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Diastolic dyssynchrony by SPECT: A novel parameter to predict post-infarct adverse remodeling

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Left ventricular (LV) post-infarct remodeling is caused by an inflammatory response, which leads to the degradation of myocardial matrix, slippage of muscle bundles, wall thinning, infarct expansion, and eventually LV adverse remodeling.[1] LV post-infarct remodeling carries prognostic implications, with a higher rate of heart failure hospitalization and possibly increased mortality.[1,2] Identification of post-infarct survivors who will experience adverse LV remodeling might, therefore, provide an opportunity to focus preventative strategies on such patients. Many different predictors of LV post-infarct remodeling have been proposed, including clinical features (e.g., ST-segment resolution on the surface ECG[3]), biochemical markers (e.g., baseline N-terminal pro-brain natriuretic peptide (NT-proBNP)[4]) and imaging biomarkers (e.g., baseline LV conic index[5]).

In the current issue of the journal, Zhang[6] now adds a novel imaging biomarker (diastolic dyssynchrony [DD]) assessed with phase analysis of ^{99m}technetium-sestamibi-gated single-photon emission computed tomography (SPECT)) to the armamentarium of LV post-infarct remodeling predictors. LV infarcts were created in a swine model by percutaneous coronary balloon occlusion of the left anterior descending coronary artery. DD was assessed with phase contrast histogram bandwidth (PBW) and phase standard deviation (PSD) before the infarct, and subsequently at 1 day, 1 week, and 4 weeks post-infarct. The progression of LV remodeling was defined as the percentage change of LV end-systolic volume on echocardiography at 4 weeks post-infarct, compared to 1 day after the infarct. Both PBW (β = 0.004, 95% confidence interval [CI] 0.001 to 0.007, P = .024) and PSD (β = 0.008, 95% CI 0.000 to 0.017, P = .049) at day 1 post-infarct were independently associated with progressive LV post-infarct remodeling at 4 weeks.

SPECT is an accepted technique to quantify DD.[7] The development of DD is well documented in the presence of coronary artery disease (with or without a previous infarct) as well as in hypertensive heart disease and heart failure patients.[8–10] DD was defined as (i) the standard deviation (SD) of the time from the start of the QRS complex to the peak myocardial early diastolic velocity on tissue Doppler imaging and (ii) the maximum difference between the start of the QRS complex to the peak myocardial early diastolic velocity on tissue Doppler imaging). DD was not found to correlate with systolic dyssynchrony (r = 0.03, P = .68 and r = 0.03, P = .74, respectively, when using the abovementioned definitions), when analyzing 110 asymptomatic hypertensive individuals, thereby suggesting that these phenomena (systolic and DD) may have different underlying mechanisms.[9] Similarly, DD (defined identically to Chang et al [9]) was not strongly linked to systolic dyssynchrony in a cohort of heart failure patients of mixed ischemic and non-ischemic etiology.[10] Since diastolic dysfunction occurs earlier during the ischemic cascade than systolic dysfunction and revascularization of acute coronary artery lesions improves DD (while revascularization of chronic lesions does

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not), DD may reflect stunned (but viable) myocardium.[11]

DD (defined as the visually apprehended segmental early relaxation phenomenon on echocardiography) was not found to be predictive of angina, myocardial infarction, heart failure, stroke, or death in a group of 244 individuals referred for stress echocardiography.[12] In contrast, DD was associated with survival in patients with coronary disease and heart failure, when assessed by SPECT PBW and PSD.[13] Systolic dyssynchrony (defined as the maximum difference of the time from the start of the QRS complex to peak radial strain by speckle tracking echocardiography) was linked to LV post-infarct remodeling (adjusted odds ratio [OR] 1.03 ms, 95% CI 1.02 to 1.05, $P < .001$) in 178 patients presenting with acute myocardial infarction.[14] Similarly, when systolic dyssynchrony was defined as the SD of the time from the start of the QRS complex to the peak myocardial systolic velocity on tissue Doppler imaging, it was also an independent predictor (OR 1.19, 95% CI 1.07 to 1.32, $P = .001$) of post-infarct LV remodeling.[15] In contrast, DD (defined as the SD of the time from the start of the QRS complex to the peak myocardial early diastolic velocity on tissue Doppler imaging) was not independently predictive of adverse LV remodeling in post-infarct patients ($P = .6$).[15] In a group of 48 ST-segment myocardial infarction patients, DD (defined as the maximum difference of the time from the start of the QRS complex to the peak myocardial early diastolic velocity on tissue Doppler imaging) was also not independently associated with adverse LV remodeling.[11]

Early identification of post-infarct patients who will develop adverse LV remodeling has potential clinical utility. No comprehensive, head-to-head comparison of the multitude of predictors of LV post-infarct remodeling has ever been performed. In the current issue of the journal, Zhang et al[6] introduce DD, which was assessed with phase analysis of ^{99m}technetium-sestamibi-gated SPECT, as a tool for the early identification of progressive adverse LV remodeling post-infarct. The choice of progressive LV remodeling, rather than remodeling per se, is interesting since most studies have focused on LV remodeling which was defined at a specific time point post-infarct. Few data exist on predictors of progressive LV remodeling, and as such the current analysis adds valuable insight to post-infarct remodeling. Although the authors could show SPECT-derived DD to be associated with progression of adverse LV remodeling, there are some issues which will be of interest for future studies. While Zhang et al[6] compared DD (assessed with SPECT) to echocardiographic measures of DD (the maximum difference of the time from the start of the QRS complex to the peak myocardial early diastolic velocity on tissue Doppler imaging and the SD of the time from the start of the QRS complex to the peak myocardial early diastolic velocity on tissue Doppler imaging), there is no evidence presented that DD is superior to any other marker of future adverse LV remodeling. Two prior echocardiographic studies could not confirm DD to be a predictor of LV post-infarct remodeling, which is in contradiction to the results presented and which raises the question if SPECT is a more sensitive technique as compared to echocardiography.[11,15] The study by Zhang et al[6] is preclinical and still has to be applied in the clinical setting. The novelty of the current study lies in the focus on DD—a phenomenon which has not been extensively investigated in coronary artery disease, and which may not only have a unique underlying mechanism, but also different clinical implications as compared to systolic dyssynchrony. Direct comparison of post-infarct biomarkers is required to determine which will most accurately predict adverse LV remodeling. Finally, the clinical value of targeting the population, which will undergo such remodeling in terms of effective prevention, will have to be prospectively studied before application to routine practice can become a reality.

Disclosures

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Ethical approval

This article does not contain any studies with human participants performed by any of the authors.

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