

The Role of Carotid Artery Screening Before Coronary Artery Bypass Graft Surgery

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Abstract

Background: The incidence of stroke is 2.1-5.2% in bypass surgery patients with a mortality of 0-38%. This study was designed to evaluate the incidence of significant carotid artery stenosis and its related risk factors in candidates for coronary artery bypass graft (CABG) surgery.

Methods: 1045 consecutive candidates for CABG underwent carotid artery Doppler examination in a prospective study. The relation of age, sex, smoking and diabetes as well as lipid profile and carotid stenosis was evaluated. . .

Results: In 1045 CABG candidates with the mean age of 60 years, the prevalence of significant carotid stenosis (>60%) was 6.9%. In the patients who aged 65 years and older, significant stenosis was 12.5%. Age of 50 years and above, female gender, hypercholesterolemia and diabetes mellitus are independent risk factors for significant carotid stenosis.

Conclusion: Significant carotid stenosis has an earlier beginning in our study. Cost effectiveness studies are recommended for revising the previous screening protocols. .

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Introduction

Excluding intraoperative death, stroke is the most dreaded perioperative complication in patients that undergo coronary bypass surgery. The incidence of stroke is 2.1-5.2% in bypass surgery patients with a mortality of 0-38%.¹ Shedding debris from carotid or aortic atherosclerotic plaques, embolization of the intracardiac clot and a decrease in perfusion pressure to <60 mmHg are the etiologic causes of stroke associated with bypass surgery.² The carotid stenosis can be diagnosed

and managed preoperatively. Therefore, several studies recommend preoperative carotid screening in all bypass candidates.^{3,4} However, some others recommend it only in high risk patients. The stated risk factors are: over 65 years of age,¹ carotid bruit on physical examination,^{1,5,6} female gender, previous cerebrovascular accident or transient ischemic attack, peripheral vascular stenosis,^{1,7,8} hypertension,¹ left main coronary stenosis, history of smoking,^{7,8} and diabetes

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mellitus.⁷ This study is designed to reevaluate the prevalence of significant carotid artery stenosis and its pertaining risk factors among the patients who should undergo coronary bypass surgery.

Methods

In June 2004- May 2005, carotid Doppler study was performed on all the patients (n=1,045) who referred to Tehran Heart Center (a university referral center) for coronary

bypass surgery. Carotid Doppler was done by an expert radiologist who had been practicing Doppler studies on a daily basis for more than

5 years. The device was a Toshiba Eccocee with linear 7.5 MHZ and convex 3.75 MHZ transducers. A standard protocol based on Nicolaides criteria⁹ (Table 1) was applied to all the patients. Common carotid arteries, carotid bulbs, and internal carotid arteries were assessed for stenosis using color Doppler and pulse Doppler techniques. If the 7.5 MHZ transducer could not be used due to patient's obesity, a 3.75 MHZ transducer was used. All the patients had a lipid profile (triglyceride, cholesterol, low density lipoprotein, high density lipoprotein and lipoprotein a). Cholesterol and triglyceride (TG) levels were measured by enzymatic methods, high density lipoprotein (HDL) by direct method, low density lipoprotein (LDL) by Friedewald formula, and lipoprotein a(LPa) by immunoturbidometry. All the laboratory measurements were done using Pars Azmon reagents that are licensed by Germany Diagnostic. All the laboratory measurements were done within 24 hours of Doppler studies. This study was approved by the ethics committee of the hospital.

Table 1. Duplex Ultrasound criteria used to Quantify Internal Carotid Artery stenosis According to Nicolaidis*

NASCET stenosis grade	PSV	EDV	PSV _{ICA} / PSV _{CCA}	PSV _{ICA} / EDV _{CCA}	EDV _{ICA} / EDV _{CCA}
1-49%	<150				
50-59%	<250	<80	<2	<10	<2.6
60-79%	>250	<130	<3.2	<10	<2.6
80-89%	>250	>130	>4	<25	<5.5
90-99%	Trickle flow	130-	>4	>25	>5.5
100%	No flow				

*The velocities are measured as cm/s.

