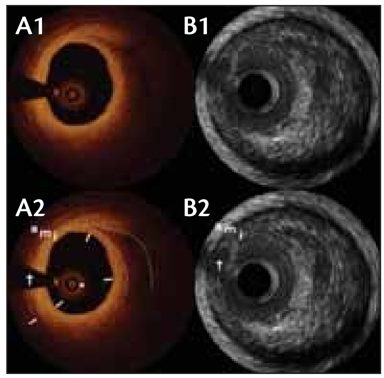
How does optical coherence tomography visualize coronary atherosclerotic lipid pool?

Optical coherence tomography (OCT) represents a relatively new intravascular imaging technique capable of providing cross-sectional images of tissues with a resolution of 10 µm—an order of magnitude higher than that of intravascular ultrasound (IVUS).[1] Although fundamentally different from histology, OCT shares some similarities with histology in that it can identify specific tissue components that correspond to histological features.[2] Lipid pools are of special interest to detect because they constitute the core of thick-cap fibroatheromas that may, over time, progress into thin-cap fibroatheromas,[3] and pathological studies have reported that lipid-rich atheromas with thin fibrous caps are most commonly encountered in lesions causing fatal myocardial infarction or cardiac death.[4]



OCT was performed with the C7-XR system and the Dragonfly catheter (St. Jude Medical, St. Paul, MN), and IVUS with the iLab system using the Atlantis SR Pro 40 MHz catheter (Boston Scientific, Natick, MA).

The figure shows corresponding OCT (A1/A2) and IVUS (B1/B2) cross-sections of a coronary artery from a patient with stable angina. The left-hand side of the vessel wall displays by OCT (A1/A2) a trilaminar structure with a signal-rich adventitia (a), signal-poor media (m) from 8 to 1 o'clock, and a homogeneous, signal-rich intima (i) measuring 550 µm at its thickest point (arrows), suggestive of intimal thickening.[2,3] As opposed to this, the right-hand side of the vessel wall shows a mass lesion with a homogeneous, relatively signal-rich area adjacent to the lumen, overlying a signal-poor region with diffuse borders (A2, dotted line), consistent with a fibrous cap covering a lipid pool.[2] IVUS of the corresponding region shows evidence of an echogenic area covering a crescent-shaped echolucent region (B2, dotted line), which is generally the result of fibrous tissue and a high lipid content, respectively.[5] The lumen size and shape is well preserved due to positive remodeling (expansion of the external elastic membrane, which often accompanies an increase in plaque burden)—a common feature of lipid-containing plaques, which may show only modest luminal narrowing on angiography. Due to the limited tissue penetration by OCT, the media in the area of the lipid pool is undetectable. Caution should be exercised when diagnosing lipid pools deep in the vessel wall because the attenuation of the OCT signal may also appear as a signal-poor region. Nevertheless, in the shown example, a slight increase in the OCT signal deep in the vessel behind the signal-poor region can be observed, indicating that we are indeed observing a lipid pool and not the effect of signal attenuation, which is also confirmed by IVUS. The fibrous cap thickness amounts by OCT to 350 µm at the center of the fibroatheroma (arrow), whereas it becomes thinner in the shoulder region (220 µm, arrow), which is the predilection site of plaque ruptures.[6] The minimum cap thickness of 220 µm indicates a thick-cap fibroatheroma as opposed to a thin-cap fibroatheroma, where the cap thickness is per definition < 65 µm.[3] It is noteworthy that so far, a commonly accepted methodology to assess the cap thickness in a reproducible way is lacking. Of note, IVUS does not show the same level of detail as OCT. However, our example also demonstrates the deeper tissue penetration provided by IVUS, and thus how these two imaging modalities complement each other. The crosses indicate shadowing artefacts from the guidewires (A2/B2), which should not be confused with side branches, whereas the asterisk (A2) highlights that the OCT catheter was insufficiently purged, which did not affect the overall quality of the image. ■

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