

CT-based plaque characterization in the DISCHARGE trial

This definition is meant to help reading for plaques in DISCHARGE and filling in the related eCRFs. Any suggestions can be addressed to Pál, Robert, and Marc.

1 General Description of Standard Plaque Features

Calcified plaque



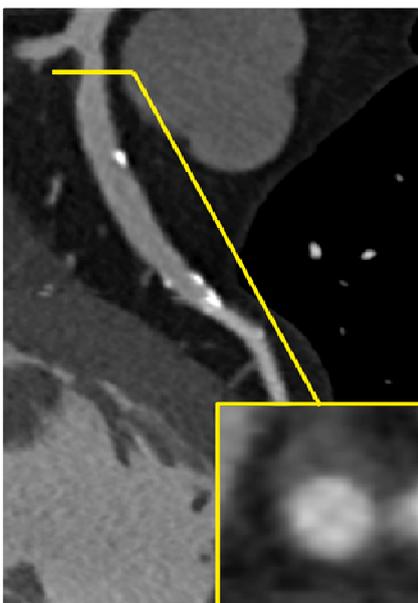
The figure shows a calcified plaque (CP) in the left main coronary artery (LM) bifurcation. The lower inset shows a cross-sectional view of this CP.

Definition

Any structure with a density of 130* Hounsfield units (HU) or more that can be visualized separately from the contrast-enhanced coronary lumen and can be assigned to the coronary artery wall, furthermore it can be identified in at least 2 independent planes, but without any discernible non-calcified components, will be defined as calcified atherosclerotic plaque.

(Modified after Achenbach et al.: Circulation, 2004;109;14-17)

Non-calcified plaque



The figure shows a non-calcified plaque located in the proximal LAD. The right lower inset illustrates a cross-section of this plaque.

Definition

Any discernible structure that can be assigned to the coronary artery wall, has a CT density below 130* HU but above the surrounding connective tissue, and can be identified in at least 2 independent planes is defined as non-calcified coronary atherosclerotic plaque (NCP).

(Achenbach et al.: Circulation, 2004;109;14-17)

***NOTE:** The threshold might change with intraluminal enhancement. E.g., NCPs may have 200-300 HU if the adjacent luminal enhancement is high

Partially calcified plaque



The figure shows a partially calcified plaque (PCP). The lower inset shows a cross-sectional view of this PCP.

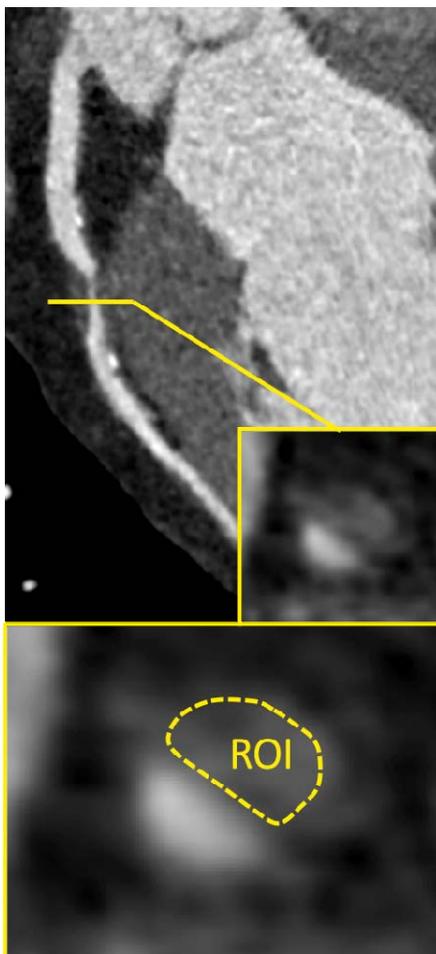
Definition

Both non-calcified components and calcified components are clearly visible. If there is any calcified component seen within non-calcified components, the plaque is classified as partially calcified plaque.

IMPORTANT: If there is a question whether the apparent calcification represents intra-plaque contrast penetration vs. calcium, the corresponding region should be carefully reviewed on the non-contrast scan (“calcium score scan”); if calcium is seen in the corresponding region, it should be considered partially calcified plaque. If no calcium is seen in the corresponding region on the non-contrast scan, judgment call determination needs to be made whether it is intra-plaque hemorrhage.

2 High-risk plaque features

Low attenuation plaque



The figure shows a non-calcified plaque with low CT attenuation (LAP) in the proximal LAD. The lower panel illustrates the ROI measurements on the plaque visible in the upper panel.

Definition

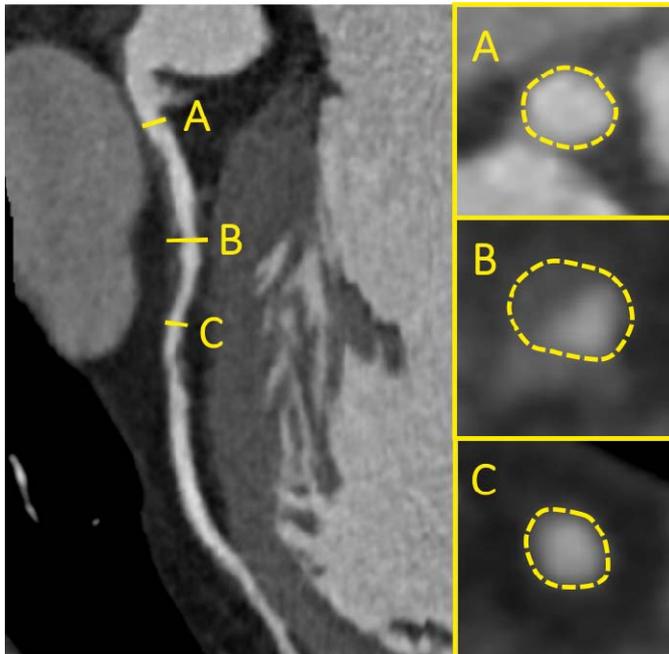
When there is a visually apparent non-calcified region within the plaque cross-section the region of interest (ROI) is directly traced (dashed line) around the non-calcified plaque portion. An average ROI attenuation ≤ 50 HU, will be used to define LAP.

