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Prevalence of Carotid Stenosis in Elective CABG Patients

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Abstract

Background: Atherosclerosis is a systemic disease involving different arterial territories. While cardiac involvement is rather symptomatic in most patients, carotid lesions are silent until an acute ischemic cerebral event happens. Ultrasound carotid screening is often part of the preoperative protocol for coronary bypass surgery patients to predict the risk of stroke.

Aim: The aim of this paper is to evaluate the prevalence of severe carotid artery stenosis (CAS) in candidate patients for coronary bypass surgery (CABG), its correlations with severity of coronary artery disease (CAD) and atherosclerotic risk factors and its impact in CABG outcome.

Study design: Cohort study.

Material and Method: 211 consecutive patients hospitalized for elective CABG from January 2012 to December 2018 were screened for CAS with preoperative Duplex ultrasound. All patients had CABG and no intervention for CAS prior or concomitant with it. Their clinical recordings were retrospectively controlled for presence and severity of CAS, classic atherosclerotic risk factors, CAD severity and the outcome of surgery. CAS severity was graded according to hemodynamic parameters measured with Duplex ultrasound. Occlusion or ≥ 70% stenosis of at least one internal carotid artery was considered severe.

Results: 32 patients (15.2%) had severe CAS, 13.3% with ≥70% stenosis and 1.9% with occlusion of Internal Carotid Artery (ICA).

There was no statistically significant correlation between the prevalence of severe carotid artery stenosis and the prevalence of atherosclerotic risk factors or the severity of coronary artery disease,

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although there was a statistically significant higher prevalence of ICA occlusion for female sex. Two patients (0.95%) had in-hospital stroke, one transient and one persistent.

There were only 4 (1.9%) in hospital deaths, none of them due to cerebro – vascular complication.

Conclusions: Severe CAS is not frequent in coronary bypass surgery patients. There is no clear correlation between atherosclerotic risk factors or importance of CAD and severe CAS. Patients with symptomatic severe carotid stenosis are at high risk for peri-procedural stroke and might benefit from concomitant treatment, but the overall burden of carotid disease complications for CABG is low.

Key words: Carotid stenosis, carotid disease, CABG

INTRODUCTION

Both coronary and carotid artery disease are expressions of advanced atherosclerosis, but while cardiac involvement is rather symptomatic and the majority of patients are diagnosed before having an acute myocardial infarction, carotid lesions are silent until an acute ischemic cerebral event happens. Stroke is a rare but serious complication of coronary artery bypass surgery and for this reason carotid screening is part of the preoperative protocol of such patients. Duplex scanner (Echo Color Doppler) is the method of choice for carotid artery disease screening because it is simple, non invasive, cheap and with high sensitivity and specificity. There is ongoing debate if prior carotid or concomitant surgery is justified in patients with both diseases.

Objectives

The aim of this study is to evaluate the prevalence of severe carotid artery stenosis (CAS) in elective CABG patients, its correlations with severity of coronary artery disease (CAD) and atherosclerotic risk factors and its implication in coronary bypass surgery outcome.

Material and Methods

This is a retrospective study of prospective collected data of consecutive patients who had surgery for coronary artery disease at our institution from January 2012 to December 2018. There were 281 patients operated for CABG in total. 70 patients were excluded from analysis because operated in emergency, thus the number of patients for analysis is 211.

Sex, age and major atherosclerosis risk factors were taken into account. Patients were considered positive for diabetes, high blood pressure and dyslipidemia if such conditions were diagnosed previously or at admission. They were considered active smokers if they were still smoking at the moment when CABG was indicated. Ex-smokers were not considered.

Patients were categorized as 1, 2 or 3 vessel disease and presence or not of left main disease according to coronarography results. Other important pre-existent heart conditions were included: acute myocardial infarction within one month prior to hospitalization, aortic or mitral valve disease and chronic atrial fibrillation.

