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BEDSIDE USE OF SPECKLE TRACKING ECHOCARDIOGRAPHY IN THE EMERGENCY DEPARTMENT TO IDENTIFY ACUTE MYOCARDIAL INFARCTION

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☐ Abstract—Background: Rapid diagnosis of acute myocardial infarction (AMI) in the emergency department (ED) is often hindered by the limitations of the electrocardiogram (ECG). Speckle tracking echocardiography (STEch) is a semiautomated, computer-assisted process that provides accurate detection of regional ventricular wall motion abnormalities and can be performed at the bedside by operators with limited experience. Case Reports: Two separate patients, each with history and ECG findings concerning for AMI, were evaluated using STEch performed by an emergency physician. Ventricular wall motion abnormalities found on STEch accurately reflected the findings of emergent cardiac catheterization, with one patient requiring urgent coronary artery revascularization and the other with no coronary artery occlusion. Why Should an Emergency Physician Be Aware of This?: STEch is a novel, easy-to-use form of echocardiography that can be used in the ED to identify patients with AMI who would benefit from emergent revascularization. © 2019 Elsevier Inc. All rights reserved.

☐ Keywords—speckle tracking echocardiography; emergency echocardiography; bedside echocardiography; emergency ultrasound; myocardial infarction

INTRODUCTION

The timely diagnosis of acute myocardial infarction (AMI) in the emergency department (ED) is crucial to allow for appropriate care and reperfusion therapy. The most readily available bedside tool to diagnose AMI is the electrocardiogram (ECG). Unfortunately, the ECG is an imperfect screening test for AMI, with sensitivity of 90% and specificity of 95% for AMIs caused by occlusion of the left anterior descending coronary artery. For AMIs caused by occlusion of the right coronary artery or circumflex coronary artery, it is even less useful (sensitivity 53%, specificity 98%) (1). Identification of regional systolic left ventricular wall motion abnormalities, also referred to as wall strain, by echocardiography is an accurate and validated means by which to diagnose acute myocardial ischemia (2). Regional myocardial systolic dysfunction begins within seconds of the onset of ischemia (3). Identification of segmental wall motion abnormalities by echocardiography has traditionally been made by subjective assessment or with the aid of tissue Doppler imaging. Both of these methods are technically difficult and not recommended for use by emergency physicians (4).

Speckle tracking echocardiography (STEch) has recently emerged as an alternative to assess ventricular wall motion. It is relatively simple to perform at the bedside with highly reproducible results (5). STEch analyzes myocardial wall motion using computerized image processing of user-identified regions of interest in the ventricular wall described as "speckles" (Figures 1 and 2). A loop of one to three cardiac cycles is recorded by the operator, and then speckles are defined into the image of

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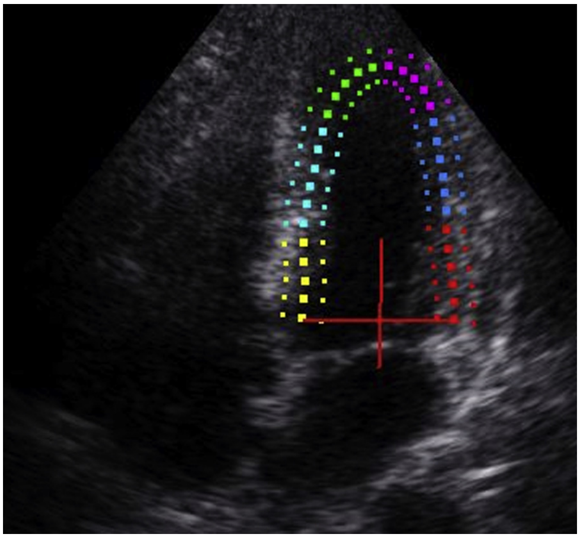

Figure 1. Apical four-chamber image of the heart demonstrating a semiautomated tracing of the endocardial border of the left ventricle using speckle-tracking software. This view can then be used to measure wall strain in the longitudinal plane.

the ventricular wall, either independently by the operator or as part of an automated process. Speckles are then tracked consecutively frame by frame on the loop throughout the cardiac cycle, yielding negative values when speckles are moving towards one another, as occurs in systole, and positive values when they are moving away from one another, as occurs in diastole. Wall strain can be measured in the radial, longitudinal, and the circumferential planes of the left ventricle. Wall strain is noted earliest in the longitudinal plane, making it the most useful orientation (6). Peak longitudinal wall strain during systole can be measured for different wall segments of the left ventricle and expressed as a negative percentage change in the distance between speckles. This information from several different views of the left ventricle can be combined and then displayed using a "bullseye" map showing the different wall segments and comparison between the segments can be made. In this report, we describe the use of STEch in the ED evaluation of 2 patients with history and ECG findings suggestive of AMI.

