Cardiac Magnetic Resonance Imaging: The New Tool for Clinicians

ABSTRACT

Cardiac magnetic resonance imaging (cMRI) scan is rapidly becoming an indispensable tool for the management of various disorders. This technique has the advantages of good temporal and spatial resolution and no exposure to radiation. Various ischemic and non-ischemic conditions of the heart may be diagnosed with high sensitivity and specificity. This review article aims to introduce the clinicians to the various uses of cardiac MRI and its future potential.

Keywords: Cardiac, Contraindications, Gadolinium, Magnetic resonance imaging

How to cite this article: Paul R, Sarkar R. Cardiac Magnetic Resonance Imaging: The New Tool for Clinicians. Bengal Physician Journal 2018;5(2):7-9.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

Cardiac magnetic resonance imaging (cMRI) is an imaging technique that is now widely used for structural and functional assessment of the heart. Not only the myocardial disease but also intracardiac shunts may be diagnosed with the help of cMRI; pericardial diseases are also diagnosed with the newer, more sensitive MRI techniques. This technique allows for high spatial and temporal resolution in imaging and thus, accurate diagnosis may be obtained in most of the cases. Unlike Echocardiography, this is not much operator dependent or dependent on the acoustic window, and unlike computed tomography (CT) scan, there is no risk of radiation exposure.

Now, with recent advances in imaging techniques and software algorithms, cMRI can be used for not only structural diagnosis but also for prognosis in different cardiac diseases. More details will be given later in this article. As the evidence for benefit of cMRI is accumulating, different professional bodies are also incorporating this novel technique in their position statements. CMRI has been accepted in standard clinical protocols according to different guidelines. In the most recent 2018 American College of Cardiology (ACC) guideline on congenital heart diseases, cMRI has been mentioned as an important test for evaluation and follow up of conditions like coarctation of the aorta, congenital aortic stenosis, and tetralogy of fallot. Thus, clinicians should be familiar with this emerging technique as this is likely to be an indispensable tool in the near future.

Cardiac magnetic resonance imaging (cMRI) is now used in many advanced centers of India. A recent study from Bangalore depicted the usefulness of this technique in the Indian setting. Even myocardial iron overload and coronary anatomy could be studied. In another study from Hyderabad, valvular morphology in rheumatic heart disease could be assessed quite well by cMRI. Thus, clinicians in India are also becoming familiar with this new technique and can use it for daily clinical management.

This treatise is not meant to be an exhaustive discussion on all the uses of cMRI. In this article, the author aims to introduce the readers to the most common uses of cMRI and the usefulness of those techniques in daily patient care.

Technical Details

Cardiac magnetic resonance imaging (cMRI) may be done with both 1.5 T and 3 T machines. However, a dedicated cardiac RF coil should be used.

Contraindications

Presence of some metal implants or devices inside the body is generally considered a contraindication to MRI of any part of the body. But now, this view is changing. Many patients now get pacemakers or implantable cardioverter-defibrillator (ICD) devices which are MRI compatible. Also, there are some recent studies which have shown that the risk of a pacemaker or ICD dysfunction, even the old models, after MRI scan is not as great as it was once feared. There are safety measures, during the scanning procedure, which can be used to protect the pacemaker from the influence of the magnetic field. Another study of 2011 further showed that even cMRI can be safely done in patients with either pacemakers or ICD. However, these should only be done in centers experienced with cMRI.

Nowadays, many patients get artificial metallic heart valves and coronary stents. Most of these are considered to be absolutely safe for MRI scan, including cardiac MRI. However, there are certain technical details which have to be followed during MRI scanning. Those details can be obtained from the valve manufacturer product insert. Another valuable resource is http://www.mri-
Acute myocardial injury can be diagnosed by cMRI even before ECG changes or echocardiographic wall motion abnormalities appear. Another advantage is that cMRI not only shows the area of infarction but can also show the myocardial area, besides the infarct zone, at risk of damage. While actual infarct is seen as LGE, the at-risk myocardium is seen as high intensity in T2 black blood images.

