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Advances in Cardiac Imaging: Cardiac Magnetic Resonance Imaging

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Editorial

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Editorial

Cardiac Magnetic Resonance Imaging (CMR) is an important noninvasive tool for diagnosis of several heart diseases. Using this single tool with various sequences, allows defining cardiac anatomy and function, myocardial perfusion, myocardial viability, and coronary artery anatomy [1].

However, CMR was considered difficult test, taking long time and requiring good patient's compliance with unpredictable results.

Recently, advances in different CMR techniques, with increasing magnetic field strengths and surface coil channels, rapid k-space sampling, post-processing techniques, and sophisticated sequences for myocardial characterization, have had a spectacular effect on cardiac MR applications, bringing back the attention about its diagnostic power [1].

Magnetic resonance imaging (MRI) of the heart has several advantages; MRI has good spatial resolution that can help in evaluation of even subtle abnormalities. Currently, it also has good temporal resolution that helps in evaluating and quantifying dynamic events with high accuracy. An unrivaled feature of MRI is the ability to perform tissue characterization; using its inherent contrast brought out by different sequences and also by administration of intravenous contrast. MRI can detect and quantify several different tissues including normal myocardium, fibrosis, scar, edema, iron, and amyloid. It has wide field-of-view, multiplanar imaging and reconstruction capabilities that help in visualizing not only cardiac but also extra cardiac abnormalities.

It is a noninvasive exam, and there is no exposure to ionizing radiation. That is why CMR is very safe and no long-term ill effects have been demonstrated [2].

Disadvantages of the MRI include the tight space of some MRI machines which can be problematic to individuals with Claustrophobia (about 2% of patients), but mild anxiolysis is often effective. One of the most important safety issues for CMR is the prevention of introduction into the scanner area of ferromagnetic objects which can become projectiles. However, recently most of the metallic implants such as hip prostheses, prosthetic heart valves, coronary stents and sternal sutures present no hazard since the materials used are not ferromagnetic (although an artefact local to the implant may be present). Care is required in patients with many cerebrovascular clips however, and specialist advice is needed for such patients. Patients with pacemakers, implanted cardioverter defibrillators (ICD), retained permanent pacemaker leads and other electronic implants are not regularly scanned, although sometimes with specific precautions and arrangements they can be scanned successfully [3,4].

Various MRI sequences are used for CMR; Dark ("black") blood sequences utilize inversion recovery (IR) prepulse to null the signal from blood alone (double IR), for better definition of the anatomy, or from both blood and fat (triple IR) for better evaluation of abnormal high

signal in the myocardium due to inflammatory changes. Bright blood sequences are typically based on balanced steady-state free precession (b-SSFP) methods which are fast sequences used to acquire cine images for the heart in different planes. This is important for volumetric analysis and accurate measurement of left ventricular ejection fraction, and the degree of wall motion abnormalities. Post contrast images following administration of intravenous Gadolinium based contrast agent have a special importance as the early post contrast images can be used to assess myocardial perfusion and delineation of the vascular anatomy and late post contrast images (10 – 12 minutes) can be used for assessment of the focal areas of interstitial change, or myocardial fibrosis [2]. Phase contrast sequence is another sequence which is used to assess the flow direction, velocity and pressure gradients across cardiac valves, vascular structure and abnormal defects; like ventricular septal defect, atrial septal defect …etc [5]. Other sequences that can be used in specific indications are myocardial strain imaging which can be used to analyze the myocardial motion [6]. Pre and post contrast T1 mapping may be able to identify diffuse areas of microfibrosis [7]. T2 mapping recently used to detect regions of edematous myocardial tissue differentiating the acute from the chronic inflammatory changes as well as differentiating acute inflammatory changes from myocardial fibrosis.

CMR is very valuable tool in clinical practice for the diagnosis and management of diseases of the cardiovascular system. It plays an extremely important role in assessment of patients with congenital heart disease (CHD) because 3D contiguous data sets are very effective for the complete depiction of the pathological anatomy of both simple and complex CHD. Moreover, the lack of ionizing radiation is an important consideration when performing sequential studies in children and young adults. In coronary artery diseases (CAD), CMR opened new horizons in the evaluation of not only the anatomy of the coronary arteries but also the effect of the CAD on the myocardium and ventricular function in the acute and chronic settings. Recently, CMR is proving increasingly valuable in the identification and management of various types of cardiomyopathies including hypertrophic, restrictive and dilated cardiomyopathies as well as left ventricular non compaction, Arrhythmogenic right ventricular cardiomyopathy, cardiomyopathy associated with muscular dystrophies, siderotic cardiomyopathy and myocarditis. CMR plays an important role in the evaluation of cardiac tumors due to its inherent ability of tissue characterization in various sequences and also it is particularly helpful in determining the relationship of the tumor to normal intracardiac structures as well as its extension to adjacent vascular and mediastinal structures, infiltration into the pericardium, and surgical planning. In pericardial diseases, CMR has the advantage over the CT of being able to depict and quantify the functional abnormalities which may be associated with pericardial disease. Finally, CMR may play a complementary role in valvular heart disease with transthoracic echocardiography when the acoustic windows are poor and transesophageal approach is undesirable, or when results of echocardiography and catheterization are conflicting. Furthermore, CMR is a valuable tool for individual follow-up of the severity of regurgitant lesions and for quantification of the effects of valvular lesions on ventricular volumes, function and myocardial mass [8].

In conclusion, CMR with its recent advances in technique proved to have an increasingly important role in clinical practice not only in diagnosis but also in management of various cardiovascular diseases.

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