

Precision PCI:

Making the Complex Simple or the Simple Complex?

Evaluating OCT imaging guidance in everyday practice as a new standard of care.

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In the same way that comprehensive case planning has become standardized for transcatheter aortic valve replacement, we advocate for a planned and deliberate approach to percutaneous coronary intervention (PCI). Optical coherence tomography (OCT) allows for this in the cardiac catheterization laboratory with precise lesion assessment. OCT is a catheter-based, intravascular imaging technology that uses light to create high-resolution images. Image acquisition with automated OCT pullback can be completed in < 3 seconds.¹

The ability of an interventional cardiologist to accurately assess a lesion by angiography alone is one that has poor reproducibility and high variability.^{2,3} Intravascular imaging takes the guesswork out of stent sizing for PCI. Guided by intravascular imaging, meaningful case planning can occur in real-time, which ensures a consistent quality of treatment for all patients treated with PCI.

Extensive clinical data support the benefits of intravascular imaging.⁴⁻⁶ Routine intravascular imaging can lead to significant changes in the treatment strategy for most cases. In the ILUMIEN I study, the interventional strategy was modified based on baseline OCT imaging in 57% of cases, with 27% of post-PCI cases requiring further unplanned optimization based on OCT findings.⁷

We believe that OCT should be routinely used both before and after stent implantation using an algorithmic approach. This article outlines a stepwise method to ensure comprehensive OCT-guided PCI.

BASELINE OCT

The goal of baseline OCT is to assess plaque morphology, identify normal distal and proximal landing sites to determine the stent length, and measure the size of the reference vessels for stent diameter selection. Use of OCT-based angiographic coregistration can fur-

ther improve the ability to precisely implant the stent, localizing the intended target for stent deployment. If it is not possible to cross the lesion with OCT at baseline, predilatation with a small-diameter (≤ 2.5 mm) non-compliant balloon can facilitate prestent intravascular imaging.

Plaque Morphology

Assessment of plaque morphology is essential for procedure planning and to ensure an optimal result (Figures 1 and 2). Thin-cap lipid-rich plaque should be identified and avoided for a stent landing site as these areas are prone to dissection.⁸ OCT allows for the evaluation of different plaque morphologies in the target vessel and is particularly useful for recognition and assessment of coronary artery calcification. Angiography has been shown to underestimate the severity of calcium and does not define if the calcium is nodular, superficial, or deep.³ The characteristics of coronary artery calcification can guide appropriate lesion preparation strategies (Figure 3). OCT-based calcium assessment can predict when stent underexpansion is likely, without the use of adjunctive atherectomy or intravascular lithotripsy (IVL) for lesion preparation (Figure 4).⁹

The treatment of in-stent restenosis (ISR) can also be challenging, and these lesions are at high risk for future restenosis. Angiography alone fails to provide determination of the mechanism of restenosis, and consequently, the use of intravascular imaging can be beneficial in nearly all cases of ISR. Mechanisms of ISR, including neointimal hyperplasia, neoatherosclerosis, or stent underexpansion, can be clearly delineated with OCT (Figure 5). These distinct entities should be approached with different treatment modalities based on the etiology of restenosis.

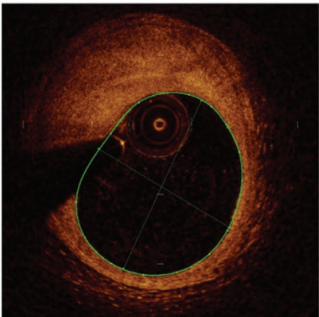
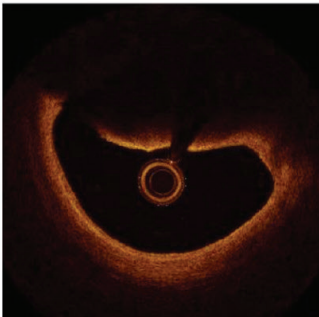
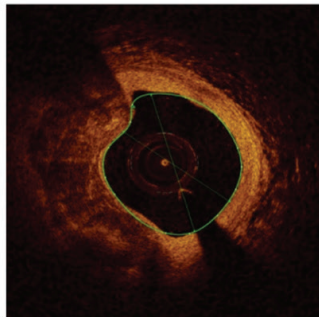
Plaque morphology	Fibrous	Lipid-rich	Calcified
OCT			
OCT appearance	• High reflectivity • Homogeneous • Finely textured	• Low reflectivity • Homogeneous • Diffuse margins	• Low reflectivity • Heterogeneous • Sharp margins
Treatment	Predilatation followed by stenting	Direct stenting	NC balloon, cutting, scoring, atherectomy (OA/RA/IVL)