PSV, Peak Systolic Velocity; EDV, End Diastolic Velocity; ICA, Internal Carotid Artery; CCA, Common Carotid Artery

Results

The patients aged 27-88 years (mean=60.57, SD=9.3 years). The study population was predominantly male, nonsmoker, non diabetic, with normal triglyceride level and moderate risk hypercholesterolemia. All the patients were coronary bypass candidates however; some of them were concomitantly undertaking another operation too (Table 2).

Table 2. Reasons for additional operations concomitantly with the bypass surgery

Reasons	Frequency
AVR+MVR	9
AVR	2
MVR+AVR+TVR	1
MVR+TVR	3
MVR	11
TVR	1

AVR, Aortic Valve Replacement; MVR, Mitral Valve Replacement; TVR, Tricuspid Valve Replacement

Of 1045 patients studied, 728 (69.7%) were men. Two hundred forty-four (23.3%) had diabetes (fasting blood sugar > 120 mg/dL in two separate examinations or history of antihyperglycemic drug therapy). 714(68.3%) were nonsmoker, 230 (22%) were active smokers, and 101 (9.7%) were ex smokers that had quit smoking more than 1 year ago. Of all the patients, Doppler study revealed bilateral carotid atherosclerotic plaque in 329 (31.5%), unilateral carotid plaque in 313 (30%), and normal in 403 of patients. In the patients with unilateral carotid plaque (n=313), in 167 patients it occurred on the right side and in 146 patients in left side Carotid stenosis was estimated according to Nicolaides criteria that has a high sensitivity (98%) and negative predictive value (98%). [10] The results are tabulated in (Table 3).

Table 3. Frequency of different grades of carotid artery stenosis in each side

% Stenosis	Frequency (%)	
	Left	Right
Less than 60%	91.9	90.7
60-79%	7.2	7.1
80% or more	0.9	1.2

In the patients with atheromatous plaques, 1 had occlusion of the left internal carotid, and 5 had occlusion of the right internal carotid artery. Totally, 72 patients had significant



carotid stenosis (more than 60% stenosis) that constituted 6.9% of all the bypass surgery candidates. Of these patients, 59 had unilateral and 13 had bilateral significant stenosis. Ten patients had carotid stenosis more than 80%, 6 on the right side and 4 on the left. Six patients had obstruction in their internal carotid artery. Three hundred ninety-two patients aged 65 years and more, 49 (12.5%) of them had stenosis more than 60%, and 12 (3%) had stenosis more than 80%. The most common site for atheromatous plaques was the carotid bulb (84% of the right-sided, and 78% left-sided plaques). The cervical portion of the internal carotid and common carotid arteries were other most common sites for plaques, respectively.

In the Chi2 test for association of gender, age, and diabetes with carotid stenosis of more than 60%: 13% of women and 4.3% of men had stenosis more than 60% ($p=0.002$, $OR=1.4$). Also, 11% of the patients with diabetes and 5.6% of nondiabetic patients had significant stenosis ($p=0.003$, $OR=1.4$). The prevalence of significant stenosis was 1.3% for less than 50 years of age, and 7.9% for 50 years and over ($P<0.0001$). Regarding the low number of female smokers in our study (16 active smokers and 6 ex smokers), the association of smoking and carotid stenosis was evaluated only among the men. Thus, 5.8% of the nonsmoker men had stenosis more than 60%. It was respectively 2.3% and 2.1% in active smokers and those with history of smoking ($p=0.063$).

