Usefulness of Speckle-Tracking Imaging for Right Ventricular Assessment after Acute Myocardial Infarction: A Magnetic Resonance Imaging/Echocardiographic Comparison within the Relation between Aldosterone and Cardiac Remodeling after Myocardial Infarction Study

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Background: Right ventricular (RV) dysfunction after acute myocardial infarction (AMI) is frequent and associated with poor prognosis. The complex anatomy of the right ventricle makes its echocardiographic assessment challenging. Quantification of RV deformation by speckle-tracking echocardiography is a widely available and reproducible technique that readily provides an integrated analysis of all segments of the right ventricle. The aim of this study was to investigate the accuracy of conventional echocardiographic parameters and speckle-tracking echocardiographic strain parameters in assessing RV function after AMI, in comparison with cardiac magnetic resonance imaging (CMR).

Methods: A total of 135 patients admitted for AMI (73 anterior, 62 inferior) were prospectively studied. Right ventricular function was assessed by echocardiography and CMR within 2 to 4 days of hospital admission. Right ventricular dysfunction was defined as CMR RV ejection fraction < 50%. Right ventricular global peak longitudinal systolic strain (GLPSS) was calculated by averaging the strain values of the septal, lateral, and inferior walls.

Results: Right ventricular dysfunction was documented in 20 patients. Right ventricular GLPSS was the best echographic correlate of CMR RV ejection fraction ($r = -0.459$, $P < .0001$) and possessed good diagnostic value for RV dysfunction (area under the receiver operating characteristic curve [AUROC], 0.724; 95% CI, 0.590–0.857), which was comparable with that of RV fractional area change (AUROC, 0.756; 95% CI, 0.647–0.866). In patients with inferior myocardial infarctions, the AUROCs for RV GLPSS (0.822) and inferolateral strain (0.877) were greater than that observed for RV fractional area change (0.760) Other conventional echocardiographic parameters performed poorly (all AUROCs < 0.700).

Conclusions: After AMI, RV GLPSS is the best correlate of CMR RV ejection fraction. In patients with inferior AMIs, RV GLPSS displays even higher diagnostic value than conventional echocardiographic parameters. (J Am Soc Echocardiogr 2015;■:■-■.)

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Right ventricular (RV) dysfunction is an independent predictor of adverse prognosis after acute myocardial infarction (AMI), even in the absence of clinically apparent RV infarction.[1] Echocardiographic assessment of the right ventricular remains challenging because of its complex geometry, its marked load dependence, the limited definition of endocardial surface caused by

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Abbreviations

AMI = Acute myocardial infarction

AUROC = Area under the receiver operating characteristic curve

CMR = Cardiac magnetic resonance imaging

4C = Four-chamber

GLPSS = Global longitudinal peak systolic strain

ICC = Intraclass correlation coefficient

LV = Left ventricular

LVEF = Left ventricular ejection fraction

MI = Myocardial infarction

PTCA = Percutaneous transluminal coronary angioplasty

REMI = Relation between Aldosterone and Cardiac Remodeling after Myocardial Infarction

