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Intracoronary imaging to guide percutaneous coronary intervention: Clinical implications

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ABSTRACT

Background: Over the last decade, the intra-coronary imaging (ICI) has emerged to guide percutaneous coronary intervention (PCI), thus overcoming the limitations of "luminology" offered by angiography.
Methods: In this review, we aim at purely focusing on the clinical implications of the employment of ICI in the routine practice, thus providing suggestions for future applications. In particular, we will describe the principal contributions and implications of ICI in the following different clinical settings: 1) assessment of clinical and imaging outcomes of PCI; 2) guiding PCI before and after stent implantation; 3) identification of mechanisms of stent failure.
Results: Several studies showed the capability of ICI in assessing the clinical and imaging outcomes of PCI. In particular, they have compared the ICI-guided PCI with the angiography-guided procedures, emphasizing the advantages of using imaging.
Indeed, ICI can characterize the coronary plaque, provide a precise estimation of the coronary stenosis, select the appropriate method of intervention, and optimize stent deployment and lesion coverage. Finally, ICI has been shown to be useful to point out the mechanisms of stent failure. Conclusions.
ICI can facilitate decision-making in patients with unclear angiographic findings, guide-selected interventions and optimize the final PCI results in complex lesions or.
in high-risk patients. Finally, by the identification of specific mechanisms of stent failure, the ICI can allow to adopt a tailored therapy for the singles cases.

1. Introduction

Over the last decade, the field of intracoronary imaging (ICI) has emerged to guide percutaneous coronary intervention (PCI) and to evaluate the results of the procedures at follow-up (FU), thus overcoming the limitations of "luminology" offered by angiography [1,2]. Indeed, ICI provides a precise estimation of the coronary stenosis and selects the appropriate method of intervention [3]. Moreover, ICI points out the mechanisms of stent failure (SF), detecting the pathogenesis of in-stent re-stenosis (ISR) or stent thrombosis (ST) [4].

In this review, we will describe the principal contributions of gray scale intravascular ultrasound (IVUS), and the optical coherence tomography (OCT) in the following different settings: 1) assessment of clinical and imaging outcomes of PCI; 2) guiding PCI before and after stent implantation; 3) and identification of mechanisms of SF (Fig. 1). In particular, we aim at contributing to the actual literature reviews, purely focusing on the clinical implications of the employment of ICI in the routine practice and providing suggestions for future applications.

2. Role of ICI in the assessment of clinical and imaging outcomes of PCI

2.1. IVUS vs. angiography

In RESIST study, the use of IVUS during PCI did not translate to a statistically significant difference in the ISR rate at 6-month FU [5]. At 18 months, clinical events occurred in 37% in the group without IVUS, versus 25% in the group with IVUS. Moreover, a higher number of revascularization procedures occurred in the control group. Finally, the cumulative medical costs at 18 months were only slightly higher in the IVUS group [6].

In TULIP study, angiographic and clinical outcomes were significantly improved in patients who underwent IVUS-guided bar metal

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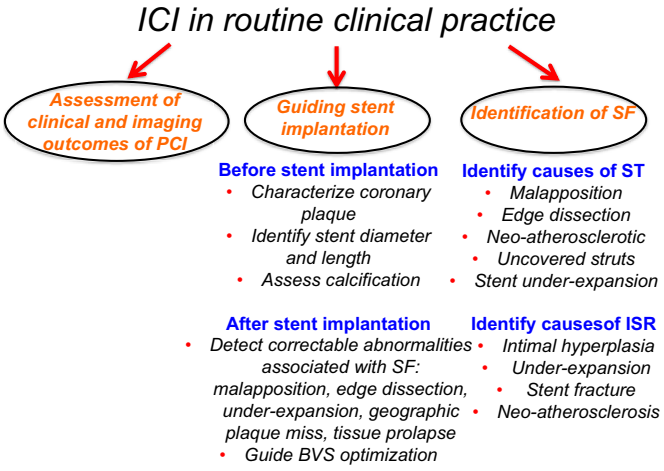

