Qualitative myocardial perfusion by CMR: principles, techniques and artifacts.

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Introduction:

Patients with typical angina or those deemed to have a high pretest likelihood of ischemic heart disease (IHD) are referred for invasive coronary angiography. This remains the gold standard technique for assessing coronary disease and is the mainstay of diagnosis and management. In patients with an intermediate pre-test probability of IHD, myocardial perfusion imaging has a central role. It is widely used as the 'gatekeeper' for angiography. While invasive coronary angiography assesses coronary anatomy, luminal stenoses & occlusions, it does not assess myocardial perfusion. Perfusion imaging attempts to assess myocardial blood flow either qualitatively and/or quantitatively and implies upstream obstruction coronary disease. Patients with a negative test have a low risk of future ischemic coronary events (usually quoted as <1% in the next 12 months) those with a positive test will be managed medically or be referred for angiography with a view to re-vascularization. The generic benefits of perfusion imaging over invasive angiography are reduced patient risk and reduced health care cost. Patient risk, however, is only reduced when the technique has a low false-negative rate and cost is only reduced when false-positives are kept to a minimum. Multiple myocardial perfusion techniques are described using different modalities, unfortunately no one technique is perfect.

All perfusion techniques rely on the same basic principles:

1. Use an exogenous tracer to detect myocardial blood flow and so allow assessment of perfusion.
2. Assess myocardial perfusion at rest.
3. Physiologically stress the heart.
4. Re-assess myocardial perfusion during stress.

Depending on the constraints of the technique, stress is achieved by exercise, by using a pharmacological stress agent or a combination of the two. In the clinical arena, different modalities use different tracers to assess myocardial perfusion; SPECT and PET use radiotracers, CT uses iodinated contrast media, echocardiography uses micro-bubble contrast media and MRI uses a variety of mechanisms but predominantly uses gadolinium-based contrast media. Some of the difficulties of perfusion imaging are generic and span all modalities, ie. quality of stress; some are modality specific ie. non-linearity of signal response to contrast concentration.

Presentation:

This presentation will focus on:

1. Principles of myocardial perfusion imaging as applied to MRI with reference to other techniques.
2. The practical clinical application of current MRI techniques in a busy CMR unit.
3. Maximizing the quality of pharmacological stress.
4. Recognizing pitfalls and avoiding artifacts.

Learning Objectives:

At the end of the presentation attendees will understand the principles behind current approaches to CMR myocardial perfusion imaging, will understand the strengths and weaknesses of CMR relative to other techniques, will recognize common artifacts and pitfalls in CMR myocardial perfusion imaging and learn how to avoid them.

Further reading:

1. Gould KL. Does Coronary Flow Trump Coronary Anatomy? J Am Coll Cardiol Img 2009;2:1009-1023

2. Berman et al. Roles of Nuclear Cardiology, Cardiac Computed Tomography, and Cardiac Magnetic Resonance: Noninvasive Risk Stratification and a Conceptual Framework for the Selection of Noninvasive Imaging Tests in Patients with Known or Suspected Coronary Artery Disease. J Nucl Med 2006;47:1107–1118

3. Hamon et al. Meta-analysis of the diagnostic performance of stress perfusion cardiovascular magnetic resonance for detection of coronary artery disease. J Cardiovasc Mag Res 2010;12:29

4. de Jong et al. Diagnostic performance of stress myocardial perfusion imaging for coronary artery disease: a systematic review and meta-analysis. Eur Radiol 2012; 22:1881–1895