In AMI, LGE can also give information about prognosis. The extent of LGE can predict the left ventricle (LV) ejection fraction after recovery and return of contractility. This is said to be a better predictor than cardiac enzyme levels. In chronic ischemic heart disease (IHD), the extent of LGE can predict the chance of success after revascularization. As the transmural extent of the LGE increases, the chance of recovery of myocardial contractility after revascularization decreases. Preoperative cMRI can also predict the likelihood of graft success before coronary artery bypass graft (CABG).

Linear gingival erythema (LGE) technique is also useful in the diagnosis of other causes of myocardial dysfunction like myocarditis (septal, subepicardial and basal enhancement), hypertrophic cardiomyopathy (junction of RV and septum enhancement), amyloidosis (diffuse enhancement) and endomyocardial fibrosis (biventricular enhancement). In myocarditis, the extent of LGE has been found to correlate with biopsy-proven inflammation of the myocardium. Thus, cMRI is emerging as a viable non-invasive option for diagnosis of myocarditis. In cases of dilated cardiomyopathy (DCM) or unexplained heart failure, often there is confusion whether the underlying etiology is ischemic or myocarditis. While the area of LGE in infarct follows a vascular territory, that of myocarditis will be diffuse. This is one important diagnostic clue.

One important use of cMRI is differentiation of hypertrophic cardiomyopathy (HCM) from athlete’s heart. In athletes, there may be some amount of LV hypertrophy due to physical training. This may often cause confusion during echocardiography as to whether HCM is present. But the distinction is important because athletes with HCM are forbidden from many sports. CMRI helps in this differentiation by accurate wall thickness measurement and features of LGE. Also, another emerging technique called T1 mapping can help in the diagnosis of HCM in contentious cases.

Cardiac sarcoidosis is another disease whose diagnosis is facilitated by cMRI. The LGE areas are predominantly basal and sub-epicardial. There is also a significant correlation between the extent of LGE and plasma brain natriuretic peptide (BNP) levels in sarcoidosis.

Another use of cMRI, which is growing very fast, is coronary MR angiography. Two specific indications where MR coronary angiography has important use are: coronary artery aneurysm and anomalous coronary artery. CT scan is still the preferred method for noninvasive imaging of coronary arteries in suspected coronary
Cardiac Magnetic Resonance Imaging: The New Tool for Clinicians

In summary, the following issues should be noted for cardiac MRI:

- Presence of devices like ICD is no longer considered an absolute contraindication to cardiac MRI.
- Cardiac magnetic resonance imaging (cMRI) can rival echocardiography in the noninvasive assessment of the myocardium.
- Use of contrast and LGE can further raise the diagnostic accuracy of cMRI.
- Cardiac magnetic resonance imaging (cMRI) can help in the diagnosis of the etiology and assessment of the prognosis in both ischemic and non-ischemic heart diseases.
- Especially for complex congenital heart diseases, cMRI is a valuable diagnostic tool.