Fig. 1. Use of intra-coronary imaging (ICI) in routine clinical practice. ICI is employed in different clinical setting: assessment of clinical and imaging outcomes of the percutaneous coronary intervention (PCI); guiding PCI before and after stent implantation; identification of mechanisms of stent failure (SF). Before stent implantation, ICI can characterize coronary plaque, identify proper stent diameter and length, and features of calcifications. After stent implantation, ICI can detect correctable abnormalities associated with SF: malapposition, edge dissection, under-expansion, geographic plaque miss, tissue prolapse; optimize the bioresorbable vascular scaffold (BVS) implantation. ICI can identify the mechanisms of SF, clarifying the causes of stent thrombosis (ST) (malapposition, edge dissection, neoatherosclerotic, uncovered struts, stent under-expansion) and of in-stent re-stenosis (ISR) (intimal hyperplasia, under-expansion, stent fracture and neoatherosclerosis).

stent (BMS) implantation, compared to those who received angiography guided PCI [7].

In AVID study, post-procedural minimal lumen diameter (MLD) was larger in IVUS-guided PCI, compared to angiography-guided procedure. Moreover, a subgroup analysis suggested that the focused use of IVUS for vessel between 2.5 and 3.5 mm, vein grafts, right coronary lesions, and lesions of >70% stenosis significantly improve ischaemia-driven target lesion revascularization (TLR) at 1 year [8].

Two meta-analyses of seven randomized IVUS versus angiographic-guided BMS implantation trials showed that IVUS guidance reduces ISR, repeat revascularization, and major adverse coronary events (MACE) [9,10].

In the ADAPT-DES registry, at 1 year, the rates of overall MACEs, myocardial infarction (MI) and ST were less frequent in IVUS-guided PCI, compared to angiography-guided PCI [11].

The HOME DES IVUS failed to demonstrate superiority of routine IVUS guidance during DES implantation over standard high-pressure post-dilatation, regarding the incidence of MACEs at 18 months, in patients with either high clinical or angiographic risk profile [12]. However the study was underpowered. In AVIO trial, IVUS optimized DES implantation in complex lesions achieved a higher post-procedure MLD, in comparison with angiography-guided PCI [13].

In RESET trial, when patients were analyzed according to the intention-to-treat principle, IVUS guidance for DES implantation in long lesions resulted in a statistically significant decrease in MACE [14].

In IVUS-XPL Trial, IVUS-guided DES implantation in long lesions resulted in a significantly lower rate of MACE at 1 year, compared with conventional PCI. These differences were primarily due to a lower risk of TLR [15].

In CTO-IVUS study, IVUS-guided PCI improved 1-year MACE rate after new-generation DES implantation in chronic total occlusion (CTO) lesions, when compared with angiography-guided procedures [16]. In AIR-CTO, the IVUS-guided stenting of CTO lesions resulted in a lower in-stent late-lumen loss and a lower incidence of "in-true-lumen" ISR at 1 year, when compared with conventional PCI [17]. Later, Tan et al. demonstrated that IVUS-guided PCI reduce the 2-years MACEs in patients with left main coronary artery (LMCA) lesions, principally lowering the TLR rate [18].

Zhang et al. [19] performed a meta-analysis of 1 RCT and 10 observational studies, reporting significantly lower rates of MACE, death, and ST with IVUS-guided PCI.

Jang et al. showed that IVUS-guided PCI was associated with significant reductions in MACE, all-cause mortality, MI, TVR, and ST [20]. In a recent meta-analysis restricted to RCTs of DES in complex lesions, IVUS-guided PCI was associated with reduced rates of MACE, principally driven by TLR and TVR [21].

Finally, another recent meta-analysis showed that IVUS guidance PCI reduces the risks of all-cause death, MI, TLR and ST [22].

2.2. OCT vs. angiography

In CLI-OPCI study, the employment of OCT revealed adverse features requiring further interventions in 34.7% of patients [23]. After 1 year, the OCT guided PCI exhibited a lower risk of cardiac death or MI and the composite outcome, in comparison with conventional procedures [24]. In CLIO-PCI II, in-stent minimum lumen area (MLA) <4.5 mm^2, dissection >200 μm at the distal stent edge, and reference lumen area <4.5 mm^2 at either distal or proximal stent edges were independent predictors of MACEs at 1 year [25].

In OCTACS trial the patients who underwent OCT-guided PCI presented 4.3% uncovered struts versus 9% uncovered struts reported in conventional PCI, at 6 months FU. Incomplete strut coverage was associated to later ST (LST) [26].

