H. Ghanaati MD[1]
N. Golchin MD[2]
M. Motevalli MD[2,3]
M. Shakiba MD[2]
A.H. Jalali MD[2]
K. Firouznia MD[1]

Carotid Doppler Ultrasonography in Preoperative Assessment of Coronary Artery Bypass Graft Surgery in an Iranian Population: Association Between Atherosclerosis Risk Factors and Carotid Stenosis

Background/Objective: The aim of this study was to assess the frequency of significant carotid artery stenosis and its association with the cardiovascular risk factors in a group of Iranian candidates for CABG.

Patients and Methods: Three hundred and one patients with critical coronary artery disease, who were candidates for coronary artery bypass graft (CABG) were evaluated by internal carotid Doppler study. The relations between age, gender, hypertension, diabetes mellitus, smoking, lipid profile, left main coronary stenosis greater than 50% by diameter and coronary artery disease with carotid stenosis were assessed.

Results: Significant carotid stenosis greater than 70% was detected in 13 patients (4.3%). According to the meaningful relationship between significant carotid stenosis and low HDL serum level (lower than 45 in women and lower than 35 in men, p=0.028), hypertension (p=0.021), history of smoking (p=0.026) and left main coronary artery stenosis greater than 50% (p=0.035), they were identified as risk factors valuable enough to guide for selective screening.

Conclusion: Among all cardiovascular risk factors, it seems that serum HDL, smoking, left main coronary stenosis and hypertension could be associated with significant carotid artery stenosis in CABG candidates.

Keywords: Doppler Sonography, CABG, Carotid Artery

1. Associate Professor of Radiology, Advanced Diagnostic and Interventional Radiology Research Center (ADIR), Tehran University of Medical Sciences, Tehran, Iran.
2. Advanced Diagnostic and Interventional Radiology Research Center (ADIR), Tehran University of Medical Sciences, Tehran, Iran.
3. Assistant Professor of Radiology, Shaheed Rajaie Cardiovascular Medical Imaging Center, Iran University of Medical Sciences, Tehran, Iran.

Corresponding Author:
Marzie Motevalli
Address: Advanced Diagnostic and Interventional Radiology Research Center (ADIR), Imam Khomeini Hospital, Keshavarz Blvd., Tehran, Iran.
Tel: +9821-6658-1579
Fax: +9821-6658-1578
Email: motevalli_m@yahoo.com

Received June 22, 2009;
Accepted after revision November 7, 2009.

Iran J Radiol 2009;6(3):125-129

Introduction

Among cerebrovascular complications after non-emergency coronary artery bypass grafting (CABG), stroke is the most dreaded complication with the incidence of 2.1%-5.2%.[1]

There are some well-known etiologies for preoperative stroke such as shedding debris, which comes from atherosclerotic plaques in the aorta or carotid arteries, embolization of intra cardiac clot, and low brain perfusion pressure during surgery.

The proper management of patients with the comorbidity of carotid and coronary artery stenosis remains precisely defined.[2]

As carotid stenosis may be an avoidable cause of stroke, the strategy of routine screening prior to surgery should be evaluated.[3]

Related studies declare that high-risk patients may be identified by some stated factors such as age,[1,4,5] female gender,[1,4] peripheral vascular stenosis

,[5-7] left main coronary stenosis,[1,5,8] carotid bruit on physical examination,[1,9] previous cerebrovascular accident,[1] hypertension,[4,10-13] history of smoking,[4,10,13] dislipidemia,[4]diabetes mellitus[4,9,10,13] and myocardial infarction.[4,5,13]

The purpose of this study was to assess the prevalence of significant carotid artery stenosis and the related risk factors in patients who are candidates for CABG in an Iranian population.

Patients and Methods

From 2006 to 2008, 301 patients with critical coronary disease who were referred to our university-affiliated hospital for CABG were preoperatively evaluated by internal carotid Doppler study.

Carotid Doppler was performed by a radiologist who was expert in Doppler studies.

The devices used were a GE medical health care Eccocee with a 10 MHz linear transducer.

Based on Nicolaides criteria, common carotid arteries, carotid bulbs and internal carotid arteries of all patients were assessed to quantify the grade of stenosis.

Lipid profile was prepared for all patients by measuring triglyceride (TG), cholesterol, low-density lipoprotein (LDL) and high-density lipoprotein (HDL).

Cholesterol and TG serum levels were estimated by enzymatic methods, HDL by direct methods and LDL by Friedewald formula.

