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Role of Echocardiography in Diagnosing Myocardial Ischemia at Emergency Department

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Because chest pain is one of the most common complaints that brings a patient to the emergency, the differential diagnosis of chest pain with or without acute coronary syndrome is very important. Traditionally, performing conventional echocardiography for detecting ischemia-related systolic abnormalities involves visually estimating the changes of wall thickening in circular muscle. This has well-documented limitations for both the interobserver variability[1] and the ability of the human eye to resolve rapid, short-lived motion.[2] Another approach to defining the regional myocardial properties could be to evaluate the deformation of a myocardial segment during the cardiac cycle. During the cardiac cycle, regional deformation of the myocardium occurs in 3 major directions: longitudinally; circumferentially; and radially. Currently, the terms "myocardial strain rate" and "strain" are used as indexes of longitudinal myocardial deformation. The physical definition of strain is the relative change in length of a material related to its original length. Regional strain rate and strain are derivative of myocardial velocities. The actual sequence of the regional changes in the myocardial function that are induced by acute ischemia has been well defined by experimental sonomicrometric techniques.[3-6] Acute ischemia induces a delay in the onset of contraction, a progressive decrease in the rate and degree of thickening, and a progressive delay in the timing of the peak thickening until this event occurs in what is early diastole for the surrounding nonischemic myocardial segments. Finally, systolic thickening is virtually or completely abolished by total occlusion, and only late systolic/early diastolic thinning occurs. Although it has been well documented in the animal laboratory setting, all the components of the above ischemic response have yet to be well documented in the clinical setting by noninvasive imaging techniques. With the introduction of tissue Doppler imaging (TDI), it has also become possible to determine segmental velocities at a sampling rate of more than 140 samples per second by using standard echo views. Prior *in vivo* animal studies based on TDI have documented a significant reduction in the peak systolic velocities, the velocity gradient[7][8] and the peak systolic strain[9][10] that occur during acute ischemia. Thus, the quantitation of the segmental systolic parameters derived from high-resolution TDI data might be the optimal solution for functional studies of patients with coronary artery disease. However, the angle dependency of the Doppler technique frequently makes evaluation of regional wall motion abnormalities confusing. 2-dimensional (2D) strain method is another tool for quantitation of regional myocardial deformation within a scan plane. Contrary to strain by TDI, this method is inherently 2D and independent of interrogation angle as it tracks speckle patterns (acoustic markers),[11] however, it is widely used for the assessment of global left ventricular (LV) longitudinal strain rather than regional wall motion.

Here, Kim et al.[12] showed that regional wall motion assessment using velocity vector imaging (VVI) could be used to detect significant ischemia in the patient with acute chest pain at emergency department. Using a novel feature-tracking algorithm, VVI can display velocity vectors of regional wall motion overlaid onto the B-mode image and allows the quantitative assessment of LV myocardial mechanics without angle dependancy.[13] The increase in V_{MVO} is considered to be caused mainly by post-systolic thickening in ischemic myocardium, which is the result of the difference in contractility with the adjacent normal regions. Although the feasibility of this method was limited in some patients with a poor echocardiographic window, and the sensitivity is limited by small number patients, but VVI may have a role in differentiation between ischemic and non-ischemic segments in emergency department.

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