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Editorial

Multimodality Imaging Evaluation in Coronary Artery Disease

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ABSTRACT

Non-invasive imaging modalities are fundamental in evaluating and managing patients with known or suspected coronary artery disease (CAD). Multimodality cardiac imaging procedures detect the presence of CAD and guide clinical decision-making. Combining anatomical and functional imaging modalities would enable a more thorough characterization of obstructive CAD. When selecting an imaging test, one must consider the many factors that interact in the development of chronic CAD and acute coronary syndrome (ACS). The clinical presentation, baseline characteristics of the patient, as well as the clinical center's local availability and expertise will determine the preferred imaging technique to confirm the diagnosis of ACS or chronic CAD. Diagnostic testing is most useful and recommended in patients with chronic coronary syndromes (CCS) when the likelihood is intermediate. The preferred options are coronary computed tomography angiography (CTA) or stress tests, but patients may be referred directly for invasive coronary angiography (ICA) if the likelihood of CAD is very high. The primary goal of the initial diagnostic evaluation in patients with suspected ACS is to confirm ACS and rule out the other most common life-threatening conditions, such as acute pulmonary embolism (PE) or acute aortic syndromes (AAS). Non-invasive imaging is essential in the differential diagnosis of ACS and frequently necessitates multimodality imaging. Cardiac magnetic resonance (CMR) is the most helpful imaging test in diagnosing

Non-invasive imaging modalities are fundamental in evaluating and managing patients with known or suspected coronary artery disease (CAD). Any combination of imaging techniques used to establish CAD diagnosis and its functional implications is commonly referred to as multimodality imaging. Over the last decade, the number of diagnostic tools available to assess CAD has grown; in particular, coronary computed tomography angiography (CTA) and cardiac magnetic resonance (CMR) have emerged as viable alternatives to echocardiography, exercise electrocardiography (ECG), and invasive coronary angiography (ICA).[1,2]

Various cardiovascular societies led by different expert groups have published many guidelines and recommendations on coronary syndromes. The European Society of Cardiology (ESC) 2019 guideline on chronic coronary syndromes (CCS) and 2020 guideline on acute coronary syndromes (ACS) in patients with non-ST-segment elevation (NSTE-ACS) emphasize the essential role of non-invasive imaging in the disease's diagnosis, treatment, and risk assessment.[3,4] Currently, the European Association of Cardiovascular Imaging (EACVI) and the American Society of Echocardiography (ASE), in collaboration with the American Society of Nuclear Cardiology, the Society of Cardiovascular Computed Tomography, and the Society for Cardiovascular Magnetic Resonance, have created a document that addresses the use of various imaging techniques in patients with diagnosed or suspected CAD. Non-invasive imaging methods used to evaluate patients with known or suspected CAD rely on assessing the following: (i) the presence and anatomic severity of stenosis, (ii) abnormal flow in epicardial arteries, (iii) abnormal myocardial perfusion, or (iv) abnormal myocardial contractility.[5]

To diagnose stable CAD or CCS, the Bayesian technique is used. The pre-test likelihood of the condition is determined using the patient's age, gender, and symptoms characteristics. The pre-test probability of CAD will determine the testing strategy, which may include a variety of imaging modalities.[3,6] When the likelihood of CCS is intermediate, diagnostic testing is most useful and recommended. Patients with an intermediate pre-test probability (PTP) of underlying CAD should have non-invasive anatomical or functional diagnostic tests performed first (Figure 1). Patients with very low PTP may not require evaluation (a positive test would most likely be a false positive), whereas patients with high PTP may require direct coronary angiography (a negative test would most likely be false negative). However, the new and revised PTP calculation allows for anatomical or functional diagnostic testing in patients with a PTP of 5-15% is taken into consideration necessary in specific clinical situations. Further testing may be recommended if a patient has a family history of early coronary artery disease (CAD), diabetes, or renal impairment.[3,7,8]

