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EDITORIAL

Coronary Imaging Modalities for Forecasting the "Eruption of the Volcano"

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Coronary plaque rupture can be likened to a volcanic eruption, given its abrupt occurrence and the "natural disaster" that follows the episode. Numerous cardiovascular researchers have aimed to identify vulnerable atherosclerotic plaques, which lead to plaque rupture and coronary thrombosis, because they are the major cause of acute myocardial infarction (AMI) and sudden cardiac death.[1] Morphological studies from autopsy have suggested the importance of necrotic core size, inflammation, and fibrous cap thickness.[2] These clinical features are similar to the amount of magma, volcanic tremor, and the distance from magma to the ground surface forecasting the explosion of the volcano. Thin-cap fibro-atheroma (TCFA), which is characterized by a large necrotic core with an overlying thin-fibrous cap measuring <65 μm, is known to lead to AMI.[3]

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Coronary imaging modalities are playing an important role in interventional cardiology.[4] According to the contemporary all-comer trials, intravascular ultrasound (IVUS) is the most frequently used and is overriding all other imaging modalities in the daily clinical settings of Japan.[5] Recent pivotal data have shown that IVUS guidance reduces the clinical events in percutaneous coronary intervention (PCI).[6] The major strength of IVUS is its ability to quantitatively and qualitatively assess atherosclerotic plaque, which enables adequate stent expansion in PCI procedures. In particular, radiofrequency signal-based IVUS (RF-IVUS) has facilitated automated plaque assessment and contributed to the building of evidence regarding the efficacy of PCI strategies.[7]

On the other hand, IVUS has reduced spatial resolution compared with the emerging newer modality of optical coherence tomography (OCT).[8] One of the major limitations of IVUS in regard to poor spatial resolution is that IVUS is incapable of clearly detecting the fibrous cap thickness of plaques. The advantages and disadvantages of IVUS vs. OCT in the evaluation of vulnerable plaques are summarized in **Table**. In particular, OCT can show subtle changes such as neovascularization.[9]

Table. Advantages and Disadvantages of IVUS vs. OCT in the Evaluation of Vulnerable Plaques

	IVUS	OCT
Evaluation of "micro" findings		
Fibrous cap thickness	×	◎
Neovascularization	×	○
Macrophages	×	○
Evaluation of "macro" findings		
Thrombus	△	◎
Spotty calcification	◎	◎
Positive remodeling	◎	×
Necrotic area	◎	△
Clinical utility		
Market penetration	◎	△
For patients with chronic kidney disease	◎	△
For ostial lesions	◎	×

◎, excellent; ○, good; △, fair; ×, poor; IVUS, intravascular ultrasound; OCT, optical coherence tomography.

In this issue of the Journal, Koga et al[10] present crisp data showing that coronary lesions with greater absolute necrotic areas categorized by iMap-IVUS are closely associated with OCT-derived TCFA (OCT-TCFA). The authors evaluated 86 coronary lesions from 73 patients with stable angina pectoris using iMap-IVUS and OCT. They defined OCT-TCFA as lipid-rich plaques with <65 mm-thick fibrous caps, which were subsequently identified in 22 (26%) lesions. Significantly larger percentages of necrotic area, absolute lipidic and necrotic areas, and a smaller percentage of fibrotic area were found in OCT-TCFA than in non-TCFA. Multivariate analysis showed that absolute necrotic area was an independent predictor of OCT-TCFA. The area under the receiver-operator characteristics curve of the absolute necrotic area required to identify OCT-TCFA was 0.86. The sensitivity, specificity, positive, and negative predictive values of absolute necrotic area ≥7.3 mm^2 for identifying OCT-TCFA were 77%, 88%, 68%, and 92%, respectively. The data from the present study are comparable with those of previous similar investigations using virtual histology-IVUS, which is a variation of the RF-IVUS system.[11]

The results of the present study are indeed promising, particularly for interventionists who perform IVUS-guided PCI. On the basis of this study, it is possible to assess the risk of future coronary events in daily clinical settings by reviewing the absolute necrotic area measured using iMap-IVUS. It may also be possible to clarify the pharmaceutical stabilization of vulnerable plaques by analyzing the serial changes of absolute necrotic area as a surrogate marker. By considering the several

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limitations of OCT, the evidence of the present study will likely lead to much future clinical evidence in daily clinical settings. For example, OCT-guided PCI requires higher levels of contrast medium, whereas a surrogate marker for the detection of TCFA using iMap-IVUS assessment enables clinical studies of patients with chronic kidney disease, which is known as a powerful risk of ischemic events. Furthermore, new tissue characterization imaging techniques, such as near-infrared spectroscopy, will improve IVUS imaging in the detection of vulnerable plaque.[12] Therefore, IVUS should continue to be a valuable imaging modality in the daily clinical setting.

There are several limitations associated with the study. First, the present data only show that the abundant necrotic area detected using iMap-IVUS frequently exists where OCT-TCFA appears,[10] and therefore must be validated with respect to clinical relevance. Notably, a previous report suggested that most of the vulnerable plaques identified using intracoronary imaging modalities may be clinically silent, and/or the prevalence of vulnerable plaques identified using imaging modalities is overestimated.[8] Regarding the possibility of overestimation of TCFA, it is known that a low or lack of signal in plaques located in regions oblique to an eccentric wire can be explained by the intrinsic properties of time-domain OCT rather than by the presence of lipid components.[13] Second, the accuracy of IVUS measurement is a concern. A previous study showed that the measurement value determined using IVUS may be greater than reality.[14] Third, the risk prediction for primary prevention of plaque rupture using invasive imaging modality is unrealistic. We should keep in mind that modern imaging technologies visualizing vulnerable plaques have yet to demonstrate improved risk prediction compared with conventional methods.[1] To foresee the future "explosion of volcano" more effectively, the innovation of non-invasive modalities also needs to be promoted.[15]

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