Prevalence of Carotid Stenosis in Patients Referred to Myocardial Revascularization Surgery

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Abstract

Background: Although the carotid stenosis is the main cause of cerebrovascular accident, the prevalence of clinically significant stenosis (≥50%) remains unknown in our country, mainly in individuals with a surgical indication for elective myocardial revascularization surgery.

Objective: To identify the prevalence and degree of carotid stenosis in individuals with a surgical indication for MRS in a reference center in Cardiology in Brazil.

Methods: Transversal study of 457 consecutive patients of both genders, evaluated between May 2007 and April 2008 through ultrasonography with color Doppler of the carotid arteries, during the preoperative period of elective MRS. The statistical analysis was performed with the SPSS program, version 10.1. A p value <0.05 was considered significant. Seven patients were lost throughout the study.

Results: : The mean age (±standard deviation) was 62.2 ± 9.4 years and 65.6% of the patients were males. The prevalence of significant carotid stenosis was 18.7%. As for the stratification of the degree of carotid stenosis: absence of stenosis was observed in 3.6%; stenosis < 50% was observed in 77.8%; stenosis between 50% and 69% was observed in 11.6%; stenosis between 70% and 99% was observed in 6.9% and arterial occlusion was observed in 0.2% of the individuals. The sensitivity and specificity regarding the carotid bruit were 34.5% and 88.8%, respectively.

Conclusion: The prevalence of significant carotid stenosis was high in the studied sample, which suggests this is a high-risk population for the occurrence of cerebrovascular accident. (Arq Bras Cardiol 2010;94(2): 169-174)

Key words: Carotid stenosis; carotid artery diseases/diagnostic; coronary artery disease; coronary artery bypass.

Introduction

Atherosclerosis is a chronic inflammatory systemic, complex and multifactorial disease that can manifest simultaneously in more than one site of the arterial bed. Depending on the place where the atherosclerotic plaque develops, the prognosis of the individual can be different.

The technical, surgical and anesthetic advancements in cardiac surgery are unquestionable, but the neurological complications, mainly the cerebrovascular accident (CVA) secondary to significant carotid stenosis (SCS), remain a concern for the assistance teams and all strategies must be used to reduce them in the perioperative period[1-3].

The CVA constitutes the second major cause of death among the vascular diseases, being second only to coronary ischemic syndromes. In Brazil, it is the third cause, after cancer and cardiac diseases and it is estimated that 250,000 deaths occur per year[4]. It is very often an incapacitating disease of considerable socioeconomic and family impact, and, consequently, has a significant effect on the quality of life[5]. Of the victims, one third presents a satisfactory evolution, one third dies and the remaining one third survives with sequelae.

In spite of the magnitude of the problem, the prevalence of SCS is unknown in our country and the controversy remains on the necessity to routinely investigate it at the preoperative period before myocardial revascularization surgery (MRS), considering the high cost and the unfavorable socioeconomic conditions of our country.

Therefore, our aim was to prospectively assess the prevalence and degree of carotid stenosis in patients with severe coronary diseases referred to MRS in a reference center in Cardiology in Brazil.

Methods

The present was a transversal study approved by the local Ethics Committee in Research, carried out in an inpatient clinic

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of the Brazilian Public Health System (SUS). Data collection started in May 2007 and ended in April 2008.

The inpatients or those referred to the clinic with a surgical indication for MRS[6,7] were invited to participate in a screening of carotid stenosis in the preoperative period. After signing the Free and Informed Consent Form, they answered a questionnaire to supply detailed information on the current and prior medical history, family history of atherosclerotic disease, personal history of systemic arterial hypertension (blood pressure ≥140/90 mmHg or use of anti-hypertensive drugs), dyslipidemia (total cholesterol >200mg/dL, HDL-C <40mg/dL and/or triglycerides >150mg/dL and/or use of hypolipemiant drugs), diabetes mellitus (controlled by diet; use of oral hypoglycemiant agents, insulin; fasting glucose levels ≥126mg/dL), obesity (body mass index ≥30Kg/m^2), smoking status (never, stopped one month before hospitalization or current smoker) and use of medications, based on the Guidelines for the Perioperative Assessment of the Brazilian Society of Cardiology[8], applied by the main investigator.