Similarly, the DETECT OCT study showed a superior stent coverage at 3 months when OCT was applied in 894 stable patients [27].

Recently, in DOCTORS trial, OCT guidance slightly improved post-procedural fractional flow reserve (FFR) in patients with no-STEMI compared with angiography guidance, without affecting clinical outcomes [28].

2.3. OCT vs. IVUS

In ILUMIEN III trial, OCT was non-inferior to IVUS and angiography in PCI guidance, but not superior to IVUS guidance. Procedural MACEs were reported in 3% of OCT group, 1% in IVUS group, and 1% in angiography group [29]. Finally, in OPINION trial, 1-year clinical outcome in patients undergoing OCT-guided PCI was non-inferior to that of patients undergoing IVUS-guided PCI. Both OCT-guided and IVUS-guided PCI yielded excellent angiographic and clinical results, with very low rates of 8-month angiographic ISR and 1-year target vessel failure [30].

Finally, a recent meta-analysis showed as PCI guidance using either IVUS or OCT was associated with a significant reduction of MACEs and cardiovascular death. No differences in terms of comparative clinical efficacy were found between IVUS and OCT for all the investigated outcomes [22].

3. Role of ICI before stent implantation

3.1. Diagnosis of significant stenosis

The current ESC guidelines endorse the use of IVUS to assess severity of unprotected LMCA lesions with a class of recommendation IIa and level of evidence B [3]. Fassa et al. showed that deferring revascularization for patients with MLA ≥7.5 mm^2 appears to be safe [31]. Recently, in patients from western countries an IVUS MLA <6 mm^2 best correlates with a FFR <0.75 [32] while studies done in Korea [33] suggested that an IVUS MLA of 4.5–4.8 mm^2 is adequate. One of the plausible explanations of the difference of MLA cut-off between previous studies might be the ethnicity difference (i.e. plaque morphology, body mass index, and left ventricular mass) [33,34]. Of note, Park et al. [33] showed that, among lesions with MLA of >4.5 mm^2, 24.1% exhibited an FFR of ≤0.80 ("reverse mismatch"). In LITRO registry, patients with an IVUS MLA >6 mm^2 who did not have revascularisation had similar long-term outcomes to patients who had a MLA <6 mm^2 and revascularisation; in a

small number of patients with a MLA of 5–6 mm^2 who were treated with pharmacotherapy, the event rate was especially high [35].

When angiography is ambiguous, IVUS pullback should be performed on both branches of the LMCA bifurcation or at least on the branch with the lower degree of angiographic disease. This strategy will ensure determination of the distribution of atherosclerosis at the site of the bifurcation, as well as at the ostium of the LMCA. LMCA disease frequently involves both branches of the bifurcation, even when angiography appears to be 'normal' [36] Understanding the exact distribution of plaque burden at the bifurcation is crucial to determine if a provisional stenting strategy can be applied to treat LMCA disease or if an intentional two-stent strategy should be considered upfront. In this context, an MLA cut-off value of <3.7 mm^2 or plaque burden >56% in the left circumflex ostium has been shown to predict the need for a second stent after provisional stenting of the main vessel [37].

Finally, OCT also can be employed in assessment of LMCA. However, if OCT imaging for non-ostial LM lesions seems quite feasible, the assessment of the proximal LM segment is limited because of systematic missing of the LM ostium and the increased rate of artefact occurrence [38].

Several IVUS studies have attempted to identify anatomical criteria for clinically relevant non-LMCA lesions [39,40]. Although the IVUS MLA best correlates with ischaemia, reported IVUS MLA cut-offs range from 2.1 mm^2 to 4.4 mm^2, which are typically smaller in Asian studies compared to western studies [39].

Moreover, IVUS studies show a relatively high negative predictive value, but a low positive predictive value. This means that the use of IVUS to indicate the need for PCI is incorrect about half of the time [39,40].

