JACC: CARDIOVASCULAR IMAGING
PUBLISHED BY ELSEVIER ON BEHALF OF THE AMERICAN
COLLEGE OF CARDIOLOGY FOUNDATION

VOL. 11, NO. 11, 2018

EDITORIAL COMMENT

Improving Plaque Classification With Optical Coherence Tomography*

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Optical coherence tomography (OCT) allows resolution of tissue microstructural interfaces ranging from depths of 2 to 5 μm (1–4). Inasmuch as contrast in standard OCT is primarily due to microstructural optical interfaces, identification or segmentation of tissue constituents and their composition must be inferred from the structural information in recorded OCT images. Acceptance of intravascular OCT (IV-OCT) and its use in routine cases in the catheterization laboratory has lagged despite demonstration that the high-resolution images can provide novel microstructural information (5,6). One source of the delayed acceptance is the fact that, because IV-OCT relies on backscattered light, multiple tissue constituents and their corresponding microenvironments can give rise to features with similar appearance in IV-OCT images (7). For example, superficial macrophages can give rise to an image dropout that can be misinterpreted as a lipid pool (8). Moreover, large registry data in percutaneous coronary interventions (5) have raised questions regarding the clinical significance of the detailed findings of high-resolution IV-OCT images. Many investigators have acknowledged these limitations and recognized that methods to improve plaque classification are needed. Two general approaches are being pursued: 1) modifications to existing OCT hardware that can provide enhanced contrast; and 2) advanced neural networks or machine learning approaches founded on histology which automate IV-OCT image analysis and provide improved plaque classification (9,10). Polarization-sensitive OCT (PS-OCT) is an example of the first approach and provides contrast based on the structural anisotropy of the tissue constituents (11,12). Moreover, PS-OCT has the advantage that existing IV-OCT systems may be converted to polarization sensitivity with a moderate upgrade. The upgrade includes using a polarization diverse receiver and an electro-optical polarization module in the sample arm of the interferometer, as well as modulating the polarization state between successive A lines as linear and circular. Although PS-OCT has been applied previously to image coronary arteries (13–16), the work reported by Tearney et al. (4) and Villiger et al. (17) represents an important and significant step forward.

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Studies by Villiger et al. (17), reported in this issue of *iJACC*, incorporated polarization sensitivity into a current clinical OCT system to improve contrast and the identification of both fibrous tissue and smooth muscle cells. Because both tissue types are anisotropic or birefringent, PS-OCT provides excellent contrast to identify these structures along the length of the artery. It is also interesting that the presentation of depolarization images (11,12,17) where an unexpected improvement in detection of both lipid collections and macrophage identification is provided. Adding both of these modalities into routine OCT imaging in the catheterization laboratory holds the promise of improved plaque identification. Ultimately, this improved tissue type identification will have to result in a better understanding of the natural history of coronary artery disease or be combined with a therapy to prevent the progression of coronary artery disease. Otherwise, such improved tissue type identification will be of scientific interest but may not translate into a clinically applicable therapy. A similar conclusion can be drawn regarding other more advanced OCT imaging approaches such as elastography and photothermal imaging.

Despite these concerns, the importance of IV-OCT for cardiovascular basic science studies will increase as methods for automated image analysis advance

*Editorials published in *JACC: Cardiovascular Imaging* reflect the views of the authors and do not necessarily represent the views of *JACC: Cardiovascular Imaging* or the American College of Cardiology.

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ISSN 1936-878X/$36.00

https://doi.org/10.1016/j.jcmg.2017.11.007

and hardware methods for additional contrast are demonstrated. OCT is an information-dense imaging approach with the capacity and potential that is being explored and leveraged. The work reported by Villiger et al. (17) is potentially important and significant not only for cardiology but also serves as an excellent example of how this latent information may be applied to an important clinical problem. For instance, the current identification of thin-capped fibroatheroma (TCFA) by OCT is limited due to their false identification due to other nonlipid materials which give the OCT the appearance of a TCFA (8). We anticipate the development of newer therapies to treat atherosclerosis which require more image guidance and more precise identification of TCFA. The advances by Villiger et al. (17) could eliminate these false identifications with improved identification of the lipid pool and overlying fibrous and smooth muscle cells. As new methods are developed to treat and stabilize TCFA, advances such as those reported by Villiger et al. (17) will become even more relevant and essential to providing successful therapies.

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KEY WORDS cholesterol crystals, collagen, optical coherence tomography, optical frequency domain imaging, polarized light