Abstract

Background: It has been shown that there exists a relation between the severity of coronary artery disease and morphologic changes in peripheral arteries. It was shown that increased intima-media thickness (IMT) of the carotid artery has been associated with coronary risk factors and atherosclerotic disease. Although the IMT measurement of the carotid artery is well established, there is limited evidence suggesting a relationship between the BA and coronary artery disease. Indeed, morphologic changes such as increased IMT of the carotid artery have been associated with coronary risk factors and atherosclerotic disease. The IMT measurement of the BA is less well established, although atherosclerosis also occurs in this vessel. Although the BA has not been widely examined for the prevalence of atherosclerosis, a recent autopsy study by Sorensen et al. showed that atherosclerosis in this artery is a frequent finding and that correlation between BA and coronary and carotid lesions are at least as strong as between the latter 2 arterial beds. These findings support the use of the BA as a surrogate vessel for coronary circulation, provided it can be measured with the use of ultrasound. Accordingly, we examined the feasibility of BA-IMT measurement with high-resolution ultrasound and its relation to the angiographic evidence of CAD.

Methods: A total of fifty two patients (30 males and 22 females with mean age 43±9 years) in whom coronary angiography due to chest pain was performed in the University of Science and Technology hospital in Yemen; were consecutively enrolled into the study. All patients underwent selective CAG to determine coronary artery stenosis, followed on the next day with ultrasound assessment of Brachial artery IMT using high-resolution ultrasound.

Results: There were no significant differences between both groups as regard the baseline characteristics. Patients in group II (patients with CAD) revealed significantly greater BA-IMT than those in group I (0.35±0.04 Vs 0.27±0.03, p<0.001). A significant correlation was observed between BA-IMT and severity of coronary artery disease as the mean BA-IMT was significantly higher in patients with two or three vessel disease rather than patients with single vessel disease (0.37±0.034 Vs 0.32±0.044, p 0.006).

Conclusion: The data of our study suggests that IMT of brachial artery is a reliable and feasible non-invasive parameter for the assessment of coronary artery disease.

Key Words: Brachial artery intima – Media thickness – Coronary artery disease.

Introduction

ULTRASOUND examinations of peripheral arteries have been increasingly used for the non-invasive assessment of early atherosclerotic changes [1,2]. Indeed, morphologic changes such as increased intima-media thickness (IMT) of the carotid artery have been associated with coronary risk factors and atherosclerotic disease [3]. The IMT measurement of the BA is less well established, although atherosclerosis also occurs in this vessel. Although the BA has not been widely examined for the prevalence of atherosclerosis, a recent autopsy study by Sorensen et al. showed that atherosclerosis in this artery is a frequent finding and that correlation between BA and coronary and carotid lesions are at least as strong as between the latter 2 arterial beds [4]. These findings support the use of the BA as a surrogate vessel for coronary circulation, provided it can be measured with the use of ultrasound. Accordingly, we examined the feasibility of BA-IMT measurement with high-resolution ultrasound and its relation to the angiographic evidence of CAD.

Material and Methods

Study population:

A total of fifty two patients (30 males and 22 females with mean age 43±9 years) in whom coronary angiography due to chest pain was performed in University of Science and Technology hospital in Yemen; were consecutively enrolled into the study. Exclusion criteria were congestive heart failure, left ventricular ejection fraction <40% and significant valvular disease. Coronary artery disease (CAD) was defined as ≥50% diameter stenosis in one or more major vessels. Coronary risk factors were assessed as follows: Smokers were defined as subjects who had smoked regularly during the previous 12 months. Systemic hypertension was defined as systolic blood pressure ≥140mm Hg and/or diastolic blood pressure ≥90mm Hg. With regard to hypercholesterolemia, for the purpose of

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this study, subjects with plasma LDL cholesterol >130mg/dl or those taking current cholesterol lowering therapy were classified as being at increased risk. Patients were considered diabetic if they were receiving treatment with insulin or oral hypoglycemic agents or if fasting blood glucose was >140mg/dl. History of medication use was taken.

Coronary angiography:

All patients who were referred for coronary angiography had selective CAG performed upon them with orthogonal projections using the Judkins technique. Coronary artery stenosis was estimated by 2 independent observers who were blinded to the identities and clinical information of the patients. Based on angiographic findings, patients were categorized in two groups:

• Group I: Patients without CAD.

• Group II: Patients with CAD (defined as ≥50% diameter stenosis in one or more major vessels).

Ultrasound assessment of BA IMT:

On the day after angiography, high-resolution ultrasound (13MHz) was used for the assessment of BA IMT; the right BA was scanned and the IMT at the far wall was measured directly as the distance between lumen-intima and media-adventitia border. Measurements were made at two sites per image with a total of four different images per patient. The two sites per image were defined as being at or close to 1mm of the "peak" of the vessel arch. Usually, this peak is the location that gives the clearest image. The mean of eight measurements was defined as BA-IMT. A written informed consent was obtained from all patients.

Statistical analysis:

Data were expressed as means ± SD (range) or as frequencies (percentages). Patient characteristics were compared using the unpaired *t* test or the Mann-Whitney U test for continuous variables and the chi-square or Fisher’s exact test for categorical variables as appropriate. Multiple linear regression analyses were used to adjust for univariate associations of IMT with clinical characteristics. For the presence of CAD, logistic regression analyses were performed. Values of *p* <0.05 were considered statistically significant.

