Specialty Area: Recent Innovations in Cardiac MR: Techniques to Image Cardiac Function

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Highlights:

- Heart shape and motion can be precisely and accurately quantified from cine cardiac MRI
- Comparable strain measures can be obtained from tagging, feature tracking, or DENSE imaging
- Torsion is a useful index of cardiac function, but should be calculated in a standard way
- Atlas-based analysis can give additional clinical information not available otherwise

Target Audience: Clinicians seeking to apply the latest cardiac MRI methods to patients, and engineers/physicists seeking an understanding of how MRI provides insight into the mechanical function of the heart.

Outcome/Objectives: Cardiovascular MRI can provide detailed information on the function of the heart. This talk will give course participants an overview of current methods used to evaluate cardiac performance on a global and regional level. In particular, similarities and differences will be highlighted between the various methods available for quantifying myocardial strain, and atlas based methods for quantifying variation between patient groups.

Methods: The standard clinical assessment of global pump function comprises sequential 2D breath-hold cine steady state free precession (SSFP) imaging in multiple slices covering the heart. MRI enables a variety of imaging protocols for the detailed analysis of myocardial strain. The tomographic nature of MRI data lends itself to building 3D atlases of cardiac function. One study, the Cardiac Atlas Project, has combined data from several sources to construct registered maps of regional cardiac function (1). These statistical atlases of shape and function enable automatic characterization of clinical shape and motion abnormalities (2).

Results: Atlas based methods have been used to examine the shape differences between individual born pre-term, and those born at full term. Similarly, in the MESA study, significant differences have been found in heart shape due to gender, smoking habits, and hypertension. In the area of strain imaging, DENSE and SPAMM showed similar ability to quantify non-homogeneous strain in a deformable phantom, but better reproducibility in radial strain was obtained with DENSE imaging in healthy volunteers (3). However, the advantages and disadvantages of each method in particular clinical applications remain to be demonstrated.

Conclusions: Cardiovascular MRI offers a variety of techniques for the evaluation of cardiac performance. The high accuracy and precision of MRI, combined with the ability to image all areas of the heart with equal fidelity and provide a variety of contrast mechanisms, have led to an increasing reliance on MRI in research and clinical studies.

References

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