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Sensitivity and Specificity of Treadmill Test and Myocardial Perfusion Imaging with SESTAMIBI in the detection of Coronary Artery Disease at the Hospital San Juan de Dios

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Abstract

Aim: Coronary artery disease is the first cause of mortality in the world and Costa Rica does not escape this reality. The treadmill test, myocardial perfusion imaging with SESTAMIBI and coronary angiography are methods used to diagnose this disease. Our country does not have data regarding the information provided by these tests. The research's aim is to determine the diagnostic performance of each of them.

Methods: It is an observational, analytic cohort research. Patients included were those with cardiovascular risk factors that had undergone a treadmill test, a myocardial perfusion imaging test and a coronary angiography at the *San Juan de Dios* Hospital, from 2003 to 2007. The sensitivity and specificity of these tests was calculated. Also, a descriptive statistical analysis of the sample's characteristics and of the different cardiovascular risk factors was conducted.

Results: Eighty three patients were included in the study; 75% male. The main risk factors found were dyslipidemia (84%) and artery hypertension (70%). The treadmill test had a sensitivity of 40% and specificity of 57%. Myocardial perfusion imaging with SESTAMIBI had a sensitivity of 66% and specificity of 71%. The majority of patients had lesions in 1 or 2 coronary vessels, with more than 90% obstruction, mostly in the anterior descending artery.

Conclusion: A high prevalence of conventional risk factors was present in the studied population. The treadmill test showed a low sensitivity and specificity, however, it coincides with the range described by literature. The myocardial perfusion imaging with SESTAMIBI showed a significantly higher diagnostic performance (*p =0.05)*.

Key words: coronary artery disease, treadmill test, myocardial perfusion imaging, Technetium Tc 99m SESTAMIBI, coronary angiography.

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Abbreviations: CAD, coronary artery disease; myocardial perfusion imaging with SESTAMIBI, MPI-SESTAMIBI; HRmax, maximum cardiac frequency; HSJD, San Juan de Dios Hospital; DM, diabetes mellitus; AHT, arterial hypertension; CLOBI, Local Bioethics Committee; SD, standard deviation; ADA, anterior descending artery; RCA, right coronary artery; CXA, circumflex Artery.

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An obstructive coronary artery disease (CAD) is defined by the presence of atherosclerotic lesions in one or more of the main branches of the epicardial coronary arteries, with obstructions greater than 50%. It is known that over 90% of ischemic heart disease is due to CAD.[1-3]

According to data from the National Center for Health Statistics and the American Heart Association, heart disease affects over 71 million Americans and causes more than 30% of deaths in the United States.[4,5] In Costa Rica, epidemiological data reports diseases of cardiovascular origin as the first cause of mortality, with a rate for 2006, of 11/10 000 inhabitants.[6]

CAD probability estimates should focus on the presence of risk factors.[3] There are some scales, like Framingham's, to determine a patient's individual risk of having a major coronary event or death, in the next 10 years.[7]

The country has CAD diagnosis and assessment methods, among them the treadmill test, the myocardial perfusion imaging with SESTAMIBI (MPI-SESTAMIBI), with physical or pharmacological effort, and the coronary angiography.[8-10] The treadmill test has a highly inconsistent sensitivity and specificity that depends on the patient's sex, age and number of obstructed coronary vessels, maximum heart rate (HRmax) achieved during the test period, the probability of CAD and the experience of the health professional that performs the test.[3] The MPI-SESTAMIBI is a nuclear medicine test performed in 2 stages: rest and exercise, and is able to differentiate if reperfusion defects are due to a former ischemic necrosis ("scarring") or to current myocardial ischemia.[11] This test is also prescribed for risk stratification in emergency rooms, where it has been useful to improve the categorization between high and low risk patients.[12] Coronary angiography is used for definite diagnosis of CAD and is still considered the "gold standard."[3,9,13]

Due to a lack of prediction data on these tests, the diagnostic performance (sensitivity, specificity) of treadmill testing and MPI-SESTAMIBI, compared with angiography was analyzed. Also, cardiovascular risk factors of the research's population were characterized.

Methods

The present is an observational, analytic cohort research. The studied population was adults, older than 18 years, from the area of attraction of the *San Juan de Dios* Hospital (HSJD) in San José, Costa Rica, with cardiovascular risk factors and suspected of or with CAD, which had undergone a treadmill test, a MPI-SESTAMIBI and a coronary angiography at this medical center, during the period from 1 January 2003 to 31 December 2007.

