Carotid Evaluation in Patients with Suspected Coronary Disease: Is There a Negative Prediction?

Avaliação de Carótidas em Pacientes com Suspeita de Coronariopatia: Existe Predição Negativa?

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Abstract

Introduction: Due to its prevalence and gravity, coronary diseases require a more definite and early sort of diagnosis. Thus, there is extreme urgency in identifying patients under the risk of such problem. The most important indicator of risk is a previous manifestation of atherosclerosis itself. In this context, the study of subclinical atherosclerosis may bring to light essential information.

Objective: To evaluate if there is any connection between carotid and coronary alterations; if the absence of atherosclerosis in the arterial bed may indicate absence of obstructive atherosclerotic disease in the coronary bed; and if the absence of carotid lesion might substantiate the non indication of coronarography, keeping in mind the clinical characteristics of each patient.

Methods: This study was observational, transversal, analytic and comparative. Fifty consecutive patients were included, having clinical indication for coronarography. A vascular ultrasound exam of the carotids was performed for a comparison of the results.

Results: All patients with no carotid plaque, evaluated using vascular ultrasound, did not present any significant coronary obstruction, as evaluated via coronarography. All patients who showed significant carotid obstruction, ≥ 50%, also presented significant coronary obstruction, ≥ 70%. Among the evaluated points, only the result of the vascular ultrasound exam of the carotids was seen as a risk predictor in the findings obtained via vascular ultrasound (odds ratio of 2,58; confidence interval 1,66-4,02; p < 0,001).

Conclusion: There was a positive association between the degree of the atherosclerotic lesion of the carotid and of the coronary. No patient without carotid lesion showed significant obstruction of coronary artery, presenting high negative predictive value.

Keywords: Coronary Diseases; Carotid Artery Diseases; Atherosclerosis; Cardiac Catheterization; Ultrasonography, Doppler.

Resumo

Introdução: Pela prevalência e pela gravidade, a doença coronariana demanda diagnóstico definitivo e precoce. Há necessidade premente de se identificarem indivíduos sob risco. O mais importante identificador de risco é a manifestação prévia da própria aterosclerose. Nesse contexto, o estudo da aterosclerose subclínica pode trazer informações essenciais.

Objetivo: Avaliar se há relação entre alterações de carótida e coronária; se a ausência de aterosclerose no leito carotídeo poderia indicar ausência de doença aterosclerótica obstrutiva no leito coronariano; e se a ausência de lesão de carótida poderia fundamentar a não indicação da coronariografia, respeitadas as características clínicas do paciente.

Métodos: Estudo observacional, transversal, analítico, comparativo. Foram incluídos 50 pacientes consecutivos, com indicação clínica para realização de coronariografia. Foi realizada ultrassonografia vascular de carótida para comparação dos resultados.

Resultados: Pacientes sem placas carotídeas avaliados pela ultrassonografia vascular não apresentaram obstrução coronariana significativa verificada pela coronariografia. Todos os pacientes que apresentaram obstrução carotídea maior do que 50% também tiveram obstrução

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significativa de coronária ≥ 70%. Dentre os fatores avaliados, apenas o resultado da ultrassonografia vascular de carótidas foi associado como fator de risco preditor dos achados da coronariografia (razão de chances de 2,58; intervalo de confiança 1,66-4,02; p < 0,001).

Conclusão: Houve associação positiva entre grau de lesão aterosclerótica de carótida e de coronária. Nenhum paciente sem lesão de carótida apresentou obstrução significativa de artéria coronária, conferindo alto valor preditivo negativo.

Palavras-chave: Doença das Coronárias; Doenças das Artérias Carótidas; Aterosclerose; Cateterismo Cardíaco; Ultrassonografia Doppler.