The impact of serum lipids including TG, cholesterol, LDL and HDL on extra cranial carotid stenosis was evaluated.

Based on the serum TG level, patients were classified into two groups of normal TG (<200mg/dl) and high TG (>=200mg/dl); according to the serum cholesterol level, into desirable (<200mg/dl) and at risk (>=200mg/dl) groups; based on the serum LDL level as normal (130mg/dl) and high (>=130mg/dl) LDL groups; for serum HDL level as normal (>35 mg/dl for men and >45 mg/dl for women) and low (<35 mg/dl for men and <45 mg/dl for women).

Other evaluations included cardiovascular risk factors, clinical examinations, serum glucose and angiographic data.

All acquired information containing medical records, laboratory test results, angiographic and ultrasonographic data were recorded into the database sheets.

SPSS version 11.5 was used for statistical analysis. A probability value below 5% ($p<0.05$) was considered significant

Chi-square and Fishers' exact tests were used for investigation of the association between gender, hypertension, diabetes mellitus, history of smoking and lipid profile and carotid artery stenosis of greater than 70%. Logistic regression model was used for multivariable analysis.

Results

The subjects were 301 consecutive patients, 215 men (71.4%) and 86 women (28.6%). The mean (SD) age of our patients was 60.3 (7.8), (range, 41-88 years).

All patients were scheduled for elective CABG; however, there was a necessity for some of them to go under another concomitant surgery.

Of the 301 patients; 87 (28.9%) had diabetes, 127 (42.2%) had hypertension, 113 (37.5%) were active or ex-smokers, 41 (13.6%) had hypertriglyceridemia, 52 (17.3%) had hypercholesterolemia, 36 (12%) had a high serum LDL level and 136 (45.2%) had a less than normal serum HDL level (<35 for men and <45 for women).

According to coronary angiographic data, 220 (73.1%) patients were diagnosed with triple vessel disease, 47 had two-vessel disease, 15 had one-vessel disease and not specified in 19 patients. Of these patients, 28 had left main coronary stenosis of 50% or greater.

The patency of left main coronary artery was less than 50% in 30 (10%) patients.

Aortic artery dilatation of more than 30 mm was detected in 11 (3.7%) patients.

Doppler studies were performed on bilateral carotid arteries. Bilateral sonography revealed presence of atherosclerotic plaque in 136 (45.2%) patients.

Frequency and percentage of different grades of carotid stenosis according to Nicolaides criteria are shown in Table 1.

Four (1.3%) patients had occlusion on one side. Significant carotid stenosis (70% or more) was detected in 13 patients (4.3%). Among our patients, 5.1% of

Table 1. Distribution of Different Grades of Carotid Stenosis

Stenosis Severity	Left Carotid		Right Carotid		Maximum Stenosis Considering Both Sides	
	Number	Percent	Number	Percent	Number	Percent
No	171	56.8	173	57.5	138	45.8
<50%	76	25.2	79	26.2	97	32.2
50-59%	18	6.0	12	4.0	22	7.3
60-69%	5	1.7	5	1.7	7	2.3
70-79%	3	1.0	5	1.7	7	2.3
80-99%	1	0.3	2	.7	2	.7
Total Occlusion	4	1.3	0	0	4	1.3

Table 2. Comparison of Risk Factors Between Significant and Nonsignificant Carotid Stenosis Groups

Variable or Risk Factor	Levels (No.)	Frequency of Both Side Maximum Stenosis Greater than 70% No.(Percent)	P-Value	Odds Ratio [95% Confidence Interval]
Sex	Male(195)	10(5.1)	0.76	0.73
	Female(79)	3(3.8)		[0.2-2.7]
Smoking	Yes(106)	9(8.5)	0.026	3.6
	No(161)	4(2.5)		[1.1-12.1]
Triglyceride	Normal(166)	8(4.8)	0.99	0.5
	Abnormal(38)	1(2.6)		[0.1-4.4]
Total Cholesterol	Normal(153)	8(5.2)	0.69	0.39
	Abnormal(48)	1(2.1)		[0.5-3.2]
LDL	Normal(154)	8(5.2)	0.99	0.55
	Abnormal(34)	1(2.9)		[0.07-4.6]
HDL	Normal(72)	0(0)	0.028	----
	Abnormal(126)	9 (7.1)		
Significant Left Main Stenosis	Yes(28)	4(14.3)	0.035	4.3
	No(218)	8(3.7)		[1.2-15.6]
Opium	Yes(31)	2(6.5)	0.68	1.3
	No(134)	7(5.2)		[0.25-6.3]
Hypertension	Yes(114)	9(7.9)	0.021	4.3
	No(153)	3(2)		[1.1-16.2]
Diabetes Mellitus	Yes(78)	3(3.8)	0.99	0.8
	No(190)	9(4.7)		[0.2-3.1]

the men and 3.8% of the women had significant carotid stenosis (p=0.76).

