

PATTERN AND IMPACT OF ALTERED REGIONAL MYOCARDIAL EXCURSION ON GLOBAL VENTRICULAR PERFORMANCE AFTER FIRST-TIME ACUTE ANTERIOR WALL MYOCARDIAL INFARCTION BY REAL-TIME THREE-DIMENSIONAL ECHOCARDIOGRAPHY

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SUMMARY

Background: The regional wall motion score index obtained by two-dimensional echocardiography in myocardial infarction (MI) has a significant impact on left ventricular (LV) global contractility and is of extraordinary prognostic value, whereas data regarding real-time three-dimensional echocardiography (RT-3DE) are lacking. We sought to clarify the relationship between RT-3DE and LV contractility in patients after MI.

Methods: RT-3DE was performed in 50 patients with anterior wall acute myocardial infarction and 30 normal controls. Global (16 segments) and regional ring-based LV systolic excursions were analyzed offline using the commercially available software Q-Lab version 5.0. The correlations between the LV global and regional systolic excursions and the global LV contractile performance were examined in the MI patients, and further compared with the control group.

Results: The global and regional (basal and middle ring-based) LV systolic excursions were lower in the MI patients (age, 61.8 ± 13.1 years) than in the normal controls (age, 40.0 ± 15.4 years). Global excursion showed inverse linear relationships with LV end-systolic volume ($r = -0.26$, $p < 0.05$) and end-diastolic volume ($r = -0.22$, $p < 0.05$) but no significant relationships with LV ejection fraction ($p = 0.08$) and stroke volume ($p = 0.49$).

Conclusion: Regional wall motion abnormalities quantified by RT-3DE are clinically convenient and feasible in both MI patients and the normal population. This rapid and objective quantification may also help discriminate abnormal from normal regional and global functions after infarction and, therefore, has the potential to be an attractive solution for clinical diagnosis. [International Journal of Gerontology 2008; 2(4): 196–205]

Key Words: anterior wall acute myocardial infarction, global ventricular performance, real-time three-dimensional echocardiography, regional myocardial excursion

Introduction

The conventional regional wall motion score index obtained by two-dimensional (2D) echocardiography

in patients with myocardial infarction (MI) and coronary artery disease is of extraordinary prognostic value^{1,2}. However, this visual interpretation remains subjective with higher variability, and may rely on the reader's experience to a large extent^{3,4}. In addition, the partial information obtained about the cardiac structure and anatomy by traditional 2D echocardiography is limited by the cross-sectional planes without fully exploiting the volumetric information owing to the lack of detailed spatial resolution⁵. Although previous three-dimensional (3D) studies by multiplane acquisition



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have been clinically promising in their spatial resolution, they are time-consuming and prone to artifacts⁶. However, recent advances in 3D transducer design and computing technology have led to more rapid processing of dataflow, by using fast scanning with real-time image acquisition and overcoming the shortcomings of conventional 2D echocardiography. These improvements in both hardware and software design may lead to more accurate assessments of left ventricular (LV) volume⁷, mass^{8,9}, surrounding anatomy and function¹⁰ from a single position without geometric assumptions^{11,12}. Good agreement between the emerging real-time 3D echocardiography (RT-3DE) reconstruction technique and magnetic resonance imaging (MRI) has been proven^{4,6,7,13}, and the technique is convenient, widely feasible and noninvasive for clinical applications.

The semiautomatic border detection strategies in the different software programs used for objective analyses of RT-3DE datasets offer diverse means for potential evaluations of global and regional functions^{4,12,13}. Corsi et al.⁵ reported good validation and high accuracy between RT-3DE and cardiac MRI for objective global and regional volumetric quantifications in subjects with dilated cardiomyopathy and coronary artery disease. This novel approach provides accurate, fast and semiautomatic quantification of regional LV function by calculating the regional ejection fraction using a similar algorithm to that applied to MRI¹³. In the present study, we hypothesized that using RT-3DE for objective quantifications of LV regional and global functions may provide rapid and accurate measurements and aid in identifying wall motion abnormalities in patients with anterior wall MI. We further sought to investigate the impacts of the regional functional abnormalities detected by RT-3DE on LV global performance in our patient population.

Materials and Methods

Study population

This study involved 50 patients with anterior wall MI and 30 normal volunteers. The 50 patients with anterior wall MI were selected from the local emergency department for primary angioplasty based on good-quality images. The criteria for anterior wall MI were defined as: (1) chest pain of more than 30 minutes; (2) persistent ST segment elevation of more than 1 mm from the baseline in precordial leads; and (3) evidence

of culprit left anterior descending coronary artery lesion by angiogram or documented elevated cardiac enzymes. All echocardiography images, including M-mode and 2D images, were obtained within 12 hours of acute myocardial infarction (AMI) after primary angioplasty. A cardiac marker (troponin I) was repeatedly measured three times after AMI using the Immulite cTnI assay (DPC, Gwynedd, Wales, UK) based on the principle of chemiluminescence, and the highest value was used for analyses. Patients with previous cardiac surgery, morphologically abnormal cardiac valves, old MI, or previous heart surgery according to medical records were excluded from the study. The study was approved by the local Ethics Committee and all patients provided oral informed consent to participate in the study.

Echocardiographic assessments

All echocardiograms including M-mode, Doppler and 2D images were digitized from the DICOM format acquired by iE33 (Philips, Andover, MA, USA), and analyzed using an offline workstation. The left atrial (LA) area was measured by manual tracing from a four-chamber view at the end-systolic phase at one frame before mitral valve opening. The LV mass was calculated from the LV linear dimension using the formula recommended by the American Society of Echocardiography. The mitral regurgitation grade was expressed as the proportion of the LA area by tracing the largest jet area in the LA from four-chamber views from the start of the QRS complex to the end-systole phase. The LV mass was obtained by the cube formula using the correction described by Devereux et al.¹⁴: $LV\ mass\ (g) = 0.8 \times \{1.04 \times [(interventricular\ septum + LV\ internal\ diameter + posterior\ wall\ thickness)^3 - LV\ internal\ diameter^3]\} + 0.6$. The LV functional systolic indices, including the LV end-diastolic volume (LVEDV) and LV end-systolic volume (LVESV) in milliliters and derived LV ejection fraction (LVEF), were all quantified offline using Q-Lab version 5.0 (3DQ version 6.0).

Transthoracic RT-3DE

A real-time pyramidal 3D full-volume dataset was acquired with a second-generation matrix array iE33 (Philips, Andover, MA, USA) X3-1 transducer. The full-volume dataset was composed of four smaller pyramidal real-time subvolumes (93 × 20 degrees each) from four continuous cardiac cycles with QRS complex gating and breath-hold at the end-expiratory phase of each participant from LV apical views. A wide-angled mode

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