Introduction

Atherosclerosis is a chronic inflammatory disease of multifactorial origin, which occurs in response to endothelial aggression, primarily affecting the intima layer of medium- and large-caliber arteries.[1]

Because atherosclerosis is a systemic disease, its presence or absence in a specific arterial bed may provide indirect information about the situation of other associated arteries. In Brazil, 30% of all deaths are caused by cardiovascular diseases. An acute coronary event is the first manifestation of atherosclerotic disease in at least half of the people with this complication.[2]

Considering its prevalence and severity, coronary disease warrants a definitive and early diagnosis. Often, in clinical practice, patients with typical clinical symptoms may not present with coronary disease on the findings from usual diagnostic methods. In other cases, the disease can be confirmed in patients with atypical clinical symptoms. Similarly, even in asymptomatic individuals, current risk markers may not safely predict or exclude the disease. Individuals at risk must be urgently identified. Subclinical atherosclerosis usually precedes cardiovascular events and can be considered a risk marker.[3]

The risk of atherosclerotic disease is estimated by means of a combined analysis of characteristics that increase the likelihood of an individual developing the disease. The most important predictor is prior manifestation of atherosclerosis itself. Thus, the first step in risk stratification is the identification of clinical manifestations of atherosclerotic disease or its equivalent.[2] Carotid plaque is a manifestation of atherosclerosis and has 35% greater ability to predict cardiovascular risk than the measurement of intima–media thickness (IMT) alone.[4]

Clinical scores alone may fail to stratify risk. According to Grewal et al., 23% of individuals classified as low-risk patients based on the Framingham score showed subclinical atherosclerosis, requiring complementary evaluation.[5]

The medical literature highlights the limitations of risk stratification algorithms regarding the prediction of atherosclerotic coronary disease. In general, they overlook the family history in early-onset disease and tobacco smoking or they underestimate the risk in young individuals or in women with uncontrolled risk factors, among other variables.[6]

The classic risk factors for cardiovascular diseases (age, smoking, systemic arterial hypertension [SAH], diabetes mellitus [DM], and dyslipidemia [DLP]) can help identify individuals at risk. However, half of the individuals who develop coronary heart disease have no risk factors or have at most one factor.[6]

Coronary catheterization (CC) is the gold standard for the diagnosis of obstructive coronary artery disease (CAD).[7] It is, however, an invasive and expensive technique and cannot be used for routine screening purposes. A safe and noninvasive imaging method for rapid and effective evaluation of cardiological screenings is necessary to expand the clinical assessment of atherosclerotic disease in symptomatic and asymptomatic individuals.[8]

Numerous studies have evaluated the role of subclinical atherosclerosis as an aggravating factor for cardiovascular risk over time. In contrast, there is little information on the immediate correlation between carotid disease and the extent of coronary atherosclerosis in CC. Such information could be used to select patients indicated for CC.[8] Strategies for appropriately selecting patients who will undergo invasive coronary stratification (coronarography) are crucial to avoid unnecessary procedures, reducing health care costs, protecting the patient from additional risks, and avoiding the therapeutic cascade, which could lead to inappropriate angioplasty. The proportion of major clinical complications during CC is approximately 1.7%.[9]

The proportion of elective coronary angiographies with normal or minimal coronary disease results is approximately 39%, which indicates the need for additional tools for properly selecting patients for this invasive assessment.[10] Considering that carotid ultrasound (CUS) and coronary arteriography show arterial disease, the present study aimed to compare, in patients with suspicion of atherosclerotic CAD, atherosclerotic carotid and coronary alterations on CUS and CC, respectively, to evaluate the association between the degree of atherosclerotic carotid lesions and the degree of coronary lesions and to determine whether the absence of atherosclerotic carotid disease is be a negative predictor of CAD.

Methods

Ethics

The present study was submitted to *Plataforma Brasil* [Brazil Platform], in accordance with Resolution 466/12 of the National Research Ethics Committee (*Comissão Nacional de Ética em Pesquisa* – CEP) for research on human beings, together with its international documents, and was approved by the Research Ethics Committee of the *Santa Casa de Misericórdia* of Belo Horizonte (Santa Casa de Misericórdia de Belo Horizonte – SCBH; Certificate of Presentation for Ethical Consideration [*Certificado de Apresentação para Apreciação Ética* – CAAE] 96446718.8.0000.5138).

Study design

This was an observational, cross-sectional, analytical, and comparative study.

Sample characteristics

In total, 50 male and female patients, with ages ranging from 18 to 59 years and with clinical indication for coronarography, according to the guidelines in force, at São José do Avaí Hospital, in Itaperuna (RJ) were consecutively included in the study.