Figure 1. Plaque morphology by OCT. OCT allows for delineation between fibrous, lipid, and calcified plaque. NC, noncompliant; OA, orbital atherectomy; RA, rotational atherectomy.

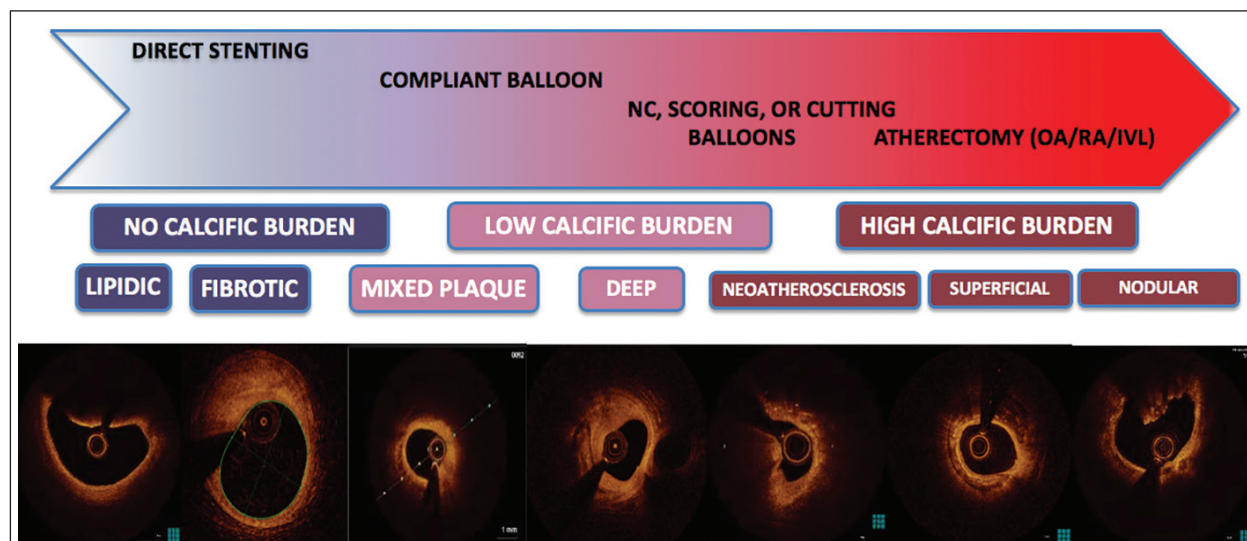


Figure 2. Plaque morphology is a determinant of pretreatment approach. Determination of the predominant plaque morphology guides the procedural strategy before stent implantation. NC, noncompliant; OA, orbital atherectomy; RA, rotational atherectomy.

Stent Length

OCT has a critical role in determining the correct stent length, as the angiogram is a lumenogram that underrepresents the extent of disease. Although OCT often leads to longer stents being selected, the overall number of stents utilized may be fewer because the

optimal stent length can be selected upfront as part of the pretreatment planning. When selecting a stent length, the goal is to find distal and proximal reference landing sites that are best suited for stent implantation. Lipid-rich plaque and superficial calcium should be avoided whenever possible in the stent landing zone.

