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Diagnostic Modalities Target CAD

Review of Technological Advances

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In recent years the development of new technologies across the range of imaging modalities has delivered most benefits to cardiovascular imaging. The result is a wide choice of modalities available to provide diagnostic and prognostic information on the presence and outcome of coronary artery disease (CAD). Imaging providers and ultimately payers have the task of defining a new diagnostic algorithm.

Visualising the Arteries and Identifying Stenoses

Conventional x-ray angiography was given a facelift in 2000 with the introduction of flat plate digital technology but was the patient already in decline? Conventional angio scans are falling as MR and CT 'slice' up the body between them: MR in the head and neck for cerebral and carotid studies, CT in the abdomen. Iliac/femoral studies comprise around half of all vascular investigations, while MR looked to have been the method of choice but lack of hardware in many sites may allow CT in. In the heart, x-ray angiography (cardiac catheterisation) remains pre-eminent but for how long? MR has problems in imaging cardiac vessels at resolutions high enough to be of clinical use, although this hasn't stopped sales of cardiac packages, which at €250k add as much as 20% of the price of a 1.5T MR unit. At the last RSNA meeting in Chicago, companies were pushing 64-slice CT as a potential alternative to image the cardiac vasculature.

Cardiac CT has been around for more than five years. As more slices have been added, it has become increasingly attractive. Patients pose a challenge due to irregular heart rates. Equally, the time needed to reconstruct and reformat the image dashed any realistic notion of patient throughput. Today a dataset, which from a 64-slice scanner may be 1,200 images, can be reconstructed and reformatted in less than ten minutes. Companies are now keen to stress that their scanners are fast enough to beat patient arrythmias. The Siemens Somatom Definition scanner launched at the RSNA is currently seen as the ultimate toy. Whether the 'dual multithread helical' scanner which has dual tubes and detectors is the future of CT is uncertain but others will need to match or better its specifications. By tailoring data collection to the cardiac cycle, dose is reduced by half that of a regular 64-slice scanner. The reported price ($2.7 -$3.2m) is twice that of a conventional 64-slice CT, but with a complete scan taking 5 - 6 seconds, 30 patients per day is achievable, bringing a cardiac CT angiogram in at a quarter of the price of a conventional study. Next year who knows. At the same meeting, Toshiba exhibited its (work in progress) 256-slice scanner which can image the heart in one beat.

Monitoring Perfusion

An alternative approach is to see how well myocardium is perfused. Functional imaging studies were traditionally used for pre-symptomatic patients or where there is less likelihood of severe CAD. Technetium or thallium scans performed using a nuclear medicine camera are the technique of choice. Popular in the US, it is less used in Europe and is hampered by issues of image interpretation.

Ultrasound or echo is restricted by a lack of regulatory approval governing the use of contrast agents which are the key to perfusion studies. MRI is a strong challenger but cost and siting has restricted its placement to specialist cardiac centres. PET using 13N ammonia is regarded as the gold standard but requires an on-site cyclotron although 82 Rubidium, which can be produced cheaply using a generator, has been suggested as a possible alternative.

Hybrid Systems

Manufacturers are promoting new generation dual modality scanners for cardiac imaging. Developed initially for oncology applications, PET/CT garnered most interest at the recent RSNA. However, it is difficult to envisage how a PET study will change outcomes in the majority of examinations where CT has also been performed. If the perfusion scan is only to check cases where CT is equivocal why not graft a nuclear camera onto a 64-slice CT? In Chicago, Philips was showing the 16-slice SPECT/CT Precedence, although others were less convinced of market potential.

Which Techniques will Suit?

In Western Europe the majority of patients present with angina, a small percentage are pre-symptomatic and enter the diagnostic algorithm because of predisposing factors; raised cholesterol, heavy smoking, abnormal ECG, etc. This varies from the US where pre-symptomatic patients comprise a far higher proportion of referrals. Both groups pose different challenges. The likelihood of coronary stenosis in the first group is high and the risk/benefit of radiation is low.

In pre-symptomatic patients the risk/benefit needs to take account of radiation dose in an outwardly healthy individual.

The cost of a diagnostic exam is primarily defined by equipment cost and throughput. Variable costs, primarily contrast agents and radiopharmaceuticals are an important item in some studies. PET/CT is expensive. Two patients per hour reflects an achievable throughput while radiopharmaceuticals are in excess of €400. 64-slice CT is cheaper as double the number of patients can be seen and contrast, at under €25, is cheap.

Safety is primarily related to radiation dose and favours ultrasound and MRI. PET and 64-slice CT deliver doses in excess of three times that of a chest x-ray and are less suited for repeated studies. The requirement for vascular intervention poses a small but finite risk in the case of x-ray angiography in addition to x-ray dose.

Where the likelihood is 1 in 100 of the patient requiring revascularisation, either a cardiac stent (PCI) or bypass graft

(CABG), perfusion studies can confirm the absence of disease but throw up many false positives. Together with true positives this requires around a quarter of patients to be followed up. The situation gets worse as prevalence increases. Over a third of patients will show positive if one in ten patients go on to have PCI – common for those attending chest pain clinics.

Modalities with sensitivity and specificity in excess of 90% are the choice when the incidence of disease is high but less sensitive tests may be attractive where incidence is lower and the test has other merits like safety or cost. Nuclear medicine, ultrasound and MRI are all contenders. Where the likelihood of disease is high, conventional angiography wins out. Where does this leave CT?

Sensitivity and specificity numbers are only starting to be published and a number of manufacturers are sponsoring multi-centre trials. In March 2006, GE announced a 20 centre trial along with bullish statements from trialists of the likely impact of CT on practice guidelines. It certainly seems likely that 64-slice will approach sensitivities and specificities of 95%.

What will Win Out?

There have been a number of false dawns. Four years ago manufacturers were pushing the merits of 4-slice CT for cardiac imaging while the cardiac potential of MR has been pushed since the mid-eighties. 64-slice does however appear to be the one. Despite problems with irregular heartbeats, radiation dose and calcified vessels, accurate diagnosis can be made in the majority of patients. Taking our pre-symptomatic population with an incidence of 1% requiring revascularisation, CT will identify 5% as positive requiring follow up. Follow-up choices are cardiac catheterisation or a perfusion exam, the latter to eliminate false positives.

If CT makes inroads then perfusion studies will lose out. In a study which we carried out in the last quarter of 2005, European nuclear medicine practitioners saw limited (<2%) growth in nuclear cardiac procedures. Diagnostic angiography is also threatened, reduced to the second choice modality for all but the seriously ill while MR's cardiac potential is outshone by the rise of CT. Providers, payers and patients may be winners, but only if modalities are used where most effective. A change in imaging mix could allow more pre-symptomatic patients to be followed up within the same budgetary envelope.

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