The patients were classified based on skin color into white and non-white (including black and brown). The body mass index (BMI) was calculated using the standard formula (weight/height^2), based on anthropometric measurements taken on the day when CUS was performed.

Family history of CAD included information provided by the patient and was considered positive when occurring in first-degree relatives, at ages <55 years in men and at ages <65 years in women. Tobacco smoking was considered when the patients actively maintained this habit at the time of their evaluation or had ceased the habit but had accumulated a tobacco smoking load of ≥20 packs per year. SAH, DM, and DLP data were retrieved from information contained in medical records or conveyed by the patients, especially whether they were taking pharmaceutical drugs.

Inclusion criteria

Patients of both sexes, aged between 18 and 59 years, referred for CC, with clinical indication according to the current guidelines, were included in the study.

Exclusion criteria

Patients with a history of previous coronary intervention (myocardial revascularization surgery or percutaneous revascularization with angioplasty) and with acute myocardial infarction with ST-segment elevation on admission were excluded from the study.

Data collection

The following data were collected: clinical symptoms justifying coronary angiography (stable angina, acute coronary syndrome, alterations suggestive of ischemia in non-invasive stratification, preoperative risk assessment), age, sex, color, BMI, family history of CAD, tobacco smoking, and the presence of comorbidities (SAH, DM, and DLP).

Vascular ultrasound of the carotid arteries

The examination was performed with the patient in the supine position, using a linear transducer to perform a transverse and longitudinal scan of the carotids, bilaterally, from the origin to the most distal accessible portion of the internal and external branches, covering grayscale images (B mode), spectral analysis (Doppler mode), and color mode. The devices used for CUS were Siemens ACUSON X300® and Philips CX50®. CUS was performed. The results were interpreted without knowledge of the results of the coronary angiography.

The results were interpreted based on the 2015 *Recomendação para a Quantificação pelo Ultrassom da Doença Aterosclerótica das Artérias Carótidas e Vertebrais* [Recommendation for Ultrasound Quantification of Atherosclerotic Disease of the Carotid and Vertebral Arteries].[4]

Coronarography

The following method was used for this examination: coronarography was performed via radial or femoral access, using the Seldinger technique, under local anesthesia. When performing coronarography via femoral access, hemostatic introducer sheath was used, catheterizing the ostia of the left and right coronary arteries for a study with intravenous infusion of an iodinated contrast agent (370 mg/mL Ultravist® iopromide). The patients received unfractionated heparin intravenously during the procedure at a dose of 5.000 IU for radial access and of 2.500 IU for femoral access.

The devices used to perform the coronarographies were Philips Allura Xper series FD 10 or 20®. CC was performed by specialists of the Hemodynamics Department at São José do Avaí Hospital, without previously knowing the results from the evaluation of the carotids by CUS. A database was constructed for subsequent statistical analysis.

Categorization of the results

The CUS was considered normal (grade 0); with IMT (grade 1), carotid atherosclerotic plaque with obstruction <50% (grade 2), or carotid atherosclerotic plaque with obstruction ≥50% (grade 3). For the purpose of assessment was coded as negative result and the group of patients without carotid atherosclerotic plaques (0 and 1) and the group of patients with carotid atherosclerotic plaques (2 and 3) was coded as positive result. CC showed absence of lesions (grade 0); obstruction <50% (grade 1); obstruction ranging from 50% to 70% (grade 2); or obstruction ≥70% (grade 3).

For assessment, in some statistical calculations, absence of obstructive CAD (0 and 1) was coded as a negative result and presence of obstructive CAD (2 and 3) as a positive result. Regarding the criteria for the indication for CC by the attending physician, the patients were divided into the following groups: stable angina, acute coronary syndrome (without ST-segment elevation), changes suggestive of ischemia on non-invasive examinations, and preoperative risk assessment.

Statistical analysis

For data analysis, exploratory statistical techniques were used to explain the general characteristics of the data. The data were presented in frequency tables, with absolute frequencies and respective percentages. Continuous data were expressed as mean and standard deviation. The variables related to risk factors were compared with the outcome variable using the chi-squared test and, when necessary, using Fisher's exact test and by calculating the odds ratio (OR).

