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Clinical Research

Assessment of Echo-Attenuated Plaque by Optical Coherence Tomography and its Impact on Post-Procedural Creatine Kinase-Myocardial Band Elevation in Elective Stent Implantation

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Objectives This study examined morphological characteristics of echo-attenuated plaques by optical coherence tomography (OCT) and evaluated their influence on creatine kinase-myocardial band (CK-MB) elevation after percutaneous coronary intervention (PCI) in patients with elective stent implantation.

Background Recent intravascular ultrasound studies have described atherosclerotic plaques with echo attenuation (EA) without associated bright echoes that are correlated with no-reflow phenomenon after PCI.

Methods We studied 135 native de novo culprit coronary lesions in 135 patients with normal pre-PCI CK-MB levels (28 with unstable angina; 107 with stable angina) who underwent intravascular ultrasound and OCT examinations before elective stent implantation. The lesions were divided into 2 groups based on the presence or absence of EA, and OCT findings were compared. We then determined predictors of post-PCI CK-MB elevation.

Results EA was found in 47 (34.8%) lesions and was associated with the presence of OCT-derived thin-capped fibroatheroma, ruptured plaques, greater lipid content, intravascular ultrasound–derived large reference and plaque area, lesion eccentricity, and microcalcification. Elevated CK-MB levels were observed in 36 (26.7%) lesions, and significantly more frequently in lesions with EA than without. In multivariable analysis, EA (odds ratio [OR]: 3.49; 95% confidence interval [CI]: 1.53 to 7.93; $p = 0.003$) and OCT-derived ruptured plaque (OR: 2.92; 95% CI: 1.21 to 7.06; $p = 0.017$) were independent predictors of post-PCI CK-MB elevation.

Conclusions Atherosclerotic plaques with EA were associated with characteristics considered to be high risk or unstable. OCT examination showed an additive predictive value to the presence of EA for post-PCI CK-MB elevation. (J Am Coll Cardiol Intv 2011;4:483–91) © 2011 by the American College of Cardiology Foundation

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Intravascular ultrasound (IVUS) can predict no-reflow or creatine kinase-myocardial band (CK-MB) elevation after percutaneous coronary intervention (PCI) based on characteristics such as a large plaque burden, intracoronary mobile mass, and lipid pool-like appearance (1–3). In addition, recent studies have described atherosclerotic plaques that show echo signal attenuation (EA) without associated bright echoes in patients with coronary artery disease, that is, associated with no-reflow and worse clinical outcome after PCI because of distal embolization (4–6). The ultrasound intensity of signal backscatter is affected by a number of factors, including tissue reflectivity and ultrasound power.

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Abbreviations and Acronyms

CK-MB = creatine kinase-myocardial band
CSA = cross-sectional area
EA = echo attenuation
EEM = external elastic membrane
IVUS = intravascular ultrasound
OCT = optical coherence tomography
PCI = percutaneous coronary intervention
SAP = stable angina pectoris
TCFA = thin-capped fibroatheroma
TIMI = Thrombosis In Myocardial Infarction
UAP = unstable angina pectoris

Coronary atherectomy specimens obtained from lesions with EA have shown the presence of predominantly lipid-rich plaque with microcalcification (4). However, very dense fibrous tissue may also produce EA (7). Lee et al. (5) reported that an echo-attenuated plaque is an exclusive marker of lesion instability observed only in patients with acute coronary syndrome, whereas others (4,6) detected a significant number of echo-attenuated plaques in stable lesions. Optical coherence tomography (OCT) is a high-resolution imaging method for plaque characterization providing information on plaque structures and tissue characterization, such as the presence of thin-capped fibroatheroma (TCFA), lipid-rich plaques, which are considered responsible for plaque instability, and intracoronary thrombi (8–12). Therefore, we hypothesized that OCT may allow us to elucidate the relevant morphological features of culprit coronary lesions with EA. To test this hypothesis, we evaluated plaques with and without EA by pre-PCI OCT examination in patients treated with elective stenting to investigate if lesions with EA are associated with OCT-derived high-risk plaque characteristics. We further hypothesized that OCT may allow us to detect lesion-related factors associated with post-PCI CK-MB elevation in these patients.

Methods

Study population. From December 2008 to December 2009, we prospectively enrolled 148 patients (32 with unstable angina pectoris [UAP] and 116 with stable angina pectoris [SAP]) without CK-MB elevation before PCI who underwent nonemergency stent implantation at single, native, de novo culprit coronary lesions at Tsuchiura Kyodo Hospital. Both IVUS and OCT examinations were performed before PCI. The study protocol was approved by the institutional review board, and all patients provided written informed consent before PCI. Patients treated with multivessel coronary intervention were excluded (1 UAP patient and 3 SAP patients). Patients were also excluded if they had significant left main disease (2 SAP patients), congestive heart failure, or renal insufficiency with baseline serum creatinine >1.8 mg/dl (133 μmol/l). In addition, those with extremely tortuous vessels or heavy calcification were excluded because of expected difficulty in advancing the OCT and/or IVUS catheters. We defined UAP as having a progressive crescendo pattern or angina at rest without an increase in troponin I. We defined SAP as no change in frequency, duration, or intensity of anginal symptoms within 6 weeks before PCI. The target lesion was identified by a combination of coronary angiograms, left ventricular wall motion abnormalities, electrocardiogram findings, angiographic lesion morphology, and scintigraphic defects. All included patients had angina, documented myocardial ischemia, or both. Three UAP patients and 4 SAP patients were further excluded from the analysis because of failure of the imaging catheter in crossing the lesion or unsatisfactory image quality. Thus, 28 UAP lesions and 107 SAP lesions from 135 patients were eventually analyzed in the present study. The presence of EA on IVUS was defined as an atherosclerotic plaque showing ultrasound signal attenuation without very high intensity echo reflectors that involved >90° of the vessel circumference and a length >1 mm. Lesions were divided into the group with EA in a culprit lesion (attenuated group) and the group without EA (nonattenuated group).

Percutaneous coronary intervention procedure. All patients received treatment with aspirin (200 mg/day) and clopidogrel (75 mg/day, 300-mg loading dose) at least 24 h before PCI. All patients received an intravenous bolus injection of 10,000 IU of heparin and intracoronary isosorbide dinitrate (2 mg) before angiography. PCI procedures were performed using a 6-F guiding catheter via the radial approach in all patients. Coronary stent implantation was performed with a balloon pre-dilation. Balloon/artery ratio for pre-dilation was 0.9 to 1.0 in all patients. To avoid aggressive stent expansion, stent size was guided by the combination of on-line quantitative coronary angiography and IVUS, although the type of stent was selected at the operator's discretion. Angiographic criteria of <25% residual stenosis were adopted as successful PCI. After achieving this endpoint, IVUS examination was performed to confirm optimal stent deployment and additional PCI was performed in case of a suboptimal result.