
Does Doppler Ultrasonography of Carotid Arteries Explore Preclinical Atherosclerosis

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Abstract

Background: It is well known that carotid intima thickness and plaques are considered as a predicted risk factor for atherosclerosis

Objectives: This study is aimed to assess the preclinical atherosclerosis by biochemical markers and Doppler ultrasound of carotid arteries in middle age patients with diabetes mellitus type-2 and hypertension

Method: This study was conducted in Department of Physiology, College of Medicine, Al-Mustansiriya University in cooperation with vascular unit at Baghdad teaching hospital in Baghdad, Iraq during 2009. A total number of 100 patients (56 females and 44 males) were able to comply with the study. Patients were categorized into 2 groups: Hypertensive (n=54) and diabetic (n=46) with or without carotid arteries plaques demonstrated by Doppler ultrasound. Anthropometric measurements and Biochemical analysis included lipid profile (fasting lipids and lipoproteins) measurements and fasting plasma glucose were considered in this study.

Results: Significant changes in lipids and lipoproteins profile in patients with carotid artery plaques whether they are hypertensive or diabetics were demonstrated in this study. Also significant changes in intima media thickness were observed in common carotid artery with plaques, rather than corresponding internal carotid artery, compared with arteries without plaques.

Conclusions: carotid artery plaque is associated with preclinical atherosclerosis in term of high blood pressure, abnormal lipid profile and increase carotid IMT in diabetic or hypertensive patients

Keywords: Doppler Ultrasonography, Carotid Arteries, Preclinical Atherosclerosis

Introduction

Baseline carotid intima-media thickness (CIMT) and plaques are considered predictors of cardiovascular events. Initiation of disease-related plaques begins as what is referred to as pathological intimal thickening; lesions characterized by the formation of lipid pools in the absence of a necrotic core.^[1]

The European Lacidipine Study on Atherosclerosis showed that carotid intima-media thickening and plaques are important added risks of cardiovascular outcomes in a treated hypertensive population independently of blood pressure and traditional risk factors^[2]. Subject with hypertension had higher frequency of abnormal common carotid – intima media thickness and carotid plaques compared with pre-hypertensives or normotensives after adjustment for other cardiovascular risk factors^[3]. Mauriello et al^[4], a strong association was observed between hypertension, low HDL-cholesterol (HDL-C) and ratio of total to HDL-C >5 with vulnerable (thin cap fibroatheroma) and thrombotic carotid plaques. A significant higher CIMT, and Max-CIMT were found in patients with type-1 diabetes mellitus and the proportion of subjects affected by plaques was equivalent to the value observed in 46-55 year-old reference group^[5]. The IMT and carotid plaques are not significantly correlated with diabetes, or clinical conditions as ischemic heart disease^[6]. The preclinical atherosclerosis, manifested by increase CIMT, that appeared in diabetes was noted with endothelial dysfunction^[7].

This study is aimed to assess the preclinical atherosclerosis by biochemical markers and Doppler

ultrasound of carotid arteries in middle age patients with diabetes mellitus type-2 and hypertension

Materials and methods

This study was conducted in Department of Physiology, College of Medicine, Al-Mustansiriya University in cooperation with vascular unit in Baghdad teaching hospital, Iraq from January to June 2009. An independent scientific committee revised and approved the study protocol and the information to be provided to the patients. Verbal consent was obtained from each patient prior to his enrollment in the study. The criteria of inclusion were hypertension and type-2 diabetes mellitus. Patients were excluded if they had any previous history of ischemic stroke, familial hyperlipidemia, history of angina, myocardial infarction, angioplasty, congestive heart failure, aortic stenosis, atrial fibrillation, coronary bypass, carotid or peripheral vascular surgery or renal insufficiency. A total number of 100 patients (56 females and 44 males) were able to comply with the study. Patients were categorized into 2 groups:

Group I (n=54): Hypertensive patients with or without carotid arteries plaques demonstrated by Doppler ultrasound.

