Imaging Methods in the Assessment of Ischemic Heart Disease: Particularities in the Obese Patient

Métodos de Imagem na Avaliação da Cardiopatia Isquêmica: Particularidades no Paciente Obeso

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Introduction

The World Health Organization (WHO) stated that, as of 2016, more than 1.9 billion people were overweight, and about 650 million were obese.[1] Obesity researchers in the Global Burden of Disease (GBD) study concluded that excess body weight was responsible for approximately 4 million deaths in 2015, with two thirds of these deaths caused by cardiovascular diseases.[2]

The association of obesity, atherosclerosis and increased risk of cardiovascular and global mortality is unquestionable. Obese patients are more likely to be evaluated for the presence of ischemic heart disease (IHD), as they more commonly present associated risk factors (arterial hypertension, diabetes mellitus, and dyslipidemia), low functional capacity, musculoskeletal limitations, and symptoms such as tiredness and dyspnea.[3]

Choosing the appropriate noninvasive test for IHD diagnosis in the obese population is a challenge, but its results play an important diagnostic and prognostic role in addition to guiding therapy. The recently published ISCHEMIA study reported that an initial invasive strategy compared to the initial conservative strategy consisting of optimized drug treatment did not reduce the risk of ischemic events or death of any cause in patients with stable coronary disease and moderate or severe ischemia after a mean follow-up period of 3.2 years.[4]

After clinical examination and resting electrocardiography, the diagnostic test is chosen based on the presence of symptoms, patient pretest probability (PTP), risk factors, presence or absence of an interpretable electrocardiogram, ability to exercise, patient preference and occupation (high-risk professions can influence choice), examination availability, and operating physician expertise.[5] Weight, body dimensions, physical effort limitations, inadequate acoustic window, presence of artifacts, and a reduced signal-to-noise ratio may limit the use of noninvasive tests in obese patients.

For the PTP calculation, the latest guideline of the European Society of Cardiology based on contemporary studies uses sex, age, and symptoms as parameters (typical, atypical, and nonanginal chest discomfort and dyspnea). Despite its limitations, this new classification estimates PTP values at about one third lower than those presented in the previous guideline version (Table 1). Coronary computed tomography (CT) angiography and functional noninvasive tests were recommended as the class I approach to assess possible ischemic symptoms since CT angiography has better diagnostic performance in lower PTP scenarios, while functional tests perform better in patients with higher PTP.[5]

Table 1 – Pretest probability of obstructive coronary artery disease among 15,815 symptomatic patients by age, sex, and symptoms according to the joint analysis of contemporary studies.

	Typical		Atypical		Nonanginal		Dyspneic	
Age, y	Man	Woman	Man	Woman	Man	Woman	Man	Woman
30-39	3%	5%	4%	3%	1%	1%	0%	3%
40-49	22%	10%	10%	6%	3%	2%	12%	3%
50-59	22%	13%	17%	6%	11%	3%	20%	9%
60-69	44%	16%	26%	11%	22%	6%	27%	14%
70+	52%	27%	34%	19%	24%	10%	32%	12%

In addition to the traditional Diamond and Forrester classes, patients with dyspnea as a predominant symptom or dyspnea alone were included. The percentage values expressed in red indicate the groups in which noninvasive tests are more beneficial (PTP > 15%). The percentage values expressed in blue indicate the groups with obstructive coronary artery disease (CAD) PTP of 5–15% in which the diagnostic tests can be considered after assessing the general clinical probability considering the presence of risk factors, resting electrocardiogram, stress test, calcium score, and left ventricular dysfunction suggestive of CAD. Adapted from Knuuti et al.[5]

Noninvasive tests

widely available, the exercise test (ET) alone can be considered an alternative method of diagnosing IHD if the electrocardiographic tracing is interpretable and imaging methods are not available, bearing in mind the possibility of false-positive or -negative test results. In patients with a low PTP, the combination of ET and calcium score (CS) can be useful for excluding IHD. However, low functional capacity, musculoskeletal limitations, and high patient weight can be impeding factors for its performance.[5]

