Atherosclerosis imaging and coronary calcification: the UK perspective

The comprehensive review by Dr Budoff in this issue (see pages 394–400) concerning atherosclerosis imaging and coronary calcium concentrates predominantly on electron beam computed tomography (EBCT).[1] Non-invasive coronary artery imaging can take the form of coronary artery calcium assessment or coronary angiography. Imaging can be performed with EBCT, or since 2001, with the latest generation of helical ('spiral') CT scanners (known as 'multislice' CT scanners in view of simultaneous acquisition of four image 'slices'). There are major differences between EBCT and multislice helical CT. Whereas with helical CT the patient is continually advanced through a rapid mechanically rotating gantry (X-ray source and detector array), EBCT relies on X-rays produced with an electronically steered electron beam.

Availability of CT in the UK

EBCT, the traditional source of cardiac applications, has gained little favour for non-cardiac scanning. In contrast, helical CT systems have been described as the 'workhorses' of general purpose scanning and are widely available.[2] There are more than 10,000 helical CT scanners in the USA, and just one manufacturer (General Electric Medical Systems) had already installed over 300 new multislice helical CT scanners by early 2001.[2] A similar pattern of increasing numbers of multislice helical CT scanners is also seen in the UK, with the NHS cancer plan assuring funding for 200 of these new, high specification CT scanners.

The manufacturer of EBCT scanners is now GE Medical Systems who acquired Imatron Inc. late last year. The EBCT scanner locations cited on www.gemedicalsystems.com (the company's website) show 78 sites throughout the USA and a further 57 worldwide. Currently there are only two EBCT scanners in the UK with a third due to be operational by September. There is, therefore, a marked disparity between the availability of multislice helical CT and EBCT worldwide. In the UK, this disparity in the relative availability of the two CT modalities is exaggerated to the extreme.

Electron beam CT

Limited access in this country dictates that EBCT is used predominantly as a research tool rather than a clinical tool. Despite this, some of the pioneering research concerning populations with coronary artery calcification has emerged from the UK.[3-8] The idea to modify coronary artery calcium quantification techniques initially to measure aortic wall calcification and, subsequently, aortic valve leaflet calcification using EBCT was originally described by Melina *et al.*[9,10] This technique has rapidly gained acceptance for quantification of aortic valve calcification outside the UK.[11,12]

The executive summary of the Health Technology Assessment of 1999 provided a comprehensive and systematic literature review of computed tomography, with particular reference to clinical applications including coronary artery disease.[13] Interestingly, the review found only scanty evidence relating to the health economics of CT. The overall conclusions drawn were that the evidence available supported EBCT use for population studies (for which it has been used in this country) but pointed out the low specificity when applied to the diagnosis of symptomatic coronary artery disease.

This has been an area of intense research in the intervening years and much of the data considered in Dr Budoff's review has been published since 1999.[1] There can be no doubting the high sensitivity that the detection of coronary artery calcium with EBCT has for the presence of significant coronary artery disease in those with symptoms. Despite the challenges to the ability of EBCT to predict significant stenoses with high specificity, the most recent American College of Cardiology/American Heart Association guidelines do support the use of EBCT in the symptomatic patient.[14] Utilising the prognostic ability and cost-effectiveness of EBCT to better risk stratify patients and direct therapy in an environment of widespread and extensive experience of the technique seems entirely appropriate.

This environment does not exist in the UK, so how can we adapt to this situation? There is a clear need for accurate non-invasive imaging. With the notable exception of the recent results published by Kim *et al.*, CT has generally been considered a more robust method of non-invasive coronary artery imaging than magnetic resonance imaging, and coronary calcium scoring can only be performed using CT.[15,16] The relative availability of the different CT modalities in the UK, a situation that is unlikely to change, should prompt us to consider the case for multislice helical CT.

Multislice helical CT

The temporal resolution (time required to acquire sufficient data to reconstruct a CT image) of helical CT is traditionally slower than EBCT.[1] However, recent advances in CT technology have led to the latest generation of helical CT scanners being promoted for non-invasive coronary artery imaging. It is the 'detector array' technology available in multislice helical CT scanners, along with more rapid gantry rotation and partial reconstruction algorithms with retrospective ECG gating, which have enabled effective improvements in temporal and spatial resolution. The rapid development of 8- and 16-slice scanners will further these improvements.

Despite the relatively short time since its first description, there is already excellent comparative multislice CT and invasive coronary (and graft) angiography data published for over 200 patients from four trials.[17-20] There are also advocates for multislice helical CT for coronary calcium assessment.[21] The lack of gaps/overlaps between slices of a multislice acquisition scan has led to the suggestion that multislice CT could improve the reproducibility of coronary artery calcium scoring.[2] Modest hardware (gating equipment) and software additions to the multislice helical CT machines being installed throughout the UK for general scanning purposes will make non-invasive imaging a realistic possibility for many UK hospitals in the near future. This equipment has the advantage of improving numerous CT applications as well as cardiac imaging.

The assumption that multislice helical CT coronary calcium scores equate with EBCT has been made and its use is becoming established in the USA. The evidence supporting this is currently sparse and care should be taken interpreting helical CT calcium scores by extrapolation of established EBCT data, as differences in sensitivity and specificity may exist. Care should also be taken with radiation doses. The technique of 'retrospective gating' (as opposed to prospective triggering with EBCT), which is common place in multislice helical CT coronary imaging, exposes the patient to more radiation than EBCT. However, the techniques for coronary angiography and calcium scoring using multislice helical CT do undoubtedly hold great promise. It has already been demonstrated that multislice helical CT can accurately differentiate coronary artery plaque morphology (in comparison with intracoronary ultrasound), which is of relevance to potential plaque rupture.[22]

Summary

For most UK cardiologists the place and role of EBCT has remained as controversial as it is unavailable. The controversy will no doubt continue but the availability of cardiac CT, in the form of multislice helical CT, is set to change. The early results of clinical trials and the imminent widespread availability of this technology dictate that further research to ascertain the appropriate clinical niche for this powerful new imaging tool is vital.

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