CASE REPORTS

Patient 1

A 56-year-old man presented to the ED with sudden onset mid-sternal chest pain without shortness of breath that woke him from sleep in the night. He reported experiencing similar, less severe chest pains over the previous 2 days. The chest pain radiated to his right neck and back and was reportedly similar to the pain he had experienced with a previous AMI. The patient had been

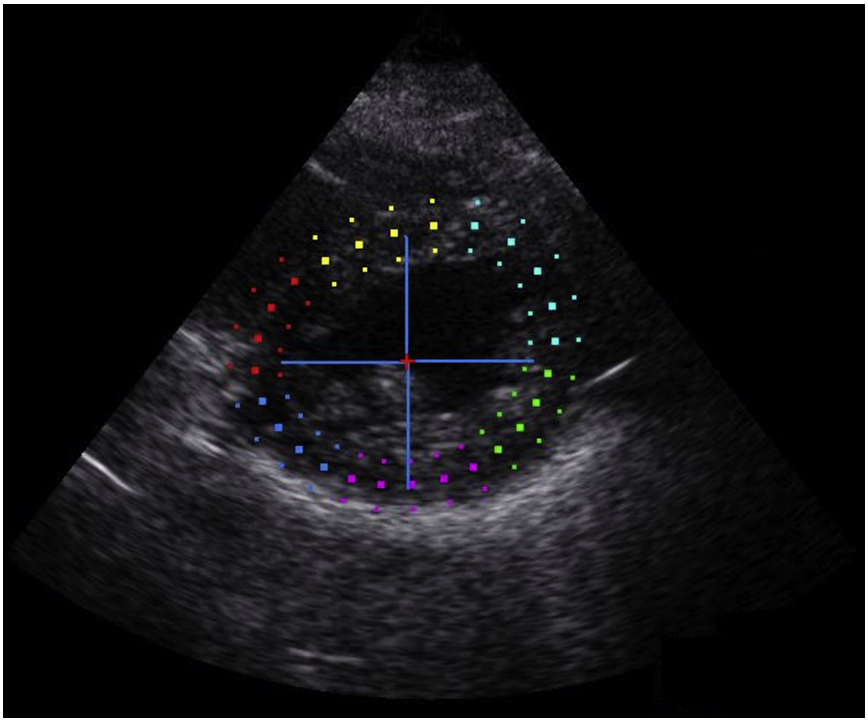

Figure 2. Parasternal short axis image of the heart demonstrating a semiautomated tracing of the endocardial border of the left ventricle using speckle-tracking software. This view can then be used to measure wall strain in the radial and circumferential plane.

