Management of coronary artery disease by cardiac magnetic resonance

To reduce deaths from AMI, early detection of CAD is required to treat patients. CMR provides excellent diagnostic performance, superior to that of established techniques such as scintigraphy. In addition, CMR is not limited by ionising radiation and therefore is ideally suited for the management of CAD, which requires repetitive examinations

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Coronary artery disease (CAD) is the number one cause of death in the Western world and approximately 60% of all cardiac deaths in the USA in 2004 occurred in patients before they got access to adequate in-hospital treatment (ie, deaths occurred in the emergency department or even before patients reached the hospital).[1] Thus, less than half of patients with acute myocardial infarctions (AMI) benefit from the latest improvements in in-hospital care. Consequently, early detection of CAD in its "pre-AMI phase" is crucial to initiate treatment of CAD before an AMI occurs, since mortality rate of AMI is still high, particularly during the time period before the patient reaches hospital care.

Efforts are undertaken to reduce the "time-to-needle", the time interval from onset of AMI symptoms to in-hospital treatment, and automatic external defibrillators are installed in public areas. While necessary, these emergency concepts do reach physical limitations and they require hospital resources (infrastructure and manpower) being reserved for emergencies and consequently not being available for regular cases, which decreases cost-effectiveness. By concentrating our healthcare efforts on the treatment of AMI, approximately 60% of patients do not benefit, as they die before they reach these treatment options.

How to detect CAD in the "pre-AMI phase"?

CAD causes symptoms such as angina pectoris (chest pain), dyspnoea or arrhythmias, particularly during exercise. However, according the latest US statistics in 2006, 50% of men and 64% of women who die suddenly from CAD had not had previous symptoms.[1] These numbers clearly indicate that concentrating healthcare efforts on symptomatic patients will miss more than half of the patients having CAD. Myocardial ischaemia and severe stenoses are linked to a high probability of plaque rupture and, thus, future AMI.[2] Accordingly, tests for detecting ischaemia or the presence of coronary artery stenoses, ideally in a noninvasive fashion, would provide the solution. In addition to noninvasiveness, these tests should show high diagnostic reliability, bring no harm to patients (since they have to be repeated to monitor the patient's health status over many years); in addition, they should be low in price and comfortable.

Both stress-echocardiography and single-photon-emission computed tomography (SPECT) demonstrate adequate sensitivity and specificity for CAD detection. However, stress-echocardiography shows some operator dependence and is limited in patients with suboptimal "acoustic windows". SPECT brings some radiation burden, which translates into an increased risk for cancer development. In the past years, cardiac magnetic resonance (CMR) has become a robust and clinically well accepted method. Quality of CMR images is independent of patient anatomy and it is not associated with ionising radiation, so it is repeatable. At the beginning of this century, several single-centre CMR perfusion studies documented a high performance of CMR to detect CAD,[3] which was confirmed in several multicentre CMR studies in Europe and the USA.[4] Finally, a large international programme, the MR-IMPACT (magnetic resonance imaging for myocardial perfusion assessment in coronary artery disease trial) was launched, which demonstrated superiority of perfusion-CMR over SPECT for the detection of CAD (significantly larger area under the receiver-operator characteristics [ROC] curve for CMR.[5,6] The availability of reliable and cost-effective tests will allow the detection of patients in the "pre-AMI phase" (ie, an active strategy will become reality by utilisation of CMR).

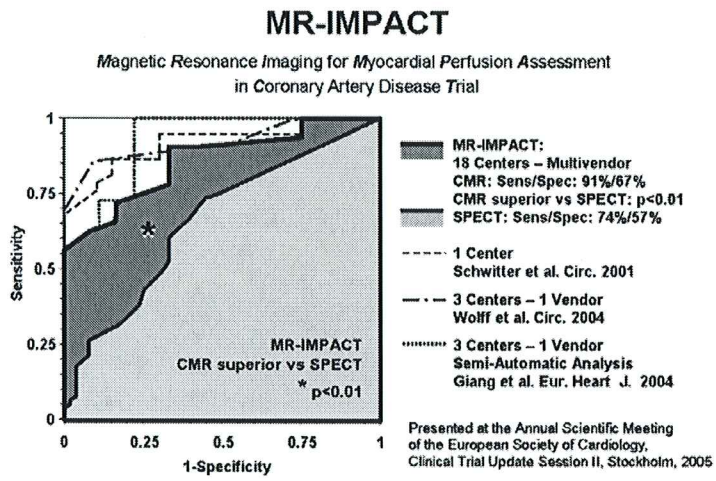

Figure 1.
Diagnostic performances are demonstrated by means of receiver–operator characteristics curves (ROC), which simultaneously evaluate sensitivity and specificity of a test over a range of thresholds. The larger the area under the ROC curve the better the diagnostic test. Recent international multicentre trials (MR-IMPACT) confirmed high CMR reliability of single-centre studies and demonstrated superiority of diagnostic performance over SPECT. The MR-IMPACT II with 33 centres recently confirmed CMR superiority (p<0.0001) also over gated-SPECT (Schwitter et al, Annual Scientific Meeting of the American Heart Association, Chicago, 2006)

