Cardiac applications of multislice computed tomography

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Introduction

Coronary artery disease (CAD) is one of the leading causes of death in the Western world. There are 260,000 heart attacks in the UK annually and, of these, 112,000 people die. Screening high risk patients, i.e. those with risk factors such as family history of CAD, obesity, hypertension, hyperlipidaemia, diabetes, smoking and sedentary lifestyle is recommended. Any combination of these factors predisposes to CAD and warrants early diagnosis and prevention of treatment, as only 50% of the patients getting diagnostic coronary angiogram undergo angioplasty or bypass surgery.

Coronary angiography is considered the gold standard in diagnosis of CAD. It is, however, like any invasive procedure, not without complications and therefore cannot be used as a screening procedure. Evaluation of coronary arteries with intravascular ultrasound has also been promising but, as with angiography, it is invasive and costly. Therefore, the search for a non-invasive, accurate and safe form of imaging has led to interest in multislice computed tomography (MSCT).

Echocardiography has been promising for evaluation of cardiac function, wall motion and cardiac valve imaging. Atherosclerotic plaques can be identified in the great thoracic vessels and carotid arteries can be imaged. However, imaging of coronary arteries is not possible.

Cardiac imaging using nuclear medicine is useful for cardiac function, myocardial perfusion and viability of myocardial muscle. These imaging modalities are useful for functional assessment and imaging of perfusion patterns but cannot be used for cardiac and coronary artery morphology.

Magnetic resonance imaging (MRI) has shown promising results, both in the evaluation of cardiac morphology, function and myocardial viability using dynamic imaging technique. MRI has also proven very useful for imaging of coronary artery stenosis and imaging of coronary artery grafts. However, the long imaging times required and the lack of availability is a limiting factor for using MRI as a screening modality of choice at present.

Computed tomography (CT) using multislice technology has revolutionised and renewed the interest in this form of imaging as it has increased scanning speed and therefore reduced motion-related artefact. Multislice techniques have led to isotropic imaging and high resolution, artifact-free two-

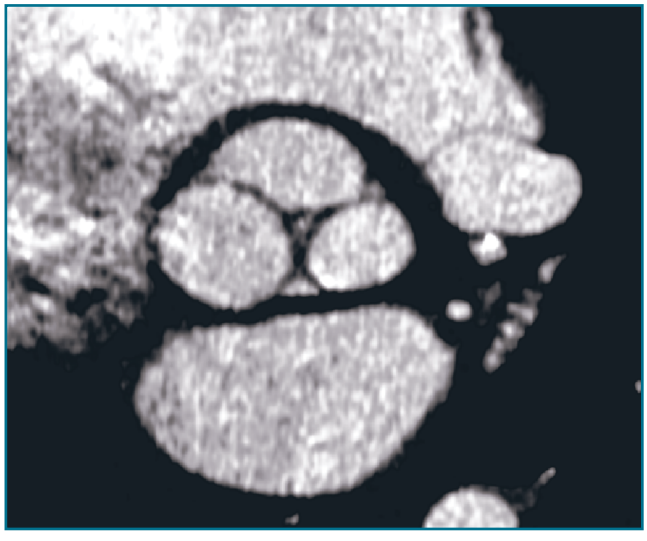

Figure 1. MSCT evaluation of the morphology of the aortic valve via ECG gating.

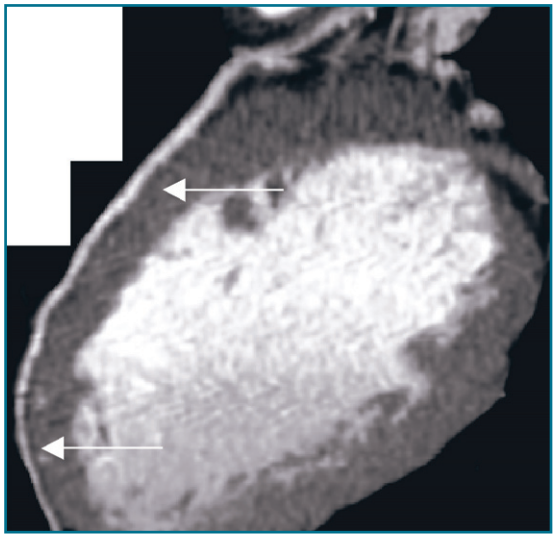

Figure 2. MSCT coronary angiography of the LAD.

