

Association of carotid intima-media thickness with the presence and severity of coronary artery disease

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ABSTRACT

Objectives: To examine, prospectively, whether the intima-media thickness (IMT) of the common carotid artery and the overlying plaque predicts the presence and severity of coronary artery events.

Methods: Two hundred and one consecutive patients (100 men and 101 women), who had recently undergone coronary angiography in Tabriz University of Medical Sciences, were enrolled in the study carried out from May 2004 to May 2005. Measurements of IMT were performed by ultrasound, while blood pressure, blood sugar and cholesterol levels were recorded.

Results: The mean IMT of the common carotid artery was significantly higher in patients with coronary artery

disease (CAD) compared with non-CAD patients, as well as in patients with significant CAD compared to non-significant CAD in both genders. The same was observed for the plaque area. Clinical systolic blood pressure, clinical diastolic blood pressure, low-density lipoprotein and high-density lipoprotein cholesterol did not significantly differ between the 3 groups. Fasting blood sugar was higher in the non-significant CAD patients.

Conclusion: The IMT of the common carotid artery is a clinically valuable parameter in the non-invasive diagnosis of non-significant CAD, as well as significant coronary artery lesions.

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Coronary artery disease (CAD) as the major cause of death in developing countries is a matter of interest in health care programs. While myocardial infarction and other acute coronary syndromes are the first symptoms of CAD in approximately one half of all patients with cardiovascular disease,¹ early detection of CAD may contribute to effective treatment and reducing mortality. Coronary angiography remains the gold standard for detection of CAD, but it is costly and an invasive procedure. Atherosclerosis is considered as a generalized disease of the vascular system. It is well established that sequential coronary angiography determines the progression of atherosclerosis of the coronary arteries, predicting coronary events.² Studies have

examined the association of occult atherosclerosis of carotid, femoral, and popliteal arteries with CAD.³ The close relation seen in autopsy studies, between carotid and coronary atherosclerosis,⁴ and many risk factors for progressing atherosclerosis shared between these 2 arterial beds, suggests carotid arterial intima-media thickness (IMT) as predictive of coronary events. The association between cerebral ischemia and coronary artery disease has been supported by different studies.⁵ Additionally, hypertension is a well-known risk factor for both coronary and carotid artery diseases, while hypertensive patients have an increased IMT. However, the association of carotid IMT with coronary artery stenosis is a matter of controversy.⁶ In the present study, the relationship

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between carotid IMT and the presence or absence of CAD was investigated, as well as its relation to the extent and severity of CAD. We examined this relation in patients who had recently undergone coronary artery angiography. Additionally, we evaluated the effect of fasting blood sugar, cholesterol, and blood pressure with reference to gender difference.

Methods. The study population consisted of 201 consecutive patients (100 men and 101 women) who were referred to the referral cardiology hospital of Tabriz University of Medical Sciences, Northwestern Iran, and admitted for coronary angiography during May 2004 to May 2005. Patients with a history of coronary bypass graft, percutaneous transluminal coronary angiography, cardiomyopathy, myocardial infarction or systemic diseases were excluded. Coronary angiography and ultrasound qualification of IMT in carotid artery were obtained for all patients. Fasting blood sugar, serum cholesterol, triglycerides, and blood pressure (3 times for each patient) were recorded on the day of admission. Gray scale ultrasound and high resolution B-mode color Doppler were carried out to obtain longitudinal views of the common carotid arteries and their bifurcation, with an ultrasound system (Hitachi EU-525) equipped with a 7.5 MHz transducer by the same sonographer blinded to patients' clinical status. Patients were examined in the supine position with the head tilted backwards. The IMT value <1 mm was assessed as normal,^{1,5}

and included the thickness of the overlying plaque. Intima-media thickness was measured at the posterior wall of the common carotid arteries, and the mean IMT value was calculated from 3 measurements, with the average value used for the analysis. Patients underwent coronary angiography by the same cardiologist according to the standard protocol of the institution. The Cardiologist was unaware of the results for measurements of carotid artery IMT. The changes in mean IMT were analyzed for patients with angiographically normal coronary arteries, non-significant CAD (stenosis less than 70% of lumen) and significant CAD (more than 70% of lumen).

The data were analyzed using SPSS for Windows, Version 11. Descriptive statistics including means, standard deviations and frequencies were computed. The chi square test was used to compare differences and student's t test, and ANOVA were used to compare means of variables. Values were considered significant if $p < 0.05$ (95% CI).

Results. There were 100 men and 101 women enrolled in the study: 12 subjects with no evidence of lesions in their coronary arteries, 81 cases had significant CAD (luminal stenosis >70% in at least one major coronary artery) and 108 cases had non significant CAD. The characteristics of the study population are outlined in **Table 1** as mean \pm SD. The mean IMT of the common carotid artery was 0.83 in the CAD patients, significantly higher than

Table 1 - Demographic data of the study population.

