CHAPTER 13

Step-by-Step Approach to Intracoronary Imaging-II: Optical Coherence Tomography (OCT)

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Introduction

Optical coherence tomography (OCT), utilizes echoes of backscattered light to produce high resolution, cross-sectional and three-dimensional volumetric imaging of microstructures in biological tissues. As such, OCT allows clinicians and researchers to acquire a real time, in situ, "optical biopsy" with resolutions of 10–15 μm, one to two orders of magnitude finer than conventional intracoronary ultrasound.[1]

Since its introduction as an intravascular imaging tool for the human coronary artery in 1996, OCT has been increasingly used in both in-vivo vascular biology research and clinical practice. Accumulating data support a clinical role for OCT in multiple clinical scenarios, including assessing the natural history of atherosclerosis, effects of statins and anti-platelets therapies, mechanisms of acute coronary syndromes and optimization of percutaneous coronary intervention (PCI).[2]

In this chapter, we provide a step-by-step approach to the clinical application of OCT, beginning with basic operative guidance to performing, troubleshooting, and analyzing OCT images. We then

conclude with the use of OCT to guide PCI, including both pre-procedural strategic planning and post-interventional assessment.

Step-by-step guide to performing OCT

OCT intravascular imaging allows a fast acquisition of a high-resolution image that can immediately aid the operator during coronary procedures. Once all the equipment and technical aspects are familiar to the operator, imaging may be performed expeditious and with high fidelity. Moreover, a proper understanding of the practicalities of OCT image acquisition can ensure an optimal image quality adequate for analysis. In order to allow new operators to confidently perform OCT, we will present a general description of the OCT equipment and step-by-step guide for the procedure as we perform it at our institutions. In this chapter, we describe OCT image acquisition technique with the OCT imaging system manufactured by St. Jude Medical/Abbott Vascular (St. Paul, Minnesota, USA).

Basic planning

As in any procedure, the operator should use OCT only if he believes it will improve his diagnostic clinical assessment and/or guide coronary intervention. Although rare, the operator should be aware and ready to treat potential complications such as arrhythmia during vessel flush, coronary dissection or perforation, and contrast-induced acute kidney injury. In specific clinical or anatomical scenarios, the operator might choose to use other imaging modalities, such as intravascular ultrasound (IVUS):

a. Abnormal kidney function: Although no formal recommendation exists, OCT employs the use of 14±3cc of contrast dye in each image acquisition. Thus, the operator should use caution in patients with acute or chronic kidney injury to reduce the risk of worsening renal failure.

b. Aorto-ostial lesions: OCT imaging of the left main ostium - and to a lesser extent the right coronary artery (RCA) ostium - might produce poor image quality due to difficulty of proper contrast flushing and large vessel size.
c. Specific vessel anatomy: Vessel tortuosity, high burden of calcium or high degree of vessel stenosis may impose difficulties in advancing the OCT catheter as well as interfere with blood clearance during contrast flushing. In case of a tight stenosis, the operator may choose to pre-dilate the vessel with a 1.5-2.0 mm balloon prior to OCT to improve image acquisition and quality.

Equipment inventory

The 3 components needed for imaging are the following: a mobile OCT console or integrated OCT system; pullback doc; and imaging catheter. The latest OCT platform provides an axial resolution of 10-20 μm and a lateral resolution of 25-30 μm. This system provides two pullback modes: a "survey mode" that scans a 75 mm vessel segment at a pullback speed of 36 mm/s (5 frames/mm) and a "high-resolution mode" which scans a 54 mm vessel segment at a slower pullback speed of 18 mm/s (10 frames/mm).

Steps for equipment preparation

1. Cover the pullback doc with a sterile transparent bag.
2. Remove with care the OCT image catheter from its protective sheath.
3. Purge the image catheter with 100% contrast using the dedicated purge syringe. The catheter is sufficiently flushed when few drops of contrast are seen at the distal end of the catheter.

4. Connect the catheter to the pullback DOC (drive-motor and optical controller). Make sure connection status is indicated on the mobile console screen. Once connected, the module will perform auto-calibration. Caution – do not flush the catheter during calibration.
5. Ensure functionality of "live view" mode prior to inserting image catheter into the vessel.

Guide catheter selection

OCT imaging requires a transient complete displacement of blood with contrast medium to avoid backscattering of light by red blood cells. To allow optimal contrast injection, a careful choice and positioning of the guiding catheter should be employed. The guiding catheter should be matched to the proximal vessel shape and aligned coaxially to facilitate a selective and safe contrast injection. A 6 French system is preferred for optimal image with minimal contrast use.

Positioning the OCT imaging catheter

Prior to coronary wiring and imaging catheter advancement, intravenous unfractionated heparin should be administered to target a therapeutic activated clotting time. The OCT imaging catheter is a 2.7 French rapid exchange monorail catheter, compatible with standard 0.014-inch coronary guidewires. The catheter is positioned in the vessel using three radiopaque markers: the distal marker located 4 mm from the tip; the mid marker (position of the optical lens) located 23 mm proximal to the distal marker, and the proximal marker located 50 mm proximal to the mid marker (total of 77 mm from the distal catheter tip) (**Figure 1**). To ensure that the entire region of interest is imaged, it is important to make sure that the mid marker is placed distal to the target lesion.

Choosing length of acquisition

The desired acquisition length, 75 or 54mm, is based on the indication for OCT and the need of the operator to view different details of the coronary vessel. Depending on the lesions of interest, the 75 mm “survey mode” may allow a first scan for basic lesion analysis while the 54 mm “high resolution” mode allows visualization of greater detail for PCI optimization.