The primary source of information was the paper or microfilmed medical records in HSJD's archive. A special spreadsheet was designed to collect data. Each patient was identified with a consecutive number and their ID number. Information of the following variables was collected: age, sex and presence of the following cardiovascular risk factors: *diabetes mellitus* (DM), arterial hypertension (AHT), cigarette smoking, sedentary lifestyle, obesity, dyslipidemia and family history of heart disease; in addition, blood pressure values, lipids profile and the reason for requesting the tests. Finally, the treadmill test report was taken as: positive (due to ischemia or scarring), negative or undetermined, with the HRmax; the MPI-SESTAMIBI report as: positive (due to ischemia or scarring) or negative; and the coronary angiography as: CAD positive or negative, with the number of obstructed epicardial vessels and the percentage of obstruction.

The data was analyzed using the SPSS version 8.0 statistical package. Two by two tables were made to calculate the sensitivity and specificity of the treadmill test and MPI-SESTAMIBI, also running a logistic regression to determine statistical significance. Besides, a descriptive statistical analysis was carried out measuring position (mode, median) and dispersion measures (standard deviation, minimum and maximum values) for each one of the risk factor variables.

Research was conducted according to the principles of autonomy, justice, beneficence and non-maleficence and was approved by the HSJD Local Bioethics Committee (CLOBI), under document number CLOBI-HSJD-038-2008.

Results

Out of 2967 angiograms performed in HSJD, 1347 were excluded, because they corresponded to studies in other territories (brain, carotid vessels, lung, aorta, iliac vessels and lower extremities). The remaining 1620 were coronary angiograms. The sample's size, with a confidence level of 0.95, a variance of 0.2 and a maximum error of 0.05 was 214 patients; with a population adjustment. According to random tables, 304 medical records were selected and reviewed, in order to have a margin of 90 more patients. Although this number of medical records was reviewed, 221 did not meet all the research's inclusion criteria and the final sample was 83 patients, who concur with 25% of the medical records reviewed. (Figure 1)

Of the patients included in the study, 62 (75%) were male and 21 (25%) female. The participant's mean age was 61 years, with a mode at 58 years; the minimum age was 35 years and maximum 85.

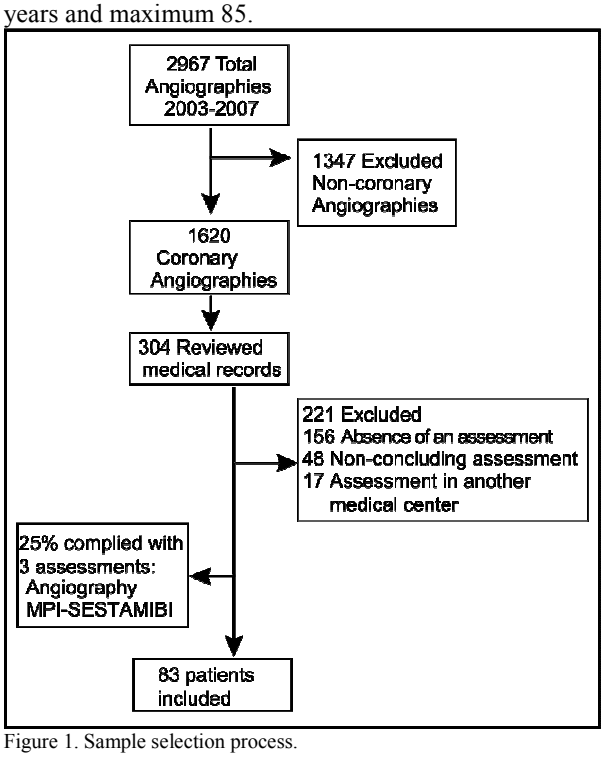

Figure 1. Sample selection process.

