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ORIGINAL ARTICLE

Value of resting myocardial deformation assessment by two dimensional speckle tracking echocardiography to predict the presence, extent and localization of coronary artery affection in patients with suspected stable coronary artery disease

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KEYWORDS

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Abstract *Background:* Myocardial deformation assessed by two dimensional speckle tracking echocardiography (2D-STE) allows accurate evaluation of regional and global left ventricular (LV) function and is sensitive to detect abnormalities induced by ischemia.
Aim: To examine the value of LV strain (*S*) and strain rate (SR) assessed by STE to detect the presence, and extent of coronary artery affection in patients with suspected stable coronary artery disease (SCAD).
Methods: 81 patients with suspected SCAD and normal resting echocardiography were subjected to 2D-STE and coronary angiography. The peak systolic (PS) global longitudinal strain (GLS)/strain rate (GLSR) and PS global radial strain (GRS)/strain rate (GRSR) were calculated as the average of *S*/SR of the 18 LV segments of the 3 apical views. The PS mid circumferential strain (MCS)/strain rate (MCSR) was calculated as the average of *S*/SR of the 6 LV segments of the mid LV cavity short axis view.
Results: 20 patients (24.7%) represented the normal coronaries group (NCG), and 27 patients (33.3%) with one/two vessel-CAD represented the low risk group (LRG) while 34 patients (42%) with three vessel/left main-CAD represented the high risk group (HRG). GLS, GLSR, GRS, GRSR, MCS and MCSR were significantly lower in patients with significant CAD compared to NCG (all $p = 0.000$). GLS, GLSR, GRSR, MCS and MCSR were significantly lower in HRG compared to LRG ($p = 0.030$, $p = 0.009$, $p = 0.000$, $p = 0.000$, and $p = 0.004$ respectively).

Abbreviations: CAD, coronary artery disease; GLS, global longitudinal strain; GLSR, global longitudinal strain rate; GRS, global radial strain; GRSR, global radial strain rate; HRG, high risk group; LRG, low risk group; MCS, mid circumferential strain; MCSR, mid circumferential strain rate; S, strain; SCAD, stable coronary artery disease; SR, strain rate; STE, speckle tracking echocardiography; two dimensional, 2-D; TDI, tissue Doppler imaging

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Conclusion: Myocardial deformation analysis by STE is not only useful to diagnose CAD, but also predicts the extent of CAD affection in patients with suspected SCAD.

1. Introduction

Stable coronary artery disease (SCAD) is a very common disease which is expected to further increase due to population aging and decline of mortality in acute coronary syndromes.[1,2] Chest pain accounts for approximately six million annual visits to emergency departments (ED) in the United States (US) making chest pain the second most common complaint in the ED.[3] As a result, more than 10 million stress tests are being performed in the US every year, as well as at least one million diagnostic catheterizations.[4] Recent guidelines also recommend non-invasive testing in SCAD patients with intermediate 15–85% pretest likelihood of CAD to identify patients who will need coronary angiography.[5,6] The search for a simple, reliable and non-invasive test to establish the diagnosis in patients with suspected SCAD has a great impact on decreasing burden on health care system. An abnormal long axis function of the left ventricle (LV) as a consequence of ischemic injury to longitudinally orientated sub-endocardial fibers has been demonstrated in patients with CAD.[7,8] Longitudinal systolic, and early diastolic myocardial velocities measured by color tissue Doppler imaging (TDI) were independent predictors of CAD after multivariable adjustment for baseline, exercise electrocardiogram (ECG), and conventional echocardiographic parameters.[9] However, TDI has the disadvantages of being angle dependent, and regional myocardial velocities can be influenced by tethering effect of adjacent segments.[10] Speckle tracking echocardiography (STE) has emerged as an accurate quantitative technique to assess deformation parameters, more reproducibly than TDI, being independent of both cardiac translation and insonation angle.[11,12] The diagnostic accuracy of LV global longitudinal strain (GLS) measured by STE in the resting echocardiogram was comparable to wall motion score index measured during stress echocardiography for detecting $\geqslant$50% stenosis of any major coronary artery and significantly improves the diagnostic performance of exercise test.[13,14] It is not known whether circumferential or radial deformation parameters measured by STE at rest are as useful as longitudinal deformation for the detection of significant CAD. The aim of this study was to determine whether assessing circumferential, radial as well as longitudinal LV deformation parameters by STE can detect not only the presence but also the extent of CAD and predict the localization of the affected coronary artery in SCAD patients.

2. Methods

2.1. Study population

From August 2013 to March 2014, 81 patients aged between 35 and 75 years presenting with suspected SCAD were included in the study. SCAD was defined as typical chest pain precipitated by effort and relieved by rest without aggravation in the last 8 weeks. Patients with evidence of acute coronary syndrome, with known ischemic heart disease, congestive heart failure, significant heart valve disease, rhythm other than sinus rhythm, left ventricular ejection fraction (LVEF) $\leqslant$ 50% or segmental wall motion abnormalities at rest as detected by echocardiography were excluded. All the patients were subjected to a complete echocardiographic examination including two dimensional speckle tracking echocardiography (2D-STE) and coronary angiography. The research protocol was approved by the ethics committee of Cairo University Hospital. The study was conducted in accordance with the Declaration of Helsinki. Written, informed consent was obtained from each patient.

2.2. Conventional echocardiography

All echocardiographic examinations were obtained using Mylab 60 XVision machine (Esaote, Italy). LV diameters and wall thicknesses were measured in the left parasternal long axis at the level of the mitral valve tips, ensuring a measurement perpendicular to the long axis of the ventricle. Pulsed wave Doppler was used to record trans-mitral flow at the tips of the mitral leaflets in the four-chamber (4-CH) apical view as well as the trans-aortic flow in the five-chamber (5-CH) apical view. Peak velocity of early (E) and atrial (A) diastolic filling of the Doppler mitral flow and E/A ratio was calculated. LVEF was determined using modified biplane Simpson's method in the 4-CH and the two-chamber (2-CH) apical views as recommended by the American Society of Echocardiography.[15]

2.3. Two-dimensional speckle tracking echocardiography

The machine "Mylab 60 XVision" uses a special acoustic tracking algorithm "Velocity Vector Imaging" which accounts for mitral annular motion, tissue-blood border detection, and the periodicity of the cardiac cycle. Three consecutive end-expiratory cardiac cycles using high frame rate (80–100 frames/s) harmonic imaging were acquired in the apical 4-CH, 2-CH, the long axis (LAX) views and the short-axis (SAX) mid-ventricular view at the level of the papillary muscles. The 2D-STE analysis was performed offline on grayscale images of the LV obtained in these views. The analysis was initiated by defining manually in the apical views three endocardial landmarks at the lateral and medial corners of the mitral annulus and the LV cardiac apex and in the mid ventricular SAX view, two landmarks at the inferior septum and the lateral wall. Thereafter, the endocardium and epicardium were delineated and the region of interest was divided into 6 segments automatically by the machine software. Manual adjustment of the segments of interest was performed when necessary. Once the regions of interest were optimized, the software generates automatically strain curves for different myocardial segments. From the apical 4-CH view, longitudinal strain/strain rate (LS/LSR) and radial strain/strain rate