All patients had a preoperative carotid Duplex scan with a 7.5 MHz linear probe. 99% of duplex scans were performed from the same physician. Evaluation was based on both grey scale bi-dimensional image and hemodynamic assessment of flow. Patients were categorized in 5 groups according to carotid ultrasound findings based on the classification of the Society of radiologists in ultrasound (1). (Tab. 1)

The same anesthetic protocol was used and coronary artery bypass grafting was performed under cardio-pulmonary bypass from the same team. No prior or concomitant carotid intervention was done for patients discovered with severe carotid stenosis or occlusions.

Neurological complications after surgery and during hospitalization were controlled.

Table 1. Ultrasound classification of carotid lesions

Disease categorization	Ultrasound characteristics
No carotid lesions	No plaques, no increased intimal thickness, no disturbance of flow.
Mild carotid disease	Increased intimal thickness, atherosclerotic plaques with less than 50% diameter reduction of ICA. (PSV < 125 cm/s) Severe stenosis or occlusion of ECA.
Moderate carotid disease	50 – 69% ICA stenosis. (PSV = 125 – 230 cm/s)
Severe carotid stenosis	≥70% ICA stenosis. (PSV > 230 cm/s, EDV > 100 cm/s, PSV-ICA / PSV-CCA > 4)
ICA occlusion	No flow detected in ICA.
ICA internal carotid artery; ECA external carotid artery; CCA common carotid artery; PSV peak systolic velocity; EDV end-diastolic velocity.	

Student T test was used to compare means and Fisher exact test for correlation of atherosclerotic risk factors and severity of coronary artery disease with carotid artery stenosis. Significance level was set at $p < 0.05$.

Results

Patient age varied from 32 to 90 years old. (Mean +/- SD = 64.9 +/- 8.6). 91% of patients were aged 51-80. There were 169 men (80%) and 42 women. Men's age varied from 32 to 90 years and

Table 2. Prevalence of atherosclerotic risk factors, complexity of coronary disease and other heart conditions

	Total Nr (%)	Men Nr (%)	Women Nr (%)	Stat. significance (Fisher exact test)
Diabetes	90 (42.7)	64 (37.8)	26 (61.9)	p<0.05
High blood pressure	170 (80.6)	133 (78.7)	37 (88.1)	
Smoking	67 (31.8)	65 (38.5)	2 (4.8)	p< 0.05
Dyslipidemia	68 (32.2)	55 (32.5)	13 (30.9)	
3-vessel coronary disease	156 (73.9)	128 (75.7)	28 (66.7)	
Left main coronary disease	72 (34.1)	60 (35.5)	12 (28.6)	
Recent myocardial infarction	73 (34.1)	63 (37.3)	10 (23.8)	
Aortic valve stenosis	18 (8.5)	12 (7.1)	6 (14.3)	
Mitral valve stenosis	2 (0.9)	1 (2.4)	1 (0.6)	
Atrial fibrillation	22 (10.4)	18 (10.6)	4 (9.5)	

P value has been shown only for significant differences.

women's from 53 to 77. Their mean age however was not statistically different, 64.62 +/- 9.13 for men and 66.09 +/- 5.88 for women (p > 0.05 T-test).

Prevalence of classic atherosclerotic risk factors and the complexity of coronary and other heart disease are presented in table 2. Diabetes was statistically more frequent in women while smoking was significantly more prevalent for men. There was no significant difference about high blood pressure and dyslipidemia for both sexes. Three-vessel coronary artery disease, recent acute myocardial infarction as well as other important heart diseases were not statistically different between male and female patients (p>0.05, Fisher exact test).

Four patients had a previous cerebral ischemic event in their history, 3 men and 1 woman, 1.8% and 2.4% respectively (p>0.05, Fisher exact test). All had completely recovered and none had neurologic deficits at admission.

Prevalence and severity of carotid lesions is presented in table 3. Less than 10% of patients had no sign of carotid disease. 28 patients (13.3%) had ≥ 70% ICA stenosis and 4 patients (1.9%) had an occlusion, what makes severe carotid disease present in 15.2%. Only one male patient had bilateral severe carotid stenosis. There was no patient with a severe stenosis and contralateral occlusion.