The active strategy of detection and monitoring of CAD in the healthcare systems

In the END-study, the work-up of patients with suspected CAD was performed by SPECT or invasive X-ray coronary angiography.[7] This study convincingly demonstrated reduced costs of work-up (and two-year follow-up) by approximately 40% by means of SPECT with identical outcome. This END-study is likely indicating the beginning of an era where tests in a multicentre setting will be compared so that test performance can be objectively determined and, from that, cost-effectiveness can also be calculated (eg, by cost curves).

This information is invaluable in the light of the ongoing implementation of diagnosis-related groups in most countries in Europe and USA. As diagnostic performance for CAD detection is currently best achieved by CMR,[4-6] it might become the first-line test in the work-up of suspected CAD or in the monitoring of CAD.

While industry highlights the multidetector computed tomography (MDCT) performance for CAD detection, this technique is limited by several drawbacks such as limited diagnostic performance (about 40% dropout rate in the only multicentre trial available so far,[8] therefore not confirming single-centre

References
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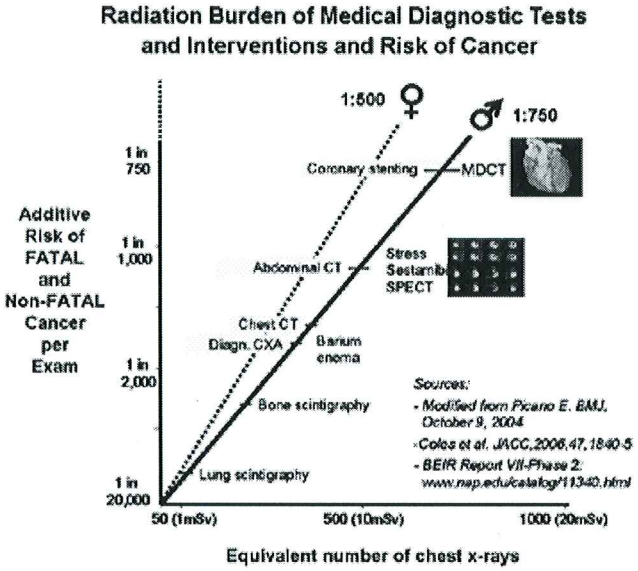

Figure 2.
The radiation burden for various medical diagnostic tests or interventions (on the x-axis) is related to the corresponding risk to develop solid cancer per exam (y-axis). MDCT for coronary artery imaging (MDCT) is related to one cancer/750 examinations in men. Women are more susceptible to ionising radiation, causing one cancer/500 examinations. Notably, the risk accumulates for repetitive examinations. While a similar cancer rate is given for coronary artery stenting and MDCT coronary angiography, this cancer rate for coronary stenting is acceptable because it is obtained in a population with severely compromised prognosis unless treated. This differs for MDCT coronary angiography, if utilised, for example, for exclusion of CAD in healthy individuals with a good prognosis (screening approach).

studies using the same technology), and more importantly, by its substantial radiation burden causing one solid cancer per 670 examinations based on cancer incidence per mSv (unit of radiation burden) reported in the most recent BEIR VII (phase II) report.[9] Consequently, future utilisation of tests will be based on test performance indices[10] (demonstrated by multicentre ROC curves) and their cost-effectiveness, which will also have to include costs for treatment of side-effects such as cancer. Public health services will most likely rely on these test features (as they will allow for a meaningful benchmarking between hospitals and private providers).

As high-end scanners should run at full capacity, this imaging service will most likely be provided by hospital policlinics or private networks. In parallel, the patients will have an increasing influence on this process of test selection, in particular in the private healthcare sector. To better involve the public into this discussion, it may be necessary to provide information on test side-effects, as suggested recently (see Figure 1). The information from multinational registries on test performances will be of utmost importance to permanently adapt healthcare resources allocation to the best and most cost-effective techniques available.[10] ●

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