Signal intensity enhances diagnostic capacity in myocardial infarction

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Over the past years cardiovascular magnetic resonance (CMR) imaging has become one of the most prominent noninvasive imaging modalities in cardiovascular medicine [1–5]. Using CMR imaging, a wide variety of diseases can be detected varying from coronary artery disease, myocardial viability, vein graft disease to congenital heart disease [6–18]. An interesting application of CMR is the detection and quantification of infarcted myocardium in humans and experimental animals by a technique called delayed-enhancement CMR [19–25]. With this technique a gadolinium CMR contrast agent is injected intravenously followed by a long interval in which the perfused area has lost the contrast, whereas the infarcted area has slowly gained some contrast and releases that contrast with a long delay. The infarcted area is “enhanced” by this delay and this in vivo determined infarct size has been found to correlate well with postmortem determined infarct size [26–28]. Particularly in non-transmural infarction the area

of late gadolinium enhancement correlated only weakly with the infarct size determined by perfusion scintigraphy [29]. The occurrence of microvascular obstruction causes dark zones in the area of late gadolinium enhancement as appearance of gadolinium is obstructed [30, 31]. Over time, the area of delayed gadolinium enhancement becomes progressively smaller due to scar formation and hypertrophy of surviving myocardium. These late gadolinium enhancement techniques use T1-weighted images and are used regularly in clinical cardiology and experimental research.

In this issue of the *International Journal of Cardiovascular Imaging*, Choi et al. [32] investigated to which extent useful information is present in T2-weighted images of porcine hearts with reperfused myocardial infarction. For over 25 years it is known that in the acutely infarcted heart the signal intensity in T2-weighted images correlates well with myocardial edema [33, 34]. This “edema imaging” on T2-weighted images was shown to be dependent of infarct age: edema-associated hyper-intense zones in T2-weighted images resolved over time and the area of T2 abnormality delineated the area at risk rather than the infarcted area [35]. In the present study [32], the left anterior descending artery (LAD) was occluded for 90 or 180 min followed by reperfusion for 90 min. In total 15 pigs were studied of which 9 pigs underwent 90 min of LAD occlusion followed by 90 min of reperfusion, whereas the other 6 pigs underwent 180 min of LAD occlusion followed by 90 min of reperfusion. The

Editorial comment at the article titled “Investigation of T2-weighted signal intensity of infarcted myocardium and its correlation with delayed enhancement magnetic resonance imaging in a porcine model with reperfused acute myocardial infarction” by Choi et al. doi:10.1007/s10554-009-9425-6.

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authors identified two groups of infarcts on the basis of the T2-weighted images: group A, infarcts with homogeneous and hyper-intensive signal intensity on T2-weighted images, and group B, infarcts with iso-, low-, or heterogeneous signal intensities on T2-weighted images. In group B infarcts, T2-weighted images exhibited about twice as large microvascular obstructions than the T2-weighted images of group A infarcts. The contrast ratios of T2-weighted images were inversely correlated to the area of microvascular obstruction observed in late gadolinium enhancement images. It has been shown that areas of microvascular obstruction are usually filled by hemorrhage due to microvascular damage [36, 37]. Choi and colleagues found an almost 1:1 relationship between area of microvascular obstruction and the area of hemorrhage. Previously, van den Bos et al. [38] reported that signal voids on T2-weighted images of reperfused infarctions in porcine hearts were due to the presence of hemorrhage. In addition, Choi et al. found a significant inverse correlation between contrast ratio of T2-weighted images and area of hemorrhage determined postmortem. However, T2-weighted images are not optimal for determination of infarct size as they overestimate infarct size determined by (1) late gadolinium enhancement imaging in vivo, and (2) triphenyl tetrazolium chloride staining postmortem.

Detection of intramyocardial hemorrhage, either by T2-weighted images or by late gadolinium enhancement imaging (or myocardial contrast echocardiography), has prognostic value [30, 31, 38]. Patients without hemorrhage showed significant improvement in wall motion score in the weeks after acute infarction, whereas left ventricular contractile function of patients with intra-myocardial hemorrhage did not improve at 1 month follow-up [38]. An advantage of the clinical use of T2-weighted images is the fact that T2-weighted imaging detects acutely infarcted myocardium better than chronic infarction, the latter being assessed best with late gadolinium enhancement imaging. Finally, the use of gadolinium-based CMR contrast agents is contraindicated in patients with renal insufficiency ($\text{GFR} < 15 \text{ ml/min}$) as it may precipitate nephrogenic systemic fibrosis [39]. Therefore, several indications exist to use T2-weighted images in the setting of the acute myocardial infarction. Whereas decreased T2-weighted contrast ratios significantly correlate with the extent of persistent microvascular obstruction and intra-

myocardial hemorrhage, contrast enhanced imaging may contribute to early detection of myocardial injury due to myocardial infarction. The study by Choi et al. [32] underscores therefore the diagnostic capability of CMR imaging techniques in patients with acute myocardial infarction.

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