Kaohsiung Journal of Medical Sciences (2014) 30, 29–34

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ORIGINAL ARTICLE

Alteration in the global and regional myocardial strain patterns in patients with inferior ST-elevation myocardial infarction prior to and after percutaneous coronary intervention

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Received 22 December 2012; accepted 14 March 2013
Available online 17 August 2013

KEYWORDS
Echocardiography;
Inferior wall myocardial infarction;
Percutaneous coronary intervention;
Strain

Abstract This study was designed to investigate the alteration on regional and global strains of left and right ventricle (LV, RV) in patients with inferior wall ST-elevation myocardial infarction (MI). Patients were examined prior to and 7 days after percutaneous coronary intervention (PCI) using speckle-tracking techniques. Fifty-nine patients (36 males and 23 females) and 60 healthy controls (40 males and 20 females) were enrolled in this study. LV strains were measured from three deformations including radial, longitudinal, and circumferential. RV strains were measured only from the longitudinal. Three types of LV global strains were significantly lower in patients than in controls, and LV global longitudinal and circumferential strains were moderately improved by PCI. The LV regional strains reduced significantly in most of the segments (87%) after inferior wall MI and over half of them (60%) were improved by PCI. The RV global longitudinal strains were significantly lower in patients than in controls, and they were moderately improved by PCI. In conclusion, the regional and global strains of LV and RV were reduced in patients with inferior wall MI, and PCI most markedly improved the global strains and regional strains of the infarct and adjacent myocardium in the apical and middle levels.

Conflicts of interest: The authors have no conflicts of interest relevant to this article.

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1607-551X/$36
http://dx.doi.org/10.1016/j.kjms.2013.04.005

Introduction

Reliable assessment of regional or overall heart contractility is critical for the diagnosis of disease, evaluation of therapeutic interventions, and prediction of clinical outcomes in the field of myocardial ischemia and infarction. Currently, most echocardiography laboratories continue to use the visual assessment of wall thickening or wall motion score index for clinical use; nonetheless, it is known that subjective visualization and semiquantitative scores are hampered by substantial observer variability [1]. Strain imaging has been proposed as an objective and quantitative measurement of wall motion abnormalities [2]. Regional myocardial strain can be measured by velocity gradient from tissue Doppler imaging (TDI). However, TDI is Doppler angle-dependent, which makes the acquisition and correct interpretation of the data more difficult. Furthermore, the clinical use of strain measured by TDI is limited to experienced users due to the low signal-to-noise ratio. Recently, improved hardware and software have allowed angle-independent quantification of myocardial strain based on the speckle-tracking technique in two-dimensional B-mode echocardiography. Strain measurement using the speckle-tracking method has been shown to identify the presence, location, and transmural extent of myocardial infarction (MI) [3,4], and to predict the clinical outcomes and left ventricle remodeling following myocardial infarction [5,6].

Left ventricle (LV) contractility is a commonly used indicator of the severity of myocardial damage after MI. Speckle-tracking imaging-derived strains might more accurately reflect intrinsic measures of myocardial contractility and enable quantification of LV regional myocardial deformation by three principal types of deformation: longitudinal, radial, and circumferential. Right ventricle (RV) function is an important prognostic factor for clinical outcomes in patients with acute MI of LV. Moreover, RV involvement occurs in a percentage of patients suffering an inferior wall MI and increases in-hospital death rates [7,8]. The objective of the present study was to quantify regional or global deformation of LV and RV in patients with inferior wall MI prior to and after percutaneous coronary intervention (PCI).

Materials and methods

Study population

From June 2010 to July 2012, 82 consecutive patients were admitted to our hospital for inferior wall ST-elevation MI. The diagnosis of MI relied on characteristic chest pain, electrocardiographic changes, and diagnostic changes in cardiac enzymes. Inferior wall MI was defined as squeezing chest pain lasting for $>$30 minutes, ST segment elevation $\geq$ 1 mm in inferior leads (leads II, III, and aVF), and a significant rise in serum-specific cardiac enzymes. Sixteen patients were excluded for the following reasons: nine for RV involvement (ST segment elevation $\geq$ 0.1 mV in lead V_4R) [9], two for the history of MI, two for pulmonary hypertension (pulmonary artery systolic pressure $>$ 30 mmHg by echocardiographic studies), and three for the poor acoustic window. Fifty-nine of the remaining 66 patients underwent emergency PCI within the first 12 hours of symptom onset and were finally enrolled in the study. Sixty age-matched adults without acute ischemic attacks were enrolled and served as controls. Baseline clinical characteristics of patients and control participants are summarized in Table 1. The study was approved by the ethics committee of Renmin Hospital of Wuhan University and all participants gave written informed consent.

Echocardiographic data acquisition

Thoracic echocardiography was performed with the patients in the left lateral decubitus position prior to PCI in the angiography laboratory and 7 days after PCI in the wards. The echocardiographic evaluation was performed using the Vivid E9 commercial ultrasound scanner (version BT11; GE Vingmed Ultrasound AS, Horten, Norway) and 2.5-MHz transducer. All echocardiography was performed by another physician blinded to the electrocardiographic finding. Conventional echocardiographic measurements were performed according to the recommendations of the American Society of Echocardiography [10]. LV ejection fraction (EF) was calculated according to the modified Simpson's rule using the apical four- and two-chamber views. After standard echocardiographic examination, parasternal long-axis, parasternal short-axis, four-, three-, and two-chamber views were obtained in end-expiration to minimize translational movement of the heart. All data were acquired at a high frame rate of 70—80 frames/second. At least three cardiac cycles were digitally stored for offline analyses.

Strain measurement by speckle tracking model

The high frame rate acoustic capture grayscale images were analyzed offline using EchoPac 6.4 (GE Vingmed Ultrasound AS). This software allows for automatic evaluation of the dynamic properties of the endocardial border and of the subendocardial tissue from two-dimensional B-mode

Table 1 Baseline clinical characteristics of patients and control participants.

Variables	Patients (n = 59)	Controls (n = 60)
Age, y	64 ± 9	62 ± 8
Sex, male/female	36/23	40/20
Height, cm	164 ± 8.4	166 ± 9.5
Weight, kg	63 ± 8	64 ± 8
Body mass index, kg/m^2	24.8 ± 2.7	23.4 ± 2.5
Hypertension	12 (20.0)	7 (11.7)
Diabetes mellitus	8 (13.6)	4 (6.7)
Hyperlipemia	14 (23.7)	4 (6.7)
Smoking	15 (25.4)	8 (13.3)
Medication		
ACEI or ARB	52 (88.1)	——
β-blockers	51 (86.4)	——

Data are presented as n (%) unless otherwise indicated.
ACEI = angiotensin converting enzyme inhibitor; ARB = angiotensin II receptor blocker.