

Detection and Prediction of Plaque Rupture Using OCT

So-Yeon Choi, MD., PhD.

Department of Cardiology, Ajou University Medical Center

The most common cause of acute coronary syndrome (ACS) is rupture of an atherosclerotic lesion followed by acute luminal thrombosis because the rupture of fibrous cap allows contact of the platelets with the highly thrombogenic necrotic core. Pathologic studies have suggested that the precursor of the ruptured plaque is the so-called thin cap fibroatheroma (TCFA) defined as a plaque with a fibrous cap less than 65~100 at its minimum thickness, macrophage infiltration especially in the thin fibrous cap and a large lipid/necrotic core. Intravascular ultrasound (IVUS) based intracoronary imaging has been considered the gold standard for detecting ruptured plaque in vivo. However, the resolution of IVUS is below that of a rupture-prone thin fibrous cap. The 10-fold better resolution of optical coherence tomography (OCT) allows accurate measurement of fibrous cap thickness and even detection of macrophage infiltration within the cap.

OCT studies showed culprit lesion plaque ruptures are common in ACS patients and the frequency of secondary plaque ruptures is greater in ACS patients than in stable patients. In addition, previous OCT studies presented plaque ruptures were related with acute and late complications in ACS patients undergoing percutaneous coronary intervention. What causes a TCFA to rupture? Plaque rupture would be as a marker for the extent of the inflammatory reaction of atherosclerosis. Furthermore, an OCT study of the morphologic difference between rest-onset and exercise-triggered plaque rupture showed that exercise-triggered plaque rupture had a thicker fibrous cap and a more frequent shoulder distribution of the rupture site compared to rest-onset plaque rupture. But not all TCFA rupture (just like not all ruptured plaques thrombose). One baseline and 9-month follow-up OCT study in patients with myocardial infarction and hyperlipidemia showed a greater increase in fibrous cap thickness in the statin treatment group than in the control group.

True natural history studies of TCFA and their transition to ruptured plaques are rare. Natural history studies will be necessary to document the full spectrum of unstable coronary plaques – from fibroatheroma development and evolution to TCFA and from vulnerable plaque to plaque rupture and thrombosis. New evolving imaging tools such as NIRS-OCT, SWIR-OCT will complement current OCT in detecting ruptured and rupture-prone plaque and in understanding the mechanism and natural history of vulnerable plaques and plaque rupture.