Variables whose comparison showed a p value <0.20 were included the multiple logistic regression model, using the forward stepwise regression method. In this method, the most relevant variable is incorporated in each stage to construct

the most numerically stable model, minimizing the number of variables, because the more variables are included in the model, the more data-dependent it becomes. To calculate the OR, a "base" or reference category should be chosen to interpret the OR value. In this case, the first category of the variable was chosen as the base category. Significance level at 5% was adopted, considering comparisons with a p value of ≤0.05 significant. The power of the tests was >80%. Statistical Package for Social Science version 20.0 was used for statistical analysis.

Results

Descriptive data analysis

The sample consisted of 50 patients. The clinical characteristics of the patients are outlined in Table 1.

Only 12% of the patients included in the study were suspected of acute coronary syndrome when referred for CC. The criteria for indication for CC and results of carotid and coronary changes are outlined in Table 2.

Table 1 – Clinical and demographic characteristics of the study patients.

Variables	
Age in years	52.5 ± 6.1
BMI	27.5 ± 5
Sex	
Female	27 (54.0)
Male	23 (46.0)
Color	
White	32 (64.0)
Black	12 (24.0)
Brown	6 (12.0)
Systemic arterial hypertension	
No	11 (22.0)
Yes	39 (78.0)
Diabetes mellitus	
No	37 (74.0)
Yes	13 (26.0)
Dyslipidemia	
No	27 (54.0
Yes	23 (46.0)
Tobacco smoking	
No	34 (68.0)
Yes	16 (32.0)
Family history	
No	39 (78.0)
Yes	11 (22.0)

Results expressed as mean ± standard deviation or n (%). BMI: body mass index.

The 19 patients without carotid plaques, evaluated by CUS, showed no significant coronary obstruction when evaluated by CC. Regarding the other 31 patients, CUS revealed obstruction of <50% in 27 patients, whereas CC revealed obstruction of <50% in 12 patients. The presence or absence of carotid or coronary obstruction in the patients, evaluated by CUS and CC, respectively, and the recoded data are outlined in Table 4.

For comparative analysis, grades 0 and 1 of the CUS

Table 2 – Criteria for indication for coronary catheterization and results of carotid and coronary changes of the study group.

Variables	
Indication for CC	
Stable angina	12 (24.0)
Alteration suggestive of ischemia	23 (46.0)
Acute coronary syndrome	6 (12.0)
Preoperative risk assessment	5 (10.0)
Others	4 (8.0)
CUS	
Normal	13 (26.0)
Intima–media thickness	6 (12.0)
Carotid atherosclerotic plaque with obstruction <50%	27 (54.0)
Carotid atherosclerotic plaque with obstruction >50%	4 (8.0)
CC	
Absence of CAD	19 (38.0)
CAD with obstruction <50%	12 (24.0)
CAD with obstruction ≥70%	19 (38.0)
Affected coronary territories	
0	31 (62.0)
1	7 (14.0)
2	6 (12.0)
3	6 (12.0)
Affected carotids	
Absence of plaques	19 (38.0)
Unilateral	12 (24.0)
Bilateral	19 (38.0)

Results expressed as n (%). CC: coronary catheterization; CUS: carotid ultrasound; CAD: coronary artery disease.

Table 3 – Degree of obstruction of carotid and coronary arteries evaluated by carotid ultrasound and coronary catheterization, respectively.

Degree of obstruction	Carotid	Coronary
Absent	19 (38)	19 (38)
< 50%	27 (54)	12 (24)
> 50%	4 (8)	19 (38)

Results expressed as n (%).

and CC were considered negative. Grades 2 and 3, in both situations, were considered positive. Most patients (62%) showed positive results on CUS, that is, manifestation of atherosclerotic plaques. Of these patients, 54% showed carotid plaques with obstruction of <50%, and 8% showed carotid plaques with obstruction of ≥50%. Among the patients with positive findings on CUS, most showed bilateral carotid plaques (61,3%), whereas 38.7% presented with unilateral involvement.

The percentage of patients with normal results on CUS was 38%. The percentage of patients with significant coronary obstruction (≥70%) was also 38%, distributed as follows: 14% cases involving the coronary territory, 12% involving two territories, and 12% involving three territories. A small percentage of patients (24%) presented with CC with coronary obstruction <50% (Figure 1).

