Novel CT-based imaging markers for high-risk coronary plaques

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Received 28 May 2012; accepted after revision 29 May 2012; online publish-ahead-of-print 25 June 2012

A large proportion of patients with suspected coronary artery disease who are referred for coronary computed tomography angiography (CTA) have coronary atherosclerotic lesions that do not cause significant anatomical luminal obstruction.1–5 These non-obstructive coronary artery lesions provide incremental prognostic information over the presence of obstructive lesions and clinical variables.1–5 However, the management of such lesions remains inadequately defined and there is a need for markers that could identify atherosclerotic plaques associated with high risk of events.

Coronary plaques that are vulnerable to rupture and subsequent vessel thrombosis have been termed as thin cap fibroatheroma (TCFA) and show morphological features similar to disrupted plaques.6 Based on autopsy studies, they have large plaque volume associated with positive remodelling of the vessel and large necrotic core that are covered by a thin fibrous cap.6 Clinical observations from the PROSPECT study by Stone et al.7 showed that the TCFA phenotype on radiofrequency intravascular ultrasound (IVUS virtual histology) imaging was associated with increased risk of recurrent coronary events after an acute coronary syndrome. Of non-culprit-lesion-related recurrent events occurring in the imaged segments, 51% occurred at sites with thin-cap fibroatheromas.7

Previously, plaque characterization by coronary CTA has been validated against other imaging modalities including IVUS virtual histology and optical coherence tomography (reviewed in ref. 8). Some features, such as large plaque size, low attenuation, spotty calcifications, and eccentric vascular remodelling have been associated with culprit lesions of acute coronary syndromes. In clinical studies, qualitative characterization into calcified, non-calcified (the so-called soft plaques with presumably a high lipid content), or mixed (i.e. plaques with calcified and non-calcified components) is the most common approach. Pundziute et al.7 reported an independent prognostic value of mixed plaque phenotype. Subsequent studies have identified non-calcified plaques with low computed tomography plaque attenuation and positive vessel remodelling as predictors of future acute ischaemic events.4,5,9

In this issue of EHJCI Papadopoulou et al.10 report the distribution and composition of coronary atherosclerotic plaques at 33 bifurcation lesions in 33 patients with IVUS virtual histology and coronary CTA in relation to the bifurcation angle. They found that the high-risk plaque phenotype defined by IVUS virtual histology was more common in the segments proximal to bifurcation than in bifurcation or distal to bifurcation. The high-risk plaques were characterized by CTA more commonly as non-calcified (72%) than mixed (28%) or calcified. The study extended the evaluation of bifurcation lesions beyond volumetric and compositional analysis by integrating information on the geometry of coronary bifurcations. Coronary arterial plaques are typically reviewed by CTA in either axial or multiplanar reformatted planes, as well as in curved multiplanar reformats allowing the definition of the bifurcation angle. Interestingly, a wide bifurcation angle predicted the presence of high-risk and non-calcified plaques in the proximal segment.

The findings of Papadopoulou et al. are consistent with the observations that local haemodynamic factors, in particular low endothelial shear stress, play a major role in the regional localization of atherosclerosis and promote the development of plaques with high-risk features, such as positive remodelling, large lipid core and inflammation.11,12 This can explain why these lesions form at specific regions of the arterial tree where there is disturbed flow, such as at the sites of coronary artery bifurcations.13,14 Once plaques start to obstruct the lumen, local biologic effects and mechanical stress exerted by high shear stress have been proposed to play a role in destabilizing the fibrous cap and even inducing plaque rupture.12

Determination of wide bifurcation angle is a unique possibility provided by 3D geometry in CTA images. Unlike compositional analysis of plaques, it is not heavily dependent on spatial resolution of images. Provided that its independent association with a high-risk plaque phenotype is confirmed in larger series, it could have important implications on both identification of high-risk plaques by CTA and planning of interventional strategies.
Funding
The authors acknowledge financial support from the Academy of Finland Centre of Excellence on Molecular Imaging in Cardiovascular and Metabolic Research, Helsinki, Finland and Finnish Foundation for Cardiovascular Research.

Conflict of interest: none declared.

References