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Vulnerable Plaque Imaging: Grayscale-and VH-IVUS, OCT, NIRS, CT, etc

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Vulnerable plaque has been defined as a plaque thrombus prone, related with future cardiovascular events such as lesion progression needing revascularization, acute coronary syndrome and sudden cardiac death. Previously pathologic studies have demonstrated that the most common cause of acute coronary syndrome (ACS) was rupture of an atherosclerotic lesion containing a large necrotic core and a thin fibrous cap followed by acute luminal thrombosis because the rupture of the thin fibrous cap allows contact of the platelets with the highly thrombogenic necrotic core. Plaque erosion, calcified nodule, spontaneous dissection or spasm have been considered as other causes attributable to ACS.

Current invasive and non-invasive imaging modalities including grayscale- and virtual histology intravascular ultrasound (VH-IVUS), optical coherence tomography (OCT), near-infrared spectroscopy (NIRS) and coronary computed tomography angiogram (CTA), even though each test method has its advantages and disadvantages, could provide the information of coronary plaque morphology and components. Vulnerable features such as large lipid core, thin fibrous cap, positive remodeling and spotty calcification could be detected by imaging modalities and are highly comparable with pathologic findings. Recent published data using variable intracoronary imaging showed that among features of vulnerable plaque, lipid core burden in non-culprit lesion, regardless detected by any imaging modality, was strongly related with future cardiovascular events.

The PROSPECT (Providing Regional Observations to Study Predictors of Events in the Coronary Tree) study, was the first study to evaluate the natural process of

vulnerable plaque, demonstrated that non-culprit VH-thin cap fibroatheroma (TCFA) was related with future cardiac events especially lesion progression during 3 years follow-up in patients with ACS. However, the resolution of IVUS is below that of a rupture-prone thin fibrous cap (known as 65 μ m). The 10-fold better resolution of OCT allows accurate evaluation of the thickness and the integrity of fibrous cap even detection of macrophage infiltration within the cap. Xing and his colleagues evaluated that the prognostic significance of lipid rich plaque (LRP) detected by OCT (OCT-TCFA) in patients undergoing PCI and showed patients presenting with (LRP) of longer lipid length, wider lipid arc, and higher degree of luminal narrowing are at particularly high risk for future cardiac events. Recently, Madder and his colleagues reported the association between large LRPs, detected by NIRS, at non-stented sites in a target vessel and subsequent events.

Coronary CTA is a very promising to detect vulnerable plaque in non-invasive method. Previous study in ACS found that coronary plaques that were more likely to rupture if they had the following features on CTA: 1) positive remodeling, 2) presence of non-calcified or low attenuation plaque measured to be <30 HU, and 3) spotty calcific. Additionally, the presence of a napkin ring sign, as characterized by a low attenuation core (<30 HU) surrounded by a rim like area of higher (>130 HU) attenuation has been proposed as an alternative marker of high-risk plaque. In the future, CTA holds potential for characterizing and identifying high-risk plaque as well as monitoring plaque progression for individualizing treatment.