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EDITORIAL COMMENT

IVUS in CTO Lesions

"Rolling Into Deep"*

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During the last decade, the interest in percutaneous coronary intervention (PCI) for chronic total occlusions (CTOs) has emerged along with the development of dedicated equipment and techniques. High success rates ranging from 80% to 90% have been reported in this field, but they still remain lower than those achieved in conventional angioplasty. Failure of guidewire crossing is usually the most common cause for unsuccessful CTO attempts. Moreover, several angiographic features, including blunt proximal CTO cap, tortuosity, heavy calcification, and lack of visibility of the path in the distal vessel, also increase procedural difficulty. A better understanding of the behavior of the guidewire within the CTO segment might be the key point for successful outcomes (1).

In this respect, intravascular ultrasound (IVUS) plays a crucial role in the recanalization of CTOs. Pre-PCI imaging is useful to evaluate the path and understand lesion complexity and morphology. IVUS can easily and accurately identify superficial and deep calcified areas, proximal cap, dissections, and side branches. Using it as a roadmap allows the guidewire to be navigated back and forth into the true lumen in case of subintimal re-entry, and after CTO lesion crossing, IVUS can confirm the presence of the wire in the distal true lumen (2,3).

Available evidence highlights the clinical benefits of the use of IVUS in CTO lesions. The AIR-CTO (Angiographic and clinical comparisons of intravascular ultrasound- versus angiography-guided drug-eluting stent implantation for patients with CTO lesions) randomized study demonstrated comparable rates of clinical events between IVUS and angiography-guided PCI, whereas the CTO-IVUS trial indicated that IVUS guidance improved 1-year clinical outcomes after newer-generation drug-eluting stent implantation (4,5). Among 201 propensity-score matched pairs in the Korean-CTO Registry, IVUS-guided PCI was correlated with a lower trend of myocardial infarction and less stent thrombosis compared to the angiography-guided procedure during a 2-year follow-up period (6). Conversely, the multicenter PROGRESS CTO (Prospective Global Registry for the Study of CTO Intervention) registry did not find a difference in crossing, procedural success, or in-hospital major adverse cardiac events (7). Subsequently, the most recent expert consensus document of the European Association of Percutaneous Cardiovascular Interventions endorsed by the Chinese Society of Cardiology recommends IVUS as the preferred imaging modality for the assessment and treatment of CTO lesions (8).

From a technical point of view, the basic principle is that the IVUS probe is advanced into the coronary artery, and during pullback, the precise location of the occlusion and calcification are acknowledged. The CTO lesion consists of both soft tissues (scattered fibrous tissue, lipid core, neovascular channels) and hard tissues (dense fibrous tissue, calcium). The most difficult part of PCI-CTO is to penetrate tissue at the distal end of CTO, reaching distal true lumen. Once the guidewire enters into the subintimal space, it is hard to direct it into the true lumen because of the lower resistance of the subintimal tissue against the guidewire tip compared to the true lumen. Furthermore, the enlargement of subintimal space might push the atheromatous plaque to the distal true lumen, leading

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to its collapse. All of these factors contribute to failure of the guidewire crossing, increasing the risk of coronary artery perforation (1).

Until now, interventionalists were used to observing only the true lumen and the shaft, but not the tip of the wire. In addition, and after several ambiguous attempts, they could merely confirm that the shaft was into the true lumen and not at the position that was supposed to be the true lumen (9).

Hence, novel CTO-dedicated IVUS catheters with a forward-looking design might offer better visualization options and, presumably, new recanalization strategies. In this concept, the AnteOwl (AO) WR IVUS (AO-IVUS, Terumo Corp., Tokyo, Japan), an upgraded version of Navifocus WR IVUS (Navi-IVUS, Terumo Corp.), was developed, providing the most accurate guidewire manipulation for CTO-PCI. The major transformation of a Navi-IVUS to an AO-IVUS was the addition of a lengthier pullback system that allowed the transducer to be pulled back by 15 cm, providing more penetrating distance in the subintimal space. This system has the ability to construct IVUS-based real-time 3-dimensional (3D) images and graphics of the shaft and tip sections and determine their relationship with the true lumen, simplifying 3D wiring (9,10).

Because CTOs represent one of the most complex lesion subsets, this technique might be a novel approach that could enrich existing literature regarding CTO PCI strategy. This new CTO-IVUS system allows precise guidewire control, improving the success rate of antegrade wiring. Also, it could potentially lead to less contrast and less radiation, reducing procedural time. Nevertheless, the clinical evaluation of this procedure is still lacking, and several issues remain to be solved. For instance, this equipment requires large—at least 7-F sheaths—and, therefore, an alternative transradial access is yet limited. Another disadvantage is that the bulky IVUS probe may deflect away guidewires and microcatheters from the stump and preclude simultaneous contrast injections. In the meantime, experience is limited worldwide; thus, an educational learning curve is mandatory for operators to achieve higher success rates.

To conclude, the usefulness of IVUS in CTO PCI is apparent, facilitating case efficiency and improving patient outcomes. Efforts should be taken to make its use widespread in clinical practice. An ideal futuristic concept involving a single catheter and pullback with the fusion of near-infrared streptoscopy-IVUS in 3D sounds amazing.

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REFERENCES

1. Galassi AR, Sumitsuji S, Boukhris M, et al. Utility of intravascular ultrasound in percutaneous revascularization of chronic total occlusions: an overview. J Am Coll Cardiol Img 2016;9:1979–91.

2. Matsuno S, Tsuchikane E, Harding SA, et al. Overview and proposed terminology for the reverse controlled antegrade and retrograde tracking (reverse CART) techniques. EuroIntervention 2018;14:94–101.

3. Yamamoto MH, Maehara A, Poon M, et al. Morphological assessment of chronic total occlusions by combined coronary computed tomographic angiography and intravascular ultrasound imaging. Eur Heart J Cardiovasc Imaging 2017;18:315–22.

4. Kang SJ, Mintz GS. Outcomes with intravascular ultrasound-guided stent implantation: a meta-analysis of randomized trials in the era of drug-eluting stents. J Thorac Dis 2016;8:E841–3.

5. Kim BK, Shin DH, Hong MK, et al. Clinical impact of intravascular ultrasound-guided chronic total occlusion intervention with zotarolimus-eluting versus biolimus-eluting stent implantation: randomized study. Circ Cardiovasc Interv 2015;8:e002592.

6. Hong SJ, Kim BK, Shin DH, et al. Usefulness of intravascular ultrasound guidance in percutaneous coronary intervention with second-generation drug-eluting stents for chronic total occlusions (from the Multicenter Korean-Chronic Total Occlusion Registry). Am J Cardiol 2014;114:534–40.

7. Karacsonyi J, Alaswad K, Jaffer FA, et al. Use of intravascular imaging during chronic total occlusion percutaneous coronary intervention: insights from a contemporary multicenter registry. J Am Heart Assoc 2016;5:e003890.

8. Raber L, Mintz GS, Koskinas KC, et al. Clinical use of intracoronary imaging. Part 1: guidance and optimization of coronary interventions. An expert consensus document of the European Association of Percutaneous Cardiovascular Interventions. Eur Heart J 2018;39:3281–300.

9. Okamura A, Iwakura K, Iwamoto M, et al. Tip detection method using the new IVUS facilitates the 3-dimensional wiring technique for CTO intervention. J Am Coll Cardiol Intv 2020;13:74–82.

10. Suzuki S, Okamura A, Iwamoto M, et al. New CTO-specific IVUS: AnteOwl success in previously failed CTO case treated with Navifocus IVUS. J Am Coll Cardiol Case Rep 2020;2:961–5.

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