OCT-derived MLA cut-offs for non-LMCA lesions are smaller than with IVUS and range from 1.6 mm^2 to 2.4 mm^2 [41]. This may be due to the superior ability of OCT to visualize the lumen intima interface compared with IVUS, therefore allowing OCT to visualize the true lumen dimensions and causing IVUS to overestimate [42]. Moreover, OCT provides less inter-observer variability in measuring lumen dimensions [41]. In one meta-analysis, [43] anatomic assessment of lesion severity was reported to be mildly better with OCT than with IVUS. Finally, for the OCT also the negative predictive value is higher than the positive predictive value.

3.2. Plaque assessment

Because of its ability to image the deeper layers of the arterial wall, IVUS is currently the best technique for the qualitative assessment of plaque composition at the site of LMCA. As a general rule, lesion preparation is pivotal in LMCA PCI. Calcium is expected and use of rotational atherectomy [44] should be considered as a default strategy.

The extension of the calcific arch is a parameter easily available with IVUS, with a calcific arch >180° representing a strong indication for rotational atherectomy. Beside identifying its circular and longitudinal extension, IVUS can also help to identify the depth of the calcific component [45]. This is relevant as deep and thick calcium might be associated with a higher risk of coronary perforation during balloon inflation and thus mandate rotational atherectomy [46].

In non-LMCA lesions, OCT showed a greater ability to carry out quantitative and qualitative evaluation of coronary calcification in comparison with IVUS (Fig. 2, panel A and A') [47]. Saita et al. reported as it can even characterize the various types of coronary calcifications: superficial dense calcified plates, deep intimal calcifications, scattered micro-calcifications, calcified nodules [48]. Recently, Fujino et al. suggested that an OCT-based calcium scoring system can identify lesions that would benefit from plaque modification prior to stent implantation (e.g. rotational atherectomy, cutting balloon, excimer laser). Indeed, lesions with calcium deposit with maximum angle >180°, maximum thickness >0.5 mm, and length >5 mm may be at risk of stent underexpansion (SU) [49]. The presence of OCT-detected fractures following lesion preparation was associated with greater stent expansion in a small-scale observational study [44]. Finally, OCT has been validated against histology for accurate measurement of cap thickness, tissue composition (fibrous, calcific, lipid-rich/necrotic), plaque rupture, and thrombus.

However, the histological findings underlying the false positive diagnoses of OCT for thin fibrous cap atheroma (TFCA), included large amounts of foam cell accumulation on the luminal surface, microcalcifications at the surface, hemosiderin accumulation, or organized thrombus [50]. OCT accuracy may be improved using lipid arc ≥80° and fibrous cap thickness ≤85 μm over 3 continuous frames [51]. Finally, combined VH-IVUS/OCT imaging markedly improved TCFA identification [52]. Several limitations remain also for the OCT identification of macrophages, cholesterol crystals and neovascularization [53].

Lipid-rich plaque has been consistently associated with a higher risk of post-procedural MI, distal embolization, and no reflow phenomenon [54]. In this context, adjunctive preventive management should be required.

3.3. Stent sizing

ICI can in the end provide information about true vessel dimensions in order to facilitate stent sizing.

IVUS-guided stent or adjunct balloon sizing is based: on reference diameters of proximal and distal vessels or diameters of the lesion site external elastic lamina (EEL); reference lumen diameters that are typically larger than by angiography, especially in smaller vessels; or midwall sizing, midway between the lumen and the internal elastic lamina. Stent lengths are based on proximal and distal landing zones—where the edge of the stent meets the un-stented vessel wall or plaque—having the largest lumens and least plaque [55].

IVUS represents also a valuable tool for recanalization of CTOs. It is ensures proper stent sizing, lesion coverage and stent optimization and detects procedure-related complications, therefore contributing to a better clinical outcome [56]. Moreover, IVUS-guiding PCI allows contrast reduction and even contrast sparing [57,58]. Finally, it resulted in cost-effectiveness for unstable patients with renal insufficiency and diabetes [59].

The OCT stent-sizing strategy foresees that the proximal or distal reference EEL diameter are used to select stent sizes when >180° of its circumference is visible; otherwise, the selection of stent size is based on lumen diameters. Proximal and distal stent edge landing zones are selected to avoid lipid plaques. After intervention, the stent is divided into proximal and distal halves and each half's minimum stent area (MSA) is compared with the respective reference lumen area with a 95% or greater area than the reference considered optimal and an area of 90% or greater considered acceptable [29].