Choosing contrast volume

Contrast flushing of the desired vessel can be achieved either by manual injection using a Luer-Lock syringe or by automatic injection using an injector pump. The aim should be a complete blood removal throughout the image acquisition cycle, which takes approximately 5 seconds. Operators generally use a flush rate of 3-4 ml/s in the RCA and 3-5 ml/s in the left coronary artery, with a total bolus of 15 ml and 15-20 ml, respectively. Alternatively, one may connect an automatic injector to the back of the manifold with a 3-way stopcock and computed to apply a total contrast bolus of 14 ml at a flush rate of 4 ml/s. For patients with chronic kidney disease, the contrast may be diluted with saline using 70% contrast media; alternatively, 10% Dextran can be used.

Steps for OCT image acquisition

1. When ready for image acquisition, the operator should make sure again that the guiding catheter is well engaged and consider administering intracoronary nitroglycerin to reduce vessel spasm.
2. After checking the positioning of the catheter in the coronary vessel, press the “live view” button and real-time imaging begins. Do not advance the catheter in “live view” mode.
3. Prior to image acquisition, calibration should be performed by pressing the “enable” button once. After calibration, image acquisition becomes unlocked.

4. Press the “enable” button again to enable pullback. At this point, the engine starts to spin rapidly. Following enabling of the device, the operator has 20 seconds to inject contrast.
5. Inject contrast medium under cine angiography. Sufficient contrast flushing will activate the automatic trigger to start the pullback. During OCT acquisition, the mid marker moves proximally together with the lens, which can be seen on the angiogram (note: manual triggering of pullback can also be performed).

Note that if the 10 seconds passes without triggering pullback (e.g., due to incomplete blood clearance), the system automatically returns to the low-speed “live view” mode. These steps can be repeated until a satisfactory OCT pullback has been acquired.

Troubleshooting

Troubleshooting issues with vessel flushing

A suboptimal image due to insufficient blood clearance is perhaps the most frequent problem with intracoronary OCT. Sub-optimal flushing may be affected by a number of factors and the operator may try the following steps to improve vessel flushing. Preferably, these steps should be performed prior to each OCT acquisition:

1. Check that the guiding catheter is adequately positioned in the target vessel. Make sure that the catheter is properly engaged in the ostium during the entire flush.
2. When using an automatic injector, make sure that the line to the pump is open, purged of air bubbles, and that the pump is enabled. Should this not be adequate, the flow rate might need to be increased. However, please note that a sufficient total contrast volume is used to flush during the entire pullback and that too high of a rate may destabilize the catheter and push it out of the ostium.

3. If the above steps are not sufficient, the final step is to perform a pre-dilatation of the region of interest with a 1.5-2.0 mm soft balloon. The operator should take into account that the lesion may be modified by the procedure.

Troubleshooting issues with poor imaging catheter signal

Problems with the catheter signal are rare with modern OCT catheters. Potential causes for poor signal are: catheter related issues, poor connection to the pullback DOC, or console software issues. Catheter-based problems include insufficient purge or a malfunctioning or broken catheter. In either case, the connection status can be seen on the main OCT screen (i.e. during connection, the green bar indicates whether the catheter is fully connected or not). The operator may choose to disconnect the catheter from the doc, check to make sure it is not kinked, purge it thoroughly, ensure that the plastic bag has not been caught in between, and then reconnect. If the connection stops halfway, the operator may consider restarting the OCT system. If there continues to be a poor signal, the catheter should be replaced with a new catheter.

<u>Image interpretation</u>

The normal artery[3]

The normal coronary arterial wall appears on OCT as a 3-layered structure composed of an intima, media, and adventitia (**Figure 2A**). The intima and adventitia appear as bright, signal-rich (high-reflectivity) layers, whereas the intervening media appears as a darker, signal-poor (low-reflectivity) layer. Although the internal and external elastic lamina that bind the media are below the resolution of OCT and cannot be directly visualized, their location is demarcated by the transition from the signal-rich intima to the signal-poor media and from the signal-poor media to the signal-rich adventitia.

Plaque and thrombus characterization[3]

In the presence of atherosclerotic plaque, the 3-layered structure of the normal coronary arterial wall is lost, and the lumen may appear narrowed. Plaques can be categorized by their tissue composition, and the OCT appearance of fibrous, lipid-rich, and calcific plaques have been validated against corresponding histology samples. Fibrous tissue appears on OCT imaging as a homogeneous area of high reflectivity with low signal attenuation (**Figure 2D**). Lipid appears as a homogeneous area of low reflectivity with high signal attenuation that may limit the visualization of deeper structures (**Figure 2E**). Calcium appears as a heterogeneous area of either high or low reflectivity, with low signal attenuation and most notably a sharp demarcating border (**Figure 2F**).

Thrombus is readily identified by OCT as a luminal mass attached to the arterial wall. Because red blood cells attenuate OCT signal, "red thrombus" - composed primarily of red blood cells - appears as a signal-rich mass with high signal attenuation (**Figure 2B**). In contrast, "white thrombus" consists primarily of white blood cells and platelets and therefore appears as a signal-rich mass with low signal attenuation (**Figure 2C and Figure 3B**)

OCT imaging artifacts[1, 4, 5]

Artifacts are errors in the perception or representation of visual information, resulting in features that are not present in reality. Learning how to recognize and understand OCT artifacts will allow image interpretation to become much more accurate. Artifacts in OCT can be categorized into three main groups: (1) artifacts that originate from light propagation in the catheter, lumen or vessel wall, (2) artifacts related to catheter location and movement, and (3) artifacts associated with stents. Although many different types of artifacts exist, this chapter will concentrate only on a few of the common artifacts encountered with OCT.