(Yamaki et al.: Cardiovasc Ultrasound. 2012 Aug 6;10:33)

***NOTE:** The threshold might change with intraluminal enhancement. E.g., LAPs may have >50 HU if the adjacent luminal enhancement is high.

Kristanto et al. argue that generalized CT attenuation values for lipid-rich and fibrous plaques are unreliable for clinical use due to large variations. In conclusion measurements for distinction of lipid-rich (low attenuation) and fibrous plaques should be checked visually. (Kristanto et al.: PLoS One. 2013 Sep 3;8(9):e73460)

Positive remodeling



The figure shows a non-calcified plaque with positive remodeling in the proximal LAD. The panels on the right show coronary cross-sections with reference areas (dashed line). A: proximal reference area, B: area at the maximal stenosis, C: distal reference area.

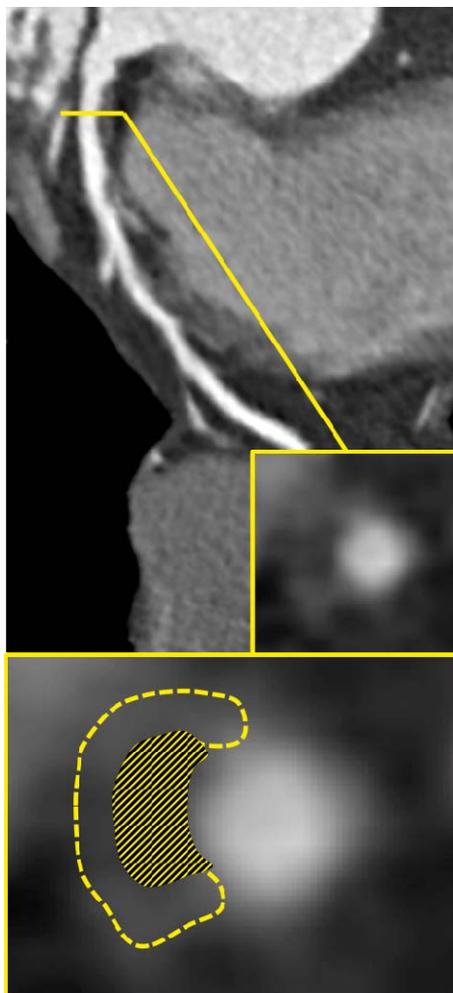
Remodeling index

The remodeling index is calculated as the vessel cross-sectional area at the site of maximal stenosis (B) divided by the average of proximal and distal reference segments' cross-sectional areas (average of A and C). Remodeling index threshold of ≥ 1.1 will be used to define positive remodeling visualized by CCTA

(Maurovich-Horvat P et al.: Nat Rev

Cardiol. 2014 Jul;11(7):390-402, Motoyama S et al.: J Am Coll Cardiol. 2009 Jun 30;54(1):49-57, Otsuka K et al.: JACC Cardiovasc Imaging. 2013 Apr;6(4):448-57)

Napkin-ring sign



The figure shows a non-calcified plaque with a napkin-ring sign (NRS) in the proximal LAD. The lower panel illustrates the NRS visible in the upper panel with color overlay

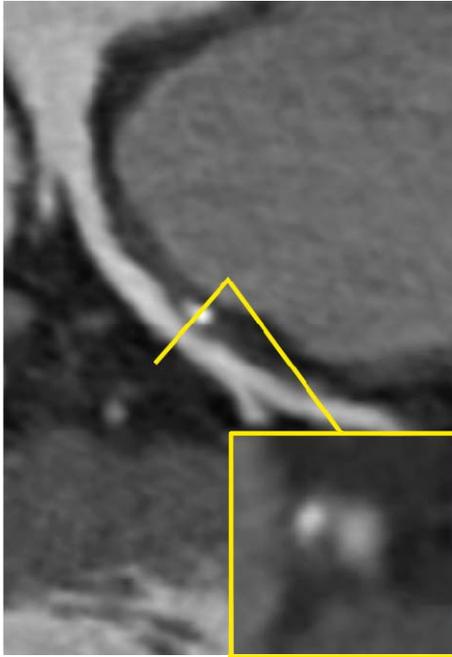
Definition

The NRS is a qualitative plaque feature and can be defined in a non-calcified plaque cross-section by the presence of two features: a central area of low CT attenuation that is apparently in contact with the lumen; and a ring-like higher attenuation plaque tissue surrounding this central area.

(Maurovich-Horvat P et al.: Nat Rev Cardiol. 2014 Jul;11(7):390-402, Otsuka K et al.: JACC Cardiovasc Imaging. 2013 Apr;6(4):448-57)

3 Additional plaque feature

Spotty calcification



Spotty calcification is defined as a small, dense (>130 HU) plaque component surrounded by noncalcified plaque tissue. The typical cut-off to define a small calcification in CCTA as spotty is <3 mm. Spotty calcification is no high risk plaque feature. Still it is more frequent in culprit lesions in acute coronary syndromes than in target lesions in stable angina pectoris and thus will be recorded in DISCHARGE. (Motoyama et al.: JACC; 2007; 50, 319–326).