Co-registration of ICI and angiography represents an important tool to facilitate stent length selection and precise implantation [60].

4. Role of ICI after stent implantation

Following implantation, ICI detect correctable abnormalities related to the stent and underlying vessel wall which have been associated with risk of SF: malapposition, edge dissection, SU, geographic plaque miss (GPM), and tissue prolapse. Uniform, standardized criteria for PCI optimization in relation to IVUS findings remain to be established and currently represent a great unmet need. In this context, due to its high resolution, OCT is more accurate and sensitive than IVUS for visualizing subtle stent- or lumen-related morphologies [41].

If IVUS guidance was reported to be associated with a change in PCI strategy 74% of the time [11], Wijns et al. showed that pre-PCI OCT can influence the decision making process in 57% of stenoses and post-PCI OCT can prompt further stent optimization in 27% of cases [61].

Malapposition is defined as lack of contact of stent struts with the vessel wall [62]. It can occur either in the acute, post-procedural period, or it may develop later. One OCT study showed as maximum incomplete

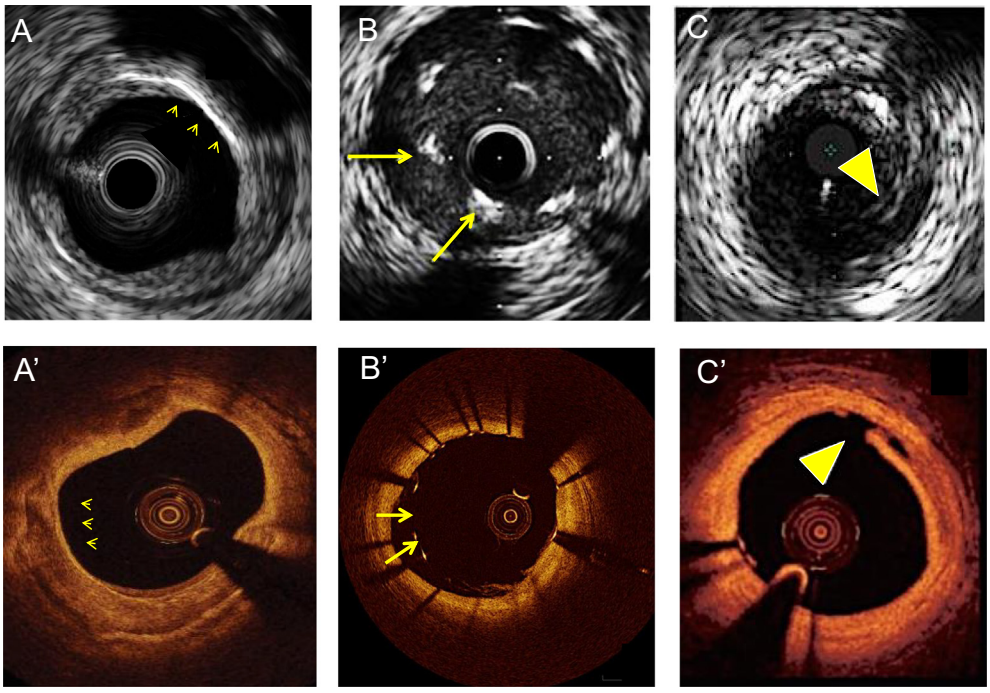

Fig. 2. Features visualized by intravascular coronary imaging. Panel A and A': example of calcifications (yellow arrowheads) at intravascular ultrasound (IVUS) and optical coherence tomography (OCT), respectively. Panel B and B': example of incomplete stent apposition (ISA) at IVUS and OCT, respectively. Panel C and C': example of stent edge dissection (flap indicated by yellow arrowhead) at IVUS and OCT, respectively. IVUS and OCT images are taken from different coronaries of different patients.

stent apposition (ISA) (Fig. 2, panel B and B') distance <270 μm after stent implantation appeared grossly covered and spontaneously reapposed in 100% of cases at FU, whereas maximum ISA distances >850 μm resulted in persisting malapposition and grossly delayed coverage in 100% of cases [63].

Extensively malapposed struts should be avoided following stent implantation and should be corrected with post-dilation [64,65].