Patients were divided into two age groups of younger and older than 60 years.

Significant carotid artery stenosis was found in 4.8% and 5.6% of the younger and older than 60 age group patients, respectively (p=0.86).

Significant stenosis was detected in the carotid artery in 7.9% of the hypertensive and 2.0% of the non-hypertensive patients (p=0.021).

Significant stenosis was seen in 3.8% of the diabetic patients and 4.7% of the other patients (p=0.99).

In patients with a history of smoking and non-smokers, significant stenosis was detected in 8.5% and 2.5%, respectively (P=0.026).

The percentages of patients with significant stenosis according to the lipid profiles are shown in Table 2.

None of the patients with single vessel disease had significant carotid stenosis; whereas, 5.1% and 5.4% of the patients with two and three vessel disease had significant stenosis, respectively (p=0.672).

Among patients with left main coronary stenosis of greater than 50%; 14.3% had significant carotid stenosis and 3.7% of the patients without left main coronary stenosis of greater than 50%, had significant carotid stenosis (p=0.035).

Atherosclerotic plaques in men who were older than 60 years were obviously more frequent (p=0.013).

In patients who were identified to have a higher than 30 mm dilatation of the abdominal aorta, the presence of atherosclerotic plaque in the carotids was more probable (p=0.028), however a dilatation of more than 30 mm in the aorta was more frequent in men (p=0.033).

In a multivariable logistic regression analysis, we assessed the effect of statistically significant variables in a model together. These variables included smoking, HDL level, significant left main stenosis and hypertension. Because of technical errors, HDL was omitted from the model and the multivariable model was formed with three variables (smoking, hypertension and significant left main stenosis). In this situation, two variables of smoking and hypertension remained in the model (odds ratio of smoking: 4.3, [95% confidence interval: 1.1-17.1], P-value=0.037, odds ratio of hypertension: 4.1, [95% confidence interval: 1.01-15.9], P-value=0.048) and the significant left main stenosis was exited from the model (odds ratio of significant left main stenosis: 2.9, [95% confidence interval: 0.7-12.6], P-value=0.15).

Discussion

Perioperative cerebrovascular complications in CABG candidates are mainly due to carotid stenosis. These complications also increase the in-hospital mortality and the length of hospital stay.[11]

In order to find significant stenosis, preoperative carotid screening can help to avoid the occurrence of stroke. In the case of existing significant carotid stenosis, the management strategy may change to endarterectomy prior to or in conjunction with isolated coronary revascularization.[8,11]

With consideration of cost-benefit ratio for carotid Doppler studies, it is necessary to identify high-risk patients in order to plan the most profitable approach.

According to several studies, the age of older than 65 years,[4,5,7,13] female gender,[1] hypertension,[1,4] carotid bruit,[1,4] peripheral vascular stenosis,[1,5,6] diabetes mellitus,[1,4,10] dyslipidemia,[1,4] history of smoking[1,4,10] and left main coronary artery stenosis[5,7,8,13] are the risk factors for carotid stenosis.

The purpose of this study was to reevaluate the prevalence of carotid artery stenosis and the assumed risk factors.

Unlike a few studies which recommend routine preoperative screening of all candidates, for the purpose of cost effectiveness, more evaluation of previous screening strategies is suggested. Furthermore, 42 (14%) of the patients had carotid stenosis of greater than 50 %, therefore, depending on the patients' condition (e.g. symptomatic carotid stenosis such as cervical bruit, undesirable past medical history such as cerebrovascular events) and considering the costliness of carotid Doppler, routine screening could be considered.

According to the meaningful relationship between significant carotid artery stenosis and low serum HDL level, hypertension, history of smoking and left main coronary artery stenosis of greater than 50% in this study, we identified them as risk factors, which led us to some criteria for elective screening.

Despite Durand[11] and Mitu[4] studies, the age of more than 60 years and female gender were not confirmed as risk factors by our study.

Diabetes was not a risk factor for carotid stenosis, which approved Durand's findings.

In conclusion, among all cardiovascular risk factors, it seems that serum HDL level, smoking, left main carotid artery stenosis and hypertension could be associated with significant carotid artery stenosis in CABG candidates.

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