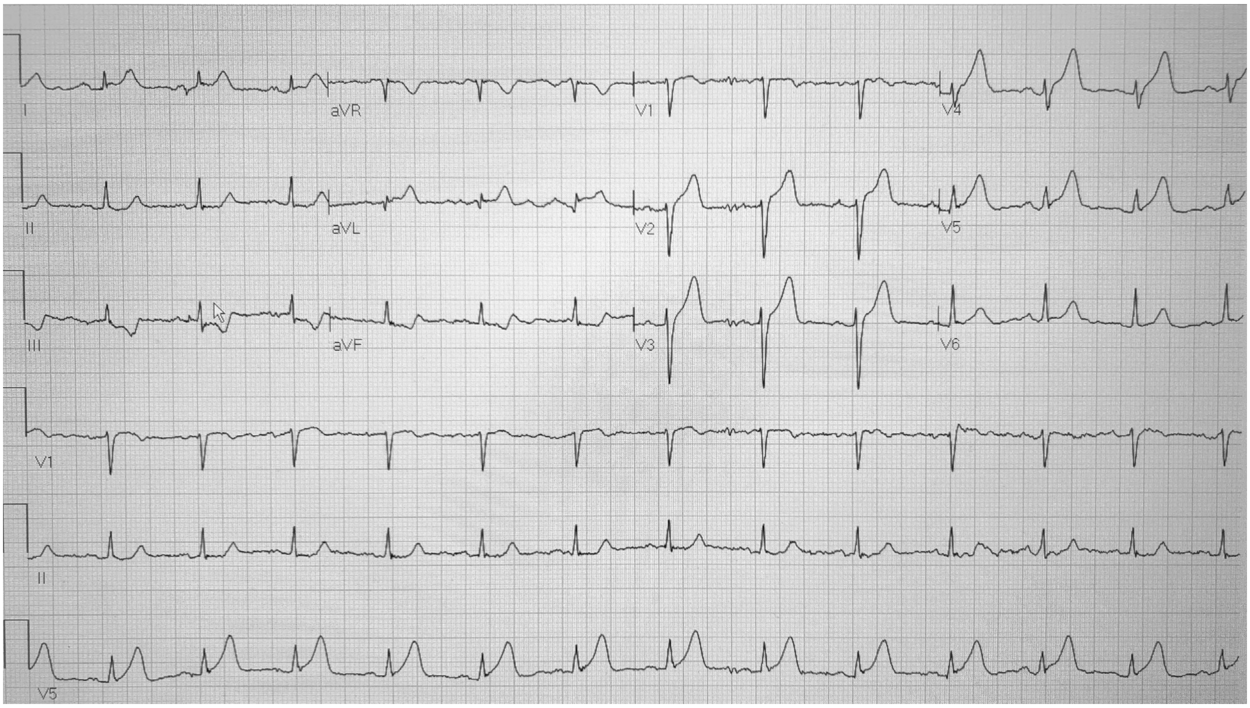

Figure 3. Electrocardiogram of patient 1 with ST-segment changes consistent with anterior wall myocardial infarction.

treated for AMI 8 years before with coronary artery stenting performed at a different institution. On presentation, the patient was afebrile with pulse 92 beats/min, respiratory rate 22 breaths/min, and blood pressure 124/73 mm Hg. On physical examination, he appeared to be in pain but not in distress. His cardiac examination revealed a regular rhythm with no abnormal sounds, and his breath sounds were equal and clear bilaterally. The remainder of his physical examination was unremarkable. An ECG performed at the time of ED arrival (Figure 3) was interpreted as being consistent with an anterior wall AMI and preparations were made for emergent cardiac catheterization.

While awaiting the arrival of the cardiology team, a bedside ultrasound using STEch was performed by the emergency physician, confirming the presence of a wall motion abnormality of the anteroseptal portion of the left ventricle (Figure 4). The ultrasound machine used was a GE Vivid Q™ (GE Healthcare, Chicago, IL) equipped with automated function imaging and tissue tracking.

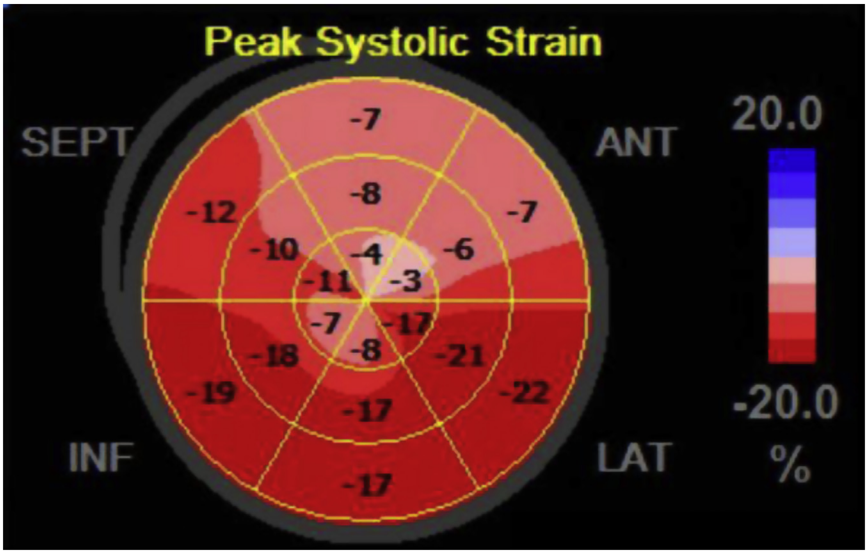

Figure 4. Bullseye map of left ventricular strain of patient 1 demonstrating impaired longitudinal strain of the anterior wall.