Characteristic	No CAD	Non-significant CAD	Significant CAD	P-value
Mean age (male)	35.2 \pm 2.4		57.1 \pm 9.2	NS
Mean age (female)	26.1 \pm 2.41		61.3 \pm 8.9	NS
Common carotid IMT	0.53 \pm 0.16	0.74 \pm 0.19	0.83 \pm 0.26	<0.005
Bifurcation IMT	0.79 \pm 0.24	0.99 \pm 0.22	1.12 \pm 0.33	<0.005
Length of plaque	0	0	33.62 \pm 11.43	<0.005
Width of plaque	0	0	3.64 \pm 1.46	<0.005
Blood sugar	85.83 \pm 16.94	110.86 \pm 43.87	113.11 \pm 43.19	NS
HDL cholesterol	37.41 \pm 9.12	40.65 \pm 19.27	36.44 \pm 8.19	NS
LDL cholesterol	51.74 \pm 51.47	128.91 \pm 23.35	124.97 \pm 49.24	NS
Clinical SBP	118.33 \pm 11.93	127.04 \pm 16.62	124.01 \pm 16.07	NS
Clinical DBP	74.16 \pm 6.83	78.94 \pm 9.12	86.17 \pm 9.76	NS
IMT – intima-media thickness, HDL – high-density lipoprotein, LDL – low-density lipoprotein, SBP – systolic blood pressure, DBP – diastolic blood pressure, CAD - coronary artery disease				

that in patients with normal coronary arteries in both genders ($p < 0.005$). Additionally, we observed a significant difference in IMT between non CAD patients and patients with non-significant CAD. The mean measured IMT calculated for patients with normal coronary artery was 0.53 ± 0.16 mm, with one vessel CAD was 0.76 ± 0.23 mm, with 2 vessel CAD was 0.87 ± 0.28 mm, and with 3 vessel CAD was 0.85 ± 0.26 mm. A significant correlation between IMT and advancing CAD was found: patients with 2 and 3 vessel CAD had significantly higher IMT than patients without CAD ($p < 0.005$). Clinical systolic blood pressure, clinical diastolic blood pressure, fasting blood sugar (FBS), LDL and HDL cholesterol did not significantly differ between the 3 groups, however, FBS was significantly higher in the non-significant CAD compared to non-CAD patients ($p = 0.039$).

Discussion. The results of our study show a significant association between IMT and the size of plaque on the common carotid artery and coronary artery disease. Carotid arterial IMT, expressed as a single measurement (in millimeters) or a rate of changes (in millimeters per year) has been suggested as a surrogate end point for atherosclerosis of the coronary artery.² Adjustment for common carotid lumen diameter does not seem to affect the magnitude and precision of the results.⁷ The main determinants of IMT of the carotid artery as an aspect of atherosclerosis seem to be aging and blood pressure.⁴ Insulin resistance was considered to be an independent risk factor for carotid wall thickening.⁸ The common carotid artery IMT has been reported to be related to the prevalence and risk factors of stroke, while studies have shown that asymptomatic coronary disease is correlated with the occurrence of stroke.^{9,10} Our observations are confirmed by previous studies, although methods used in some of them to measure IMT differ with the present study, (which includes the plaque lesion as well), and a significant association was found between common carotid IMT and coronary artery disease, however, we also noticed an association with non significant lumen stenosis. The size of the carotid plaque, which was significantly different within different groups of our study, has been suggested as an important indicator of outcome, the risk of stroke, death or myocardial infarction.^{11,12}

Sufficient visualization of the carotid wall structure with B-mode ultrasonography on several arterial segments of the carotid arteries makes it possible to evaluate the early atherosclerotic changes, such as thickening of the intima-media complex and non-significant carotid plaques.¹³ This imaging technique

may predict atherosclerotic lesions in vital arteries such as coronary arteries as well as peripherals. However, there are large variations in IMT according to the arterial site. Despite the lesser involvement of the CCA, it increasingly becomes the site of choice for measurement of IMT. The main limitation of this study is that the case selection is not population based. However, acute coronary artery diseases lead to hospitalization in most cases, and the indications for coronary angiography are well established. Patients were included consecutively in this study from the main referral hospital in our region. We believe that the results will be useful while considering the characteristics of the study population.

In conclusion, this cross-sectional study shows that an increase in IMT of the carotid artery, measured at the site of the plaque, is associated with the presence and severity of coronary diseases. Our results suggest that noninvasive B-mode ultrasonography measurement of carotid artery IMT could be considered a useful marker for early detection of the development of coronary artery stenosis, which can be considered for patients who cannot undergo, or refuse coronary angiography.

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