Residual blood from incomplete vessel flushing

Red blood cells diffusely scatter the OCT light, resulting in light attenuation and shadowing. In order to prevent artifacts resulting from OCT light scattered by red blood cells, blood must be completely flushed from the lumen during OCT imaging. When blood is present, lumen artifacts can appear in the OCT image as signal-rich areas instead of a transparent lumen. Blood in the lumen may appear as "whirls", but can also resemble thrombus-like structures (**Figure 3A**). Residual blood artifacts and vessel shadowing may cause difficulty in interpretation of arterial wall structure as well as introduce significant changes to stent strut appearance. Repeating the imaging procedure, after addressing the possible interferences to optimal flushing, can correct this artifact (see troubleshooting section above).

Thrombus

Thrombi, formed on the surface of the arterial wall, stent struts or the catheter, cause OCT light shadowing. Shadow effects are greater for thrombi positioned closer to the catheter. As describe above, a white cell thrombus is more translucent to OCT light and result in less shadowing than red cell thrombus. Red cell thrombus will typically not only shadow the arterial wall beneath, but also obscure the backside of the clot, thus introducing uncertainty in assessing the full size and volume of the thrombus (**Figure 3B and Figure 2C, 2B**).

Fold-over artifact

When the diameter of the vessel imaged is too large for the field-of-view of the imaging catheter, as well as in a large side branch bifurcation, a fold-over artifact may be observed. This artifact is a consequence of OCT signal aliasing when signals are reflected from outside the system's field-of-view. The image falsely appears to fold back on itself depicting an inverted reflection of the tissue. Therefore, this section should not be used to assess vessel geometry (**Figure 3C**).

Guidewire and metallic stent struts shadow

Light cannot penetrate metal, which creates a shadow on the sides of guidewires and metallic struts, thus hindering adequate visualization of the structures behind (**Figure 3A, 3B**). As the guidewire is essential for every clinical OCT imaging, its shadow artifact is present in every image.

Interestingly, the round metallic guidewires appear crescent-shaped and the rectangular metal stent struts appears as a bright line. This optic phenomenon is due to the high reflection properties of metal that does not allow its backside to be visualized. The size of the shadow depends on the location of the metallic structures in relation to the imaging catheter and the vessel wall. The shadow will become wider when the metallic structure is farther from the vessel wall and closer to the imaging catheter.

The guidewire shadow will completely mask the underlying tissue including stents, and may from time to time be confused with a side branch. The presence of residual blood in the lumen can introduce various artifacts in the appearance of the metallic stent struts, including “merry-go-round”, blooming, and ghost strut artifacts.

<u>Guiding intervention</u>

Assessments of underlying plaque characteristics to develop a pre-PCI strategy

OCT-guided intervention should preferably begin by assessing the baseline underlying plaque characteristics. The operator can plan the optimal lesion preparation and intervention technique aiming to allow better stent expansion and apposition, while striving for reducing complications such as dissection, perforation and periprocedural myocardial infarction (MI).

*Lesion preparatio*n

If the OCT image reveals only the presence of fibrous plaque or lipid rich plaque, direct stenting or pre-dilatation with compliant undersized balloons can be pursued. In contrast, if a calcified lesion is present, a more aggressive lesion preparation should be performed to allow for better stent expansion.[4] The high resolution of OCT and its calcium penetrance properties allows better estimation of calcium width than IVUS. The presence of a thin calcium layer can guide the operator that non-compliant balloons may suffice. In cases of deeper calcium visualized, one might consider the use of cutting or scoring balloons. On the other hand, a thick superficial layer of calcium may be best treated with atherectomy devices. Successful calcium fracture will yield better stent expansion. An OCT-based calcium scoring system has been developed, aiming to identify lesions that would benefit from plaque modification prior to stent implantation.[6] This study suggested that lesions with calcium deposit with maximum angle >180°, maximum thickness >0.5 mm, and length >5 mm may be at risk of stent under-expansion. Finally, the presence of thrombus, its type and burden, might guide the use of thrombectomy devices or the need for adjunctive pharmacological treatment (e.g. glycoprotein 2B3A inhibitors) prior to or after stenting.

Analysis of target vessel dimensions

Measuring vessel dimensions with OCT can aid with balloon and stent diameter selection. The high resolution of OCT along with lumen flushing provide sharp border definition between the lumen and the vessel wall, allowing for accurate automated measurements of vessel dimensions. In fact, measurements of vessel dimensions are more reproducible by OCT than IVUS.[1] Nevertheless, the low penetrance of OCT does not always allow for imaging of the EEL, specifically in diseased vessels. Therefore, in diseased parts of the coronary artery, OCT often tends to deliver lower values of lumen areas compared to IVUS. For this reason, the operator should take care not to confuse IVUS vessel size guidelines with OCT sizing.

