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Longitudinal Distribution of Plaque Burden and Necrotic Core–Rich Plaques in Nonculprit Lesions of Patients Presenting With Acute Coronary Syndromes

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OBJECTIVES In this substudy of the PROSPECT (Providing Regional Observations to Study Predictors of Events in the Coronary Tree) study, we examined the longitudinal distribution of atherosclerotic plaque burden, virtual histology–intravascular ultrasound (VH-IVUS) characterized necrotic core (NC) content and VH–thin-cap fibroatheroma (TCFA) distribution in nonculprit lesions of patients presenting with acute coronary syndromes.

BACKGROUND Previous analyses suggested that vulnerable plaques and acute myocardial infarction may occur more frequently in the proximal than the distal coronary tree.

METHODS A total of 4,234 proximal, mid, and distal 30-mm-long segments of each epicardial coronary artery were compared with each other and to the left main coronary artery (LMCA).

RESULTS Combining IVUS data from all 3 arteries, there was a gradient in plaque burden from the proximal (42.4%) to mid (37.6%) to distal (32.6%) 30-mm-long segments ($p < 0.0001$). Overall, 67.4% of proximal, 41.0% of mid, and 29.7% of distal 30-mm-long segments contained at least 1 lesion (plaque burden >40%). Proportion of NC, however, was similar in the proximal and mid 30-mm-long segments of all arteries (10.3% [interquartile range (IQR): 4.8% to 16.7%] vs. 10.6% [IQR: 5.0% to 18.1%], $p = 0.25$), but less in the distal 30-mm-long segment (9.1% [IQR: 3.7% to 17.8%], $p = 0.03$ compared with the proximal segment and $p = 0.003$ compared with the mid segment). Overall, 17.3% of proximal, 11.5% of mid, and 9.1% of distal 30-mm-long segments had at least 1 lesion that was classified as VH-TCFA ($p < 0.0001$). Comparing the LMCA with the combined cohort of proximal left anterior descending, left circumflex, and right coronary artery 30-mm-long segments: 1) plaque burden was less (35.4% [IQR: 28.8% to 43.5%] vs. 40.9% [IQR: 33.3% to 48.0%], $p < 0.0001$); 2) fewer LMCAs contained at least 1 lesion (17.5%, $p < 0.0001$); 3) there was less NC (6.5% [IQR: 2.9% to 12.2%] vs. 9.3% [IQR: 4.3% to 15.9%], $p < 0.0001$); and 4) LMCAs rarely contained a VH-TCFA (1.8%, $p < 0.0001$).

CONCLUSIONS The current analysis appears to confirm that lesions that are responsible for acute coronary events (large, plaque burden–rich in NC) are somewhat more likely to be present in the proximal than the distal coronary tree, except for the LMCA. (J Am Coll Cardiol Img 2012;5:S10–8)

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The majority of acute coronary syndromes are caused by coronary plaque rupture at the site of a thin-cap fibroatheroma (TCFA) with subsequent local thrombosis (1,2). The PROSPECT (Providing Regional Observations to Study Predictors of Events in the Coronary Tree) study was the first multicenter, natural history study that employed angiography and grayscale and radiofrequency virtual histology-intravascular ultrasound (VH-IVUS) to relate site-specific quantitative and qualitative measures of coronary disease to major adverse cardiac events at 3 years (3). In this substudy of the PROSPECT study, we examined the longitudinal distribution of atherosclerotic plaque burden, nonculprit lesions, VH-IVUS necrotic core (NC) content, and TCFA plaque phenotype in patients presenting with an acute coronary syndrome (ACS).

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METHODS

Patient population and IVUS image acquisition. The enrollment criteria and the methodology of the PROSPECT study have been previously described in detail (3). In brief, 697 patients with ACS who underwent successful percutaneous coronary intervention of all lesions responsible for the ACS event and other angiographically significant stenoses (culprit lesions) underwent grayscale and VH-IVUS examination of the proximal 6 to 8 cm of the coronary vessels. Imaging was performed using a synthetic aperture array, 20 MHz, 3.2-F catheter (Eagle Eye, Volcano Corporation, Rancho Cordova, California). During a motorized catheter pullback at 0.5 mm/s, grayscale IVUS was recorded, and radiofrequency data were captured gated to the R-wave (In-Vision Gold, Volcano Corporation). In contrast to conventional grayscale IVUS, VH-IVUS uses spectral analysis in addition to amplitude analysis to classify plaque into 4 components: NC, fibrofatty plaque, fibrotic plaque, and dense calcium. This classification has been correlated to histological samples with high specificity and sensitivity (4).

Image analysis. Qualitative and quantitative coronary angiographic assessment of the entire length of the coronary tree was performed at an independent core laboratory (Cardiovascular Research Foundation, New York, New York) using a proprietary methodology modified from standard Medis CMS software (version 7.0, Leiden, the Netherlands); this analysis included each major epicardial coronary artery and every side branch ≥1.5 mm in diameter. This 3-vessel angiographic analysis served as a roadmap to identify each lesion on the basis of longitudinal axis location (mm). The methodology and classification of the lesions is described in this issue of *iJACC* by Maehara et al. (5).

All IVUS images were also analyzed at an independent core laboratory (Cardiovascular Research Foundation). Offline grayscale and VH-IVUS analyses were performed using: 1) QCU-CMS (Medis) for contouring; 2) pcVH 2.1 software (Volcano Corporation) for contouring and data output; and 3) proprietary qVH software for segmental qualitative assessment and quantitative data output. External elastic membrane (EEM) and lumen borders were contoured for all recorded frames (median interslice distance = 0.40 mm). Quantitative IVUS measurements included EEM, lumen, plaque and media (P&M, defined as EEM minus lumen) cross-sectional area (CSA), and plaque burden (P&M divided by EEM CSA). The slice with minimal lumen CSA and the slice with maximum NC CSA were identified. VH-IVUS plaque components were color coded as dense calcium (white), NC (red), fibrofatty plaque (light green), and fibrotic plaque (dark green) and reported as CSA and percentages of total plaque

ABBREVIATIONS AND ACRONYMS

ACS = acute coronary syndrome(s)
CSA = cross-sectional area
EEM = external elastic membrane
IVUS = intravascular ultrasound
LAD = left anterior descending coronary artery
LCX = left circumflex coronary artery
LMCA = left main coronary artery
NC = necrotic core
P&M = plaque and media
RCA = right coronary artery
STEMI = ST-segment elevation myocardial infarction
TCFA = thin-cap fibroatheroma
VH = virtual histology

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