Early Assessment of Strain Echocardiography Can Accurately Exclude Significant Coronary Artery Stenosis in Suspected Non–ST-Segment Elevation Acute Coronary Syndrome

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Background: Many patients with suspected non–ST-segment elevation acute coronary syndrome (NSTE-ACS) do not have significant coronary artery disease. The current diagnostic approach of repeated electrocardiography and cardiac biomarker assessment requires observation for >6 to 12 hours. This strategy places a heavy burden on hospital facilities. The objective of this study was to investigate whether myocardial strain assessment by echocardiography could exclude significant coronary artery stenosis in patients presenting with suspected NSTE-ACS.

Methods: Sixty-four patients presenting to the emergency department with suspected NSTE-ACS without known coronary artery disease, inconclusive electrocardiographic findings, and normal cardiac biomarkers at arrival were enrolled. Twelve-lead electrocardiography, troponin T assay, and echocardiography were performed at arrival, and all patients underwent coronary angiography. Significant coronary stenosis was defined as >50% luminal narrowing. Global myocardial peak systolic longitudinal strain was measured using speckle-tracking echocardiography. Left ventricular ejection fraction and wall motion score index were calculated.

Results: No significant stenosis in any coronary artery was found in 35 patients (55%). Global peak systolic longitudinal strain was superior to conventional echocardiographic parameters in distinguishing patients with and without significant coronary artery stenosis (area under the curve, 0.87). Sensitivity and specificity were calculated as 0.93 and 0.78, respectively, and positive predictive value and negative predictive value as 0.74 and 0.92, respectively. Feasibility of the strain measurements was excellent, with 97% of segments analyzed.

Conclusions: Myocardial strain by echocardiography may facilitate the exclusion of significant coronary artery stenosis among patients presenting with suspected NSTE-ACS with inconclusive electrocardiographic findings and normal cardiac biomarkers. (J Am Soc Echocardiogr 2014;27:512-9.)

Keywords: Acute coronary syndrome, Speckle-tracking, Myocardial strain, Echocardiography, Emergency department

Symptoms suggestive of acute coronary syndrome account for up to a quarter of acute hospital admissions in the Western world.[1] However, most patients presenting with chest pain and suspected acute coronary syndrome do not have significant coronary artery disease.[2] Diagnostic protocols to rule out coronary artery disease are based on risk factors, multiple electrocardiographic (ECG) assessments, repeated cardiac biomarker assessments, noninvasive stress testing, and, if indicated, invasive coronary angiography.[3] This approach is resource intensive and time-consuming and places a heavy burden on overcrowded emergency departments. To cope with these challenges and facilitate early discharge of patients with low or intermediate likelihood of coronary artery disease, accelerated diagnostic protocols based on clinical scoring, imaging, and high-sensitivity biomarkers have been proposed.[4,5] However, these have not yet gained wide clinical acceptance. To improve the identification of patients without significant coronary artery stenosis, more robust diagnostic methods are needed.

Myocardial strain by speckle-tracking echocardiography is a technique based on widely available two-dimensional grayscale echocardiography, enabling the accurate evaluation of global and regional myocardial function, and it has been shown to be sensitive to

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Abbreviations

cTnT = Cardiac troponin T

ECG = Electrocardiographic

ER = Emergency room

GRACE = Global Registry of Acute Coronary Events

LV = Left ventricular

LVEF = Left ventricular ejection fraction

NSTE-ACS = Non–ST-segment elevation acute coronary syndrome

ROC = Receiver operating characteristic

WMSI = Wall motion score index

abnormalities caused by ischemia and necrosis.[6] Strain echocardiography can be performed bedside in the emergency setting at low cost and has been demonstrated to identify high-risk patients with non–ST-segment elevation acute coronary syndrome (NSTE-ACS) in this setting.[7] However, even low-grade ischemia might cause deterioration of myocardial function and can be detected by myocardial strain imaging.[8] We therefore hypothesized that strain echocardiography might be used to identify patients admitted with suspected NSTE-ACS and without significant coronary artery disease.

The aim of our study was to evaluate the ability of myocardial strain by echocardiography to predict significant coronary artery disease among patients presenting to the emergency department with suspected NSTE-ACS with inconclusive ECG findings and normal initial biomarkers.

