Chapter 12

OCT in the Clinical Practice and Data from Clinical Studies

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ABSTRACT

This chapter provides a detailed description of the role of the OCT technique in the clinical practice. A review section on data from clinical studies is provided, underlining the extent usage of OCT during the last years. Finally, the capability of OCT to assess ambiguous lesions and deferral of interventions is discussed just before describing the role of the technique during the post-procedural assessment.

INTRODUCTION

The introduction of stents in clinical practice was initially burdened by an unacceptably high incidence of sub-acute thrombosis. Later on the use of intravascular ultrasound (IVUS) opened the way to the understanding the reasons for stent failure. IVUS clarified that despite optimal angiographic results many first generation stents were still having a marked under-expansion with irregular eccentric lumen and incomplete apposition of the stent struts to the vessel wall. These findings led to a new strategy for stent deployment based on high-pressure balloon dilatation inside the stent, to be done with angiographic guidance (Goldberg, Colombo, Nakamura, Almagor, Maiello, & Tobis, 1994), (Serruys & Di Mario, 1995), (Colombo, et al., 1995), (Spanos, Stankovic, Tobis, & Colombo, 2003). In other words, IVUS taught us how to implant a stent but then it failed to become the technique to be used for routine guidance.

The last two decades were characterized by the growth of new technical solutions to improve percutaneous coronary intervention. Stents are...
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nowadays capable of eluting drugs or exerting an anti-thrombotic action due to specific coverage. Other new concepts are being investigated; for instance bioabsorbable stents capable of eluting drugs may have a role in the next future.

Since the clinical introduction of IVUS, new imaging modalities came out, with optical coherence tomography (OCT) being the most promising to improve results of interventional cardiology.

OCT is an optical analogue of IVUS, based on infra-red light emission. In comparison with IVUS, OCT has improved resolution (10 mm) and contrast and a limited penetration that does not exceed 1.3 mm, offering therefore a high resolution superficial picture of coronary arteries. This feature of OCT allows the visualization of specific components of the atherosclerotic plaques and details the architecture of stented segments, providing information similar to histology (Tanigawa, Barlis, & Di Mario, 2007), (Jang, et al., 2005), (Prati, et al., 2010), (Guagliumi & Sirbu, 2008).

METHODOLOGICAL ISSUES

Technical Details and Image Acquisition

The main obstacle to the adoption of TD-OCT imaging in clinical practice is that OCT cannot image through a blood field, and therefore requires clearing or flushing of blood from the lumen (Prati, et al., 2010). Time domain (TD) was the first OCT technology to be used in Europe and Japan. TD-OCT was complex and time consuming, requiring a soft occlusion balloon and saline injection in the coronary artery. This modality of acquisition was limiting the OCT widespread application in the clinical arena, focusing its role to the research settings.

Vessel imaging by TD-OCT is now much simpler due to the introduction from our group of a non occlusive modality of image acquisition (Prati, et al., 2008), (Prati, Cera, Ramazzotti, Imola, Giuduce, & Albertucci, 2007). This technique, that simply requires the administration of contrast through the guiding catheter, has been recently applied for the novel frequency domain (FD) catheters. We will discuss in detail only the FD acquisition as it is replacing the TD technique.

The LightLab Dragonfly™ FD-OCT catheter, is so far the only in the market. The Dragonfly™ catheter has a distal diameter of 2.7 Fr and is compatible with 6 Fr guiding catheters. It has a larger crossing profile as compared to the first generation of the ImageWire, and this may limit the use in very stenotic segments. On the other hand, the higher profile of the catheter precludes extremes wire eccentricity, resulting in fewer artifacts and out of focus images.

The OCT probe is first advanced over a regular guide wire, distal to the region of interest. Identification of the pull-back starting point is a simple task as a dedicated marker identifies the exact position of the OCT lens, located 10 mm proximal to the marker itself. The infusion rate of contrast is usually set to 3-4 ml/sec for the left coronary artery and 2-3 ml/sec for the right coronary, but can be modified based on the vessel run-off and size. When the OCT catheter is positioned and blood clearance is visually obtained distally by mean of the contrast injection, the acquisition of a rapid OCT image sequence with fast pull-back can be automatically or manually started. Contrast is injected through the guiding catheter, with the acquisition speed set between 5 and 25 mm/sec. Most expert users advocate the use of automated contrast injection to optimize image quality.

With an acquisition speed of 20 mm/sec, it is possible to obtain 200 cross-sectional image frames over 4-5 cm length of artery in 3.5 sec with a total infused volume of 14 ml contrast. This allows the quick evaluation of the treated artery. The FD-OCT pull-back speed is too fast to interpret the run during the acquisition but the recorded images, that are digitally stored, can be reviewed in a slow playback loop (Tearney, et al., 2008), (Imola, et al., 2010).