ICI can be used also to detect stent edge dissection (Fig. 2, panel C and C'), commonly characterized by their depth (at least disrupting the medial layer), their lateral extension (>60°) as well as their length (>2 mm) [66]. OCT can identify less extensive edge dissection which are missed by IVUS. Dissections >200 μm at the distal stent edge by OCT emerged as an independent predictor of MACE [24]. Of note, minor edge dissections are unlikely to be clinically significant and possibly do not require correction by stent implantation [67]. Detection of intra-and extramural haematoma by ICI in case of angiographic appearance of a residual stent edge stenosis may be relevant. Indeed, the progression of uncovered haematoma may lead to ST [68].

SU is a major predictor of SF [69]. It describes the MSA either as an absolute measure (absolute expansion), or compared with the predefined reference area, which can be the proximal, distal, largest, or average reference area (relative expansion) [69] (Fig. 3). SU and malapposition can coexist or occur independently. Different targets for stent optimization include either MSA greater than the distal reference lumen area; or >80% or >90% of the average (proximal and distal) reference area. A cut-off>80% for the MSA (relative to average reference lumen area) appears to be a reasonable approach to adopt in clinical practice [70]. Of note, an MSA of >5.5 mm^2 by IVUS and >4.5 mm^2 by OCT should be achieved in non-LMCA lesions.

GPM (lipidic plaque ≥185°, MLA ≤4.1 mm^2 at OCT; plaque burden>40% located at either the proximal or the distal edge of the stent at IVUS) can be defined as the mismatching of lesion and injury vascular targets with subsequent stent deployment sites and it has been also associated with an increased incidence of repeated revascularization within the first year after PCI [71,72].

Tissue prolapse, defined as tissue extrusion from inside the stent area, is adversely related to outcomes, primarily driven by TLR. Irregular tissue protrusion is associated with a high low-density lipoprotein concentration, thrombus or lipid on OCT, and a large IVUS plaque burden [73] In this context, landing zone in plaque burden >50% or lipid rich tissue can be avoided.

Also, ICI helps to optimize PCI results after bioresorbable vascular scaffolds (BVS) deployment. Indeed, despite achieving angiographic success in all BVS implantations, further optimisation is required in over a quarter of patients on the basis of OCT findings [74].

5. Role of ICI in the identification of mechanisms of SF

The current ESC guidelines endorse the use of ICI to assess mechanisms of SF with a class of recommendation IIa and level of evidence C [3]. Indeed, ICI allows the identification of the mechanisms of ISR or ST, guides appropriate treatment, and reduces the risk of subsequent events.

Of note, a separate mention deserves the use of imaging in the failure of the BVS implantation.

5.1. Stent thrombosis

Although there being no head to head clinical comparison, for its peculiar properties (higher spatial resolution, better lumen differentiation, ability to distinguish between platelet rich and fibrin rich thrombi), OCT appears a better modality than IVUS to evaluate the causes of ST (Fig. 4 in Supplemental material, panel A and B) [30,75].

In PESTO registry, malapposition, SU and edge dissection were prominent mechanisms for acute ST and sub-acute ST [64], whereas neoatherosclerosis, malapposition (Fig. 5, panel A and A'), uncovered struts and SU were frequently observed in LST and very late ST (VLST) [65].

Neo-atherosclerosis (Fig. 5, panel B and B') is histologically characterized by an accumulation of lipid-laden foamy macrophages with or without necrotic core formation and/or calcification within the neointima.