Table 3. Severity of carotid lesions and their prevalence

	Nr of patients (%)
No sign of disease	21 (9.9%)
Mild atherosclerosis	118 (55.9%)
Moderate lesions	40 (18.9%)
Severe stenosis	28 (13.3%)
Occlusions	4 (1.9%)

Mean age of patients with important carotid disease was slightly higher than patients with less severe involvement (67.5 vs 64.5 years old) but not statistically important (p > 0.05, T – test).

There were 23 men and 5 women with severe carotid stenosis, 14.8% and 11.9% respectively with no significant difference. Carotid occlusions were found in 1 man and 3 women, 0.6% and 7.1% respectively or 12 times more frequently in female patients. This is a significant difference. (p<0.05, Fisher exact test).

Table 4 represents the prevalence of severe carotid disease in patients with and without the major atherosclerotic risk factors. There isn't any difference between diabetics and non-diabetics, active smokers or patients with dyslipidemia and those who were not (p > 0.05, Fisher exact test). Although there is a slightly higher prevalence in hypertensive patients this isn't statistically significant. There is no difference for prevalence of severe carotid disease even between diabetic males and females, 12.5% versus 15.4% (p>0.05, Fisher exact test).

Table 4. Correlation of severe carotid disease with atherosclerotic risk factors

Risk factor for atherosclerosis	Patients with the risk factor		Patients without the risk factor		Statistical Significance (Fisher exact test)
	Total	**Patients with severe carotid disease Nr (%)**	**Total**	**Patients with severe carotid disease Nr (%)**	
Diabetes	90	14 (15.5%)	121	18 (14.9%)	p > 0.05
High blood press.	170	24 (14.1%)	41	8 (19.5%)	
Smoking	67	11 (16.4%)	144	21 (14.6%)	
Dyslipidemia	68	10 (14.7%)	143	22 (15.4%)	

No statistically significant difference was observed for prevalence of severe carotid disease according to coronary artery disease severity: three-vessel or left main coronary artery disease (LM artery disease), or presence of acute myocardial infarction (p > 0.05, Fisher exact test). There was also no correlation in patients with or without aortic valve disease or atrial fibrillation. (Tab. 5)

Four patients died (1.9%) because of cardiac related complications, one of them with severe, one with moderate and the other two with mild carotid disease. Two patients suffered a stroke in the whole cohort (0.95%), one with mild carotid disease and the other who had recovered from a recent stroke prior to surgery and had severe carotid disease. The rate of stroke in patients with and without severe carotid disease is respectively

Table 5. Correlation of severe carotid disease and complexity of heart disease

Risk factor for atherosclerosis	Patients with the risk factor		Patients without the risk factor		Statistical Significance (Fisher exact test)
	Total	**Patients with severe carotid disease Nr (%)**	**Total**	**Patients with severe carotid disease Nr (%)**	
Diabetes	90	14 (15.5%)	121	18 (14.9%)	p > 0.05
High blood press.	170	24 (14.1%)	41	8 (19.5%)	
Smoking	67	11 (16.4%)	144	21 (14.6%)	
Dyslipidemia	68	10 (14.7%)	143	22 (15.4%)	

LM left main, AMI acute myocardial infarction.

3.13% and 0.56%, but the difference is not statistically significant. The combined stroke and death rate is 2.8%, 6.25% for patients with severe carotid disease and 2.23% for those without it, but the difference is not statistically significant ($p>0.05$, Fisher exact test).

Discussion

This is a retrospective study of prospectively collected data of patients who had elective coronary surgery. There is substantial number of severe CAD patients in this cohort, the majority being 3-vessel and left main disease or having had a recent acute myocardial infarction. This is very different from the general coronary disease patient population which enrolls less severe disease, suitable for conservative or percutaneous treatment. Furthermore, there is no previous study in Albania to elucidate the combination of coronary and carotid disease prevalence in our population.

