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# Tomographic Imaging of Coronary Artery Disease using Computed Tomography versus Cardiac Magnetic Resonance: Concurring or Complementary to each Other?

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## Editorial

Currently, coronary artery disease due to atherosclerosis of the epicardial vessels remains the leading cause of death in Western societies. Traditionally, X-ray coronary angiography is regarded as the clinical gold standard technique for the diagnosis of the presence and extent of CAD. Current guidelines however, recommend the use of coronary angiography only in patients with ≥ 85% pre-test probability for obstructive CAD, where coronary intervention by PCI or CABG will be necessary [1]. In patients with intermediate pre-test probability between 15% and 85% on the other hand, non-invasive imaging techniques are preferable. In this regard, coronary computed tomography angiography (CCTA) and cardiac magnetic resonance (CMR) have emerged as promising non-invasive tomographic imaging modalities for the assessment of CAD.

The versatility of CMR provides the accurate assessment of myocardial function, perfusion, viability and if required strain and metabolism within a single examination and without radiation exposure for the patients. The accuracy of CMR is excellent due to its high spatial and temporal resolution and intrinsic blood-to-tissue contrast. In addition, its tomographic nature provides excellent comparability between perfusion and function in the corresponding myocardial segments. The foremost strength of CMR is the evaluation of the functional relevance of CAD. Hereby, regional wall motion and perfusion abnormalities, during dobutamine or vasodilator stress, respectively precede the development of ST-segment depression and angina, enabling the precise detection of functionally significant CAD [2]. In addition, a meta-analysis which systematically analysed stress CMR studies conducted in ≥ 11,500 patients and with a mean follow-up duration of ≥ 2.5yrs, found that patients with inducible ischemia by CMR exhibited a markedly higher risk for future cardiac events (odds ratio~7.7) [3]. Furthermore, the recent CE-MARC study for the first time in the current literature demonstrated the superior diagnostic accuracy of CMR compared to SPECT in a randomized manner [4]. An economic evaluation of this study, which used a decision analytic model to compare different diagnostic strategies in secondary care out-patients, showed that CMR is also a cost-effective strategy [5].

An example of the CMR scan of a young male patient with atypical angina, arterial hypertension and diabetes mellitus, but without history of vascular or coronary artery disease can be appreciated in Figure 1. Stress CMR during adenosine infusion exhibited inducible ischemia in the anterior-septal wall (a) during pharmacologic hyperemia, which was absent at baseline (b). Coronary angiography exhibited occlusion of the LAD (c), which was successfully treated by PCI and implantation of 3 drug-eluting coronary stents (d), resulting in complete resolution of clinical symptoms.

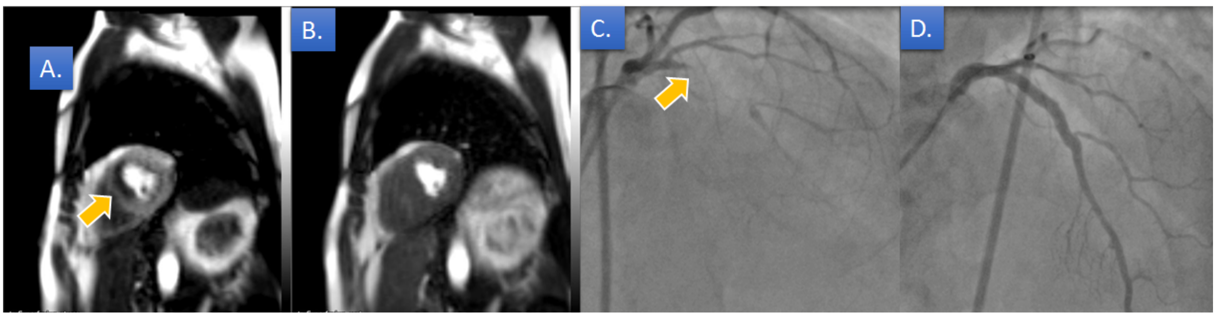


**Figure 1:** CMR images, demonstrating inducible perfusion defect of the anterior-septal LV wall during pharmacologic hyperemia with adenosine in (yellow arrow in a), which is not present at baseline (b). The patient underwent coronary angiography, where occlusion of the LAD was noticed (yellow arrow in c). Recanalization of the LAD was achieved by PCI and placement of 3 drug eluting stents with a good angiographic result (d).

CCTA on the other hand, provides non-invasive imaging of moving coronary arteries with sub-millimeter spatial resolution and high signal-to-noise ratio. The strengths of CCTA encompass the visualization of coronary calcification, lumen narrowing and atherosclerotic plaque composition. The great clinical strength of CCTA is it's to 'rule-out' obstructive CAD in patients at intermediate risk, whereas in patients with high pre-test probability its clinical value may be limited [6]. Therefore, recent guidelines recommend the use of CCTA rather in patients at low intermediate pre-test probability for CAD (between 15% and 50%), especially in candidates with low and stable heart rate and with therefore expected good image quality and in the presence of adequate technology and local expertise [1].

The recent SCOT-HEART multicentre trial included over symptomatic 9,500 patients with suspected CAD, who were randomly assigned to standard care plus CCTA or standard care alone [7]. In this study, CCTA clarified the diagnosis of angina secondary to coronary heart disease, enabling targeting interventions. In addition, a trend for cardiac event reduction was observed in the CCTA arm, which however did not reach statistical significance. This reduction of cardiac events was possibly attributed to changes in medical treatment and to the identification of patients with left main or severe triple vessel disease, who were subsequently referred for coronary revascularization. Furthermore, the recently published EVINCI trial included 475 symptomatic patients with intermediate pre-test probability for CAD, who randomly underwent CCTA versus functional imaging by SPECT, stress echocardiography or CMR [8]. Hereby, CCTA exhibited significantly higher precision compared to functional tests for the detection of significant CAD, using X-ray coronary angiography in combination with FFR as the reference standard. In addition, recent studies suggested the ability of CCTA to calculate the functional significance of CAD with the so called CT-FFR, using invasive FFR measures as the reference standard [9]. If the implementation of this technique in the clinical realm is successful in the future, this will possibly increase the diagnostic accuracy of CCTA even in patients with high coronary calcification [10]. In this regard, CCTA may in that case represent a true valuable alternative to functional imaging in patients with moderate to high pre-test probability for CAD, who nowadays usually undergo non-invasive functional testing or invasive angiography in combination with FFR measures.

The cost-effectiveness of CCTA for the diagnostic work-up of patients with suspected CAD was systematically evaluated in a recent meta-analysis, where CCTA represented a cost-effective diagnostic strategy for the evaluation of symptomatic patients with stable and acute chest pain [11]. In the last decade several strategies have been developed to reduce radiation dose with CCTA, including dose modulation techniques, prospective ECG triggering, low-tube voltage CT imaging and iterative reconstruction algorithms. All these strategies, helped to reduce radiation exposure down to <1 mSv in most patients who currently undergo CCTA.

In conclusion, CCTA and CMR are in the meanwhile both clinically established techniques for the diagnosis of CAD. Current guidelines therefore encourage their liberal use as first choice modalities for the diagnostic work-up of patients with low and intermediate likelihood for CAD. Technical developments with both tomographic imaging techniques CMR and CCTA will definitely help further increasing the precision of both techniques and reducing the radiation exposure with CCTA and will possibly define the most suited technique for the clinical imaging of CAD in the future.

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