Expert Review of Cardiovascular Therapy

ISSN: 1477-9072 (Print) 1744-8344 (Online) Journal homepage: informahealthcare.com/journals/ierk20

# Acute chest pain syndrome: will MRI shake up cardiovascular care in the emergency room?

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**To cite this article:** Andreas Kumar & Matthias G Friedrich (2007) Acute chest pain syndrome: will MRI shake up cardiovascular care in the emergency room?, Expert Review of Cardiovascular Therapy, 5:2, 139-141, DOI: 10.1586/14779072.5.2.139

**To link to this article:** https://doi.org/10.1586/14779072.5.2.139

Published online: 10 Jan 2014.

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# Acute chest pain syndrome: will MRI shake up cardiovascular care in the emergency room?

'From a research tool used by mainly radiologists as little as 10 years ago, increased involvement of cardiologists into CMR research, the advent of improved hardware and development of highly sophisticated imaging sequences have turned CMR into what can be regarded today as the single most comprehensive imaging method in clinical cardiology.'

*Expert Rev. Cardiovasc. Ther.* 5(2), 139–141 (2007)

Cardiovascular magnetic resonance imaging (CMR) has come a long way. From a research tool used by mainly radiologists as little as 10 years ago, increased involvement of cardiologists into CMR research, the advent of improved hardware and development of highly sophisticated imaging sequences have turned CMR into what can be regarded today as the single most comprehensive imaging method in clinical cardiology. High spatial and temporal resolution images can be obtained in any orientation, and it has become the gold standard method for assessment of right and left ventricular volumes and function. The true strength of the technique, however, lies in its unique ability to provide the clinician with a noninvasive means of tissue characterization based on genuine tissue properties. Dedicated sequences are available to assess tissue alterations, such as hyperemia, edema, fibrosis, necrosis, perfusion and deposition of hemoglobin metabolites. CMR is the method of choice to assess the etiology of nonischemic cardiomyopathies and can deliver a comprehensive assessment in ischemic cardiomyopathy. It is a cornerstone of modern cardiovascular diagnostics for stable in- and out-patients. But will it ever reach the emergency room?

'It is a cornerstone of modern cardiovascular diagnostics for stable in- and out-patients. But will it ever reach the emergency room?'

A substantial number of patients enter and occupy the emergency rooms of North American hospitals daily with the complaint of chest pain. Only a minority of them has straight-forward ST-elevation myocardial infarcts, that can be recognized rapidly with history, an electrocardiogram (ECG) and a quick Troponin test. If the symptoms are less typical, the ECG does not show ST elevation and the Troponin is negative or borderline, a very wide variety of differential diagnoses come into play, including non-ST elevation acute myocardial infarction, pulmonary embolism, aortic dissection, myocarditis, pericarditis, aortic valve stenosis, stress-induced cardiomyopathy, hypertrophic cardiomyopathy and others.

CMR can make a valuable contribution to most of these disease entities, and it has been demonstrated to be safe in patients with acute chest pain [1,2].

Cine CMR covering the entire left ventricle can be performed in as little as two breath-holds and identifies regional and global wall

10.1586/14779072.5.2.139  ISSN 1477-9072 

motion abnormalities, major valvular lesions, such as aortic valve stenosis, as well as hypertrophic cardiomyopathy with or without left ventricular outflow tract obstruction. With state-of-the-art sequences, this information is typically obtained in two or three breath-holds.

In experienced CMR centers, it may take just a few more minutes to rule out ischemic heart disease: myocardial edema is a hallmark of acute tissue injury [3]; it develops early in the course of myocardial infarction and reflects the area at risk [4]. It can be imaged reliably by T2-weighted CMR sequences. In the absence of ST-elevation myocardial infarction, adenosine stress perfusion can be performed safely and has been shown to have a very high negative predictive value [5]. Finally, late enhancement imaging is the gold-standard method for *in vivo* assessment of myocardial infarction [6], and has been shown to detect small myocardial injuries involving less than 2 g of tissue [7], and smaller than those detectable by single photon emission computed tomography imaging [8]. Although not required to establish the diagnosis at this stage, a coronary angiogram could be added in selected cases. Recently, simplified protocols have been published [9]. Taken together, CMR has the potential to diagnose or exclude ischemic heart disease and myocardial infarction as a cause of chest pain in as little as 25 min of imaging time. Without any modifications, the same protocol will exclude pericarditis, which will reflect as pericardial thickening on the functional images and pericardial effusion on the T2-weighted images.

With minimal modification, the protocol can be used to rule out or confirm acute myocarditis, using T2-weighted images for visualizing edema [10] and contrast-enhanced images for inflammatory activity [10,11]. The late enhancement patterns allow for the discrimination of ischemic versus nonischemic injuries [10,12,13].

The two major differential diagnoses not yet covered are aortic dissection and pulmonary embolism. Aortic dissection can be diagnosed with straight axial T1-weighted spin echo sequences or a 3D angiogram [14], which can be obtained in two breath-holds. Pulmonary embolism would require a 3D angiogram [15]. This would increase the total amount of contrast applied to the patient to 1.5-times of what is usual in cardiac imaging. However, side effects with gadolinium diethylenetriaminepentaacetic acid are in the range of side effects of placebos.

In summary, a comprehensive imaging protocol could confirm or rule out most causes of acute chest pain and all life-threatening causes of acute chest pain with a maximum scan time of 45 min. In most patients the diagnosis would be obtained before the imaging protocol is completed, reducing the scan time even further. Moreover, patients with negative test results could be safely discharged after the CMR study.

'...a comprehensive imaging protocol could confirm or rule out most causes of acute chest pain and all life-threatening causes of acute chest pain with a maximum scan time of 45 min'

This approach would not only be fast, but also safe and cost effective. Although the initial investment for the purchase of a CMR scanner is substantial, the costs for a study are in the range of few hundred dollars, which is a fraction of the costs generated by a day of unnecessary hospital stay. Not only would the suggested approach lead to rapid identification and discharge of not critically diseased patients, it would also reduce costs by rapidly identifying the cause of chest pain and fast-tracking therapy and by decreasing delay times that would potentially be created by additional diagnostic tests. This, however, implies that dedicated chest pain CMR scanners would be available on-site, in the emergency rooms, to provide CMR without delays.

CMR provides the tools for a comprehensive diagnostic strategy for stable in- and out-patients on an unprecedented level. The time has come to include CMR into our thinking about acute care patients in the emergency room.

### Disclosure

Dr Andreas Kumar is a Canadian Institute of Health Research Strategic Training Fellow at TORCH (Tomorrow's Research Cardiovascular Health Professionals) at the University of Calgary. He is also supported by an unrestricted research grant from Siemens Medical Solutions, Erlangen, Germany.

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