All negative carotid results were also negative for obstructive CAD, as evaluated by CC (Table 5 and Figure 2). In a sub-analysis of this group, most patients (63.2%) showed normal CC, and a minority (36.8%) showed CC with mild coronary atherosclerosis (plaques with obstruction lower than 50%).

Approximately 61.3% of the patients with positive results for carotid obstruction on CUS were also positive for obstructive CAD on CC, whereas 38.7% showed no obstructive coronary alterations. In the group of patients with altered carotids but without coronary obstruction, only 25% showed bilateral carotid involvement. However, in the group of patients with altered carotids and with coronary obstruction, 84.2% showed bilateral carotid involvement. All patients with carotid obstruction of >50% also showed significant coronary obstruction of ≥70%. The sensitivity and specificity values and the positive predictive value (PPV) and the negative predictive value (NPV) were calculated to use CUS in the identification of obstructive CAD, by correlating negative (without plaques) or positive plaques (to any degree) on CUS with negative (normal or with plaques <50%) or positive (plaques ≥50%) CC result.

Table 7 outlines the comparison between variables known as risk factors on CC. No significant differences were found in most comparisons. Only CUS results are associated with predictive risk factors of CC findings.

The variables with p value <0.20 in Table 7 were included in the multiple logistic regression model. The regression analysis is outlined in Table 8.

The assessment of the model fit parameters (percentage of hits, pseudo R^2 and Hosmer-Lemeshow test) showed no violation or poor fit, thus indicating the absence of the combined effect of the variables. In the final step of the model, all fit measures improved. The percentage of hits was high (82%). The Hosmer-Lemeshow test indicated correct predictions, although this pseudo R^2 (59.1%) value was far from ideal, without validating the model. Nevertheless, this model did not produce variables that, when combined, were related to the response variable, which was CC.

Table 4 - Presence or absence of carotid or coronary obstruction, evaluated by carotid ultrasound coronary catheterization, respectively, with recoded data.

Obstruction	Carotid	Coronary
Absent (0 and 1)	19 (38)	31 (62)
Present (2 and 3)	31 (62)	19 (38)

Results expressed as n (%).

Discussion

CAD, due to its high level of morbidity and mortality, necessitates early and accurate diagnosis. In medical practice, however, there are some difficulties. The atherosclerosis process and its different clinical manifestations have been the subject of studies on risk predictors, aiming at prevention and enhanced diagnostic accuracy. One of the objectives of the present study was to assess, in patients under clinical suspicion of coronary disease, whether the evaluation of carotid lesions, defined by CUS, can be used as a predictor of coronary lesions evaluated by CC.

Regarding the study design, two groups are normally required to evaluate a diagnostic test: one without a defined disease and the other with a disease. However, ethical restrictions preclude the use of invasive tests for

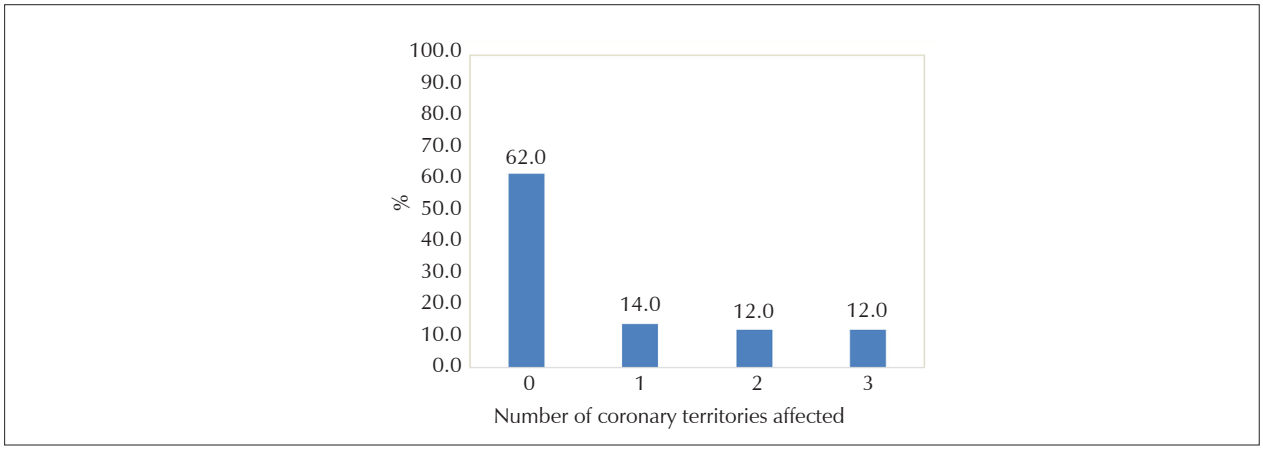


Figura 1 – *Coronary territories with obstruction of >50% on coronary catheterization.*