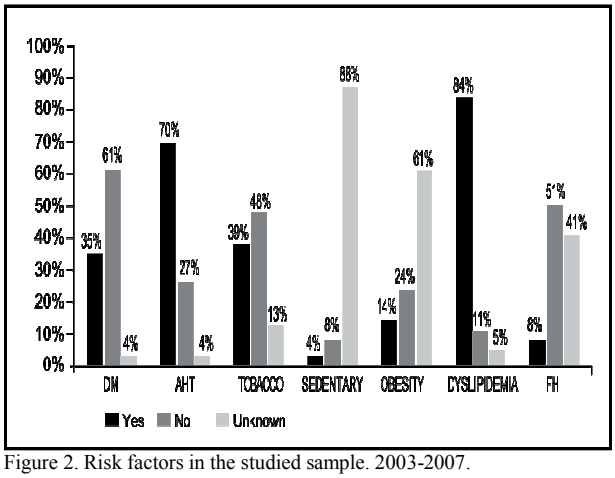

Figure 2. Risk factors in the studied sample. 2003-2007.

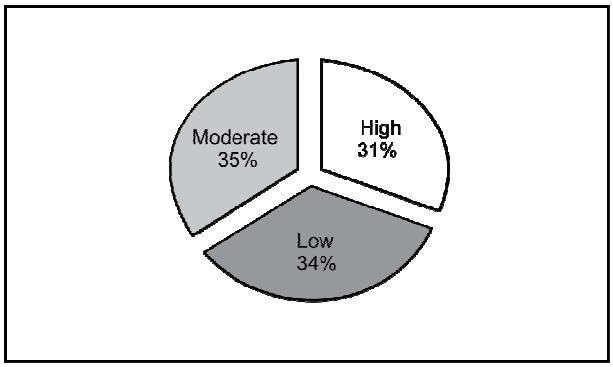

Figure 3. Framingham's Cardiovascular Risk Classification. 2003-2007.

The risk factors found in the study, apart from gender and age over 65, were: DM, AHT, cigarette smoking, sedentary lifestyle, obesity, dyslipidemia and family history of heart disease. As shown in Figure 2, the main risk factors for this population were dyslipidemia, in 84% of cases, and AHT, in 70% of cases, with a frequency of DM of 35% and cigarette smoking of 39%. The frequency for a sedentary lifestyle was unknown in 88% of the cases, of obesity in 61.5% and of family history in 41%.

Other documented data included the presence of thrombophilias in 3 patients: 2 diagnosed of Antiphospholipid Syndrome and 1 with antithrombin deficiency. Besides, 45 patients had one or more coronary *stents* and 16 patients underwent a cardiac revascularization surgery.

According to Framingham's Classification, approximately one third of individuals were low-risk patients, another third moderate-risk and a last third, high-risk patients. (Figure 3)

With regard to the lipid profile, 79 patients had at least one report in their medical record and 4 patients did not have. From the analyzed data for total cholesterol, the average was 189 mg/dl, with a standard deviation (SD) of 44 mg/dl, a minimum value of 92 mg/dl and a maximum one of 362 mg/dl; 61% had levels below 200 mg/dl and 34% levels equal or higher than 200 mg/dl. With respect to LDL, the mean was 111 mg/dl, with a SD of 42 mg/dl, a minimum value of 24 mg/dl and a maximum one of 331 mg/dl; 39% had levels below 100 mg/dl and 57%, equal to or greater than 100 mg/dl. HDL had an average of 38 mg/dl, with a SD of 10 mg/dl. On average, triglycerides were of 242 mg/dl, with a SD of 149 mg/dl, a minimum level of 61 mg/dl and a maximum one of 726 mg/dl. The reasons for studying these patients were: 33 patients with acute myocardial infarction, 18 with stable angina, 18 for unstable angina, 6 for heart surgery, 4 for atypical chest pain, 3 for arrhythmia and 1 to identify the cardiac reserve.

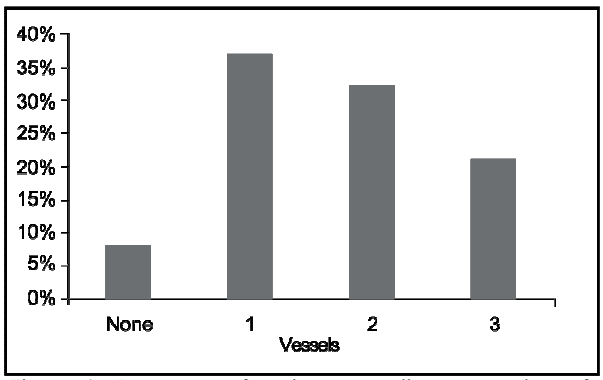

Figure 4: Percentage of patients according to number of compromised coronary vessels. 2003-2007

