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CME

Is Discordance of Coronary Flow Reserve and Fractional Flow Reserve Due to Methodology or Clinically Relevant Coronary Pathophysiology?

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CME Objective for This Article: At the completion of this article, the reader should be able to: describe the relationship between CFR and FFR as focal stenosis and diffuse disease vary; identify the dominant mechanism of flow alteration given a specific pair of CFR and FFR values; discuss the clinical implications for mechanical revascularization when CFR and FFR are discordant.

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OBJECTIVES The purpose of this study was to determine whether observed discordance between coronary flow reserve (CFR) and fractional flow reserve (FFR) is due to methodology or reflects basic coronary pathophysiology.

BACKGROUND Despite the clinical importance of coronary physiological assessment, relationships between its 2 most common tools, CFR and FFR, remain poorly defined.

METHODS The worst CFR and stress relative uptake were recorded from 1,500 sequential cardiac positron emission tomography cases from our center. From the literature, we assembled all combined, invasive CFR-FFR measurements, including a subset before and after angioplasty. Both datasets were compared with a fluid dynamic model of the coronary circulation predicting relationships between CFR and FFR for variable diffuse and focal narrowing.

RESULTS A modest but significant linear relationship exists between CFR and FFR both invasively ($r = 0.34$, $p < 0.001$) and using positron emission tomography ($r = 0.36$, $p < 0.001$). Most clinical patients undergoing CFR or FFR measurements have diffusely reduced CFR consistent with diffuse atherosclerosis or small-vessel disease. The theoretical model predicts linear relationships between CFR and FFR for progressive stenosis with slopes dependent on diffuse narrowing, matching observed data. Reported changes in CFR and FFR with angioplasty agree with model predictions of removing focal stenosis but leaving diffuse disease. Although CFR-FFR concordance is common, discordance is due to dominant or absent diffuse versus focal disease, reflecting basic pathophysiology.

CONCLUSIONS CFR is linearly related to FFR for progressive stenosis superimposed on diffuse narrowing. The relative contributions of focal and diffuse disease define the slope and values along the linear CFR and FFR relationship. Discordant CFR and FFR values reflect divergent extremes of focal and diffuse disease, not failure of either tool. With such discordance observed by invasive and noninvasive techniques and also fitting fluid dynamic predictions, it reflects clinically relevant basic coronary pathophysiology, not methodology. (J Am Coll Cardiol Img 2012;5:193–202)

Coronary physiology plays an increasingly clinical role in cardiology. Multiple imaging techniques provide routine quantification of absolute flow and myocardial or coronary flow reserve (CFR), from positron emission tomography (PET) to cardiac magnetic resonance, myocardial contrast echocardiography, and contrast computed tomography. Based on randomized clinical trials and strong national/international guidelines, fractional flow reserve (FFR) procedures are growing even as percutaneous coronary intervention (PCI) volume decreases (1).

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However, 2 different measurements quantify coronary physiology: flow, summarized by CFR, and pressure, summarized by FFR. Although the quadratic relationship between absolute flow and the pressure decrease across a stenosis has been demonstrated in theoretical, animal, and human studies spanning almost 25 years (2–4), the relationship between the common clinical tools of CFR and FFR is not well defined. This void produces clinical uncertainty when an imaging study suggests low CFR but invasive measurement determines normal FFR or vice versa. Additionally, recent publications have sought to determine noninvasive CFR cutoffs using FFR as a reference. However, the gold-standard FFR cutoffs