

Quantitative Regional Analysis of Left Atrial Function by Doppler Tissue Imaging-derived Parameters Discriminates Patients with Posterior and Anterior Myocardial Infarction

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Background: Doppler tissue imaging can now be used for the assessment of left atrial (LA) function. LA function was evaluated by this technique in a group of patients hospitalized for acute myocardial infarction and in a control population.

Methods: Patients were all prospectively imaged with a scanner. To study the LA, a region of interest was located in the proximal part of the lateral and septal LA walls. Doppler tissue imaging, tissue tracking, strain, and delays were recorded.

Results: In all, 12 patients with posterior (age 54 ± 9 years) and 13 with anterior (age 64 ± 16 years)

acute myocardial infarction, along with 16 control patients (age 54 ± 9 years), were analyzed. Early diastolic septal velocity was found to be the best parameter for discriminating among the 3 groups. Peak strain was also relevant and did not correlate with left ventricular function.

Conclusions: LA is accessible to Doppler tissue imaging analysis. Strain can quantify LA function relatively independently of left ventricular function, and may provide new insights on LA function. (J Am Soc Echocardiogr 2005;18:32–8.)

Doppler tissue imaging (DTI) can now be used to quantify regional myocardial function, as it measures myocardial velocities, displacement, and deformation.^{1–5} Left atrial (LA) size, volume, or both have been described as a strong prognostic parameter in heart failure and in postinfarction or atrial fibrillation conditions.^{6–8} Studies on mitral inflow (late diastolic [A] wave) and pulmonary vein flow (PVF) (A reversal wave) have also been used to assess LA function.^{9,10} LA function is not yet assessed in routine practice. LA appendage emptying is more commonly assessed by transesophageal echocardiography, which only provides an indirect evaluation of LA function.^{11,12} DTI may represent a valuable quantitative technique that can be used as a matter of routine. In experimental studies, several parameters have been proposed for investigation of ventricular function.^{13–15} We, therefore, attempted to assess the relevance of such parameters for quantitative assessment of the LA in clinical practice.

METHODS

This study was a single-center observational study. The patients' informed consent was obtained, and the study was designed to comply with the ethical principles of our institution.

The study group consisted of a series of consecutive patients with acute myocardial infarction (AMI) treated by primary percutaneous coronary angioplasty (PTCA) of either the left anterior descending coronary artery (15 patients; age 66.5 ± 17 years) or the right coronary artery (13 patients; age 54 ± 13 years). None of these patients had any history of coronary artery disease. All patients had S-T elevation AMI, and after PTCA none had severe residual left ventricular (LV) dysfunction ($<30\%$). PTCA was performed within 12 hours of the onset of chest pain. The exclusion criteria were: coronary artery stenosis ($>50\%$) other than the culprit lesion; left bundle branch block; presence of a pacemaker; significant valve disease; atrial fibrillation; dilated or hypertrophied cardiomyopathy; and cases in which more than 12 hours had elapsed between the onset of the chest pain and coronary angiography. We did not consider patients with AMI caused by circumflex artery occlusion as they belonged to a smaller, more heterogeneous population (posterior or apicolateral AMI).

The control group consisted of 17 patients without known myocardial disease who had been referred to the catheter laboratory for the investigation of chest pain. Each of these patients had a normal coronary angiogram

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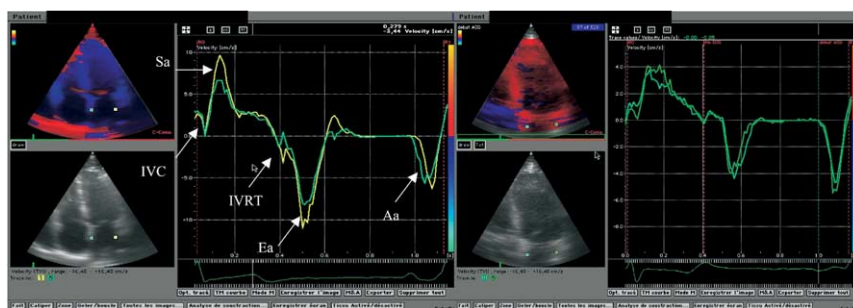


