.955</td>
<td>2.022</td>
</tr>
<tr>
<td></td>
<td>Moderate/severe</td>
<td>-6.941*</td>
<td>2.075</td>
<td>.005</td>
</tr>
<tr>
<td></td>
<td>Mild</td>
<td>Moderate ischemia</td>
<td>-1.986</td>
<td>2.407</td>
</tr>
<tr>
<td>ABI</td>
<td>Normal</td>
<td>Mild ischemia</td>
<td>.050262</td>
<td>.024946</td>
</tr>
<tr>
<td></td>
<td>Moderate/severe</td>
<td>.099795*</td>
<td>.025592</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>Mild</td>
<td>Moderate/severe</td>
<td>.049533</td>
<td>.029685</td>
</tr>
<tr>
<td>Duration</td>
<td>Normal</td>
<td>Mild ischemia</td>
<td>-2.266</td>
<td>1.207</td>
</tr>
<tr>
<td></td>
<td>Moderate/severe</td>
<td>-3.244*</td>
<td>1.238</td>
<td>.036</td>
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<tr>
<td></td>
<td>Mild</td>
<td>Moderate/severe</td>
<td>-.978</td>
<td>1.436</td>
</tr>
<tr>
<td>IMT</td>
<td>Normal</td>
<td>Mild ischemia</td>
<td>-.10579</td>
<td>.04504</td>
</tr>
<tr>
<td></td>
<td>Moderate/severe</td>
<td>-.20996*</td>
<td>.04621</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Mild</td>
<td>Moderate/severe</td>
<td>-.10418</td>
<td>.05360</td>
</tr>
</tbody>
</table>
Cardiac symptoms was reported between 59-69% which is influenced by type of stress and imaging technique (2). In our study the prevalence of Ischemia in SPECT was about 48.5%. But one of understandable limitation of our study was absence of angiography which is recommended for future studies.

The PAD are simply diagnosed by ABI (31-32). Also ABI can be as a diagnostic prognostic factor of CAD in diabetic patients (34-35). Previous studies documented the association between CAD, CVD and PVD (36-38) which was according with our findings.

ABI is a simple, non-invasive, inexpensive, available and sensitive method in diagnosis of CAD (39-40) ABI is an acceptable screening method before any other invasive and expensive modalities.

Lack of gold standard in CAD diagnosis should be noticed as the major limitations of our study. Valuation of CIMT has been previously suggested for this Question (42).

Relationship between CIMT and CAD has not been fully recognized in asymptomatic diabetic patients. In our study, increased CIMT was revealed to be a predictor of the degree of severity in MPI. Lower CIMT values were related with a low risk MPI. In current study the analysis showed significance correlation between ABI, IMT, Diabetes duration and age but in additional analysis partial correlation suggests that age is a confounding factor. Also, Diabetic patients who referred to diabetes center with CAD risk more than the general asymptomatic Diabetic population, current study results recommend that CIMT for initial risk stratification.

Many study limitation should be deliberated. Small number of cases and therefore gender imbalance of the participants. Furthermore, the age of participant was a confounding factor .As a result, the clinical usefulness of IMT as a screening method for CAD should be verified in studies with larger sample size. Especially, the cut-off level of maximum IMT should be confirmed by further studies.

### Conclusion

Our findings showed that ABI is significantly different between patients with and without ischemia. The 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).
References


40. Yoon JK, Lee KH, Park JM. Usefulness of Diabetic Retinopathy as a Marker of Risk for Thallium Myocardial Perfusion Defects in Non-Insulin-dependent Diabet mellitus. American