The effect of atherogenic factors (triglyceride, cholesterol, LDL and LpA) were assessed in regard with carotid stenosis. Patients were grouped for LpA level as normal (< 30 mg/dL) and high (≥ 30 mg/dL), for cholesterol level as desirable (< 200 mg/dL), moderate risk (200-240 mg/dL), and high risk (≥ 240 mg/dL), for triglyceride level as normal (< 200 mg/dL), moderately high (200-400 mg/dL), and high (≥ 400 mg/dL), and for LDL level as normal (< 160 mg/dL), and high (≥ 160 mg/dL). Accordingly, the significant stenosis was 7.1% in patients with normal LpA and 6.7% in the high LpA group ($p=0.78$). Normal LDL and high LDL groups had respectively 5.4% and 12.6% significant carotid stenosis ($p=0.0006$). Significant carotid stenosis occurred in 5.6% of desirable cholesterol levels, 4.6% in moderate risk, and in 13.4% of high risk groups ($p=0.0001$). Carotid artery stenosis of more than 60% was observed in 6.5% with normal TG, 7% with moderately high TG, and 17.4% with high TG ($p=0.12$). Only 23 patients had high (>400 mg/dL) TG.

Discussion

In coronary bypass surgery candidates, carotid stenosis is the risk factor for stroke, in-hospital mortality and longer in-hospital stay.¹⁰ screening carotid arteries for stenosis combined with endarterectomy reduces perioperative as well as postoperative stroke. Screening also helps to discover and follow the significant carotid artery stenosis cases that do not

have neurological symptoms. Presence of significant carotid artery stenosis can change the bypass schedule to a bypass with endarterectomy or endarterectomy and then bypass surgery.¹¹ considering the costliness of carotid Doppler studies, it is important to determine those bypass candidates who would benefit from carotid screening. Age of more than 65 years,¹ carotid bruit on examination,^{1,5,6} peripheral vascular stenosis,^{1,7,8} hypertension,¹ left main coronary stenosis,^{1,7,8} history of smoking,^{7,8} and diabetes mellitus⁷ have been stated as the risk factors associated with carotid stenosis in different studies. However, some other studies did not find any association between hypertension, hypercholesterolemia, smoking¹² and diabetes^{1,12} with carotid stenosis. In regard with the fact that atherosclerosis is a multifactorial phenomenon with both genetic and environmental factors playing a role, and considering the fact that previous studies have shown coronary artery diseases are occurring at an earlier age in last decade,^{13,14} this study sought to assess the prevalence of carotid stenosis and its pertinent risk factors. Of 1,045 patients in this study with a mean age of 60.57 years, 72 patients (6.9%) had carotid stenosis of more than 60%. Significant stenosis was 12.5% in 65 year olds and above, which is in accordance with Berens¹¹ and Faggioli's¹² results. Unlike Faggioli's study that prevalence of carotid stenosis significantly increased after 60 years of age, we observed it at 50 (i.e. 1.3% at 50 years and less, and 7.9% at more than 50, $p=0.002$). Faggioli did not report hypercholesterolemia, hypertension, diabetes, and smoking as the risk factors for carotid stenosis, postoperative stroke and death. However, in our study high risk hypercholesterolemia (>240 mg/dL) and diabetes were associated with significant carotid stenosis ($p=0.0001$ and 0.003 respectively) and therefore were identified as risk factor. The risk of carotid stenosis is 17.4% with TG more than 400 mg/dL, and 6.5% with TG less than 200 mg/dL. However, the small number of the patient with TG more than 400 mg/dL in our study (33 out of 1,045) renders the statistical evaluation non conclusive. LDL level higher than 160 mg/dL was also a risk factor for carotid stenosis ($p=0.0006$). In the current study, smoking was not a risk factor for carotid stenosis, and hypertension was not studied. Identifying diabetes as a risk factor in our study is against the findings in Dunard's study. Dunard observed that 32% of the patients with less than 70% carotid stenosis had a history of diabetes and the prevalence of diabetes was 34% in patients with stenosis of 70% and more. Female gender was known to be a risk factor by Dunard and Faggioli ($p<0.005$ and 0.02 respectively). In our study this association was stronger ($p<0.0001$). High serum LpA levels (more than 30 mg/dL) is a controversial atherogen factor. We did not find an association between high LpA and significant carotid stenosis.¹⁵

Conclusion

Fifty years of age and over, female gender, diabetes, and



hypercholesterolemia were identified the risk factors for carotid artery stenosis among our patients. In regard with the earlier occurrence of carotid stenosis in our patients by one decade, it is recommended to assess the cost effectiveness of carotid screening after the age of 50 in another study.

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