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EDITORIAL COMMENT

Intravascular ultrasound versus optical coherence tomography: Calibrating the use of intracoronary imaging

IVUS *versus* OCT: calibrando o uso da imagem intracoronária

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Coronary angiography (CA) has been used as the gold standard approach to assess the presence and severity of coronary artery disease. However, it is limited by semiquantitative assessment consisting of subjective descriptions of luminal narrowing of major epicardial vessels, although improvements have been made such as the development of quantitative coronary angiography.[1] The use of intravascular imaging in clinical practice, including intravascular ultrasound (IVUS) and optical coherence tomography (OCT), enabled in vivo assessment of coronary atherosclerosis and mechanisms of plaque progression and destabilization. IVUS has enabled in vivo visualization of coronary plaques and vessel sizing in daily clinical practice. However, due to limited resolution, IVUS may not provide sufficient data regarding plaque vulnerability.[2] OCT has superior ability to accurately characterize coronary atherosclerotic plaques to detect the different plaque components when compared with other imaging modalities, due to its higher spatial resolution.[3] Nonetheless, intracoronary imaging techniques are still underused, which cannot be fully explained by the need for adequate training in the acquisition and interpretation of the images.

Evidence for the use of intracoronary imaging has been growing in recent years. Clinical trials and meta-analyses have demonstrated that both OCT and IVUS may improve percutaneous coronary intervention (PCI) outcomes. Benefits associated with the use of intracoronary imaging seem to be greatest the higher the complexity of the lesion and foreseen intervention technique, with stronger evidence for the PCI of left main (LM) lesions and chronic total occlusions, mostly based on data obtained using IVUS.[4] Current European Society of Cardiology/European Association for Cardio-Thoracic Surgery Guidelines on myocardial revascularization recommend using IVUS or OCT for selected patients to optimize stent implantation and to optimize treatment of unprotected left main lesions with class IIa, level of evidence B.[5] There are multiple differences between IVUS and OCT but, while recognizing the advantages and limitations of each, it is unknown whether one is superior to the other in optimizing PCI outcomes.[6]

Post-PCI minimum stent area (MSA) has been found to be the strongest predictor of both restenosis and stent thrombosis. In this regard, both available intracoronary imaging techniques have published evidence of improved results when compared to angiography. Despite these findings, comparison of vessel sizing between IVUS and OCT remains a running debate because published data are not always consistent. Kubo et al. studied 100 coronary lesions to investigate the reliability of frequency domain optical coherence tomography for coronary measurements compared with quantitative coronary angiography (QCA) and IVUS. The IVUS lumen area was larger than OCT (3.68 ± 2.06 mm^2 vs. 3.27 ± 2.22 mm^2).[7] However, these findings may not always hold in individual cases. For example, Bland-Altman plots in multiple IVUS-OCT comparative studies showed that in one-third of cases, OCT lumen area was larger than IVUS lumen area.[8]

The differences in measured sizes have not been fully understood. At the start of coronary OCT practice, time-domain OCT was the available technology but required proximal balloon occlusion, resulting in smaller vessel dimensions. Further explanation may reside in the limited

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capacity of OCT in visualizing the external elastic lamina (EEL) when the plaque burden is high, with many publications having been based in procedures guided by lumen size, thus resulting in final smaller stent sizes and MSA. When the EEL was the basis for sizing, differences between imaging techniques seem to dissipate. In the ILUMIEN (Observational Study of Optical Coherence Tomography in Patients Undergoing Fractional Flow Reserve and Percutaneous Coronary Intervention) III study stent sizing was based on the proximal and distal reference segment EEL measurements, and lumen size was only used for decisions when the EEL was not visible in at least 180 degrees. Among 450 randomized patients, the final median MSA was 5.79 mm^2 after OCT guidance, 5.89 mm^2 after IVUS guidance, and 5.49 mm^2 after angiography guidance. OCT guidance was noninferior ($p<0.001$) but not superior to IVUS guidance ($p=0.42$).[9]

In this issue of the Journal, Oliveira et al.[10] analyzed the differences between IVUS and OCT in achieving accurate coronary vessel sizing. For consistent comparison, the authors created a simulation scenario in which five three-dimensional printed models of a left main to left anterior descending (LAD) lesion were assembled in a pulsatile simulator that allows for catheter insertion, guidewire advancement, stent placement and then IVUS or OCT acquisitions. For the latter, and since the simulation system uses saline perfusion, image acquisition was performed without contrast media. Obtained images in reference locations were used for comparison of dimensions after stent implantation from the LAD to the LM by proximal optimization technique. In the final analysis, OCT significantly underestimated the area, minimal diameter, and maximal diameter measurements in comparison to IVUS and HD-IVUS ($p<0.001$), with a median difference of measured diameters between OCT and both IVUS modalities that ranged 0.42–0.52 mm. The authors then used a correction factor based on the delivery catheter lumen size. When the correction factor was used, the differences between results were no longer statistically significant.

Curiously, in the OPUS-CLASS Study, and apart from the 100 in-vivo coronary lesions, Kubo et al. also used FD-OCT in 5 phantom circular, polytetrafluoroethylene arterial models of known lumen dimensions, filled with contrast media for OCT acquisition. In the phantom model analysis, the mean lumen area according to FD-OCT was equal to the actual lumen area of the phantom model. IVUS overestimated the lumen area and was less reproducible than FD-OCT (8.03 ± 0.58 mm^2 vs. 7.45 ± 0.17 mm^2; $p<0.001$).[7]

The article by Oliveira et al. is most welcome, and the results bring to light yet another explanation for measurement discrepancies. In a world of medicine by numbers, one must account for calibration error. In fact, the OCT catheter sectional dimension is quite small, usually purged with contrast media, and small calibration errors may translate into augmented error when measuring the vessel. How can we relate the contrasting findings of Kubo et al. and Oliveira et al.? There must be a missing link. Additionally, one may emphasize that the materials and conditions were not entirely the same. We need further data, especially on whether any measurement differences result in different outcomes.

Intracoronary imaging provides an immense array of information. The quantification of vessel size and luminal area is a critical step when planning and performing PCI, but not an isolated step. Additional information derived from imaging aids in proper planning, plaque preparation, selection of optimal landing zones and further optimization after stent deployment. Both imaging techniques, within their physical limits, provide useful information that can be ultimately translated to interventional decision-making. And, finally, one should not forget that the optimal results are those that translate into improved clinical outcomes. Specifically for OCT, we eagerly await the results of the large-scale ILUMIEN IV trial, which are set to be announced this year to resume this discussion above.

Technology revolutionizes the way we practice medicine. Intracoronary imaging offers impressive pathophysiological insights that were unobtainable in vivo before its introduction into the clinical scenario. Together with tools for functional assessment of stenosis severity, these technologies are expected to further improve outcomes in patients undergoing PCI, in a logic that will certainly contribute to the evolution of interventional cardiology towards a new era of precision medicine.

Conflicts of interest

The author has no conflicts of interest to declare.

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