There remains a debate in the literature whether to use lumen or vessel dimensions when guiding PCI for intracoronary imaging. Until recently, lumen dimension has been the only approach for OCT-guided intervention. This was translated in the past into lower stent sizes employed in OCT-guided vs. IVUS-guided PCI,[2] yet with no proven long term clinical implications. Two recent studies have advanced our understanding in this controversial area. The ILUMIEN III trial[7] introduced an alternative OCT algorithm for optimal stent selection based on the measurement of the EEL-EEL diameter, and demonstrated similar post-PCI minimal stent area (MSA) between OCT and IVUS guidance. Regrettably, this study was not designed to detect the difference in clinical outcomes. In the OPINION trial,[8] the investigators used the standard OCT lumen dimension to guide PCI. This has resulted in smaller stent diameter achieved in the OCT-guided PCI compared with the IVUS-guided PCI group. However, no difference in angiographic late lumen loss, percent diameter stenosis and restenosis rate was observed at 8 months. More importantly, there was no difference in the rate of target vessel failure within 12 months. Further studies will inform the field of the preferred method for PCI optimization with OCT.

Landing zone and stent size selection

OCT provides the opportunity for precise and meticulous stent sizing, eliminating the ambiguity of visually-based vessel sizing and of visually selecting “normal-appearing” reference segments on angiography. The operator can use the high resolution cross sectional and longitudinal views to identify the proper landing zone, calculate the lesion length, and measure the reference vessels dimensions. OCT provides the opportunity to avoid implantation of stent edges in a lipid-containing plaque. Incomplete stent coverage of coronary lipid pools appears to be associated with an increased risk for postprocedural myocardial infarction, a higher risk for edge dissection and for late stent edge restenosis[4,9]. Therefore, the selection of an appropriate stent length is crucial in order to avoid: i) residual disease in the inflow

and/or outflow vessels segments, ii) implanting the stent edge in a lipid-containing or a calcified plaque, and iii) geographical miss and the need for additional stents.

For specific sizing, an OCT cross-section with the most normal looking reference vessel needs to be selected. Then, the operator may choose to guide his intervention using lumen area measurements (OPINION study[8]) or to make EEL-EEL ("media to media") measurements (ILUMIEN III study).[7] Stent diameter selection is dictated by the smallest reference mean vessel diameter, which is usually the distal reference (**Figure 4**).

As discussed above, stent diameter can be determined either by measuring the lumen diameters or vessel diameter. When vessel diameter (EEL-EEL) stent sizing is used, the smaller of the mean proximal or distal EEL, rounded down to the nearest 0.25 mm is used[4] (e.g. if the smaller reference EEL measures 2.7 x 2.9 mm, the mean is 2.8 mm, which is then down-sized to 2.75 mm stent). A general rule is that sizing-up (i.e choosing a stent size larger than the measured value) is prohibited when using EEL-EEL measurements, while it is permitted (to a limited extent) when using lumen criteria. In the absence of randomized comparative data for sizing, the adoption of one or both approaches is left to the discretion of the individual operator.

To facilitate stent sizing, the operator may use the console's automatic post-processing analysis. The operator may move the proximal and distal lesion cursors to the desired landing zones. This will allow for automatic reference lumen diameter analysis while the longitudinal view will allow stent length calculation. For EEL-EEL measurements, the operator will need to manually analyze the desired vessel by using the measurement tool (**Figures 4 and 5**). Recently, an angiography and OCT co-registration function has been developed and is in clinical use in many coronary catheterization laboratories. Co-registration may aide the operator in implanting the stent precisely in the landing zones chosen on OCT.

Optimization of intervention

Evaluation of stent expansion

Stent expansion is probably the most important and validated metric of PCI optimization that is translated to clinical outcome.[2, 10] Stent expansion can be expressed using absolute values such as minimum stent area (MSA) or relative values such as post-PCI stent expansion. This is defined as the percentage of MSA to mean reference lumen area. In long stents, this ratio can be calculated separately for the proximal and distal segments. Stent expansion is considered optimal if the MSA of the proximal segment is ≥95% of the reference lumen area. It is considered acceptable when ≥90% and <95% and unacceptable when <90%[4] (**Figure 5**).

Post-dilation is performed separately for proximal and distal segments of the stent. If vessel sizing is used, balloon size should always be ≤ the EEL measurement at the proximal and distal reference segments analyzed in the pre-PCI assessment. Alternatively, if lumen sizing is used, the post-dilation balloon is sized ≤0.5 mm larger than the post-PCI mean lumen diameter measurement of the proximal and distal reference segments.

Tissue/thrombus protrusion

Intra-stent plaque or thrombus protrusion is defined as a mass, at least 0.2 mm in dimension, attached to the luminal surface or floating within the lumen. These includes smooth protrusion, disrupted fibrous tissue protrusion, and irregular protrusion. It is considered major when protrusion area/stent area at the site of tissue protrusion is ≥10% and minor when <10%.[4] In a large OCT clinical study, only irregular protrusion along with small MSA were found independent predictors of 1-year clinical end points.[10] The clinical significance of other types of tissue and thrombus protrusion remains unclear. In general, we would only recommend additional mechanical intervention in the more pronounced forms of tissue or thrombus protrusion. For example, in the ILUMIEN III study,[7] only

thrombus or tissue protrusions with an area exceeding >10% of the stent area was an indication for further post-dilation or additional stent implantation.

Stent edge dissection

Edge dissections are defined as disruptions of the luminal surface in the 5 mm segments proximal and distal to the stent. The high-resolution image available with OCT allows detection of many small, clinically insignificant edge dissections. Therefore, not every dissection demonstrated should be treated. Usually, when there is no haziness or other angiographic abnormality in the stent edge region, it would be unusual to detect a clinically important edge dissection on OCT. On the other hand, haziness on angiography after stenting is considered an excellent indication to perform OCT, as it can help to discriminate between edge dissection, intramural hematoma, thrombus, plaque protrusion or underexpansion.

