

Chapter 26

Optical Coherence Tomography Image Interpretation and Image Processing Methodologies

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ABSTRACT

Optical coherence tomography (OCT) is a light-based invasive imaging method allowing accurate evaluation of coronary luminal morphology and reliable characterization of plaque. Its high resolution (10-20 μ m) offers the unique possibility of identifying clinically important coronary plaque microstructures such as macrophages, the presence and type of thrombus, stent expansion and endothelization and provides accurate assessment of the fibrous cap thickness in high risk plaques. These attributes placed OCT in a unique position as useful tool in research and clinical practice. As a new image modality, many interventional cardiologists are not familiar with its interpretation. In addition, there are only few developed methodologies able to process the OCT data and give comprehensive vessel representation and reliable measurements. Thus, this chapter focuses on the interpretation of OCT images and discusses the available image processing methodologies.

INTRODUCTION

Optical coherence tomography (OCT) is an invasive catheter based imaging modality that provides high resolution cross-sectional images of coronary artery. In contrast to intravascular

ultrasound (IVUS) OCT is based on the analysis of reflected light instead of acoustic waves and this allows visualization of intra-coronary features with a by far higher axial resolution (10-20 μ m vs. 100-150 μ m). Thus, OCT allows accurate evaluation of stent deployment and endothelization as well as identification of vessel wall trauma and thrombus with higher sensitivity and specificity

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than the other available invasive imaging modalities (Kubo *et al.* 2007, Guagliumi and Sirbu 2008). In addition, OCT provides reliable characterization of plaque's composition and is considered as the gold standard for assessing plaque's pathology (Kawasaki *et al.* 2006, Kume *et al.* 2006).

Although OCT has unique features its applicability remains limited. This has been attributed to the fact that it is a relatively new imaging modality and that most of the interventional cardiologists are Not familiar with the interpretation of OCT. Another significant limitation is the time required for processing and identification of the regions of interest in the large number of the obtained images. Thus, over the last years there has been an increased interest in standardizing the interpretation of OCT and developing new methodologies for quantitative analysis of the acquired sequence. The aim of this chapter is to provide useful guidance about the interpretation of OCT and present the available image processing methodologies.

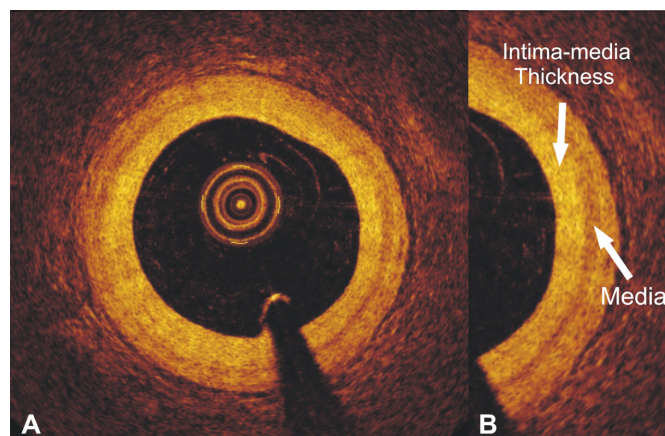
Background: Normal Coronary Anatomy

In contrast to IVUS which can visualize only the intima-medial thickness, OCT imaging with its

high resolution, allows complete imaging of the vessel wall. More specifically the internal elastic lamina, though it has thickness $\approx 3\mu\text{m}$, is shown as an echo lucent layer proximal to the lumen while the tunica media is illustrated as a medium dark layer structure. This can be attributed to the fact that the internal elastic lamina generates a signal-rich band (around 20 mm) probably caused by the different tissue composition of the internal elastic lamina the tunica media and intima (Prati *et al.* 2010). The media corresponds to the low signal area outer of the internal elastic lamina while the signal rich layer which surrounds the media corresponds to the external elastic lamina (Figure 1).

The feasibility of OCT to detect the vessel wall structures in the coronaries has been assessed by Kume *et al.* (2005) using histological data as the gold standard. The results confirmed the superiority of OCT compared to IVUS in measuring the intima-medial thickness ($r=0.95$, $p<0.001$, mean difference= -0.01 ± 0.07 mm for vs. $r=0.88$, $p<0.001$, mean difference= -0.03 ± 0.10 mm for IVUS) and showed that OCT in contrast to IVUS provides also accurate assessment of intima thickness.

Figure 1. OCT image showing a coronary segment with mild intima-medial thickening. The bright zone corresponds to the intima-media while the dark layer surrounding the intima-media corresponds to the media. It is apparent that the high resolution of OCT allows accurate measurements of vessel wall structure.



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