Percutaneous Coronary Intervention Planning and Optimization with Optical Coherence Tomography

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KEYWORDS

• Optical coherence tomography • Coronary artery disease • Percutaneous coronary interventions

KEY POINTS

- Optical coherence tomography (OCT) provides high-resolution, easy-to-interpret images that can help to plan and map complex percutaneous coronary interventions (PCI).
- The precise morphologic information obtained across long segments of the coronary vessels, automatic measurements, and enhanced software capabilities, make OCT more than an additional and promising intravascular tool for PCI guidance.
- Whether OCT-guided PCI leads to superior clinical outcomes versus angiography alone remains to be proven with large, prospective, randomized clinical trials.
- OCT criteria for stent optimization, based on preprocedural and postprocedural assessment, have been tested in prospective registries.
- Co-registration is a critical step-up for comprehensive integration of OCT into PCI workflow both before and after an intervention.

Videos of OCT to diagnose nonatherosclerotic disease and OCT pull back accompany this article. http://www.interventional.theclinics.com/

INTRODUCTION: WHY OPTICAL COHERENCE TOMOGRAPHY IMAGING?

Coronary angiography is routinely used for the invasive diagnosis and treatment of coronary artery disease (CAD). For even the most experienced angiographer, however, angiography has major limitations for decision making and procedural guidance (**Box 1**).[1] Furthermore, the complexity of percutaneous coronary intervention (PCI) has increased significantly over time, from the original simple, isolated target lesion in the proximal coronary segment of coronary arteries to the current disease scenarios such as distal left main bifurcation and multivessel disease. In this context, intravascular imaging has emerged as a critical tool to enable physicians to deliver more precise and optimal treatment during PCI, thereby providing superior clinical outcomes.[2]

Optical coherence tomography (OCT) is a light-based imaging modality that provides tomographic views of the vessel with high axial resolution, in the range of 10 to 15 μm.[3] The

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Box 1
Advantages and limits of coronary angiography

Angiography is adequate for
- Visualizing entire coronary anatomy
- Confirming or excluding disease
- Estimating mild lesions (20%–40%) and very severe stenosis (>80–90%)
- Clinical decision making during complex intervention

Angiography is not adequate for
- Intermediate lesions (40%–70%)

Angiography is least accurate for
- Decision making in a complex setting, for example, unclear clinical settings, acute coronary syndromes, in presence of thrombus, diffuse disease, bifurcation, left main coronary artery disease, bioabsorbable scaffolds.

strength of OCT lays in its ability to visualize clearly the surface and subsurface of the coronary vessels with high tissue contrast, providing superb clarity of plaque composition and easier interpretation compared with intravascular ultrasound (IVUS; Table 1).[4] OCT is the only clinically available technique that can identify thin cap fibroatheroma, differentiated plaque erosion/rupture, and intraluminal thrombus with a high level of accuracy.[5–9] In addition to high-quality cross-sectional images, OCT automatically provides a longitudinal view and lumen profile of the vessel and on-line 3-dimensional (3D) reconstruction. Based on these views, OCT promptly identifies the lesion site and severity with automatic detection of minimal lumen area (MLA) and the extension of the atherosclerotic disease. Furthermore, owing to the clarity of the acquired images, OCT does not require substantial expertise for image interpretation. After stent implantation, OCT is also more accurate than IVUS in detecting the morphologic details of suboptimal stent implantation, including underexpansion, malapposition, residual thrombus, plaque prolapse, and edge dissections.[3,10]

The key features of OCT for preprocedural use and procedural guidance are shown in Box 2. In follow-up stent investigations, OCT is the only imaging technique to assess precisely strut coverage and the extent of tissue growth, thereby allowing the operator to identify the underlying mechanisms of stent failure (ie, stent thrombosis and/or restenosis).

CURRENT EVIDENCE ON OPTICAL COHERENCE TOMOGRAPHY FOR GUIDING PERCUTANEOUS CORONARY INTERVENTION

The 2014 European Society of Cardiology/European Association for Cardiothoracic Surgery Guidelines on Myocardial Revascularization state that OCT can be used in select patients to optimize stent implantation (class IIb, level of evidence C) and to assess the mechanisms related to stent failure (class IIa, level of evidence C).[11]

Table 1
Advantages and limits of intravascular imaging modalities

	Advantages	Disadvantages
IVUS	Good depth of penetration	Limited axial resolution (>100 μm)
	Tomographic view without blood removal	Low speed in pullback
	Detection of remodeling and plaque mass	Limits in presence of thrombus and calcium
	Details on plaque composition (IVUS-VH)	Not easy to be interpreted
OCT	High axial resolution images (≅10 μm)	Requires displacement of blood
	High rate of data acquisition	Limited depth of penetration
	Rapid to perform Easy to be interpreted	Lot of details, relative value to be clinically proved
	High quality longitudinal view	Need of additionally contrast
	3D-vessel reconstruction	
	Detection of thrombus, thin cap fibroatheroma, culprit plaques rupture, causes of stent failure	

Abbreviations: IVUS, intravascular ultrasound; OCT, optical coherence tomography.