To date, no firm OCT-based rules have been established to guide when to intervene on edge dissections. Yet, certain morphologic characteristics may identify a larger edge dissection where intervention should be considered. These includes dissections with circumferential extent ≥60 degrees of the vessel, longitudinal length ≥3 mm in length, and those that extend beyond the intima into the media or adventitia. An additional factor to consider is the “intra-dissection” lumen area, especially if it is <90% of the respective reference area.

Stent malapposition

The clinical relevance of acute stent malapposition is still debated. On the one hand, no clear correlation of acute stent vessel wall malapposition with clinical outcome has been established. On the other hand, histopathology studies report acute stent malapposition as a cause for delayed arterial healing and as a potential trigger for thrombus formation. Generally, it is accepted that any

malapposition with a distance from the top of the strut to the vessel wall of <200-250 µm is not to be considered a clinically relevant malapposition. Notably, the OCT console allows for automatic stent malapposition analysis with color coding as follows: white - well-apposed stent, yellow - >200µm, and red - >300µm. Not every spot of malapposition should be treated. If a long segment of malapposition is discovered, one may consider post-dilating this region.

Untreated reference segment disease

As a general rule, stenting over residual disease in the inflow and outflow parts of a stented segment should be avoided, as it has been associated with a higher risk for stent thrombosis.[11] Untreated reference segment disease may be defined as untreated minimum lumen area (MLA) ≤60% of the adjacent reference segment lumen area up to 10 mm from the proximal and distal stent edges.[7] As described above, the longitudinal and cross sectional OCT views may help distinguish specific plaque features and aid in the selection of the most appropriate stent length, thereby permitting the best possible compromise between exclusion of residual edge segment disease and avoidance of unnecessary prolongation of stent length. The angio-OCT co-registration function, if available, can be particularly helpful in avoiding geographical miss.

Case presentation

A 62-year-old female with severe pulmonary disease, undergoing lung transplant evaluation, presented for an elective right and left heart catheterization. Coronary angiogram revealed severe mid right coronary artery stenosis.

Pre-PCI (**Figure 5, Panel 1**)

Severe narrowing due to lipid plaque and without evidence of calcium or plaque rupture was demonstrated (**panel 1B**). The distal reference vessel measurements were: mean luminal diameter of

2.5mm and mean EEL-EEL diameter of 2.8mm (**panel 1A**). The proximal reference vessel measurements were: mean luminal diameter of 2.9mm and mean EEL-EEL diameter of 3.2mm (**panel 1C**). Measured distance between proximal and distal landing zones was 15.6mm (**Panel 1**). Decision was made to proceed with direct stenting using a 2.75x18 mm Bare Metal Stent (due to anticipated lung transplantation).

Post-direct stenting (**Figure 5, Panel 2**)

Minimum stent area (MSA) is 5.10 mm^2 (**panel 2B**). At this point, stent expansion is 87.5% relative to the distal reference and 76.3 % relative to the proximal (**panel 2A+C**). As stent expansion was less than 90%, decision was made to proceed with post-dilatation with a 3.25x15mm non-compliant balloon.

Final post-PCI optimization (**Figure 5, Panel 3**)

Minimum stent area (MSA) was 5.92 mm^2 (**panel 3B**). Stent expansion was 95.6% relative to the distal reference and 94% relative to the proximal (**panel 3A+C**). No stent edge dissection or tissue/thrombus protrusion were observed.

