Anatomical plaque imaging with CT angiography

Eun Ju Chun

Associate professor| Department of Radiology. Seoul National University Bundang Hospital

With remarkable development of CT technique, coronary computed tomography angiography (CCTA) can visualize atherosclerotic lesions in the vessel wall in contrast to "lumenography" performed by invasive coronary angiography (ICA). Therefore, the ability to interpret CCTA images beyond the coronary lumen and stenosis is of utmost importance because it enables therapeutic interventions stratified on the basis of plaque characteristics.

The likelihood of plaque rupture has known to be based on plaque composition. In ROMICAT I and II trials, high-risk plaque detected on CCTA can predict the acute coronary syndromes independent of significant coronary artery disease (CAD) and clinical risk assessment. Several recent studies have reported low-attenuation, positive remodeling, napkin-ring sign and spotty calcifications as a feature of high-risk plaques.

To identify the low attenuated plaque, a regional of interest was set within each plaque and to calculate the plaque density. Until now, however, there have been various mehods of measuring LAP and cut-off levels for each study without an agreed guideline. Rupture-prone plaques might not lead to significant luminal narrowing, owing to the effect of positive remodeling. Positive remodelling means the compensatory enlargement of the vessel wall that occurs at the site of the atherosclerotic lesion as the plaque size increases, resulting in the preservation of luminal area. In histopathology, positive remodelling is associated with the abundance of macrophages and increased necrotic core. CCTA can measure the outer vessel wall calculated as the vessel cross-sectional area at the site of maximal stenosis divided by the average of proximal and distal reference segments' cross-sectional areas. Usually, a remodelling index threshold of ≥1.1 was defined as positive remodeling. A napkin-ring sign was characterized by a plaque core with low computed tomography attenuation surrounded by a rim-like area of higher attenuation. It seems to be a specific feature of plaque with a large necrotic core although its sensitivity is low. The spotty calcification was defined as < 3mm in size of CT density of over 130 HU within the plaque. However, there is controversy whether such calcification reflects the vulnerability of the plaque in some studies.

Although CT has the ability to reflect the plaque composition, a substantial overlap between the attenuation values of lipid-rich plaques and fibrous plaques hamper an accurate differentiation of

each plaque with conventional single energy CT (SECT). However, the introduction of the dual-energy CT (DECT) is expected to overcome these limitations and allow for improved plaque differentiation. Using this, the precise material basis pair and/or level of monochromatic energy required to obtain the advantage in plaque characterization should be established in future studies.