The individuals were assessed in the preoperative period, with emphasis on the palpation of fremitus and auscultation of cervical bruit (in order to rule out heart bruit radiation). The anthropometric data were collected, as well as information on anesthesia and the surgical procedure.

After the routine clinical-laboratory assessment, the patients underwent an ultrasonography with color Doppler of the carotid arteries, performed by three physicians specialized in vascular ultrasonography, certified by the Brazilian Society of Angiology and Vascular Surgery/ Brazilian College of Radiology, blinded to any data in the clinical history or physical examination of the patient and who adopted identical criteria for the diagnosis of carotid stenosis.

The examination was carried out in an ultrasound equipment (GE Logiq 500; *General Electric Medical Systems*, Milwaukee, WI) with a high-frequency linear transducer of 7.5 MHz and convex of 3.75 MHz, adequate for cases of high carotid bifurcation, arterial tortuosity or short neck.

The ultrasonography was carried out in B-mode (gray scale), initially for the anatomic assessment. Subsequently, the spectral analysis in color Doppler and power Doppler was assessed to measure the power (amplitude) of the received signal and flow dynamics evaluation, in addition to the detection of the blood velocity waveform (spectral analysis). At the end, to investigate the degree of stenosis of the carotid arteries, both aforementioned criteria were used (image and velocity), according to the last consensus for internal carotid artery stenosis by Doppler ultrasonography[9].

The main indicator for stenosis screening was the measurement of the flow velocity associated to the identification of atherosclerotic plaques in the bulb and the emergence of the internal carotid artery (ICA). The criteria for carotid disease were the following: absent (peak systolic velocity - PSV - of the ICA <125 cm/s and absence of visible plaque or stenosis); mild, between 0% and 49% of stenosis (peak frequency < 4 MHz = 125 cm/s and visible plaque or stenosis); moderate, between 50% and 69% (peak frequency >4 MHz and visible plaque); severe, between 70% and 99% (PSV of the ICA >230 cm/s and visible plaque or stenosis) and occlusion, 100% (absence of signal at color Doppler, spectral, power Doppler or gray-scale image)[10].

Two additional parameters were used to measure stenosis, when a) PSV of the ICA was not representative in relation to the extension of the disease due to technical or clinical factors; b) there was high degree stenosis on the opposite side; c) there was a discrepancy between the visual aspect and the end-diastolic velocity (EDV) of the ICA; d) increased flow velocity was observed in the common carotid artery (CCA); e) hyperdynamic cardiac state was observed; and f) low cardiac output was observed[11].

These parameters were (Table 1):

1) the PSV of the ICA/PSV of ACC ratio;

2) the EDV of the ICA.

Statistical analysis

All entered data were checked and the program SPSS 10.1 (SPSS Inc, Cary, NC) was used for the statistical analysis. The continuous variables were expressed as means ± standard deviations (SD) and compared by two-tailed Student's *t* test.

Chi-square or Fisher's Exact tests were used to compare the categorical variables: patients with absence of hemodynamically significant CS and coronary artery disease (CAD) *versus* patients with coexisting CS and CAD. A p-value < 0.05 was considered statistically significant.

For the calculation of the sample size (n), considering a beta error of 20% and an expected frequency of 7.9%, at

Table 1 - Consensus criteria for the diagnosis of ICA stenosis through gray-scale ultrasound and Doppler (Adapted from Edward G. Grant, Radiology 2003)[9]

Degree of stenosis (%)	Primary parameters		Additional parameteres	
	SPV ICA (cm/s)	Plaque (%)*	SPV ICA/SPC CCA Ratio	EDV ICA (cm/s)
Normal	<125	Nada	<2	<40
<50	<125	<50	<2	<40
50-69	125-230	≥50	2-4	40-100
≥70	>230	≥50	>4	>100
Oclusion	Non-detectable	Visible, without lúmen	Not applicable	Not applicable

**Plaque (decrease in diameter) verified through gray-scale US and Doppler.*

least 372 individuals were necessary to obtain a statistical difference (p-value < 0.05), in relation to independent predictors of CVA.

