Recent Updates of CMR (II): Motion, Perfusion, and Mapping

SY23-1

Prognostic value of Perfusion CMR

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Perfusion cardiac magnetic resonance (CMR) using adenosine stress has established as a non-invasive diagnostic tool with high accuracy for inducible myocardial perfusion defect. In addition, it has no radiation hazard or attenuation artifacts compared with radioisotope study. Combination of perfusion CMR with or without late gadolinium enhancement (LGE) or cine MRI has many significant and independent prognostic factors in several clinical situations. In the different scenarios, including in the emergency department, in detecting complications due to or after revascularization, in the prediction of myocardial recovery, in the non-ischemic cardiomyopathy, and in the risk stratification, perfusion CMR has the important roles and significant prognostic values.

The automation for quantification of perfusion defect and other the advances of CMR techniques will make the perfusion CMR more convenient and more accurate tool for myocardial perfusion analysis.

Keywords : Perfusion, Cardiac, MRI, Prognosis

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SY23-2

Regional wall motion analysis: From cine MRI to feature tracking

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The assessment of left ventricular (LV) function is the important component of a cardiac imaging study. However, global measures, such as left ventricular ejection fraction (EF), may not be sensitive enough to detect subtle changes in LV function. Cardiac strain is a sensitive measure of deformation and measurements of strain are becoming increasingly popular in both clinical and research environments.

LV myocardial systolic strain and deformation parameters are altered during early-stage disease pathogenesis and can be measured using cardiovascular magnetic resonance (CMR). Tagged-CMR, in which magnetization saturation bands arranged in a grid format are placed onto the myocardium, is now an established method for the assessment of regional LV function. However, myocardial tagging has not been widely adopted due to the necessity for additional scans and complex, time-consuming post-processing. Recently developed feature tracking software allows for the measurement of myocardial strain using CMR cine images. The software tracks endocardial and epicardial borders across frames to quantify the LV wall motion during the cardiac cycle. CMR-derived feature tracking methods are vendor-independent and thus do not require additional sequences. Furthermore, feature tracking-derived measurements of circumference exhibit acceptable inter-observer reproducibility and feature tracking-derived myocardial strain can predict acute myocarditis with high sensitivity and specificity.

Their value in the early detection of LV systolic dysfunction has been demonstrated in several settings, such as coronary artery disease, post myocardial infarction, aortic stenosis and myocarditis. This presentation will illustrate regional wall motion analysis including tagged CMR and feature tracking method using CMR and the role of myocardial strain in various forms of diseases.

Keywords : MRI, Heart, Feature tracking

Recent Updates of CMR (II): Motion, Perfusion, and Mapping

SY23-3

Routine CMR Including T1 Mapping and 4D Flow

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Cardiovascular MRI (CMR) plays an important role in cardiovascular imaging. Specifically, late Gadolinium enhancement (LGE) is a unique index for myocardial fibrosis. In addition, myocardial T1 mapping has recently become available for clinical scanners. Pre-contrast T1 mapping, called native T1, has been reported to be useful for evaluating myocardial tissue. For example, it is valuable for distinguishing Anderson-Fabry disease from other entities of hypertrophic cardiomyopathy (HCM) by detecting the elongation of T1 with exceeding accumulation of a particular type of fat, called globotriaosylceramide. Modified look-locker inversion recovery (IR) (MOLLI) is commonly used for T1 mapping. MOLLI has excellent precision; however, it is sensitive to magnetization transfer and T2 values. Counterpart techniques using saturation recovery (SR) or a combination of IR and SR (e.g., SASHA or SAPHHIRE) require further development but have the potential to provide more accurate measurements.

Another type of T1 mapping using SR, called the Saturation Method using Adaptive Recovery Times (SMART1map, GE Healthcare), was recently developed. This technique has the advantage of a single-echo acquisition with a long saturation time used to calculate the true T1 value. We obtained averaged T1 values of myocardium in healthy individuals in approximately 1240 msec in a 1.5 Tesla and in 1530 msec in a 3.0 Tesla scanner using this method, and a significant difference was found between the myocardial T1 values of healthy individuals and HCM patients.

CMR examinations are time consuming. It is necessary to shorten the scan time by employing new sequences in clinical study protocols. Three-dimensional data acquisition, the k-t technique and compressed sensing have the potential to accelerate CMR. The 3D cine with the acceleration factor of 7.7 is available, using ‘k- and adaptive-t auto-calibrating reconstruction for Cartesian sampling (kat-ARC)’. With this technique, it is possible to cover the entire the left ventricle in one breathhold during cine imaging. In our initial experience, the functional parameters and wall motion evaluation were interchangeable between conventional 2D and kat-ARC 3D cine. Compressed sensing is a technique used to generate an image with higher resolution from sparsely sampled data. This technique enables conducting cervical MRA in half of the time without image degradation.

Four-dimensional flow is another method for visualizing the blood stream and evaluating the shear stress of the vessel wall. For example, in patients with pulmonary hypertension, several reposts have revealed a good correlation between mean pressure and the duration of the vortex observed in the main pulmonary artery. The 4D flow technique can also be used for cine imaging of the entire heart, and it could contribute to the automatic analysis of function parameters. The acquisition of 4D flow is time consuming due to the large volume of image data; however, it is now possible to perform 4D flow in 5 minutes by using the kat-ARC technique. The acceleration of image acquisition is a key technique for the next generation of CMR.

Keywords : Cardiovascular MRI, T1mapping, 4D flow, 3D imaging