ROC = Receiver operating characteristic

RV = Right ventricular

RVEF = Right ventricular ejection fraction

RVFAC = Right ventricular fractional area change

STE = Speckle-tracking echocardiography

STEMI = ST-segment elevation myocardial infarction

TAPSE = Tricuspid annular plane systolic excursion

TTE = Transthoracic echocardiography

2C = Two-chamber

2D = Two-dimensional

WMSI = Wall motion score index

the heavily trabeculated myocardium, and its retrosternal position.[2] Contrast-enhanced cardiac magnetic resonance imaging (CMR) provides a completely noninvasive, highly accurate, and comprehensive evaluation of RV function without acoustic window limitations.[3] For all of these reasons, CMR is now considered the gold standard for RV assessment. Nonetheless, echocardiography, being widely available and inexpensive, with no side effects and achievable at the bedside, remains the modality of choice for cardiac evaluation after AMI in routine clinical practice. There is currently significant enthusiasm for echocardiographic strain measurement derived from two-dimensional (2D) speckle-tracking echocardiography (STE), as it provides an objective quantification of myocardial mechanical function. Although strain was primarily developed for left ventricular (LV) evaluation, numerous studies have demonstrated its usefulness for subtle RV assessment in various pathologies, such as pulmonary arterial hypertension and congenital heart diseases.[4] Strain analysis may also be useful for identifying segmental dysfunction, which may not be registered by a single-plane measure of RV fractional area change (RVFAC) or tricuspid annular plane systolic excursion (TAPSE). The clinical importance of RV dysfunction after AMI has long been underestimated, although meta-analyses have reported an increased risk for mortality with RV involvement.[5,6] Moreover, in post-AMI patients with LV dysfunction, RV function is weakly correlated with LV function and is independently associated with an increased risk for mortality and adverse outcomes.[1,7] In this context, a comprehensive assessment of RV function appears essential after AMI.

The objective of the present study was to compare the accuracy of conventional echocardiographic parameters and STE in assessing RV dysfunction, as measured by CMR, in patients with AMIs.

METHODS

Study Population

The study population encompassed all patients with successfully reperfused first acute ST-elevation myocardial infarctions (STEMIs) included in a prospective monocentric cohort study (Relation between Aldosterone and Cardiac Remodeling after Myocardial Infarction [REMI]) performed in a university hospital between April 2010 and October 2013. Approval of the institutional review board and informed consent were obtained before inclusion. The REMI study was designed primarily to determine whether aldosterone blood concentration can predict cardiac remodeling after AMI. Here we present the results of an ancillary imaging study. Cardiac function was assessed by magnetic resonance imaging and echocardiography during the first 4 days after percutaneous transluminal coronary angioplasty (PTCA). Eligibility criteria were age ≥ 18 years, hospitalization for a first STEMI revascularized in the acute phase by primary PTCA, stable clinical state, and regular sinus rhythm. Exclusion criteria were any contraindication to CMR examination, severe claustrophobia, history of oversensitivity to gadolinium salts, nonischemic cardiomyopathy, cardiac surgery scheduled within 6 months, of childbearing age without effective contraception, and unwillingness or inability to participate in a long-term trial.

Standard 12-lead electrocardiograms were recorded before PTCA, immediately after revascularization, and twice daily until hospital discharge. Troponin Ic and creatine phosphokinase levels were assayed three times daily during the first 2 days to determine peak values.

A total of 145 patients with first STEMIs were enrolled in the study. However, 10 patients could not be analyzed, because of lack of echocardiographic assessment ($n = 4$) and/or magnetic resonance imaging study ($n = 4$) or STEMI strictly limited to the lateral leads ($n = 4$).

To determine the pathologic threshold for STE-derived parameters (see "Statistical Analysis"), echocardiograms were obtained in 30 healthy subjects. These volunteers did not undergo CMR and were included in the STANISLAS study, a healthy volunteer cohort followed at Nancy University Hospital (ClinicalTrials.gov identifier NCT01391442).

Contrast-Enhanced CMR

Patients were scanned between day 2 and day 4 after STEMI in a supine position using a 3-T whole-body scanner (Signa Excite HD; GE Healthcare, Milwaukee, WI) equipped with an eight-element phased-array surface coil. A steady-state free precession pulse sequence was used to assess LV function in contiguous short-axis planes.[8] Main acquisition parameters were as follows: slice-thickness, 8 mm; repetition time, 3.5 to 3.9 msec; 14 to 16 k-space lines per segment; 30 phases per cardiac cycle with view sharing; field of view, 32 to 38 cm; phase field of view, 0.9; and matrix size, 224 × 224.

LV myocardial delayed enhancement was assessed during a dedicated sequence, 10 to 15 min after intravenous gadoteric acid injection (0.15 mmol/kg) (Dotarem; Guerbet Laboratories, Roissy, France).

The endocardial contours of the right and left ventricles were obtained using dedicated software (Mass Analysis Plus version 4; Medis Medical Imaging, Leiden, The Netherlands) and a method already described and were assessed by our group, which required careful manual tracing of the endocardial borders of the right ventricle.[8]