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## Volume 16 - Issue 3, 2016 - Cover Story

### Clinical Use of Coronary CT Angiography



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## CHANGE OF PARADIGM

During the last decades we have witnessed a tremendous progress in imaging technologies. Probably the most impressive results have been achieved in cardiac imaging. The landscape of diagnostic tools used for cardiovascular diagnostics has dramatically changed. All cardiovascular imaging technologies have improved, but the most spectacular changes have occurred in echocardiography, coronary and cardiac computed tomography (CT) angiography, cardiac magnetic resonance and hybrid modalities (position emission tomography computed tomography [PET - CT] and position emission tomography magnetic resonance imaging [PET -MRI]). These have moved from the area of research tools into routinely used ones.

Several trends in this area are obvious. First of all, progress of cardiac imaging is related to amazing improvements in scanning technology. In some ways cardiac imaging is a kind of 'probing stone' for scanners. For example, it is quite difficult to show improvements in diagnosis of pulmonary nodules using wide detector or dual-source scanners in comparison with 'traditional' low-end 16-row systems (here we are speaking about diagnostic accuracy, not radiation exposure to patients or image quality). In the case of cardiac computed tomography angiography (CTA), the difference for the better in the case of technically more advanced scanners is quite obvious.

It is interesting to note that the ability to detect and grade coronary stenosis performance of 'traditional' 64-row scanners in general is quite similar to newer and more expensive scanners. Latest trials have shown that neither coronary catheterisation nor cardiac CTA are perfect in grading coronary lesions into haemodynamically significant and not significant ones. First of all this fact concerns so called intermediate stenosis, causing luminal narrowing to 50-70 percent. This is why one of the major directions in cardiac radiology is functional imaging. In case of CCTA it can be done with the help of perfusion myocardial CT or noninvasive assessment of coronary blood flow. The last one could be done with help of CT fractional flow reserve (CT FFR) analysis or assessment of transluminal arterial gradient (TGA). Both these approaches (especially CT FFR) are promising tools for studies of coronary flow through stenotic lesions.

New generations of CT scanners can perform both CCTA and myocardial perfusion CT with fewer non-interpretable scans. It is their major advantage over standard 64-row scanners.

In the past results of CCTA in multiple single- and multicentre trials had been compared with invasive coronary angiography (ICA) using the latter as a 'gold standard'. Quite naturally CCTA was inferior to ICA in grading of coronary lesions. But after accumulation of a wealth of practical and scientific data, today we are witnessing a quite different situation.

In cardiology and cardiac surgery we are witnessing a rapid transition from the 'traditional' approach to grading of individual coronary artery lesions towards the 'modern' one, which is based on a combination of anatomy and physiology to determine the physiological consequences of coronary stenosis: does it cause myocardial ischaemia or not?

With the introduction and rapid evolution of invasive fractional flow reserve (FFR) technology, a new gold standard has been developed to invasively assess the physiological severity of a coronary artery stenosis. Several trials using FFR have demonstrated that ICA also has limited capabilities to determine the physiologic significance of intermediate (50-70 percent) coronary stenosis. In some recent trials it was shown that in case of head-to-head comparison of ICA with CCTA using FFR as a new reference, the diagnostic performance of both modalities for grading of coronary stenosis was comparable (Budoff et al. 2016).

What is even more important is that CCTA has the ability to see the vessel wall, to assess the structure of atherosclerotic plaques and even to detect (in some cases) the vulnerable plaques. CCTA provides three-dimensional imaging of the whole heart, including the myocardium, all the heart chambers and valves.

So it looks like the answer to the popular question: "When does CCTA replace ICA?" is "Tomorrow!". Why tomorrow, not today? As has been said earlier, even the best models of modern scanners still cannot provide artefact-free anatomical and physiological imaging in one hundred percent of cases, and most of them are not so common in public healthcare. Usually they are used in medical centres dedicated to cardiac imaging and research.

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But having almost 30 years' experience in cardiac imaging, I am quite enthusiastic about this transition. Let's look back: a long time ago (in the 1980s) both CT and MRI replaced catheter angiography for diagnostic workup of aortic disease. After the appearance of spiral and multislice CTA this modality practically replaced catheterisation in diagnosis of pulmonary thromboembolism, carotid and peripheral arterial disease. The next target is coronary imaging and we are almost there. Hunting for vulnerable plaques will continue and hybrid cardiac imaging (PET -CT, SPE CT-CT, MRI -CT) is steadily developing from a research tool into a clinical one.

Use of cardiac imaging is rapidly expanding and today we have plenty of scientific data providing us with reasons to use CCTA more widely in clinical routine. It is important to notice that CCTA has proven independent prognostic value and it can even improve patient outcomes (SCOT - Heart Trial) (Williams et al. 2016). Indications for use of CCTA are given in modern U.S. and European cardiological and radiological guidelines (one can refer to publications from the American College of Cardiology (ACC), Society of Cardiovascular Computed Tomography (SCCT), the European Society of Cardiology (ESC) and the American College of Radiology (ACR) - plus the recent iGuide from the European Society of Radiology (ESR). But it looks like even these modern recommendations and guidelines would be substantially changed and updated in favour of CCTA when some recent important trials of 2015- 2016 are taken into consideration.

Generally speaking, technical progress of CCTA in combination with rigorous research in this area has resulted in rapid transformed use of this diagnostic modality. Probably in the next few years we will see the situation when imaging of all vessels - big and small - will be done noninvasively with the help of CTA (or MRA) and ICA will move completely into the area of intervention (placement of stents, grafts, artificial valves, occluders etc.). It is going to be a 'win-win' situation both for physicians and patients because it will increase the number of right procedures performed rapidly and effectively for the right patients.

Published on : Thu, 25 Aug 2016