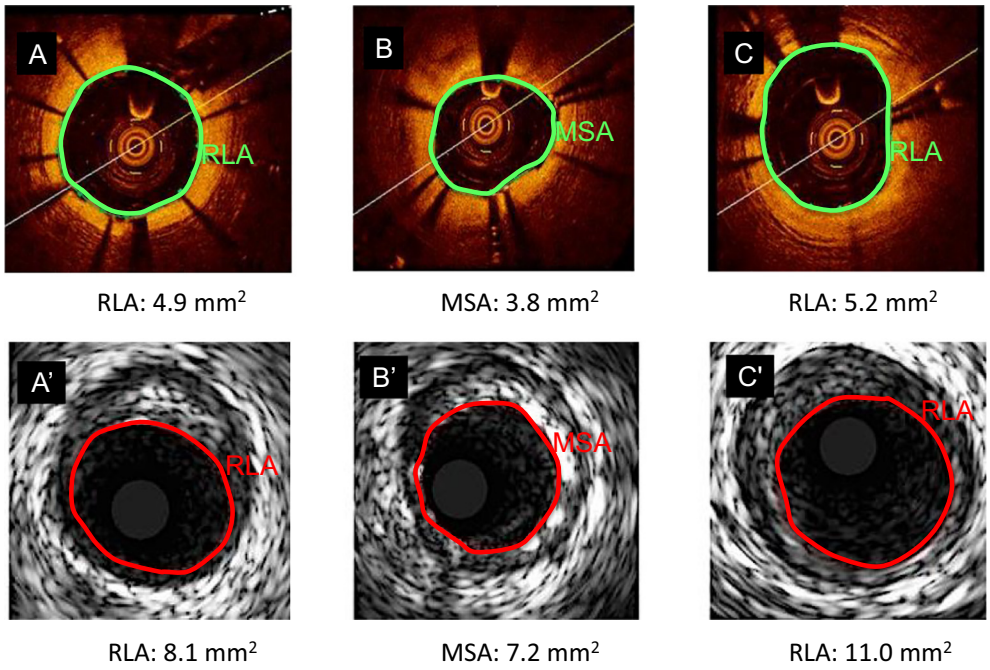

Fig. 3. Stent under-expansion (SU) at OCT and IVUS caused by negative remodelling. Panel A and A': distal reference lumen area (RLA) at OCT and IVUS, respectively; Panel B and B': minimal stent area (MSA) at OCT and IVUS, respectively; Panel C and C': proximal RLA at OCT and IVUS, respectively; SU is calculated as MSA divided by the average of proximal and distal RLA.

Neo-atherosclerosis seems to occur in months to years following stent placement and rapidly and more frequently in DES when compared with BMS [76]. It can be managed by additional stent implantation or the use of drug eluting balloon (DEB).

A malapposition identified at FU may represent either persistent (i.e. ongoing since the time of implantation), or late acquired malapposition; a differentiation of these two entities is not possible in the absence of immediately post stenting [77].

Delayed healing and incomplete endothelial cell coverage strongly correlated of LST after DES implantation [78] (Fig. 5, panel C and C').Recognition of uncovered struts in ICI is based on the visual determination that struts are detached from the luminal surface or that struts are apposed to the arterial wall with an apparent discontinuity of neointimal tissue over and/or near the strut edge [74]. On the other hand, according with the histological criteria, strut un-coverage is defined as the lack of neointimal coverage and/or surface endothelium [79]. The failure to

