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Original Research Article

Left atrial mechanics in patients with acute STEMI and secondary mitral regurgitation: A prospective pilot CMR feature tracking study

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ABSTRACT

Background and objective: Left atrium (LA) is an important biomarker of adverse cardiovascular outcomes and cerebrovascular events. This study aimed to evaluate LA myocardial deformation using cardiac magnetic resonance feature tracking (CMR-FT) in patients with acute ST-segment elevation myocardial infarction (STEMI) and secondary mitral regurgitation (MR). Additionally, to assess interobserver and intraobserver variability of the technique.

Materials and methods: Twenty patients with STEMI underwent CMR with a 1.5 Tesla MRI scanner. According to the presence of MR patients were divided into two groups: MR(+) and MR(−). Total LA strain (ε_s), passive LA strain (ε_e), and active LA strain (ε_a) were obtained. Additionally, total, passive and active strain rates (SR_s, SR_e, and SR_a) were calculated. To assess interobserver agreement data analysis was performed by second independent observer.

Results: LA volumetric and functional parameters were similar in both groups. All LA strain values were significantly higher in patients with MR: ε_s (27.67 ± 10.25 for MR(−) vs. 32.80 ± 6.95 for MR(+); $P = 0.01$), ε_e (15.29 ± 7.30 for MR(−) vs. 19.22 ± 6.04 for MR(+); $P = 0.01$) and ε_a (12.38 ± 4.23 for MR(−) vs. 14.44 ± 5.19 for MR(+); $P = 0.03$). Only SR_e significantly increased in patients with MR (−0.57 ± 0.24 for MR(−) vs. −0.70 ± 0.20 for MR(+); $P = 0.01$). All LA deformation parameters demonstrated high interobserver and intraobserver agreement.

Conclusions: Conventional volumetric and functional LA parameters do not detect early changes in LA performance in patients with STEMI and secondary MR. In contrast, LA reservoir, passive and active strain are significantly higher in patients with MR. Only peak early negative strain rate substantially increases during secondary MR. LA deformation

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parameters derived from conventional cine images using CMR-FT technique are highly reproducible.

1. Introduction

The prognosis of individuals who survived acute myocardial infarction (AMI) has substantially improved over the last decades. However, more precise and preferably individual risk stratification is necessary to further reduce cardiovascular burden in this population. Almost half of patients presenting with AMI experience acute mitral regurgitation (MR) which carries additional risk of heart failure and premature death [1].

Current evidence suggests that left atrial (LA) size and function are important markers of adverse cardiovascular outcomes and cerebrovascular events [2,3]. LA function during AMI is affected by acute ischemia of atrial myocardium. Meanwhile, MR stimulates cardiac remodeling and is associated with LA failure, atrial fibrillation and cardiac death [4].

LA size and function can be assessed using a number of noninvasive cardiac imaging modalities such as echocardiography, computed tomography or cardiac magnetic resonance (CMR). Advanced cardiac imaging for the assessment of myocardial mechanics provides additional information about atrial performance, furthermore, it allows detection of early functional changes and predicts future events [5].

Assessment of myocardial deformation using CMR imaging became possible after the introduction of myocardial tagging technique. However, the need for additional image acquisition and time consuming postprocessing make this technique less attractive. CMR feature tracking (CMR-FT) algorithm focuses on tracking of endocardial and epicardial contours. Myocardial strain and strain rate can be derived from conventional balanced steady state free precession (bSSFP) cine images and used to quantify myocardial function.

We performed this study to assess LA myocardial performance during acute ischemia and subsequent volume overload due to MR. Additionally, we evaluated interobserver and intraobserver reproducibility of CMR-FT derived LA strain and strain rate measurements.

2. Materials and methods

2.1. Study population

Patients were consecutively enrolled into the study if they presented with first ST-segment elevation myocardial infarction (STEMI) and were treated with primary coronary intervention (PCI). The diagnosis of STEMI was based on typical symptoms, specific electrocardiographic (ECG) changes (ST-segment elevation greater than 1 mm in two contiguous limb leads or more than 2 mm in precordial leads or new left bundle branch block), elevated troponin levels and detection of occluded coronary artery during conventional coronary angiography.

Transthoracic two-dimensional echocardiography was performed within 72 h from admission and primary PCI. The severity of MR was assessed according to the European Association of Cardiovascular Imaging (EACVI) recommendations by proximal isovelocity surface area (PISA) method or semi-quantitative color flow Doppler when quantitative assessment of MR was not feasible (unmeasurable PISA or continuous Doppler trace) [6]. Previously has been proved that only mild secondary MR has impact on LA longitudinal deformation therefore we selected STEMI patients with mild-to-moderate MR [7]. Ischemic MR is highly load dependent. There was no significant difference on hemodynamic conditions measured by echocardiography. According to our findings patients were divided into two following groups: patients without MR (MR(−)) or with functional MR (MR(+)). Patients with trace MR were considered as MR(−). The final study population consisted of 20 STEMI patients: 10 without and 10 with secondary MR.

The exclusion criteria were as follows: medical history of ischemic heart disease (known coronary artery disease, previous MI, PCI, coronary artery bypass grafting), structural cardiac valve disease (including previous valvular surgery), previously known MR. We excluded subjects with anterior STEMI in order to avoid distinct ischemic effect on LA myocardial performance (Table S1). Patients with absolute contraindications for CMR (ferromagnetic implants, vascular aneurysm clips or claustrophobia) and those with irregular heart rhythm (multiple premature beats or atrial fibrillation) were also excluded. The study complies with the Declaration of Helsinki and was approved by the local Ethics Committee. All patients gave written informed consent before entering the study.

2.2. Cardiac magnetic resonance

All CMR images were acquired using a 1.5 Tesla scanner (Siemens Magnetom Aera, Siemens AG Healthcare Sector, Erlangen, Germany) with an 18-channel phased array coil in a supine position. CMR was performed within 72 h from echocardiography. The study protocol included an initial survey to define imaging planes. Cine images were acquired using retrospectively gated bSSFP sequence with short periods of breath-holding in three left ventricular (LV) long-axis (two-chamber, three-chamber and four-chamber) planes. The ventricular two-chamber and four-chamber planes were used to plan contiguous stack of short-axis slices covering entire LV. The in-plane resolution of cine images was 0.9 mm × 0.9 mm, slice thickness of 8 mm with a 2-mm interslice gap and 25 phases per cardiac cycle.

2.3. Volumetric analysis

Volumetric analysis was performed using vendor dedicated software (Syngo.via, Siemens AG Healthcare Sector, Erlangen,