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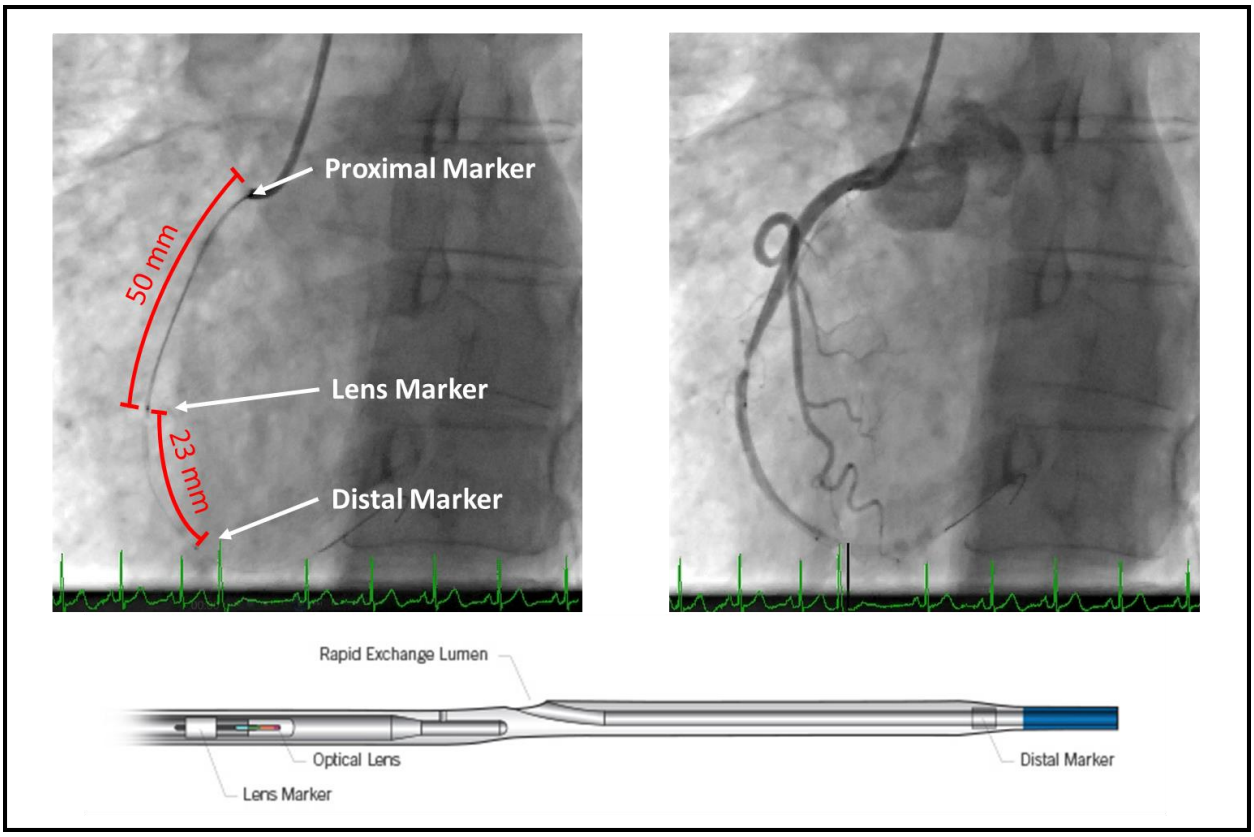
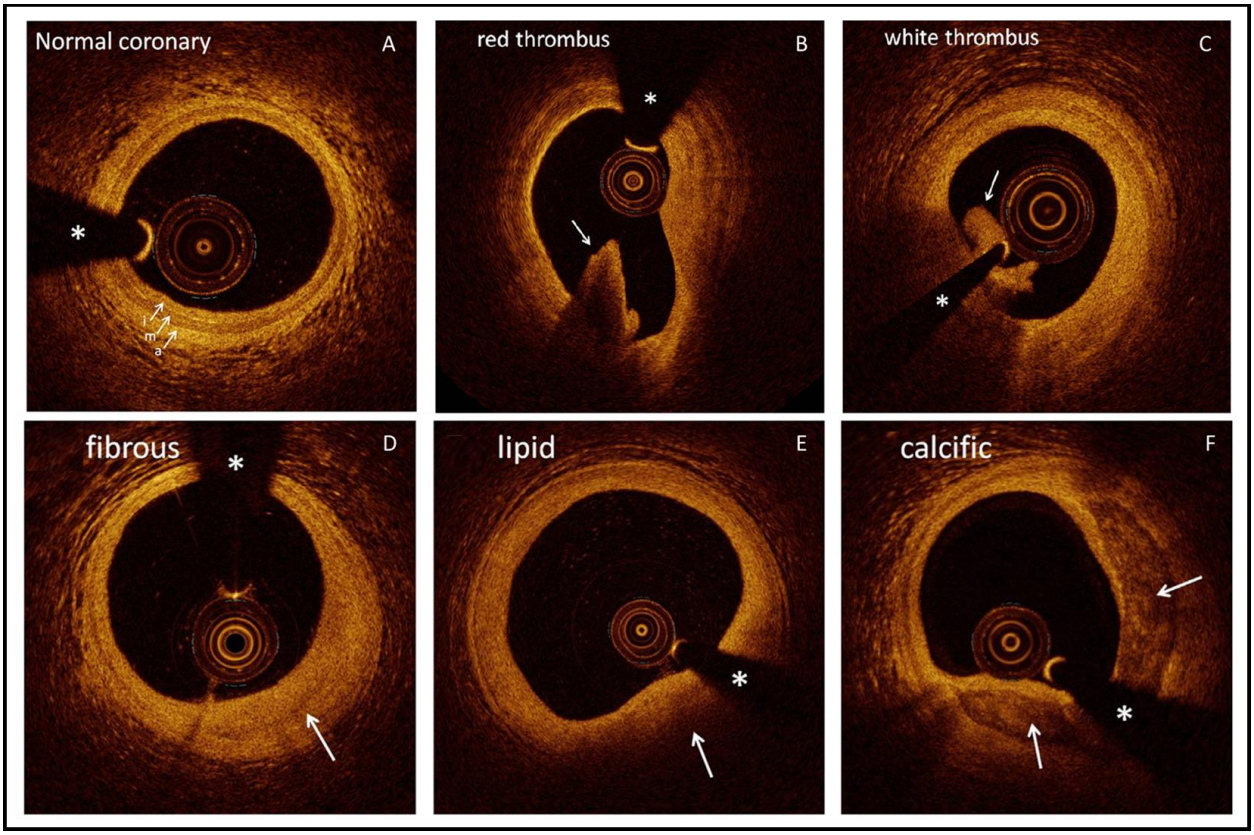
Figures

Figure 1: Positioning the OCT imaging catheter



The OCT catheter is positioned in the vessel using the three radiopaque markers: the distal marker located 4 mm from the tip; the mid marker (identifying the optical lens) located 23 mm proximal from the distal marker, and the proximal marker located 50 mm proximal to the mid marker. The mid (lens) marker is placed distally to the lesion of interest.