Stress echocardiography (SE) can be performed with physical effort using a treadmill or ergometric bicycle or using pharmacological agents. The most important advantage of using an ergometric bicycle is the possibility of recording images during the various levels of effort without depending on post-exercise images. The analysis of segmental contractions can be problematic in severely obese patients. The use of echocardiographic contrast

Keywords

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agents, which consist of microbubbles that can cross the pulmonary barrier and remain intact, allows adequate visualization of the endocardium of all segments of the left ventricle. Thus, contrast echocardiography is indicated when there are two or more contiguous segments with limited technical quality.[6]

Myocardial perfusion scintigraphy (MPS) is frequently used due to its availability and flexibility in different clinical situations. Physical or pharmacological stress can be used in cases of patients who are unable to exercise. It is also interpretable in several clinical situations, such as the presence of left bundle branch block, use of artificial pacemaker, and situations with an inadequate acoustic window for SE. However, MPS images can be affected by obesity, as the specificity of the method is reduced by the presence of diaphragmatic attenuation or by increased extracardiac tracer activity. The use of higher tracer doses (resulting in proportionally increased radiation), attenuation correction techniques, and the acquisition of prone images, among other strategies, can reduce the number of false-positive test resuls.[3] An analysis of the Prospective Multicenter Imaging Study for Evaluation study showed that MPS was the most frequently requested noninvasive test as body mass index (BMI) increased. In addition, the percentage of false-positive test results of invasive angiography as the diagnostic gold standard was significantly higher when the BMI was ≥ 35 kg/m².[7]

Compared to other techniques, cardiac magnetic resonance (CMR) has high spatial and temporal resolution, uses no radiation, and is not limited by the acoustic window during image acquisition. Thus, CMR under pharmacological stress is an excellent alternative for functional assessment. Patient body dimensions, claustrophobia, and metallic implants (in cases of incompatible equipment) are its limitations.[8]

Rubidium-82 positron emission tomography (PET) has a highly accurate attenuation correction capacity and causes fewer artifacts and false-positive results. It can also detect minor perfusion defects, showing better sensitivity than MPS. In addition, PET can quantify the absolute blood flow, increasing its diagnostic and prognostic capacity, which goes beyond the perfusion image, especially for detecting three-vessel disease and the trunk of the left coronary artery.[8] The major limitations of PET include the local availability of markers to investigate myocardial ischemia and its cost.

CT angiography is the method with the highest negative predictive value among all noninvasive methods that justifies its preference mainly to investigate patients with lower PTP. However, there was an initial reduction in image quality due to increased noise in obese patients, marginally reducing accuracy and overestimating CS. The proportion of nonevaluable segments in patients with a BMI < 26 kg/m² increases from 1.4% to 2.4% in patients with a BMI > 26 kg/m², and it is normally restricted to the smaller branches. In addition, obese patients often need greater amounts of contrast and radiation.[9] The diagnostic accuracy remains unchanged with new CT scanner generations and new acquisition and reconstruction techniques (interactive reconstruction), even in patients with a BMI > 30 kg/m².[10] Thus, the current radiation reduction techniques widely used in imaging acquisition in nonobese patients can be safely used in obese patients. Figures 1 and 2 refer to a 40-year-old male patient with a current smoking status, a BMI of 35 kg/m², and atypical chest pain. He was referred for CT angiography to exclude CAD.

The Scottish Computed Tomography of the HEART (SCOT-HEART) trial showed improvement in the primary outcome of coronary death or nonfatal myocardial infarction in the CT-guided treatment group, which had a mean BMI of 29.7 kg/m², compared to the group guided by functional noninvasive tests. This result is believed to be secondary