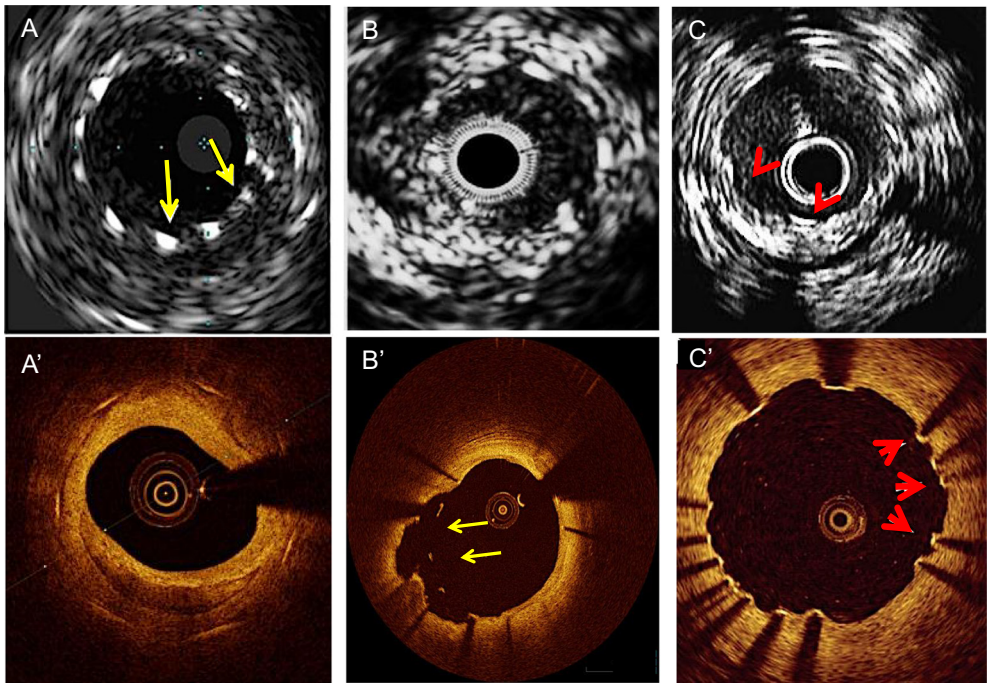

Fig. 5. The leading causes of stent thrombosis visualized by intra-coronary imaging. Panel A and A': example of malapposition at IVUS and at OCT (respectively). Panel B ad B': example of neo-atherosclerosis at IVUS and OCT, respectively. Panel C and C': example of uncovered struts (red arrowheads) at IVUS and OCT, respectively.

adequately distinguish between the 2 types of coverage (fibrin/thrombus vs. neointima) represents a central issue in the assessment of stent coverage by ICI [78]. Indeed, even OCT does not have the resolution required to identify endothelial cells at all.

Second generation DES had improved immediate-term rates of strut apposition and better strut coverage compared with first-generation DES [79].

Malapposition can be managed by using balloons sized to the intimal (outside the malapposed area) and inflated to nominal pressures [68].

Regarding the finding of uncovered struts at FU, long dual antiplatelet therapy and statins seem to have a protective effect against delayed strut coverage [80,81].

SU is a major cause of ST and it is mainly due to the undersized hard eccentric lesions, inadequate stent post-dilation. It can be identified by ICI as MSA<80% of the average (proximal and distal) reference area. SU can be treated with post-dilation with high-pressure balloons [68], rotablator, lithotripsy, laser or shock wave.

5.2. Intra-stent restenosis

Identifiable causes of ISR include intimal hyperplasia, chronic SU [82], stent fracture, and neoatherosclerosis. The first three abnormalities can be readily detected by IVUS or OCT, the latter by OCT [84]. Early-ISR has been shown to be caused by neointimal hyperplasia, whereas neoatherosclerosis represents the main mechanism of late-ISR. Actually, DEB and DES are the most effective interventional treatments for ISR [83]. In angiographic and unstable lesions and clinical patterns, implantation of DES could be preferable owing to the superior mechanical guarantees of metallic scaffolding. Of note, DEB might be indicated in patients with urgent surgical indications or at high haemorrhagic risk [84,85]. Finally, atherectomy and excimer laser coronary angioplasty for under-expanded stents deployed in heavily calcified plaques have been recently proposed [70,86].

5.3. Failure in BVS implantation

The last studies showed that the relative risk of ST was >3 times higher with BVS than with everolimus eluting stent during extended FU, with a concerning 10-fold increased relative risk of VLST between 1 and 2 years after BVS implantation [85]. The INVEST study employed OCT to elucidate the mechanisms underlying VLST, in patients underwent BVS implantation [87]. The main causes were represented by scaffold discontinuity, malapposition and neoatherosclerosis. These features were strongly associated with presence of thrombus, with scaffold strut maps providing additional evidence in support of a causal relationship. Optimized implantation techniques, including post-dilation, might mitigate the risk of VLST after BVS implantation, because it is expected to lower the frequency of SU and malapposition. Indeed, an improved expansion and embedment of scaffold struts could result in an improved neointimal encapsulation and thereby less thrombosis-prone discontinuity.

6. Conclusions and future perspectives

The use of ICI techniques represents a valuable tool both in the assessment of clinical and imaging outcomes, in the optimization of the stent implantation, and in identification of mechanisms of SF. Although the IVUS has been widely employed in large multicentre studies, we hope that the OCT will be the favourable technique in future trials, due to the ease of use and interpretation of stent-related findings.

In clinical practice, ICI could be employed to facilitate decision-making in patients with unclear angiographic findings, guide-selected interventions and optimize the final PCI result in complex lesions or in high-risk patients. Moreover, by the identification of specific mechanisms of SF, ICI allows a tailored therapy for the singles cases. Future large studies are required to assess whether this approach can improve the clinical long-term outcome.

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Disclosure

None.

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