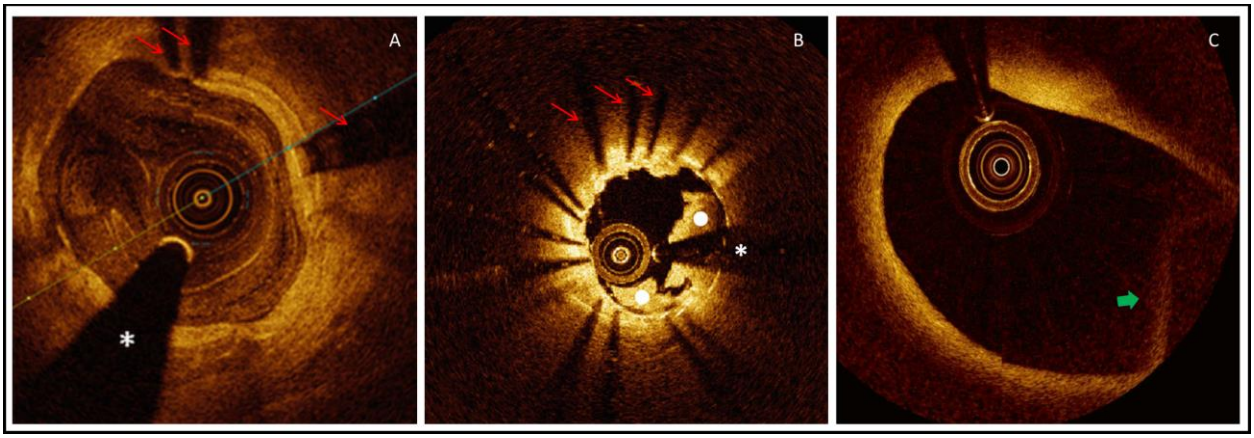
Figure 2: Basic OCT image interpretation



(A) The 3-layered structure of a normal coronary arterial wall. a, adventitia; i, intima; m, media. (B) Red thrombus composed primarily of red blood cells appears as a signal-rich mass with high signal attenuation (arrow). (C) White thrombus composed primarily of white blood cells and platelets appears as a signal-rich mass with low signal attenuation (arrow). (D) Fibrous plaque appears as a homogeneous area of high reflectivity with low signal attenuation (arrow). (E) Lipid plaque appears as a homogeneous area of low reflectivity with high signal attenuation (arrow). (F) Calcium appears as a heterogeneous area of high or low reflectivity with low signal attenuation and a sharp demarcating border (arrows).

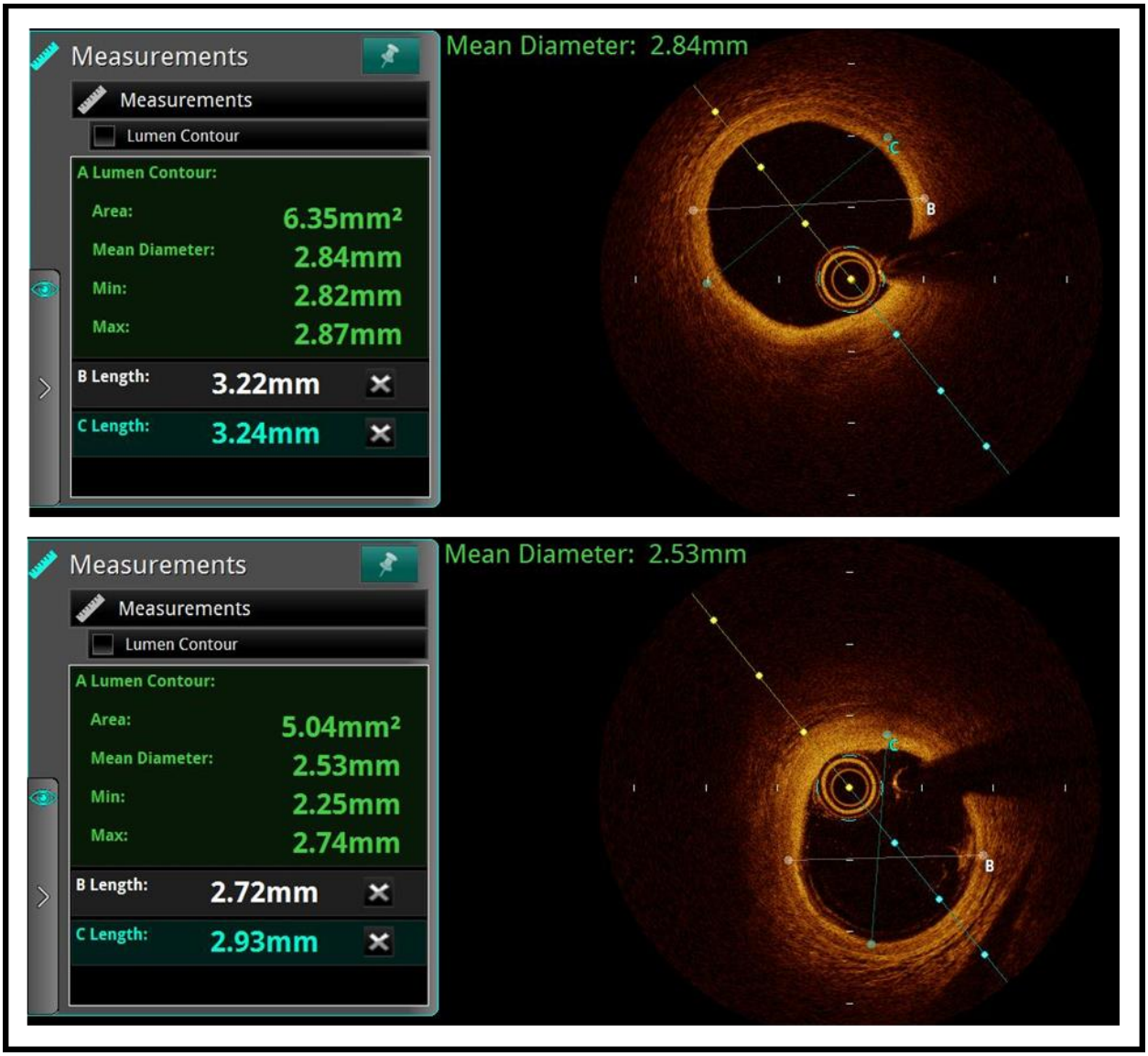
*The asterisk denotes guidewire shadow artifact.