METHODS

Study Population

Sixty-four patients with suspected NSTE-ACS without known coronary artery disease, inconclusive ECG findings, and normal cardiac biomarkers at admission were enrolled at Sørlandet Hospital Arendal. Patients admitted with suspected NSTE-ACS were enrolled if the following criteria were met: (1) acute anginal pain lasting >10 min, (2) episode of chest pain within the past 3 days, and (3) indication for coronary angiography according to current guidelines.[9] Exclusion criteria were: (1) age < 18 years, (2) QRS duration > 0.12 sec, (3) severe valve dysfunction as defined in the European Society of Cardiology guidelines for the management of valvular heart disease,[10] (4) atrial fibrillation with heart rate > 100 beats/min or other continuous arrhythmia, (5) known coronary artery disease, (6) severe mental disorder, (7) abnormal initial cardiac troponin T (cTnT), (8) abnormal ECG findings, and (9) short life expectancy of extracardiac reason. Abnormal cTnT was defined as >30 ng/L. Abnormal ECG findings were defined as a >1-mm ST-segment deviation in any lead or symmetric T-wave inversion in two or more consecutive leads at admission.

All patients were evaluated and treated according to current guidelines. The regional committee for medical research and ethics approved the research protocol. All participants gave written informed consent.

The Global Registry of Acute Coronary Events (GRACE) risk score, which has been shown to have good ability to assess risk for death in patients presenting with acute coronary syndrome,[11] was calculated on the basis of age, heart rate, systolic blood pressure, Killip class, cardiac arrest, ST-segment deviation, serum creatinine level, and cardiac biomarker status from data collected on admission.

Echocardiography

Echocardiographic examinations were performed a median of 1.7 hours (interquartile range, 4.5 hours) after arrival in the emergency room (ER) using a Vivid 7 scanner (GE Vingmed Ultrasound AS, Horten, Norway) and stored digitally. Three consecutive cycles from three apical image planes were recorded using two-dimensional grayscale echocardiography. Echocardiographic recordings were analyzed by a single observer blinded to patient data, using commercially available software (EchoPAC version 112; GE Vingmed Ultrasound AS). Peak systolic strain was defined as the maximum value of peak negative strain (myocardial shortening) or peak positive strain (myocardial lengthening) during systole (Figure 1). The end of systole was defined by the aortic valve closure signal by Doppler flow. Global peak systolic longitudinal strain by speckle-tracking echocardiography was calculated in a 16-segment left ventricular (LV) model as the average segmental value on the basis of three apical imaging planes. LV ejection fraction (LVEF) was calculated using Simpson's biplane method.

Territorial strain was calculated as the average of peak systolic strain values in segments belonging to the theoretical perfusion territory of each major coronary artery on the basis of a modified 16-segment model described by Cerqueira *et al.*[7,12] The lowest absolute territorial strain value for each patient was assessed as a marker for identification of significant coronary stenosis.

Wall motion score was visually assessed in a 16-segment model as follows: 1 = normal, 2 = hypokinetic, 3 = akinetic, and 4 = dyskinetic.[13] Wall motion score index (WMSI) was calculated by averaging all analyzed segments.

Coronary Angiography

Coronary angiography (Figure 1) was performed in all patients a median of 26 hours (interquartile range, 22 hours) after admission. Experienced operators unaware of all clinical data retrospectively analyzed the angiograms. Significant and high-grade coronary artery stenoses were defined as luminal narrowing ≥50% and ≥75% in any epicardial coronary artery, respectively. Total occlusion was defined as Thrombolysis In Myocardial Infarction flow grade 0 or 1.

Statistical Analysis

Continuous data are expressed as mean ± SD or as median (interquartile range). Comparisons between group means were analyzed using Student's *t* test, the Mann-Whitney *U* test, or Fisher's exact test as appropriate. Categorical data are presented as number (percentage).

We analyzed the diagnostic performance of echocardiographic parameters and GRACE score by calculating the area under the receiver operating characteristics (ROC) curves. ROC curve analyses were undertaken using DeLong, DeLong, and Clarke-Pearson comparison in MedCalc version 12.6.0 (MedCalc Software, Mariakerke, Belgium). All other statistical analyses were performed using SPSS version 20 (SPSS, Inc, Chicago, IL). To evaluate the diagnostic performance of the studied parameters, patients were randomly divided in a 1:1 fashion into a derived cohort and a test cohort, each consisting of 32 patients. Optimal cutoff values were calculated in the derived cohort and then applied to the test cohort, producing sensitivity, specificity, negative predictive value, and positive predictive value for the studied parameters. An optimal cutoff from the pooled cohort consisting of all 64 patients was also calculated to provide a more accurate cutoff value for future studies. The optimal cutoffs were defined as the values of the ROC curves that were closest to the upper left corner. The reliability of the optimal cutoff values was validated using