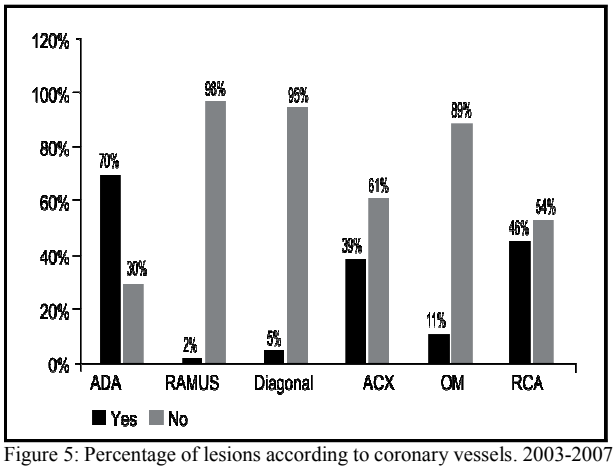

Figure 5: Percentage of lesions according to coronary vessels. 2003-2007

The treadmill test showed a 40% sensitivity and 57% specificity. The average HRmax was 88%.

The MPI-SESTAMIBI showed a 66% sensitivity and 71% specificity. It revealed the presence of myocardial scarring in 46% of the cases, ischemia in 32.5% of the cases and mixed defects in 21.5% of the cases.

The logistic regression analysis determined significant differences between the MPI-SESTAMIBI and the treadmill test (*p=0.05*).

According to the number of compromised vessels by the coronary angiography, it was seen that the majority of patients showed disease in one or two vessels, 33% and 37%, respectively. The other 22% had 3 affected vessels. (Figure 4)

According to the percentage of obstruction of the coronary vessel's lumen, there were 140 lesions: 14 with obstructions between 50 and 70 percent, 39 with obstructions between 70 and 90 percent and 87 with more than 90% obstructions.

Figure 5 shows the percentage of compromised coronary vessels. The left anterior descending artery (ADA), found in 70% of cases, was the most affected one in the research's sample, followed by the right coronary artery (RCA), found in 46% of cases, and by the circumflex artery (ACX), found in 39% of cases.

Discussion

The studied population had in average 61 years, which is within the range in which CAD occurs the most.[6] Important cardiovascular risk factors were identified, especially dyslipidemia, AHT, and in one third of them, DM and cigarette smoking.

It is interesting to note that more than 50% failed to meet the goals of optimal treatment for their dyslipidemia; only 39% of the patients had LDL cholesterol below 100 mg/dl. In the majority of medical records a sedentary lifestyle and obesity was not recorded, therefore leaving an open questions as to their role as risk factors, due to the high prevalence of high degree coronary obstructions in these patients.

The studied population behaved like patients under moderate and high-risk, since the majority of them had significant affections and in multiple coronary vessels.

The treadmill test showed a low sensitivity and specificity, however, it coincides with the range described in the bibliography.[3,13] Many studies have shown, even in Detrano's meta-analysis, that with 24000 included patients, the sensibility ranges oscillate between 23 and 100 percent, with an average of 68% and specificity between 17 and 100 percent, with an average of 77%.[14,15]

The MPI-SESTAMIBI showed a higher diagnostic performance than the treadmill test, however with values below the ones reported by literature. In Gyongyosi's study, an 81-90% sensitivity was reported and specificity between 74 and 98%.[16] This could be related to the sample's size.

Although the research was limited because of failure to achieve the ideal sample size, including only 25% of the medical records reviewed, the explanation was that many of the studies were not conducted at an appropriate time, sometimes due to damage or repair of medical equipment, or because of appointments programmed for several months ahead, so in the majority of the cases, the coronary angiography was the only practiced test.

This data is relevant, as it is the country's only information to diagnose the CAD, besides; there is no previously published data.

In conclusion, the main CAD risk factors in the patients studied are dyslipidemia and AHT. In addition, the MPI-SESTAMIBI has a significantly higher diagnosis performance (*p=0.05*) than the treadmill test for the detection of this entity. And, finally, the majority of coronary injuries at the moment of diagnosis have obstructions superior to 90% of the vessel's lumen, being the ADA the most affected one.

The authors' recommendations are:

1. To improve medical history's of medical records, where conventional risk factors such as a sedentary lifestyle and obesity are included.

2. To make another comparative study, ideally a prospective one, with a larger sample.

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