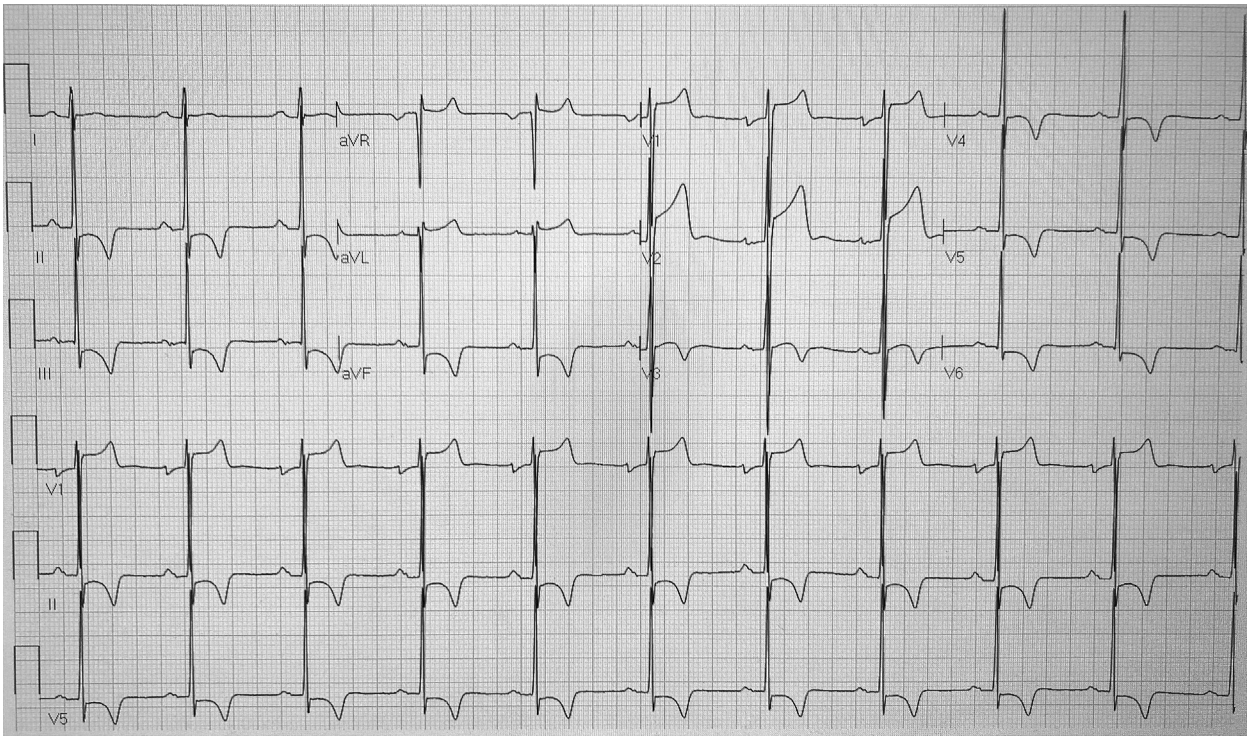

Figure 5. Electrocardiogram of patient 2 with ST-segment changes consistent with anterior wall myocardial infarction.

A GE M4S-RS phased array ultrasound probe was used (GE Healthcare). Cardiac catheterization performed approximately 1 h after the patient's arrival to the ED confirmed the presence of 100% occlusion of a previously placed stent in the left anterior descending coronary artery. The occlusion was opened by percutaneous balloon angioplasty and a new drug-eluting stent was placed with 0% occlusion of the artery noted after the procedure. The patient was discharged the next day after an unremarkable post-procedural course.

Patient 2

A 31-year-old man presented to the ED with 1 h of left-sided chest pain radiating to his left arm. The pain had started approximately 1 h after a minor motor vehicle accident in which the patient's car was struck from behind while stopped. The patient experienced no significant bodily trauma in the accident. On presentation, the patient was afebrile with pulse 64 beats/min, respiratory rate 16 breaths/min, and blood pressure 119/73 mm Hg. On physical examination, he was in no distress with clear and equal breath sounds bilaterally. Cardiac examination revealed a regular rhythm with no abnormal sounds, and the remainder of his physical examination was unremarkable. An ECG performed at the time of arrival to the ED (Figure 5) was interpreted to be consistent with an anterior wall AMI, and the patient was immediately taken for cardiac catheterization.

Cardiac catheterization performed approximately 30 min after the patient's arrival to the ED revealed normal coronary arteries with no evidence of obstruction. An ultrasound using STEch was performed by the emergency physician shortly after the cardiac catheterization and confirmed the absence of any wall motion abnormalities of the left ventricle (Figure 6). Serial serum troponin I levels remained in the normal range, and after a transthoracic echocardiogram found only mild concentric left ventricular hypertrophy, the patient was discharged the next day.