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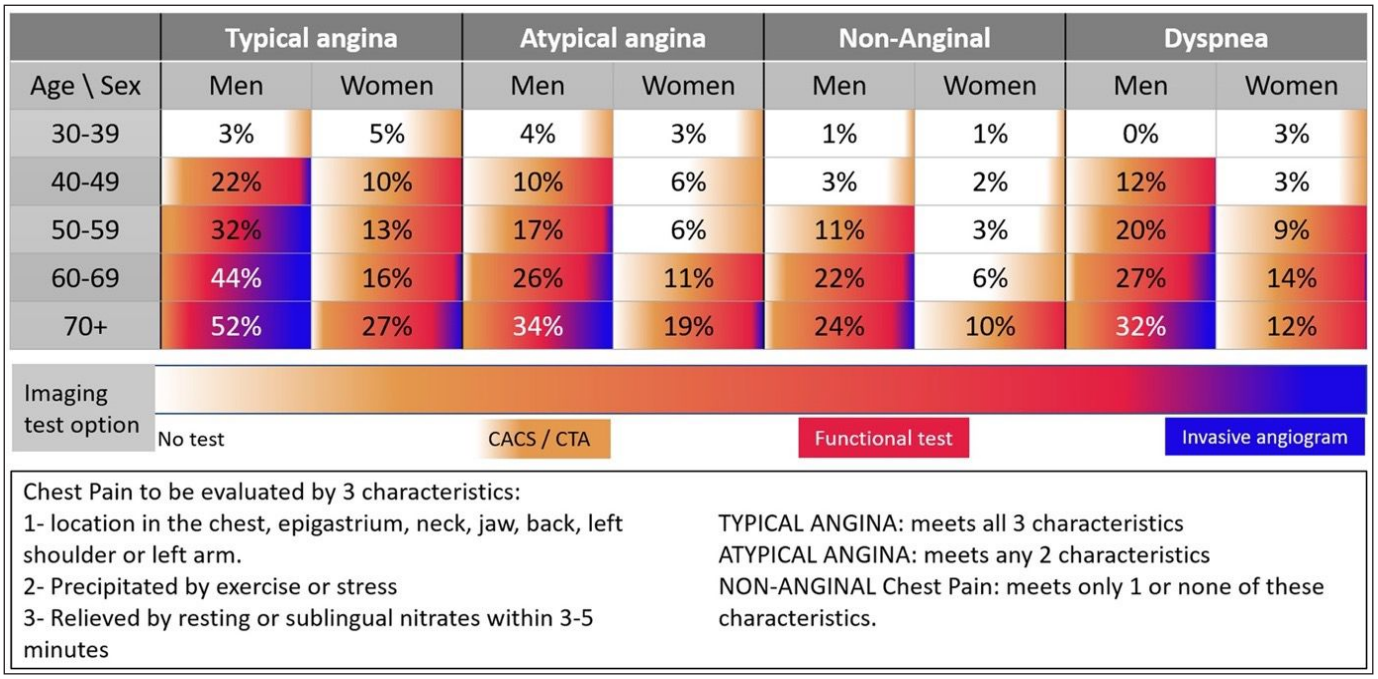

Figure 1. Pre-test probability (PTP) of epicardial CAD (modified Diamond and Forrester) and value of imaging testing. This simple (age, sex, and symptoms) assessment of pre-test probability can be complemented with other data for an improved PTP estimation. Complementary data include traditional risk factors for atherosclerosis (family history of early CAD, dyslipidaemia, smoking, diabetes, etc.) and other biomarkers such as Q or ST abnormalities in ECG, low EF, or WMA on resting imaging, etc. The value of each diagnostic approach in each box and its variance based on complementary data is reflected in the colours and their shades. Aadapted from 2019 ESC guidelines.[3]

Non-invasive diagnostic modalities can evaluate resting left ventricular (LV) function, determine the presence of myocardial scar or ischemia, and directly assess coronary anatomy (by coronary CTA). A resting transthoracic echocardiogram (TTE) is recommended as the initial imaging modality in all patients suspected of having CCS to assess structural abnormalities, wall motion, and LV systolic function. Cardiac magnetic resonance (CMR) is the gold standard for assessing the right ventricle (RV) or LV and is an excellent alternative to echocardiography, especially when the image quality is poor.[5,9]

