Editorial

The emerging role of delayed contrast-enhanced magnetic resonance imaging in the peri-operative evaluation of patients undergoing coronary revascularisation

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This editorial refers to "Visualization and quantification of peri-operative myocardial infarction after coronary artery bypass surgery with contrast-enhanced magnetic resonance imaging" by J. Steuer et al. on page 1293

In this issue of the journal, Steuer et al. describe the application of delayed contrast-enhanced magnetic resonance imaging (MRI) for the identification, characterisation and quantification of peri-operative myocardial infarction. Contrast-enhanced MRI was performed 4–9 days after coronary bypass surgery. Hyper-enhanced myocardial areas, representing myocardial necrosis, were identified in 18 of 23 patients. Biochemical markers of myocardial damage including creatinine kinase (CK-MB), troponin I and troponin T correlated with the mass of infarction. Most of the patients demonstrated patchy distribution of necrosis suggesting global, peri-operative ischaemia. However, those patients with high post-operative CK-MB levels (above five times the upper reference level) demonstrated more localised areas of infarctions. These results demonstrate the potential role of delayed contrast-enhanced MRI in the understanding of peri-operative infarction.

The prognostic impact of cardiac enzyme elevations after percutaneous and surgical revascularisation is well known. These serum markers are very sensitive in the identification and quantification of necrosis but do not allow localisation of necrosis or description of its distribution pattern. Myocardial necrosis may be following the distribution of individual coronary arteries in a focal transmural and subendocardial pattern, or be found in a more diffuse, patchy distribution. The localisation and distribution pattern reflects the underlying mechanism leading to necrosis. Diffuse necrosis after surgical revascularisation is thought to be related to global ischaemia resulting from insufficient myocardial protection and cardioplegia. More focal necrosis is related to incomplete revascularisation in the distribution of individual arteries.

A reliable imaging modality, able to identify, localise, and quantify myocardial necrosis, could provide important information in the peri-operative management in patients undergoing coronary revascularisation. Delayed contrast-enhanced MRI is well validated in the identification of acute and chronic myocardial scar in animal models and clinical patients and has sufficient spatial resolution to differentiate patterns of necrosis. Transmural and subendocardial scar in the distribution of obstructed vessels can be differentiated, and more diffuse, patchy patterns of necrosis have been observed after coronary intervention. Semi-automated analysis tools allowing the assessment of extent and distribution pattern of hyper-enhanced areas have recently been described.

Based on these results, the current paper suggests that delayed contrast-enhanced MRI can provide important information complementary to the assessment of biochemical markers of myocardial damage. However, the clinical applicability of the study results is limited by the small patient population, which is highly selected according to several entry criteria. It should be noted that MRI was performed without the use of a dedicated cardiac coil, likely decreasing the sensitivity for the identification of small areas of necrosis. These limitations can be overcome in subsequent studies. However, there is a more fundamental problem related to the inability of delayed contrast-enhanced MRI to differentiate...
between acute and chronic infarction. In the study by Steuer et al., only patients without previous evidence of myocardial infarction were included. Therefore, any post-operative evidence of necrosis was assumed to be secondary to peri-operative injury. However, in clinical practice many patients undergoing revascularisation present with previous evidence of infarction. In these patients, the described imaging approach would only be valuable if pre- and post-operative MRI acquisitions were obtained. This would add a higher level of complexity to the analysis including standardised protocols for data acquisition, matching of myocardial segments, and (semi-automated) analysis.

Imaging with delayed contrast-enhanced MRI prior to surgical coronary revascularisation is an established technique to assess the distribution of myocardial viability. Because of its high spatial resolution, areas of subendocardial and transmural scar can be identified and this distinction has been shown to predict functional recovery after bypass surgery. A standardised protocol of pre- and post-imaging could provide a comprehensive myocardial assessment including evaluation of extent and localisation of viable and necrotic tissue prior to surgery and evidence of peri-operative necrosis following the procedure. A similar approach could be applied to patients undergoing percutaneous coronary intervention. Pre- and post-interventional delayed contrast-enhanced MRI could assess the appropriateness of revascularisation and interventional outcome, respectively. For example, a pattern of patchy necrosis after percutaneous coronary intervention has been shown to be related to distal embolisation of plaque material.

However, the independent predictive value of delayed contrast-enhanced MRI in the peri-operative and peri-interventional assessment of patients undergoing coronary revascularisation is incompletely understood and this exciting imaging modality will need to be validated in large, clinical outcome studies.

References