Duplex scan is the standard examination for carotid stenosis due to its high accuracy (1, 2, 3). In our practice we use the consensus criteria of the Society of Radiologists in Ultrasound for grading the severity of carotid disease (2). These criteria have been validated in multiple studies.

Current guidelines of most important cardio-vascular societies worldwide suggest preventive carotid intervention (surgery or stent) in asymptomatic patients with ≥ 70% ICA stenosis and best medical treatment for mild to moderate carotid disease or occlusion (4). In our study 13.3% of patients resulted with ≥ 70% carotid stenosis that is patients who would have indications for carotid interventions and 1.9% had unilateral carotid occlusions. These rates are very similar with those reported in literature.

Different studies have linked prevalence of severe carotid stenosis with advanced age, smoking, diabetes, severity of coronary disease and previous stroke (5, 6, 7). We could not find any relation between the classic risk factors for atherosclerosis and the prevalence of carotid disease apart from women being more prone to carotid occlusions than men. Men and women were different only for rate of diabetes and active smoking, but differences for the prevalence of severe carotid disease in those subgroups did not reach statistical significance. We had information only about recent smoking habits of our patients. It was not specified in our database if they had ever smoke, how much and for how many years. This may have affected the role of smoke as a predictor for development of carotid disease. The age of patients was also not an indicator of carotid disease possibility. We neither found any correlation between the complexity of coronary or other heart conditions and the severity of carotid disease. There may be many reasons for such results: Tanimoto at al. (5) and Kallikazaros at al. (6) had in their studies almost the same number of patients with 1,2 or 3 vessel disease, while in our study ¾ of patients had 3 vessel disease; both afore mentioned studies had carotid stenosis considered when over 50% diameter reduction which is not consistent with indications for treatment according to guidelines; in Tanimoto

study (5) there was twice as high dyslipidemia prevalence and much more previous stroke rate compared to our study while in Kallikazaros study (6) the mean age of the patients was much younger and patients with previous myocardial infarction were excluded. Sainvil at al. (7) found a lower prevalence severe carotid stenosis (4.6% compared to our 13.3%). This means that different populations might have different prevalence of carotid disease.

The risk of stroke in elective CABG is relatively low. Large cohorts of patients (8, 9) and a review of literature (10) reported it around 2%. Yet it is not negligible because of the high mortality of post CABG stroke ranging from 14 – 23%. Stamou et al. in their study confirm CAS as a direct predictor of stroke after CABG (8). Naylor et al. in their review confirm the rise in prevalence of stroke from 2% in the overall CABG population to 3% in patients with unilateral severe CAS, to 5% to those with bilateral severe CAS and 7 – 11% for patients with ICA occlusion (10). In our series there are only two cases of stroke, less than 1%. The series is not big enough to draw conclusions about differences in rate of stroke between patients with and without severe carotid disease, but despite the low number of patients with severe carotid disease (32 patients) the 3% rate of stroke in this subgroup equals that found in the literature. There are only 4 patients with previous cerebro-vascular disease in this series and one of them suffered a stroke. Concomitant surgery for both diseases might be justified for such patients since they are more prone to recurrent stroke during CABG.

The prevalence of important carotid disease in elective coronary surgery patients is low, so the burden of its complications in overall rate of stroke and death is not important for practices with low number of patients, but it may be important for high load clinics.

Conclusions

The prevalence of severe carotid disease in CABG patients is relatively low. It is not possible to differentiate patients with high probability of carotid disease based on risk factors or severity of coronary disease so duplex screening should be uniform to all. Patients with symptomatic severe carotid disease seem to be at higher risk for stroke after CABG so they might be candidates for concomitant treatment on both diseases. Stroke after CABG is not predicable by the presence of carotid disease. Other factors should be taken into consideration.

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Conflict of Interest Disclosure: The authors’ have no conflict of interest to declare.

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