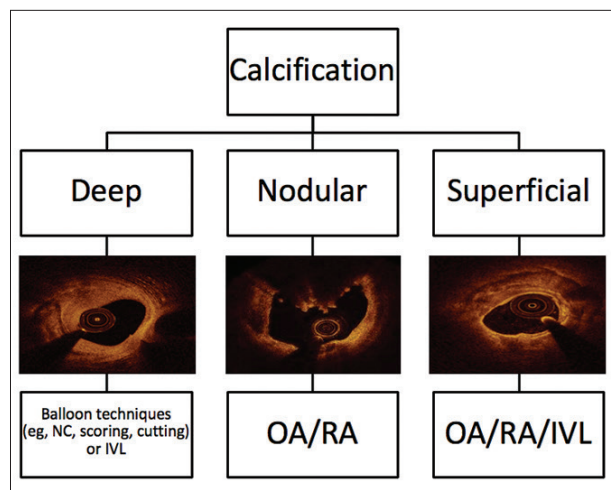


Figure 3. Patterns of coronary artery calcification. Identification of the characteristics of coronary artery calcification can help to guide the optimal lesion preparation strategy. Deep calcification is typically best managed with balloon-based modalities, including noncompliant (NC), scoring, or cutting balloons, or IVL. Nodular calcification can be treated with orbital atherectomy (OA) or rotational atherectomy (RA). Significant superficial calcification is best treated with OA, RA, or IVL.

Stent Sizing

Contemporary stent sizing is often performed by eyeballing an x-ray lumenogram from a distance and estimating the most appropriate stent size. This simple approach has been associated with the complex issue of ISR, which continues to occur at a high rate despite significant advances in stent technology.^{10,11}

With OCT, the precise size of the vessel is determined in real time by measuring the external elastic lamina at the proximal and distal reference segments and rounding down to the nearest stent diameter. If there is no disease-free reference site adjacent to the lesion and

external elastic lamina is not visualized for > 180°, stent sizing can be based on the mean lumen diameter with upsizing to the nearest available stent diameter. This OCT-based approach can safely permit the selection of larger-sized stents.

Angiographic Coregistration

After lesion preparation (when necessary) and the selection of the appropriate stent, integrated angiographic coregistration can be used with stent implantation to ensure that the stent is being delivered precisely where intended. For precise implantation of stents at bifurcation and ostial lesions, OCT-based angiographic coregistration can be of increased importance.¹²

POSTSTENTING OCT

After stent implantation, OCT should be performed to evaluate for significant edge dissections, stent malapposition, and relative stent expansion compared with the proximal and distal reference.

Edge Dissection

The high resolution of OCT images allows for the most accurate assessment of edge dissections. Although not all edge dissections require further treatment, intravascular imaging-based assessment of the dissection provides the maximum angle, length, and effective lumen area that can guide appropriate decision-making.

Stent Apposition

Although stent apposition may not play as large a role in restenosis or stent thrombosis as stent expansion or edge dissections, malapposition can be easily identified with OCT. The Optis integrated system (Abbott Vascular) allows for automated color-coded stratification of stent strut malapposition based on the distance of the stent strut from the vessel wall. Identification of significant malapposition after stent

