

SHORT EDITORIAL

Myocardial Ischemia and the Emerging Role of Coronary Flow Reserve Quantification

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Recent years have seen remarkable advances in nuclear cardiology. The introduction of cardiac positron emission tomography (PET) and the development of cadmium-zinc-telluride (CZT) imaging systems have significantly improved diagnostic accuracy, clinical decision-making, and ultimately outcomes for patients with coronary artery disease (CAD). In this issue, Giubbini and Milan review key concepts related to myocardial ischemia and explore the emerging importance of quantifying coronary flow reserve (CFR) in patients with known or suspected CAD.

PET imaging has become a preeminent modality in the evaluation of ischemic heart disease, providing high diagnostic and prognostic value.¹ PET imaging offers several advantages over other imaging modalities, including low radiation exposure, accurate assessment of left ventricular function and perfusion, and the ability to quantitatively measure myocardial blood flow (MBF) and CFR.² CFR is defined as the ratio of exercise MBF to resting MBF and reflects not only obstructive CAD but also diffuse atherosclerosis and microvascular dysfunction (CMD) throughout the coronary system.² The ability to measure absolute flow and flow reserve is particularly beneficial in cases of multivessel disease or CMD, complementing traditional perfusion imaging, as both conditions can occur even when perfusion appears normal.³

Research has shown that CFR can improve risk stratification in intermediate-risk patients and is associated with adverse cardiovascular events

independent of traditional risk factors, left ventricular function or perfusion abnormalities.⁴⁻⁶ Importantly, impaired CFR has been associated with cardiovascular events even in the absence of significant angiographic disease, highlighting the clinical relevance of CMD and diffuse nonobstructive disease.⁵ Studies have also shown that CMD, defined as a CFR less than two, is prevalent in both men and women with symptoms of CAD referred for PET scan but no evidence of flow-limiting disease.⁷ Notably, individuals with impaired CFR, regardless of gender, are at increased risk for major cardiovascular events, even if their coronary artery calcium (CAC) score is zero.⁷

More recently, evidence has emerged supporting the feasibility of quantifying CFR using single-photon emission computed tomography (SPECT). Advances in gamma cameras equipped with CZT solid-state detectors have improved temporal and spatial resolution, allowing dynamic acquisition with conventional technetium-labeled radiotracers.^{8,9} Compared with PET, CZT-based MBF and CFR measurements have also shown a strong correlation with the severity of angiographic disease in patients undergoing invasive catheterization, demonstrating their ability to detect balanced ischemia.⁹ However, this new modality has some limitations, as Giubbini and Milan expertly point out in their review. A major concern is the reproducibility of this technique, which was recently tested in a prospective study in which participants underwent two ^{99m}Tc-sestamibi SPECT scans two weeks apart.¹⁰ Results were promising, with flow differences between scans remaining below 10%. Reproducibility was further improved by using spline-fitting reconstruction algorithms.¹⁰ However, current commercially available cardiac CZT systems lack

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Coronary flow reserve, Single photon emission computed tomography, Positron emission tomography, Myocardial ischemia.

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integrated computer tomography (CT) functionality, which prevents the use of CT-based attenuation correction. As the field of nuclear cardiology continues

to evolve, larger studies will be needed to address these and other emerging challenges and help refine the diagnostic utility of these imaging technologies.

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