Effects of Left Bundle Branch Block and Right Ventricular Pacing on Assessing Myocardial Viability by Positron Emission Tomography

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Patients with ischemic heart disease referred for myocardial viability studies with left ventricular activation delay (left bundle branch block [LBBB] or right ventricular [RV] apical pacing) can result in altered septal uptake of both perfusion and metabolic positron emission tomography tracers. Reduced F-18 fluorodeoxyglucose (18F-FDG) uptake relative to perfusion has been described as a “reverse mismatch” pattern (Figs. 1 and 2). This pattern challenges the conventional scheme of viability imaging (whereby severely impaired 18F-FDG uptake implies scarred myocardium) and suggests the presence of viability based on preserved uptake of the perfusion tracer.

The underlying mechanism for this reverse mismatch pattern remains unclear. Decreased 18F-FDG uptake with preserved perfusion and oxidative metabolism has been hypothesized to be the result of impaired transmembranous transport and/or phosphorylation kinetics; implying possible metabolic alterations with a corresponding shift towards fatty acid substrate utilization despite the use of a hyperinsulinemic-euglycemic clamp (1). In addition, prior studies have indicated that alterations in ventricular mechanics related to LBBB can result in corresponding myocardial glucose metabolism changes, with a subsequent restoration of homogenous myocardial glucose metabolism following cardiac resynchronization therapy (CRT) (2). RV apical pacing can lead to hypofunctional myocardial segments in the areas surrounding the pacing site and may induce temporally related changes in regional metabolic pathways resulting in diminished 18F-FDG uptake (3). Another hypothesis of altered septal 18F-FDG uptake is histologic damage secondary to chronic RV apical pacing or to an underlying LBBB-related cardiomyopathic process (3). Although the underlying etiology for the reduced 18F-FDG uptake despite relatively preserved myocardial perfusion in RV pacing and LBBB remains uncertain, potential mechanisms as previously described include changes in substrate use, regional metabolic pathways, or ventricular mechanics with associated perfusion-independent alterations in glucose transport and phosphorylation.

Altered glucose metabolism demonstrated by a septal reverse mismatch pattern is common in LBBB and both nonischemic and ischemic cardiomyopathy, although >30% of the latter may not exhibit this pattern. A proposed mechanism for the absence of the septal reverse mismatch pattern in ischemic patients with LBBB is a hypoperfused or scarred lateral wall (4), which could drive septal metabolic demand as the septum contributes to more forward work and may also explain the lack of clinical response to CRT in such patients. Detection of such metabolic alterations is a unique feature of molecular imaging and may have important implications in directing therapy. The importance of reviewing the electrocardiogram in conjunction with identification of this reverse mismatch pattern can help avoid misinterpretation of 18F-FDG images and underestimation of myocardial viability.
An 80-year-old male with ischemic cardiomyopathy, left ventricular ejection fraction of 30%, prior coronary artery bypass grafting surgery with occluded grafts, and an atroventricular sequential dual chamber pacemaker underwent a resting myocardial perfusion study using N-13 ammonia (734.5 MBq, 19.85 mCi) and metabolic assessment using a standard hyperinsulinemic-euglycemic clamp protocol and F-18 fluorodeoxyglucose (596.1 MBq, 16.11 mCi). Representative short-axis slice, long-axis (horizontal and vertical) slices, and polar maps (right) demonstrate septal reverse mismatch with preserved perfusion in the septal wall compared with a marked reduction (predominantly) in the septal portion of the F-18 fluorodeoxyglucose metabolic images secondary to right ventricular apical pacing. Semiquantitative analysis by quantitative perfusion single-photon emission computed tomography (using the lateral wall as the reference), confirmed the visual reverse mismatch between the perfusion and metabolism images with septal-to-lateral ratios of 1.06 for N-13 ammonia and 0.46 for F-18 fluorodeoxyglucose. A = anterior, L = lateral, I = inferior, S = septal.

An 86-year-old male with ischemic cardiomyopathy (New York Heart Association functional class III symptoms), left ventricular ejection fraction of 25%, prior coronary artery bypass grafting surgery, and left bundle branch block underwent a resting myocardial perfusion study using N-13 ammonia (759.6 MBq, 20.53 mCi) and metabolic assessment using a standard hyperinsulinemic-euglycemic clamp protocol and F-18 fluorodeoxyglucose (622.3 MBq, 16.82 mCi). Representative short-axis slice, long-axis (horizontal and vertical) slices, and polar maps (right) demonstrate septal reverse mismatch with preserved perfusion in the septal wall compared with a marked reduction (predominantly) in the septal portion of the F-18 fluorodeoxyglucose metabolic images in the setting of a left bundle branch block. Semiquantitative analysis by quantitative perfusion single-photon emission computed tomography (using the lateral wall as the reference), confirmed the visual reverse mismatch between the perfusion and metabolism images with septal-to-lateral ratios of 1.1 for N-13 ammonia and 0.15 for F-18 fluorodeoxyglucose. Abbreviations as in Figure 1.
REFERENCES