Editorial

The impact of IVUS guidance in treating complex lesions; are all "complex" lesions the same?

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The main reason for the application of intravascular ultrasound (IVUS) in guiding drug-eluting stent (DES) implantation is because of its clinical benefit that has been shown in previous meta-analyses which included more than 30,000 patients across all coronary lesion subsets (1). Complex coronary lesions represent a unique subset which are more susceptible to adverse clinical events such as restenosis and thrombosis following percutaneous coronary interventions (PCI) in the DES era and while IVUS guidance has been reported to be favorable in treating some classes of complex lesions (2-4), the lingering question remains: what is a complex lesion? Regarding chronic total occlusions (CTOs) for instance, they have been graded in their own complexity according to: long *vs.* short occluded segment, extent of calcification, etc. Thus, a very short and non-calcified lesion may not be as complex as a long and severely calcified one. Likewise, bifurcation lesions could be either true bifurcations or just simply involve the ostium of the side branch. These two scenarios pose different challenges that could be resolved via imaging, but eventually their long-term outcome will be greatly defined by the extension of the pre-existing disease. Additionally, the degree of shear stress, low flow velocity and presence of multiple layers of stent struts make bifurcation lesions vulnerable to stent thrombosis (ST) and thus surrogates of their complexity (5). For these reasons, CTO and bifurcations may not be equal in terms of complexity. Specifically, by Syntax score, the maximum scoring points for a CTO is 9 points, while for a bifurcation the maximal possible point is 3. Should they both be considered complex? Should we lump these studies together in a "complex" lesion meta-analysis?

Bavishi *et al.* (6) showed in this meta-analysis, including eight RCTs, that IVUS-guided PCI led to significant reductions in the rates of major adverse cardiac events (MACE) by 36%, mainly driven by repeat revascularizations, in comparison with angiography-guidance and maximal benefit in-patients with acute coronary syndromes, diabetes mellitus and long lesions. We would like to congratulate the authors for reporting this meta-analysis, which may help trigger further studies. There are, however, a few points that merit further discussion. Firstly, the conspicuous absence of extensively calcified lesions from the cohorts reviewed must be noted, perhaps due to the limited data available for that subset of complex lesions. Secondly, the diverse anatomic characteristics of complex coronary lesions is probably one strong point in favor of imaging guidance and some may argue the importance of imaging in some over others. Two studies included in the meta-analyses included only CTOs and interestingly both studies accounted for greatest differences in ST in favor of IVUS-guidance (7,8). For example, Tian *et al.* showed that IVUS-guidance in CTO lesions led to lower incidence of stent restenosis possibly due to the optimization of stent expansion and edge dissections secondary to IVUS, and no benefit in the

Table 1 Intravascular ultrasound criteria for optimal stent deployment

Music criteria (10)
Complete apposition of the stent over its entire length against the vessel wall
MLA
In-stent MLA ≥90% of the average reference lumen area or ≥100% of the reference segment with the lowest lumen area
In-stent MLA of proximal stent entrance ≥90% of proximal reference lumen area
If the in-stent MLA is >9.0 mm^2
In-stent MLA ≥80% of the average reference lumen area or ≥90% of the reference segment with the lowest lumen area
In-stent MLA of proximal stent entrance ≥90% of the proximal reference lumen area
Symmetric stent expansion defined by the minimum lumen diameter divided by the maximum lumen diameter ≥0.7
AVIO study criteria (11)
Final minimum stent cross sectional area of at least 70% of the hypothetical cross-sectional area of the fully inflated balloon used for post-dilatation
The optimal balloon size that should be used for post-dilatation is the average of the media to media diameters of the distal and proximal stent segments, as well as at the sites of maximal narrowing within the stent. The value is rounded to the lowest 0.00 or 0.50 mm. For values ≥3.5 mm, the operator could downsize the balloon diameter based on clinical judgment
IVUS-XPL (2)
MLA
Minimal lumen cross-sectional area greater than the lumen cross-sectional area at the distal reference segments POST-PCI
ILUMIEN III (12)
MSA
Achievement of at least acceptable stent expansion (a minimum stent area of at least 90% in both the proximal and distal halves of the stent relative to the closest reference segment)
Acceptable stent expansion: the MSA of the proximal segment is ≥90% and <95% of the proximal reference lumen area, and the MSA of the distal segment is ≥90% and <95% of the distal reference lumen area

MLA, minimum lumen area; MSA, minimum stent area; IVUS, intravascular ultrasound; PCI, percutaneous coronary interventions.

MACE outcome while another randomized study by Hong *et al.* (IVUS-XPL) have reported improvement in the MACE outcome and insignificant differences in cardiac death and target-lesion related myocardial infarction between the IVUS-guided and angiography-guided groups (2). Perhaps, differences in baseline characteristics and specific types of complex lesions would require different outcome variables (i.e., for CTO/bifurcation studies having ST as the main outcome variable would be preferable and for LMCA studies mortality and revascularizations would reflect better the effect of IVUS guidance).

In addition, as reported, the meta-analysis included first-generation DES studies which may have impacted the outcomes reported when compared to the effect second-generation stents would have as shown by Shin *et al.* in a meta-analysis including studies with only newer-generation stents (9). Overall, the timing of imaging guidance is a critical aspect of employing IVUS in optimizing PCI. IVUS has been shown to be useful in preparing the lesion, facilitating device delivery and ensuring expansion in the pre-PCI phase as well as ensuring adequate apposition by guiding post-dilation in the immediate post-PCI period. Finally, there have been multiple criteria proposed for IVUS guidance in optimizing stent deployment dating back to the bare-metal stent era and subsequently tested in different variations ever since, hence the different criteria observed in recent studies (*Table 1*). So far, two of the criteria have stood out: the IVUS-XPL and the ILUMIEN III, the former having been tested and proven in a randomized trial of 1,400 patients and the latter will be further investigated in the ILUMIEN IV study.

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None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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