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Identifying Thin-Cap Fibroatheroma: Virtual-Histology Intravascular Ultrasound or Optical Coherence Tomography?

Leonardo Roever*

***Corresponding author:** Leonardo Roever, Department of Clinical Research, Federal University of Uberlandia, Av. Para, 1720 - Bairro Umuarama Uberlandia - MG - CEP 38400-902, Brazil, Tel: 553488039878; E-mail: leonardoroever@hotmail.com

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Introduction

Studies have shown that two-thirds of all myocardial infarctions are caused by the rupture of plaques with large lipid content and necrotic core (NC), resulting in luminal thrombosis [1-4]. Thin-cap fibroatheroma (TCFA) are characterized as a presence of a large lipid pool with overlying thin fibrous cap (<65 μm) and is associated with future major adverse cardiovascular events [5-7]. The diagnosis requires a high spatial resolution (axial, lateral, elevation) and temporal [8].

Virtual-histology intravascular ultrasound (VH-IVUS) is an invasive imaging modality which is used to identify plaque components, including NC, calcification, fibrous, and fibrofatty tissue (accuracies of >93.5% to characterize coronary plaque composition and a diagnostic accuracy of 76% for TCFA) [9-10]. Intravascular optical coherence tomography (OCT) allows plaque characterization using near-infrared light to display high-resolution (≈20 μm) images of coronary lesions (sensitivities around 75% for fibrous, 95% for fibrocalcific, and 92% for lipid-rich plaques)[11].

Brown and colleagues conducted a study in 258 regions of interest from autopsied human hearts, with plaque composition and classification assessed by histology and compared with coregistered ex vivo VH-IVUS and OCT. Sixty-seven regions of interest were classified as fibroatheroma on histology, with 22 meeting criteria for TCFA. On VH-IVUS, plaque (10.91 ± 4.82 versus 8.42 ± 4.57 mm^2; P=0.01) and necrotic core areas (1.59 ± 0.99 versus 1.03 ± 0.85 mm^2; P=0.02) were increased in TCFA versus other fibroatheroma. On OCT, although minimal fibrous cap thickness was similar (71.8 ± 44.1 μm versus 72.6 ± 32.4; P=0.30), the number of continuous frames with fibrous cap thickness ≤ 85 μm was higher in TCFA (6.5 [1.75-11.0] versus 2.0 [0.0-7.0]; P=0.03). Maximum lipid arc on OCT was an excellent discriminator of fibroatheroma (area under the ROC, 0.92; 95% CI, 0.87-0.97) and TCFA (area under the ROC, 0.86; 95% CI, 0.81-0.92), with lipid arc ≥ 80° the optimal cut-off value. The sensitivity, specificity, and diagnostic accuracy for TCFA identification was 63.6%, 78.1%, and 76.5% for VH-IVUS and 72.7%, 79.8%, and 79.0% for OCT. Combining VH-defined fibroatheroma and fibrous cap thickness ≤ 85 μm over 3 continuous frames improved TCFA identification, with diagnostic accuracy of 89.0% [11].

This study demonstrated that VH-IVUS and OCT can identify TCFA, although OCT accuracy may be improved using lipid arc ≥ 80° and fibrous cap thickness ≤ 85 μm over 3 continuous frames. Combined VH-IVUS/OCT imaging improved TCFA identification.

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