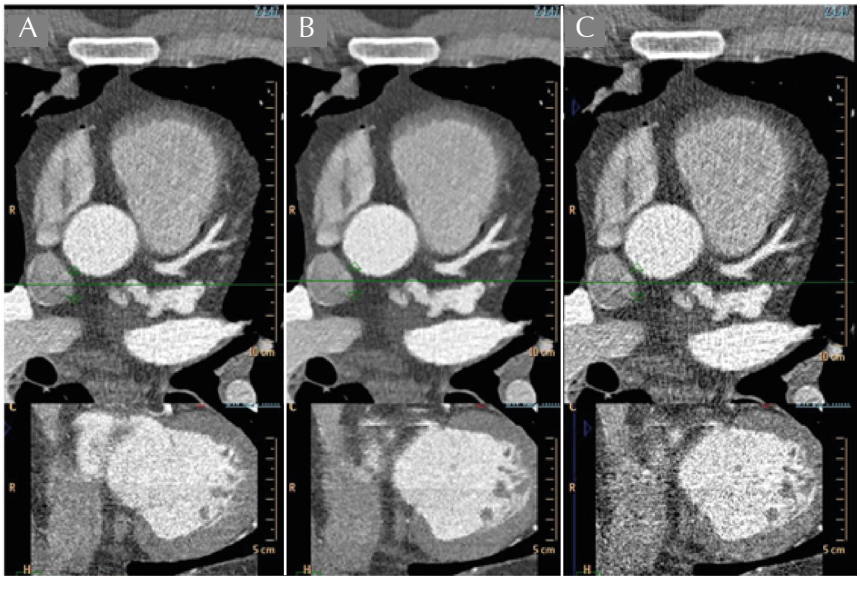

Figure 1 – *Axial and coronal sections of coronary computed tomography angiography showing different signal-to-noise ratios and the resulting quality of the images with different reconstruction techniques in an image acquired using a prospective technique and low radiation dose (2.3 mSv). Iterative reconstruction level 4 (A), iterative reconstruction level 7 (B), and the old and traditional filtered back projection (C).*

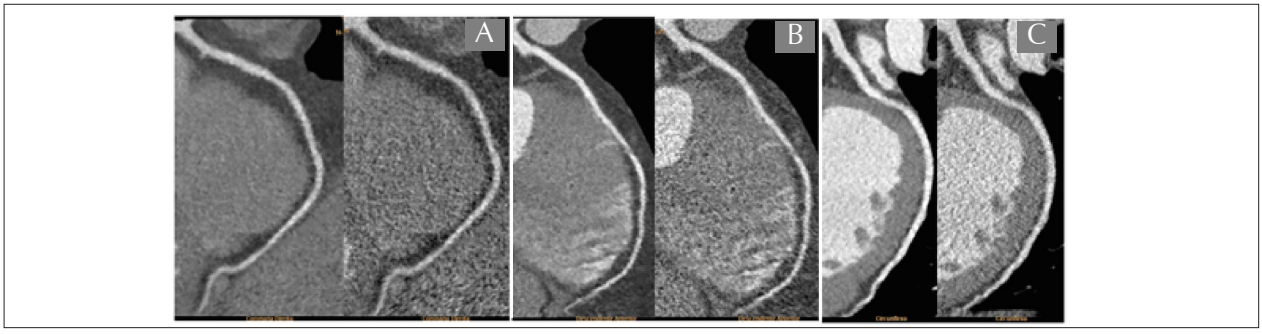

Figure 2 – *Curved multiplanar reformation of the right (A), anterior descending (B), and circumflex coronary (C) with iterative reconstruction and side-by-side filtered back projection showing a difference in image quality and excluding the presence of coronary artery disease.*

to the increased use of preventive drugs, such as statins, rather than revascularizations, which were almost identical between the two groups, suggesting that CT angiography may better guide optimized drug treatment by identifying patients with clinical and subclinical atherosclerosis (nonobstructive CAD).[11]

CT angiography became a first-line examination technique for patients with stable chest pain after the SCOT-HEART was published and will probably become even more important in guidelines created after the ISCHEMIA study publication. On the other hand, the role of invasive functional tests may be restricted to specific patient subgroups, such as those excluded from the ISCHEMIA study or those in which CT angiography provides limited information.[12]

Conflict of interest

The author has declared no conflict of interest.

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