

Heart Failure: what you need to know

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Background

Chronic heart failure is a leading contributor to the high mortality of cardiovascular diseases and it is the single most common cause for hospitalizations in the elderly population.

While secondary cardiomyopathies may present in a versatile fashion, primary cardiomyopathies represent a group of relatively well described disorders, changes and presentations with an often hereditary background. Thus family screening of individuals not presenting with any symptoms does play a role to be able to identify those who may eventually develop the disorder and may benefit from prevention measures.

The vast majority of heart failure patients though suffer from coronary artery disease (CAD), arterial hypertension or secondary cardiomyopathies. Overall these diseases either are based on primary changes of the myocardial texture with secondary dysfunction or a primary normal myocardial composition may be altered by external influences such as fibrosis, necrosis and storage disorders.

The use of MR imaging in heart failure patients thus may also need to use versatile techniques and applications to be able to highlight the various facets of the potential underlying disease. And MR techniques may also play a major role in the therapeutic decision by identifying patients that may benefit from a certain therapy.

Current MR Imaging strategies

In assessment of heart failure the following points are of major interest in the focus of MR imaging strategies:

- Evaluation of cardiac function and the longitudinal follow-up of function
- Assessment of underlying pathologies

The level of cardiac function impairment in patients with heart failure is a strong predictor of outcome and therefore a valuable tool for therapeutic planning. Evaluation of systolic function based on Cine SSFP techniques is well established and is the accepted standard of reference.

While the evaluation of cardiac function is thought to determine the current level of compromised cardiac function, the latter attempts to identify the possible underlying reason for the functional deterioration.

The widespread use of delayed enhancement MR Imaging (DE MRI) gives insight into the myocardial interstitium that has been largely invisible for us before. However while in myocardial infarction DE MRI can be used pretty straight forward, other underlying reasons for cardiac failure (e.g. cardiomyopathies, pressure related changes, inflammatory and infectious diseases, toxic diseases) may not be identified as accurately as findings of DE MRI may be relatively unspecific if not totally absent.

Potential Future MR Imaging Strategies

In early changes of heart failure diastolic function (e.g. ventricular filling and filling hemodynamics) may already show pathologic changes while systolic function is preserved. Tissue Doppler Imaging (TDI) has gained widespread use in echocardiography for evaluation of systolic and diastolic functional parameters. MR imaging allows monitoring of basic parameters of ventricular filling by phase contrast

(PC) techniques at the level of the mitral valve, the applicability of advanced techniques though such as Tissue Phase Mapping (TPM) still lacks.

As mentioned above histopathology may identify typical changes of the array of cardiomyocytes, myocardial texture, tissue replacement or depositions. Sensitive MR imaging techniques to identify composition changes or MR evaluation of the myocardial fiber structures and diffuse myocardial fibrosis may therefore add on valuable information for early and accurate diagnosis, or even may allow ruling out hereditary diseases. Based on early diagnosis, therapeutic options may be more flexible.

Possible areas of improvement

In some areas potential MR solutions have already been explored while other necessary applications may require total new developments:

- Applicable techniques for 3D motion analysis of the heart/myocardium
 - Evaluation of cardiac filling, output and myocardial contraction
- Improved contrast mechanisms for DE MRI
 - Sensitive “fibrosis mapping”
- In-Vivo DTI of myocardial fiber structures
 - Heart muscle “fiber imaging”

Background Information

1. Yu CM et al. Tissue Doppler Imaging, A new prognostic indicator for CV Diseases. JACC 2007: 1903-1914
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3. Iles L et al. Evaluation of Diffuse Myocardial Fibrosis in Heart Failure with Cardiac Magnetic Resonance Contrast-Enhanced T1 Mapping. JACC 2008: 1574-80