asymptomatic patients. Considering that the present study did not aim to perform a screening test, which would require a large sample extracted from an asymptomatic population, only one specific group was evaluated, with defined clinical indications for CC.

Of the 50 patients examined, 31 presented positive CUS findings: 19 with coronary disease (true-positive) and 12 without disease (false-positive). Of the 19 patients with negative CUS, none had coronary disease (true-negative). There was no false-negative CUS finding. Thus, a positive carotid test, to some extent, predicts CAD, whereas a negative test predicts decreased likelihood of the disease.

Based on multivariate analysis, which included demographic criteria and cardiovascular risk factors, the presence of carotid atherosclerotic plaque at any stage was the only significant risk factor (OR: 2.58; CI: 1.66-4.02; p < 0.001) for obstructive CAD. The absence of carotid atherosclerotic plaque resulted in an NPV of 100% for obstructive CAD.

CUS specificity, using coronary lesion as reference, reached 61.3%, which explains, in some cases, the presence of carotid lesion without coronary plaque. In these cases, however, in the absence of coronary lesion, only 25% patients showed bilateral carotid lesion. In the group with carotid and coronary lesions, 84.2% patients showed bilateral carotid involvement. Conversely, all patients with carotid obstruction of >50% also showed coronary obstruction at a similar grade.

The most prevalent factors in patients with positive CC were male sex, age >54 years, white, SAH, DM, DLP, tobacco smoking, and positive family history of early-onset CAD. The results from the present study, however, show that CUS should be used as an additional tool for selecting candidate patients for CC among individuals with suspicion of CAD. The proposed use of CUS may establish new likelihood estimates and increase the yield of CAD diagnosis. As a non-invasive, low-cost, and easy-to-manage method, CUS proved to be a viable procedure that can be incorporated into current medical guidelines.

The present study has limitations inherent to a cross-sectional design and a relatively small and non-random

Table 5 – Carotid alterations, evaluated by carotid ultrasound, and coronary alterations, evaluated by coronary catheterization.

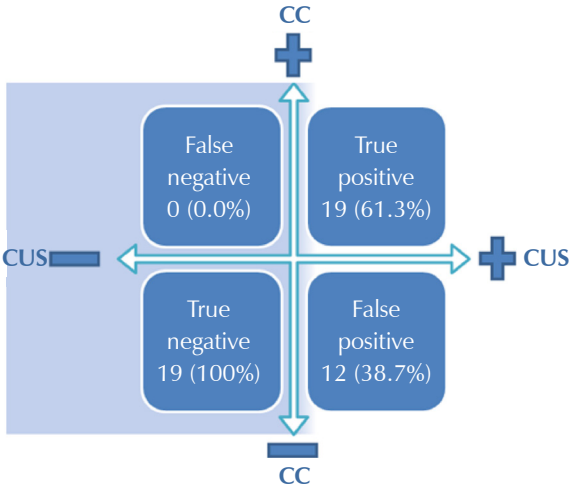
Variable	CC		OR	95% CI	P value*
	Absence	Presence			
CUS					
Absence	19 (100)	0 (0.0)	2.58	1.66-4.02	< 0.001
Presence	12 (38.7)	19 (61.3)			

*Results expressed as n (%). * Chi-squared test/Fisher's exact test. OR: odds ratio; 95% CI: 95% confidence interval; CC: coronary catheterization; CUS: carotid ultrasound.*

Table 6 – Calculation of the sensitivity, specificity, positive predictive value, and negative predictive value of the carotid ultrasound for identifying obstructive coronary artery disease, considering coronary catheterization the gold-standard method.

Sensitivity	100.0%
Specificity	61.3%
PPV	61.3%
NPV	100.0%
Prevalence	38.0%

PPV: positive predictive value; NPV: negative predictive value.