Group II (n=46): Diabetic patients with or without carotid arteries plaques demonstrated by Doppler ultrasound.

Anthropometric measurements of body weight (kg) and height (m) were done. Body mass index (BMI) was calculated using Quetlet's index. Biochemical analysis included lipid profile (fasting lipids and lipoproteins) measurements and fasting plasma glucose.

The ratio of triglycerides (TG) to high density lipoprotein (HDL) was calculated to determine atherogenic index as well as the particles of atherogenic low density lipoprotein (LDL).^[8,9]

The Doppler U/S machine used was Siemens sonoline versa pro (2001) with B-mode images of a high-resolution ultrasound scanner equipped with a 7 MHz linear array transducer. Anterior, antero-lateral, and postero-lateral projections were used to obtain images of the left and right common and internal carotid arteries. Carotid IMT measurements were done three times for each artery at each site and the average of three measurements of each carotid artery IMT was taken; the coefficients of variation of these measurements ranged from 1.5 to 2.3%.

Statistical analysis

Statistical analysis was carried out using Microsoft Excel 2003. The results are presented as absolute number, percent, and mean $\pm$ SD. The data have been analyzed using unpaired, two-tailed Student's t-test and simple correlation test, taking $p \leq 0.05$ as the lowest limit of significance.

Results

The characteristics of the study shown in Table 1. There are no significant differences between diabetic and hypertensive groups regarding the age,

gender distribution and body mass index. Significant high blood pressures (both systolic and diastolic) were observed in hypertensive patients with carotid artery plaques compared with those without carotid artery plaques. Systolic blood pressure is significantly higher in diabetic patients with carotid artery plaques compared with corresponding non carotid artery plaques. Table 2 shows significant changes in lipids and lipoproteins profile in patients with carotid artery plaques whether they are hypertensives or diabetics. In diabetics with carotid artery plaques, the serum cholesterol, triglycerides and triglycerides to high density lipoprotein ratio are significantly higher than corresponding patients without carotid artery plaques.

In hypertensive patients with carotid artery plaques, serum cholesterol, low density lipoprotein and triglycerides to high density lipoprotein ratio are significantly higher than corresponding patients without carotid artery plaques. Significant changes in intima media thickness were observed in common carotid artery with plaques, rather than corresponding internal carotid artery, compared with arteries without plaques (Table 3). The increment in intima media thickness of right and left common carotid arteries with plaques reached to the 7.7% and 17% respectively in diabetic and to the 13.7% and 15.9% respectively in hypertensives.

Table 1 the characteristics of the study.

	Diabetics (n=46)		Hypertensives (n=54)	
	Non plaque (n=22)	Plaque (n=24)	Non plaque (n=27)	Plaque (n=27)
Gender				
Male	9	6	15	14
Female	13	18	12	13
Age (year)	51.3 $\pm$ 4.0	59.3 $\pm$ 6.5	55 $\pm$ 6.5	59.1 $\pm$ 8.1
Mean duration of high BP (year)			8	15
SBP (mm Hg)	122.3 $\pm$ 12.7	130.0 $\pm$ 6.3**	145.4 $\pm$ 7.6	153.5 $\pm$ 13.9**
DBP (mmHg)	73.9 $\pm$ 8.9	77.3 $\pm$ 7.9	88 $\pm$ 9.7	97 $\pm$ 8.11*
BMI (kg/m ²)	29.3 $\pm$ 3.7	30.7 $\pm$ 2.9	30.4 $\pm$ 4.3	31.8 $\pm$ 3.1
Fasting plasma glucose	147.2 $\pm$ 35.9	168.3 $\pm$ 55.5	101 $\pm$ 11.8	99.9 $\pm$ 11.2

The results are expressed as absolute number and mean $\pm$ SD , BP – blood pressure, SBP – systolic blood pressure, DBP – diastolic blood pressure, BMI- body mass index