In patients with known or suspected CAD and low to high PTP, anatomical or functional imaging should be used as the first-line test for diagnostic and prognostic purposes. Coronary CTA is the preferred test in patients with the lowest intermediate range of clinical likelihood of CCS, no previous diagnosis of CAD, and characteristics associated with a high likelihood of good image quality due to its high negative predictive value (the ability to exclude significant CAD).[3] Patients with a higher likelihood of CCS, known CAD, a high burden of calcified atherosclerosis on prior CT imaging, and patients who are not ideal candidates for coronary CTA should undergo functional testing with imaging. In patients with chronic chest pain syndrome and equivocal functional imaging findings, coronary CTA may also be used. In patients with intermediate stenoses on coronary CTA, however, functional testing with imaging may be performed if the results of these tests may lead to changes in patient management (e.g., medical vs. revascularization strategy). When a functional test is ambiguous or uninterpretable, anatomic testing can be helpful, and vice versa.[5]

Stress-induced perfusion defects or wall motion abnormality (WMA) can indicate myocardial ischemia. Ischemia can be detected accurately using echocardiography, single-photon emission computed tomography (SPECT), positron emission tomography (PET), CMR, and computed tomography-fractional flow reserve (CT-FFR). An exercise ECG stress test may be used to establish the diagnosis of myocardial ischemia if coronary CTA and functional imaging tests are unavailable or impractical. The decision to use one test over another will be influenced by patient characteristics, relative contraindications, and local availability and expertise.[5]

Each imaging modality evaluates different aspects of viability and associates with specific characteristics or imaging phenotypes, such as metabolic activity (PET), membrane integrity (SPECT), increased extracellular space (late gadolinium enhancement [LGE] CMR), or contractile reserve (dobutamine echocardiography or cine CMR). Non-invasive imaging to detect ischemia and viability is reasonable in patients with known CAD and no angina who present with heart failure unless the patient is not eligible for revascularization. Low-dose dobutamine echocardiography, CMR, LGE CMR, as well as nuclear imaging are all options for determining viability. For scar detection, LGE CMR is the method of choice.

In CCS, all non-invasive imaging methods have shown significant prognostic value. For risk stratification in CCS, a resting TTE assessment of LV function is critical. In CCS, global longitudinal strain (GLS) complements ejection fraction (EF) by providing incremental prognostic information. A normal functional or anatomical non-invasive imaging test indicates an excellent prognosis, and ICA can be avoided without risk. In patients suspected of having CAD, coronary CTA is an excellent prognostic tool. A high scar burden as measured by SPECT and CMR is associated with a poor prognosis.

Imaging is used in patients with suspected ACS to confirm a diagnosis that would otherwise be inconclusive and to assess LV function. Non-invasive imaging tests in ACS, on the other hand, should never be used to postpone ICA if it is clinically indicated. The addition of non-invasive imaging modalities to clinical examination and blood

biomarkers in patients with suspected NSTE-ACS and non-specific ECG changes can aid in establishing the diagnosis by detecting regional or global WMA. When complications are suspected or an alternative diagnosis is being considered, bedside echocardiography can be useful. Aortic dissection, pericarditis with or without pericardial effusion, hypertrophic cardiomyopathy, mitral valve prolapse, or RV dilatation suggestive of acute pulmonary embolism (PE) are possible diagnoses.

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Patients with CAD are at risk of sudden cardiac death (SCD), heart failure, and/or recurrent ischaemic events following revascularization. Following PCI or coronary artery bypass grafting (CABG), patients with ischaemic LV dysfunction have varying degrees of functional recovery. The persistence of low LVEF is an indication for continued pharmacologic therapy for heart failure, and an implantable cardioverter-defibrillator (ICD) is indicated for primary prevention of SCD if the LVEF is less than 35% after 40 days after the acute coronary event.

Before leaving the hospital, a routine echocardiogram, including an assessment of LVEF and GLS, is recommended. If the pre-discharge echo showed an abnormal EF, an evaluation of LV function 1–3 months after an ACS should be performed and used as a post-myocardial infarctrion reference for subsequent risk stratification. It is not recommended to re-evaluate asymptomatic patients after revascularization. Scar size, as measured by nuclear imaging or CMR, and microvascular obstruction, as measured by echocardiography or CMR, are both predictors of outcome. After a successful PCI procedure, coronary CTA should not be used routinely to assess stent thrombosis or restenosis.[5]

Conflict of Interest

There is no conflict o interest

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