CUS: carotid ultrasound; CC: coronary catheterization.

Figure 2 – *Carotid ultrasound, using coronary catheterization as reference, to identify coronary artery disease.*

Table 7 – Risk factors associated with coronary catheterization.

Variables	CC		OR	95% CI	p value*
	0 and 1	2 and 3			
Sex					
Female	18 (58.1)	9 (47.4)	1.54	0.49-4.85	0.461
Male	13 (41.9)	10 (52.6)			
Age, years					
≤ 54	19 (61.3)	7 (36.8)	2.71	0.83-8.83	0.093
> 54	12 (38.7)	12 (63.2)			
BMI					
Underweight or normal weight	8 (25.8)	6 (31.6)	--	--	0.835
Overweight	14 (45.2)	7 (36.8)			
Obese	9 (29)	6 (31.6)			
Color					
White	18 (58.1)	14 (73.7)	0.5	0.14-1.72	0.264
Non-white	13 (41.9)	5 (27.8)			
SAH					
No	9 (29.0)	2 (10.5)	3.48	0.66-18.25	0.170
Yes	22 (71.0)	17 (89.5)			
Diabetes mellitus					
No	25 (80.6)	12 (63.2)	2.43	0.67	8.825
Yes	6 (19.4)	7 (36.8)			
Dyslipidemia					
No	18 (58.1)	9 (47.4)	1.54	0.488-4.853	0.461
Yes	13 (41.9)	10 (52.6)			
Tobacco smoking					
No	23 (74.2)	11 (57.9)	2.09	0.62-7.05	0.230
Yes	8 (25.8)	8 (42.1)			
Family history					
No	26 (83.9)	13 (68.4)	2.4	0.62-9.39	0.293
Yes	5 (16.1)	6 (31.6)			
CUS					
0 e 1	19 (61.3)	0	2.58	1.66-4.02	**<0.001**
2 e 3	12 (38.7)	19 (100.0)			

**Chi-squared test/Fisher's exact test. Results expressed as n (%). CC: coronary catheterization; OR: odds ratio; 95% CI: 95% confidence interval; BMI: body mass index; SAH: systemic arterial hypertension; CUS = carotid ultrasound.*

Table 8 - Multiple regression model for coronary catheterization.

Variables included in the model	B	SE	Wald	df	p value	OR	95% CI for OR
Age	1.08	0.81	1.81	1	0.178	2.96	0.61-14.35
SAH	0.11	1.15	0.01	1	0.922	1.12	0.12-10.66
Diabetes mellitus	1.28	0.99	1.69	1	0.194	3.60	0.52-24.84
CUS	21.70	8.812.30	0.00	1	0.998	2645011064.01	0.00
Constant	-22.24	8.812.30	0.00	1	0.998	0.00	

Percentage of hits = 82%, pseudo R2 = 0.591, Hosmer-Lemeshow test = 0.977. B: Beta; SE: Standard error; Wald: estatística de teste de Wald; df: degrees of freedom; OR: odds ratio; 95% CI: 95% confidence interval; SAH: systemic arterial hypertension; CUS: carotid ultrasound.

sample. The data, however, indicate the need to improve the criteria for indicating CC for the diagnosis of coronary heart disease. The findings of the present sample corroborate the trends previously described in the literature.[8,11-13]

Conclusion

No patient without a carotid lesion had significant coronary artery obstruction, resulting in 100% NPV. Among the sample variables, the presence of carotid atherosclerotic plaque, at any stage, was the only significant risk factor for the presence of obstructive CAD. The degrees of carotid and coronary atherosclerotic lesions were positively associated. In the group with carotid changes, without coronary obstruction, few cases showed bilateral carotid involvement. In the carotid obstruction group, with simultaneous coronary obstruction, most patients showed bilateral carotid involvement.

Author contributions

Study conception and design: Molina Filho JLF, Silva FCL; data collection: Molina Filho JLF; data analysis and interpretation: Molina Filho JLF, Silva FCL; statistical analysis: Silva FCL; manuscript writing: Molina Filho JLF; critical revision of key intellectual content of the manuscript: Silva FCL.

Conflict of interest

The authors have declared that they have no conflict of interest.

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