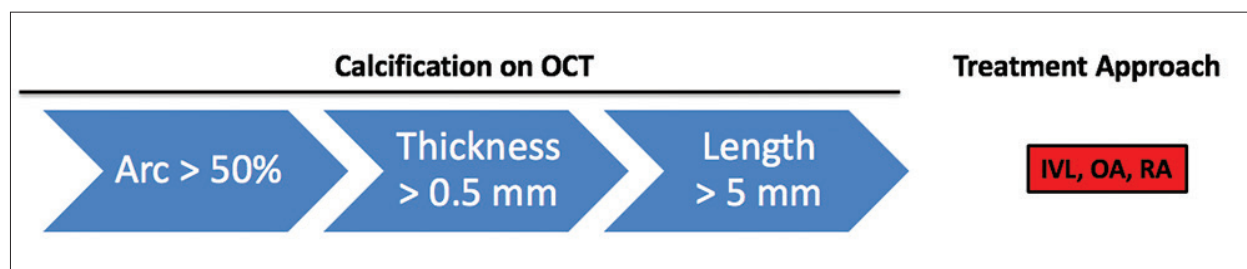


Figure 4. OCT-based features of severe calcification. The presence of coronary artery calcification comprising an arc that exceeds half of an OCT cross-section, with a thickness > 0.5 mm and a continuous length of > 5 mm, is associated with stent underexpansion. It is recommended to use lesion preparation with either IVL, orbital atherectomy (OA), or rotational atherectomy (RA) prior to stent implantation for these lesions.

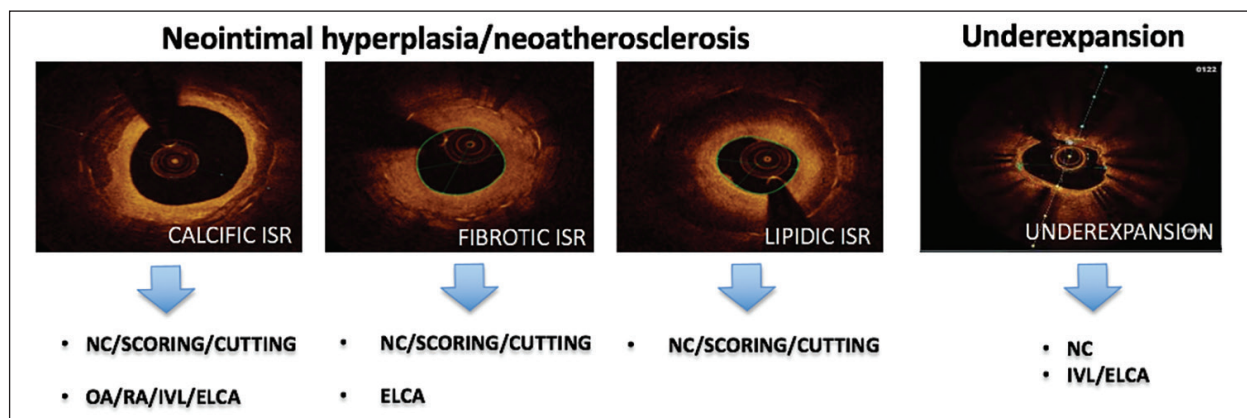


Figure 5. ISR: a mechanism-based approach. OCT identifies the etiology of ISR, which guides optimal treatment. ELCA, excimer laser coronary atherectomy; NC, noncompliant; OA, orbital atherectomy; RA, rotational atherectomy.

implantation is important in cases where a lesion may need to be recrossed with a guidewire.

Stent Expansion

Minimal stent area and luminal gain are among the most important predictors of future stent-related events. Maximizing stent expansion is critical to decrease restenosis rates. Stent expansion can be rapidly determined after OCT acquisition with automated calculation. The goal for optimal stent expansion is > 90% compared with the respective reference segment, and OCT assessment guides targeted poststenting procedural optimization to achieve this goal.

CONCLUSION

We believe that upfront, routine intravascular imaging may allow for an overall reduction in contrast, cine acquisitions, procedural time, and resource utilization. An algorithmic approach incorporating imaging into routine procedures not only optimizes treatment decisions but may improve efficiency.¹

As an interventional community, we have often been complacent in what is considered successful PCI. Precision PCI with stent optimization should not be reserved for clinical research; the time has come for routine daily use. Intravascular imaging-guided PCI should be the new standard of care. Imaging-guided PCI can optimize pretreatment strategies, which helps to determine the need for lesion preparation and selection of optimal stent sizes. Post-PCI imaging ensures that complete optimization has been achieved by confirming adequate stent expansion while excluding significant edge dissection, stent malapposition, and geographic miss. It is our belief that a simple, algorithmic, imaging-guided intervention is critical to

minimize complex mistakes from angiographic coronary evaluation. ■

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