Results

Table (1) describes the clinical baseline characteristics of the study population. The two groups were matched in terms of baseline clinical characteristics except for EF which was significantly higher in group I (52±4 Vs 48.9±6.4, *p* 0.04). This difference could be explained by the presence of significant CAD in group II including patients with STE-MI and NSTE-MI. On the other hand this difference does not affect the BA-IMT as there was no evidence of heart failure. Mean age, distribution of risk factors and history of statin and ACE inhibitor medications were not different between the two groups (26.9% Vs 38.5%, 31% Vs 35%, respectively *p* >0.05). Majority of patients were males in both groups (61.5% in group I and 53.8% in group II).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group I (no.26)</th>
<th>Group II (no.26)</th>
<th><em>p</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>43.8±8.3</td>
<td>46.6±8.5</td>
<td>NS</td>
</tr>
<tr>
<td>Smoking %</td>
<td>11 (43)</td>
<td>14 (53.8)</td>
<td>NS</td>
</tr>
<tr>
<td>Hypertension %</td>
<td>12 (46.2)</td>
<td>12 (46.2)</td>
<td>NS</td>
</tr>
<tr>
<td>Diabetes %</td>
<td>6 (23.1)</td>
<td>8 (30.8)</td>
<td>NS</td>
</tr>
<tr>
<td>Dyslipidaemia %</td>
<td>10 (38.5)</td>
<td>10 (38.5)</td>
<td>NS</td>
</tr>
<tr>
<td>BMI</td>
<td>21.3±3.1</td>
<td>21±3.6</td>
<td>NS</td>
</tr>
<tr>
<td>EF %</td>
<td>59±4</td>
<td>48.9±6.4</td>
<td>0.04</td>
</tr>
<tr>
<td>Statin %</td>
<td>7 (26.9)</td>
<td>10 (38.5)</td>
<td>NS</td>
</tr>
<tr>
<td>ACE inhibitor %</td>
<td>8 (31)</td>
<td>9 (35)</td>
<td>NS</td>
</tr>
<tr>
<td>BA IMT</td>
<td>0.27±0.03</td>
<td>0.35±0.04</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Patients in group II (patients with CAD) revealed significantly greater BA-IMT than those in group I (0.35±0.04 Vs 0.27±0.03, *p*<0.001) (Fig. 1).

![Fig. (1): Comparison of BA-IMT between the two groups.](image1)

![Fig. (2): Correlation between BA-IMT and severity of coronary artery disease.](image2)
A significant correlation was observed between BA-IMT and severity of coronary artery disease as the mean BA-IMT was significantly higher in patients with two or three vessel disease rather than patients with single vessel disease ($0.37 \pm 0.034$ Vs $0.32 \pm 0.044$, $p = 0.006$) (Fig. 2).

**Discussion**

In the Atherosclerosis Risk In Communities (ARIC) study, an increased carotid artery wall thickness in patients with prevalent CAD, cerebrovascular disease and peripheral vascular disease was demonstrated [3]. Lekakis et al., showed that the femoral and carotid arteries IMTs are independent predictors of the CAD extent [8]. In our study, BA-IMT was significantly greater in CAD compared with non-CAD patients. The more important was the demonstrated association of higher BA-IMT with the extent and severity of coronary atherosclerosis.

The present findings are in accordance with histologic data from a recent post-mortem study that found a close correlation between atherosclerotic changes in the brachial and coronary arteries [6]. Recently, Matthias et al., showed that morphologic but not functional and mechanical parameters of the BA are associated with the presence of CAD [7]. Another study done by Franz et al., proved that BA-IMT is independently correlated with the presence of CAD [8]. Taken together, these studies support the use of the BA as a surrogate vessel for the early non-invasive assessment of the presence and severity of coronary artery disease.

**Potential advantages of BA sonographic measurements:**

Assessment of an artery that is less prone to symptomatic obstructive disease than other arterial beds (carotid, ilio-femoral) may have some potential advantages. First, functional and morphologic changes can be detected easily in the same vessel. Second, in contrast to advanced lesions more frequently seen in the carotid artery, changes in the BA are diffuse and may be a more sensitive indicator of long-term systemic exposure to risk factors. Third, because of its superficial location, measurements of the BA may be less variable than those of the carotid artery. However, a direct comparison between the 2 vessels has to be performed. Fourth, according to the result of our study BA-IMT may provide a reliable non-invasive marker of the presence and severity of coronary artery atherosclerosis.

**Conclusion:**

The data of our study suggest that IMT of brachial artery is a reliable and feasible non-invasive parameter for the assessment of coronary artery disease.

**Study limitations:**

First, we included only patients undergoing coronary angiography, which may create a selection bias for more advanced stages of the disease, given that all patients were referred for symptoms of chest pain. Second, we did not use automated edge-detection software for measuring BA-IMT. Because the measurements at the 2 sites per image did not vary substantially, it is unlikely that the automated measurements would have revealed dissimilar results. Third, a small population number was enrolled in the study.

**References**