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Results

Of the sequence of 457 patients submitted to MRS from May 2007 to April 2008, seven were lost: five due to emergency surgeries performed on weekends and holidays and two cases that refused to participate. Therefore, a total of 450 patients were studied.

Mean age (±SD) was 62.2±9.4 years (ranging from 38 to 85 years) and 295 (65.6%) individuals were males. The basal clinical characteristics of the studied population are shown in Table 2.

Although differences were observed among many variables regarding the prevalence of CS, these were not statistically significant, differently from the findings of the physical examination on abdominal circumference (p=0.007) and carotid bruit (p< 0.001).

The carotid bruit was associated with hemodynamically significant stenosis in 29 (34.5%) of the patients with SCS and in 41 (11.2%) of those with CS < 50%.

Regarding the presence of carotid bruit, the sensitivity was 34.5%, the specificity was 88.8%, the positive predictive value was 41.4% , the negative predictive value was 85.5%, the positive likelihood ratio was 3.1% and the negative likelihood ratio was 0.73% for hemodynamically significant stenosis. The odds ratio for individuals with carotid bruit was 4.24-fold higher for hemodynamically significant stenosis. The prevalence of CS > 50% was 18.7% among the total number of studied patients.

According with the degree of stenosis (Table 3), 77.8% (350) of the patients presented stenosis <50%, 11.6% (52) presented stenosis between 50-69%, 6.9% (31) presented stenosis between 70-99% and 0.2% (01) of the patients presented carotid artery occlusion. The examination was normal in 3.6% (16) of the patients.

Discussion

In the present study, the prevalence of CS was high (18.7%) even when compared to other studies that included patients with coronary disease, which showed a range between 4 and 17% of hemodynamically significant stenosis[11-15]. This fact may express the improvement in the diagnostic method or be associated with the higher disease severity presented by the patients treated at our institution.

If the patient with CAD presents carotid bruit, although it is

Table 2- Clinical characteristics of the studied sample

Variable	Carotid stenosis		p
	≥ 50% (n=84)	< 50% (n=366)	
Age (years±SD)	62.5±8.2	62.2±9.6	0.793
Male gender	66.7	65.3	0.812
Caucasian ethnicity	96.4	93.7	0.237
Risk factors: n (%)			
Systemic arterial hypertension	78.6	85.2	0.132
Diabetes mellitus	28.6	30.1	0.789
Current smoker	17.9	17.5	0.936
Ex-smoker	82.1	82.5	0.936
BMI (Kg/m²±SD)	27.2±3.2	28.2±4.3	0.049
Abdominal circumference (cm±SD)	91±10.5	95±12.3	0.007
Peripheral arterial disease	23.8	23.8	0.994
LCT lesion	29.8	35	0.363
Carotid bruit	34.5	11.2	<0.001
Sedentary life style	82.1	81.1	0.833
Dyslipidemia	28.6	25.7	0.587

BMI - body mass index; LCT - left coronary trunk.

a low-sensitivity finding, there is a 30-50% possibility that the stenosis is >50% at the ultrasound assessment[16]. In the present study, patients with carotid bruit presented a 4.24-fold higher risk for hemodynamically significant stenosis, which reinforces the importance of the physical examination.

There was no statistically significant difference in relation to risk factors for carotid disease in severe coronariopathies, regarding gender, age, smoking status, dyslipidemia, arterial hypertension, family history of acute myocardial infarction or cerebrovascular accident.

Although the difference in CS incidence between males and females was apparently high, it was not statistically significant, probably due to the small sample size. The same might be true regarding the classic risk factors, such as smoking status, peripheral obstructive arterial disease, dyslipidemia and age.

The ultrasonography is the first-choice, complementary noninvasive method employed for the diagnosis of carotid atherosclerotic disease with a sensitivity of 90% to 98% and specificity close to 95%, similar to the magnetic resonance angiography[17], mainly in stenosis > 70%[18]. It has the lowest cost and provides the essential information to outline the intraluminal anatomy and also presents good reproducibility, does not require any preparation and can be performed at the bedside, although it is professional and dependent[19].