DISCUSSION

Diagnosing AMI in the ED is often a difficult task, with approximately 2% of patients with AMI mistakenly discharged from EDs (7). Complicating matters further are the other conditions that can mimic ST elevation myocardial infarction (STEMI). A study by Gu et al. found that 2.3% of patients diagnosed with STEMI and taken for emergent cardiac catheterization were ultimately diagnosed with another condition (8). In that study, aortic dissection, pericarditis, myopericarditis, cardiomyopathy, and subarachnoid hemorrhage were the conditions that were most frequently misdiagnosed as STEMI. Approximately 25–40% of AMIs present as STEMIs, with the remainder classified as non-ST elevation myocardial infarctions (NSTEMI) (9). NSTEMI is caused by coronary artery occlusion in 12–47% of cases,

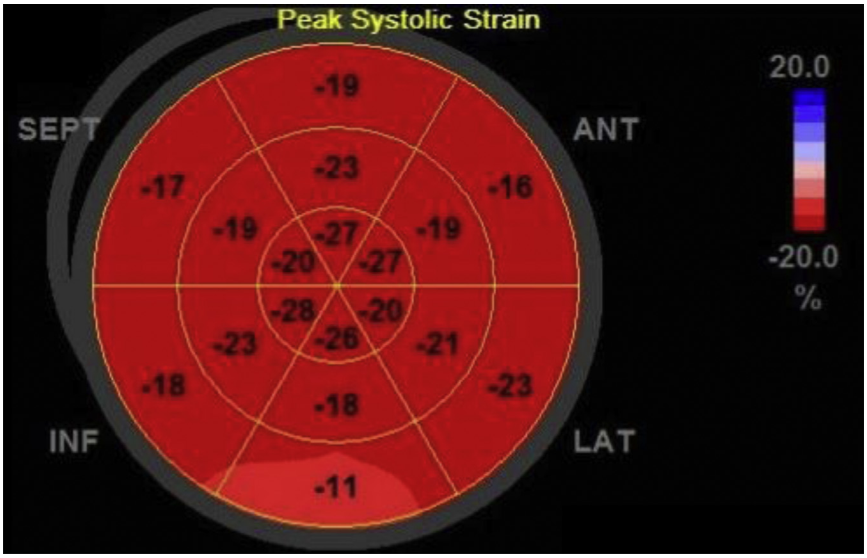

Figure 6. Bullseye map of left ventricular strain of patient 2 demonstrating no focal longitudinal wall strain abnormality.

with these patients likely to derive benefit from emergent revascularization (2). For all of these reasons, the use of STEch could prove to be invaluable in the ED evaluation of patients with possible AMI. Admittedly, a limitation of STEch would be the identification of ventricular wall motion abnormalities not due to coronary artery occlusion, such as occurs with Takotsubo cardiomyopathy or vasospasm.

Bedside ultrasound is part of the core emergency medicine residency curriculum, with cardiac ultrasound a component of that requirement (10). Farsi et al. reported comparable results between focused cardiac ultrasounds performed by emergency medicine residents and those performed by cardiologists (11). However, that study primarily evaluated operator assessment of global ventricular function and not focal wall motion abnormalities. To date, assessment of focal ventricular wall motion abnormality has been made by two different techniques: direct visual assessment by the ultrasound operator and with the assistance of Doppler imaging. Direct visual assessment is subject to significant variability and is useful primarily to ultrasonographers with considerable experience. Doppler imaging of wall motion is limited to the measurement of movement parallel to the ultrasound beam. STEch provides semiautomated images of ventricular wall strain in a format that avoids the angle-dependent nature of Doppler imaging and can be used at the bedside (12). We have found this new technology can be used with minimal training on the part of the operator.

STEch has been used to identify several different cardiac abnormalities, including hypertensive heart disease, heart transplant rejection, and cardiomyopathy related to chemotherapy (13–15). STEch has also been used to improve the diagnostic performance of exercise stress testing as well as in the ED evaluation of patients with acute heart failure (16,17). The two cases reported here highlight the potential value of STEch in the ED evaluation of patients with possible AMI. We agree with other authors that this new technology has the potential to be a useful adjunct to identify patients who would benefit from emergent reperfusion therapy (2,6,18–20). Several different ultrasound manufacturers offer this technology as an added feature on their products for a cost of usually <$5000. With the increased availability of this technology in the future, further prospective study of STEch used to aid in the diagnosis of AMI in the ED is needed.

WHY SHOULD AN EMERGENCY PHYSICIAN BE AWARE OF THIS?

STEch is a novel diagnostic tool that can be performed at the bedside in the assessment of ED patients with possible AMI. Unlike older techniques used to detect left ventricular wall motion abnormalities indicative of acute myocardial ischemia, STEch is much easier to perform. This new technology may become an important adjunct used in the ED evaluation of patients with possible AMI.

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