Figure 3: Common OCT image artifacts



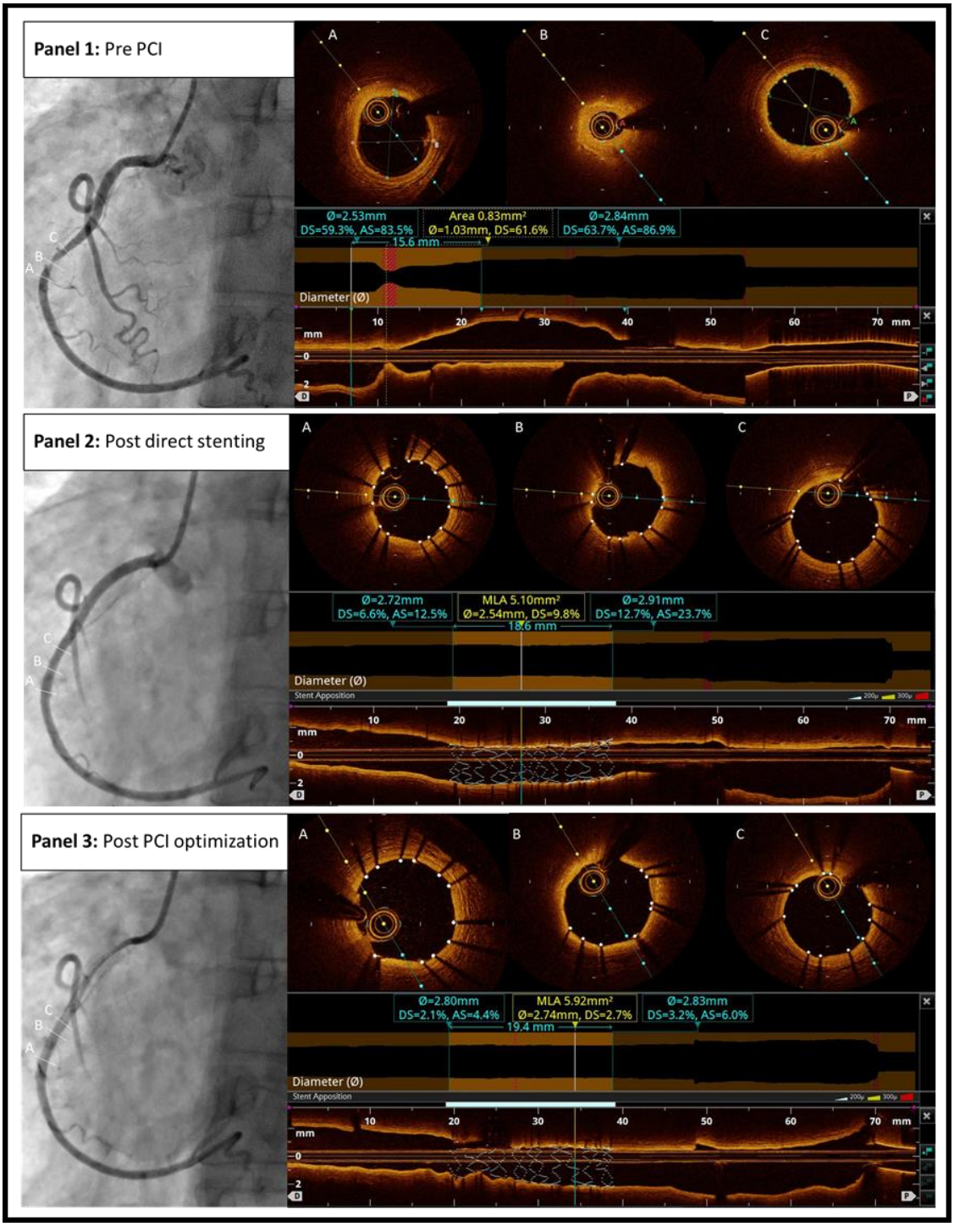
(A) Insufficient blood displacement, resulting in light attenuation and blood "whirls" artifact. Note how the light attenuation from residual blood mask some of the stent struts shadowing. (B) White blood clot (denoted by white dots) within a stented vessel causing partial attenuation of the OCT beam. (C) Fold-over artifact in a large vessel (green arrow). The asterisk (*) denotes guidewire shadow artifact. Stent strut shadow artifacts are marked with red arrows.

Figure 4: Analysis of target vessel dimensions with OCT



Lumen and vessel size measurement in the reference vessels described in case presentation (Figure 5). (Upper Panel) Proximal landing zone with mean luminal diameter of 2.84 mm and mean vessel size measured as EEL to EEL of 3.23 mm (B, C length). (Lower Panel) Distal landing zone with mean luminal diameter of 2.53 mm and mean vessel of 2.82 mm (B, C length).

Figure 5: Guiding and optimizing PCI with OCT



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