Additionally, it potentially extends the diagnostic procedure to a much larger population with asymptomatic disease[20].

However, in this context, we know that most patients do not have access to the diagnosis of CS before the MRS, notably those originally from the public health system.

The management of the cerebrovascular disease has clearly shown that the surgery, associated with the best clinical therapy, in comparison with the latter alone, significantly decreases the risk of cerebral infarction in symptomatic patients with atheromatous plaques in the carotid bifurcation, which cause stenosis between 70% and 99%[21].

For instance, patients with a degree of CS between 70% and 99% demonstrated by arteriography, symptomatic, with non-incapacitating, confirmed hemispheric or ocular neurological signs initiated within the last 120 days, with a duration > 24 hours, submitted to endarterectomy, indicated only by the percentage of stenosis, presented a decrease in the absolute risk for combined outcomes of death or CVA > 15% in five years, even with a perioperative risk of CVA and death of 6%, producing a number necessary to treat (NNT) of 6.3 (95% CI: 5-9)[22-24]. This conclusion has an "A" level of evidence[25].

On the other hand, the patients without neurological signs such as CVA or transient ischemia, with stenosis of 60% to 99%, submitted to the surgical treatment obtained an absolute risk decrease close to 5.5% in five years, with a NNT of 20, considering a combined perioperative risk of 2% to 3%. Apparently, women would present a higher benefit and therefore, a ten-year analysis is necessary[26,27].

The MRS in patients with severe stenosis of the ICA is associated with CVA in 2% to 3% of the cases[12], increasing to 7% in MRS combined with valvulopathy surgeries[1]. This might be prevented in 40% to 50% of the cases, being one of the most feared perioperative complications, with a mortality of up to 38%[2].

The more complex care in MRS must be directed at patients with high-degree stenosis of the carotid artery who, when submitted to extracorporeal circulation, can suffer a drop in blood pressure or distal flow so severe that can generate an ischemic event, due to the vasodilator response to low perfusion.

In several countries, the prevalence of CS is variable in patients candidate to MRS. In Brazil, there has been a single report with a 50-individual sample and the rate was 48% and 32% in patients with CS ≥50 and ≥70%, respectively[28].

The screening for CS, mainly in asymptomatic individuals[29], combined with prophylactic or not brain revascularization[30], decreases the rate of CVA in the intraoperative as well as in the postoperative periods.

The screening can also aid the diagnosis and follow-up of cases that have an indication for conservative treatment, because the CS is a risk marker itself that persists regardless of its treatment[31] and an opportunity to observe the vascular health in general[32]. To prevent the CVA, the identification and quantification of the CS are of utmost importance[33].

The presence of significant CS can change the surgical conduct with acceptable risks and costs, with the latter two being similar in concomitant surgeries[34], as well as in carotid revascularization with subsequent MRS[35].

Some authors have recommended the study of carotid disease in all patients candidate to MRS[14]. Others, only in cases presenting high risk: age older than 65 years[36], cervical bruit at physical examination, previous CVA or transient ischemic attack, peripheral obstructive arterial disease, systemic arterial hypertension, left coronary artery trunk stenosis, history of smoking, diabetes mellitus and aortic arch atherosclerosis[37].

Clinical implications

The angiography is the traditional and gold-standard method for cerebrovascular assessment in symptomatic individuals, but due to its high cost[18], elevated risk of CVA and other complications[39], the exclusive use of noninvasive assessment has been defended[19].

The cerebrovascular disease remains under intense monitoring and new techniques, such as the endovascular

Table 3 - Stratification of the degree of carotid stenosis

Stenosis (%)	n	%
Absent	16	3.6
0-49	350	77.8
50-69	52	11.6
70-99	31	6.9
Occlusion	1	0.2
Total	450	100

management and the pharmacological treatment of atherosclerosis remain under full development. The search for a decrease in morbimortality and costs must include the component regarding the investigation. Therefore, the effort for the stringent use of diagnostic methods and the consequent decrease in expenses and ensuing complications contribute to a more satisfactory treatment.

Conclusion

The prevalence of carotid stenosis was high in the present study, suggesting that it is a high-risk population that can benefit from an early diagnosis of the disease.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

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