Figure 1 Example of a Doppler tissue imaging curve analysis. Region of interest (ROI) was manually positioned as used for study in the left atrial septal and lateral walls. A, Peak velocity in end diastole; E, peak velocity in early diastole; IVC, peak velocity recorded at time of isovolumic contraction; IVRT, peak velocity recorded in isovolumic relaxation time; S, peak velocity recorded in systole.

and normal conventional transthoracic echocardiography (normal cavity sizes, no wall-motion abnormality, no valvular disease or myocardial hypertrophy, no restrictive filling pattern).

For the two AMI groups, echocardiographic examinations were performed within 12 hours of admission and, thus, less than 12 hours after PTCA. The echocardiogram was not performed before the coronary angiogram as it was considered unethical to delay the angiogram and, hence, the PTCA. None of these patients had any other known disease likely to have an impact on myocardial function, and the treated artery (right coronary and left anterior descending coronary artery) was the only abnormal artery on the coronary angiogram.

All the echocardiographic recordings were made by the same investigator (E. D.) on an ultrasound scanner (Vivid Five, GE Vingmed, Milwaukee, Wis) with a 2.5-Mhz phased-array transducer. The subsequent analysis was blinded to the coronary angiography results.

The patients were imaged in the left lateral decubitus position in the cardiac department. Standard 2-dimensional (2D), M-mode, pulsed, and color Doppler images were saved on digital files (Echopac 6-3-6, GE Vingmed). In apical 4- and 2-chamber view, color DTI cineloops of 3 cardiac cycles were recorded with a rate ranging from 80 to 115 frames/s depending on the sector width. The image angle was adjusted to ensure that the sampling window was aligned parallel to the myocardial wall under study. The pulse repetition frequency was between 500 Hz and 1 kHz, resulting in an aliasing velocity of 16 to 32 cm/s. Three cardiac beats were digitized and stored on a magnetic optical disk for further analysis on software (Echopac, GE Vingmed).

Data Processing and Analysis

Myocardial Doppler velocity profile signals were reconstructed offline from the DTI color images. Curve analysis was performed on an averaged analysis of the 3 recorded cardiac beats. In an apical 4-chamber view, the regional analysis consisted of placing the region of interest cursor at the mitral annulus, basal, and mid segments of the septal (sia) and lateral LV myocardial wall and on the proximal

part (about 1 cm away from the mitral valve annulus) of the lateral and sia wall of the LA (Figure 1).

The signal quality was typically best in this location. The systolic (S), early diastolic (E), A, and isovolumic contraction and relaxation peaks were recorded.

On each wall, peak S displacement was recorded in tissue tracking mode (Figure 1). The peak strain was also recorded, but we have not reported the results because of low signal-to-noise ratio and poor reproducibility. However, we used the S peak in strain rate and the delay of appearance of that contraction peak in the analysis (Figure 1).

Statistics

Before comparison, the 3-group dataset was tested for normal distribution and equality of SD. Normally distributed data were expressed as means and SD, and they were compared by parametric analysis of variance (1-way analysis of variance). Tests resulting in *P* values below .05 were considered statistically significant.

The Pearson correlation coefficient was used to assess relationships between LA parameters and regional and global LV ones. Significantly correlated parameters were subjected to linear regression analysis.

To assess intraobserver and interobserver variability, each echographic parameter was recalculated by both the original observer and an independent observer in 15 patients taken from all 3 populations.

The statistical analyses were performed using software (SPSS 10.0, SPSS Inc, Chicago, Ill).

RESULTS

Clinical and Echocardiographic Characteristics

Table 1 summarizes the clinical and general echocardiographic characteristics of the 3 groups.

As for LA DTI-derived parameters in control patients: the isovolumic contraction was a positive wave; the S wave was positive (around 10 cm/s);

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