* $p < 0.001$, ** $p < 0.01$ compared with corresponding non plaque

Table 2: Fasting serum lipids and lipoproteins levels profile

Lipid/lipoprotein level	Diabetics (n=46)		Hypertensives (n=54)	
	Non plaque (n=22)	Plaque (n=24)	Non plaque (n=27)	Plaque (n=27)
Cholesterol (mg %)	206.3 ± 45	248 ± 48.1**	218.2 ± 35.4	246.2±46.9†
Triglycerides (mg %)	145.5 ± 48.7	251.2 ± 80.7*	157.2 ± 51.2	164.7±51.4
LDL (mg %)	141.7 ± 44.8	164.2 ± 44.5	143.7 ± 33.2	179.3±42.1**
HDL (mg %)	37.7 ± 11	33.3 ± 8.2	43.0 ± 9.8	33.5±7.2*
TG/HDL ratio	3.988 ± 1.251	7.82 ± 2.517*	3.878 ±1.655	5.266±2.581

The results are expressed as mean ± SD

LDL- low density lipoprotein, HDL- high density lipoprotein, VLDL- very low density lipoprotein, TG – triglycerides.

* $p < 0.001$, ** $p < 0.01$, † $p < 0.02$, †† $p < 0.05$ compared with non plaque

Table 3: Mean intima-media thickness (mm) of common and internal carotid arteries measurement.

Arteries	Diabetics (n=46)		Hypertensives (n=54)	
	Non plaque (n=22)	Plaque (n=24)	Non plaque (n=27)	Plaque (n=27)
Right CCA	0.727 ± 0.138	0.783 ± 0.116	0.730± 0.159	0.830 ± 0.129†
Left CCA	0.740 ± 0.129	0.866 ± 0.180*	0.734 ± 0.141	0.851 ± 0.131*
Right ICA	0.463 ± 0.121	0.512± 0.156	0.522 ± 0.192	0.511 ± 0.115
Left ICA	0.504 ± 0.208	0.512± 0.129	0.544 ± 0.248	0.507 ± 0.110

The results are expressed as mean ± SD.

CCA – common carotid artery, ICA – Internal carotid artery.

* $p < 0.01$, † $p < 0.02$ compared with non plaque

Discussion

This study explores that patients with carotid artery plaque have significant pre-clinical atherosclerosis in term of high blood pressure, abnormal lipid profile and significant increase IMT of carotid arteries. This study is in agreement with Lee et al^[3], study who reported even in pre-hypertensive compared with normotensive subjects. Furthermore, European Lacidipine Study on Atherosclerosis (ELSA) shows that carotid intima-media thickening and plaques are important added risks of cardiovascular outcomes in a treated hypertensive population independently of blood pressure and traditional risk factor.^[2] This study adds the carotid plaque as a risk factor of sub clinical atherosclerosis. It is well known that the high blood pressure and abnormal lipid profile as well as the existence of diabetes mellitus, which reported in this study, are collectively shared with metabolic syndrome that can

predict the risk of sub-clinical atherosclerosis^[10]

Recent study showed that carotid plaque formation is the major risk factor of myocardial ischemia in hypertensive patients and shows a positive correlation to the onset of myocardial ischemia.^[11] Moreover, Giannoukas et al^[12], reported that the presence of an echolucent plaque appears as an important factor associated with symptomatic internal carotid artery disease particularly in young age group. Although Carotid plaque was associated with old age, hypertension, and increased IMT, and was an independent predictor of multi-vessel disease, but it is commonly associated with coronary artery disease.^[13] Sehestedt et al^[14], found that the hazard ratio of carotid plaque that associated with subclinical organ damage, and predicted the cardiovascular death was 2.5%. It can be concludes from this study, that carotid artery plaque is associated with preclinical atherosclerosis in term of high blood pressure,

abnormal lipid profile and increase carotid IMT in diabetic or hypertensive patients.

Acknowledgment:

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