REFERENCES

1. Captur G, Manisty C, Moon JC. Cardiac MRI evaluation of myocardial disease. BMJ Heart 2016;102:1429-1435.
2. Rajjah P. Cardiac MRI: Part 2, Pericardial Diseases. AJR 2011;197:W621-W634.
3. Knobelsdorff-Brenkenhoff F, Pilz G, Schulz-Menger J. Representation of cardiovasculat magnetic resonance in the AHA/ACC guidelines. Journal of Cardiovascular Magnetic Resonance 2017;19:70.
4. Stout KK, Danielis CJ, Aboulhosn JA, Bozkurt B, Broberg CS, Jack M, et al. AHA/ACC Guideline for the Management of Adults With Congenital Heart Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Coll Cardiol. 2018 Aug 10.
5. Antu OB, Bandekar K, Kamat N, Raj V. Cardiac magnetic resonance techniques: Our experience on wide bore 3 tesla magnetic resonance system. The Indian Journal of radiology & imaging. 2017 Oct;27(4):404.
6. Mutnuru PC, Singh SN, D’Souza J, Perubhotla LM. Cardiac MRI imaging in the evaluation of rheumatic valvular heart diseases. Journal of clinical and diagnostic research: JCDR. 2016 Mar;10(3):TC06.
7. Herzog B, Greenwood J, Plein S. CMR Pocket Guides. European society of cardiology. [Cited 2018 Sep 14]. Available online from https://www.escardio.org/Sub-speciality-communities/European-Association-of-Cardiovascular-Imaging-(EACVI)/Research-and-Publications/CMR-Pocket-Guides
8. Buendia F, Sánchez-Gómez JM, Sancho-Tello MJ, Olagüe J, Osca J, Cano O et al. Nuclear magnetic resonance imaging in patients with cardiac pacing devices. Rev Esp Cardiol. 2010;63:725-739.
9. Buendia F, Cano O, Sánchez-Gómez JM, Igual B, Osca J, Sancho-Tello MJ, et al. Cardiac magnetic resonance imaging at 1.5 T in patients with cardiac rhythm devices. Europace [Internet], Oxford University Press (OUP); 2011 Jan 11;13(4):533-538.
10. Karamitsos TD, Karvounis H. Magnetic resonance is a safe imaging technique in patients with prosthetic heart valves and coronary stents. Hellenic Journal of Cardiology. 2017 Dec 29.
11. Saeed M, Van TA, Krug R, Hietts SW, Wilson MW. Cardiac MR imaging: current status and future direction. Cardiovascular diagnosis and therapy. 2015 Aug;5(4):290.
12. Doltra A, Hoyem Amundsen B, Gebker R, Fleck E, Kelle S. Emerging concepts for myocardial late gadolinium enhancement-MRI. Current cardiology reviews. 2013 Aug 15(3):185-190.
13. Ricciardi MJ, Wu E, Davidson CJ, Choi KM, Klocke FJ, Bonow RO, et al. Visualization of discrete microinfarction after percutaneous coronary intervention associated with mild creatine kinase-MB elevation. Circulation. 2001 Jun 12;103(23):2780-2783.
14. Choi KM, Kim RJ, Gubernikoff G, Vargas JD, Parker M, Judd RM. Transmural extent of acute myocardial infarction predicts long-term improvement in contractile function. Circulation. 2001 Sep 4;104(10):1101-1107.
15. Kim RJ, Wu E, Rafael A, Chen EL, Parker MA, Simonton O, et al. The use of contrast-enhanced magnetic resonance imaging to identify reversible myocardial dysfunction. New England Journal of Medicine. 2000 Nov 16;343(20):1445-1453.
16. Hunold P, Massoudy P, Boehm C, Schlosser T, Nassenstein K, Knipp S, et al. Contrast-enhanced cardiac MRI before coronary artery bypass surgery: impact of myocardial scar extent on bypass flow. European radiology. 2008 Dec 1;18(12):2756-2764.
17. Baccouche H, Mahmoud H, Meinhardt G, Merber R, Voehringer M, Hill S, et al. Diagnostic synergy of non-invasive cardiovascular magnetic resonance and invasive endomyocardial biopsy in troponin-positive patients without coronary artery disease. European heart journal. 2009 Aug 20;30(23):2689-2697.
18. Rowin E, Manon MS. Cardiovascular Magnetic Resonance Imaging in the Assessment of Athletes with Heart Disease. [Cited 2018 Sept 15]. Available online from https://www.acc.org/latest-in-cardiology/articles/2016/03/10/12/50/cardi ovascular-magnetic-resonance-imaging-in-the-assessment-of-athletes-with-heart-disease
19. Ichinose A, Otani H, Oikawa M, Takase K, Saito H, Shimokawa H, Takahashi S. MRI of cardiac sarcoidosis: basal and subepicardial localization of myocardial lesions and their effect on left ventricular function. American Journal of Roentgenology. 2008 Sep;191(3):862-869.
20. Sakuma H. Coronary CT versus MR angiography: the role of MR angiography. Radiology. 2011 Feb;258(2):340-349.
21. Friedrich MG. The Future of Cardiovascular Magnetic Resonance Imaging. European heart journal. 2017 Jun 7;38(22):1698.