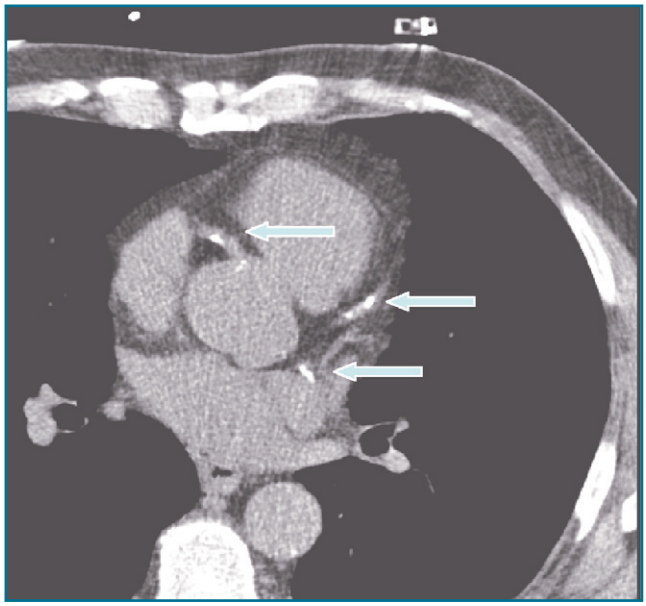

Figure 3. Heavy multi-vessel calcification.

Figure 4. Coronary CT scan shows mediastinal nodal calcification (arrow) misinterpreted as LAD calcium. The correct diagnosis was made on coronal reconstructions, often used for problem solving.

and three-dimensional reconstructions.

MSCT offers non-invasive coronary angiography and virtual coronary endoscopy. Reconstructing data obtained in multiple phases of cardiac motion can also provide valuable information on cardiac chambers, wall and valve motion/thickness and viability (see Figures 1, 2 and 5). CT angiography can evaluate patency of the coronary bypass grafts and can also detect high grade stenosis in the main segments of coronary artery branches with sensitivity and specificity approaching that of conventional coronary angiography.[1]

ECG-gated scanning offers coronary calcium scoring and, hence, effective screening for CAD (see Figures 3 and 4). Coronary artery calcium (CAC) scoring is another new technique that allows patients to be non-invasively assessed and the amount of coronary plaque quantified. The amount

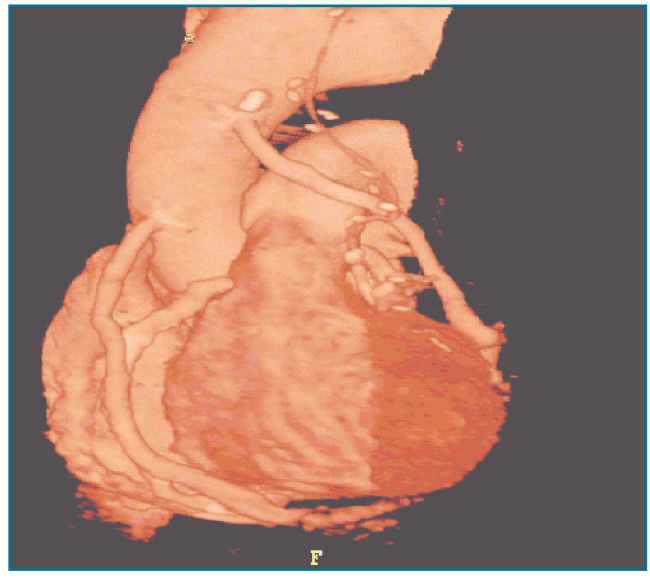

Figure 5. Contrast-enhanced CT coronary angiography.

of coronary calcium is related to the extent of coronary plaque disease, which has substantial diagnostic and prognostic implications. Approximately 50-70% of all plaques are calcified. CAC is a robust test with good interobserver agreement.[2]

A CT scan negative for coronary calcium has a high negative predictive value indicating absence of stenotic CAD and an excellent short- to mid-term prognosis. Studies using serial CT scans indicate that the annual progression of coronary calcium varies between 30% and 50% in symptomatic or high risk individuals and between 0% and 20% in patients treated effectively with lipid-lowering medication. An increased rate of progression of coronary calcium seems to indicate a substantially increased risk for adverse cardiac events.[2,3]

References

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