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STATE-OF-THE-ART REVIEW

A New Algorithm for Crossing Chronic Total Occlusions From the Asia Pacific Chronic Total Occlusion Club

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ABSTRACT

Although the hybrid chronic total occlusion (CTO) algorithm had many excellent recommendations, there has been infrequent adoption in the Asia Pacific region. The Asia Pacific CTO club propose an algorithm for case selection based on the Japan-CTO score and a new CTO algorithm, which is applicable globally. This algorithm allows for differing skill sets and equipment availability and contains practical teaching for CTO percutaneous coronary intervention. Similar to the hybrid algorithm there are 3 main questions that determine whether the primary approach is antegrade or retrograde: 1) is there proximal cap ambiguity; 2) is the distal vessel of poor quality; and 3) are there interventional collaterals present. In contrast to the hybrid algorithm occlusion length alone does not determine the choice of either a wire escalation strategy or a dissection re-entry strategy. Rather a combination of factors including ambiguity of the vessel course, severe calcification, tortuosity, length, and previous failure are used to determine this. The role of intravascular ultrasound-guided entry to overcome proximal cap ambiguity and the CrossBoss catheter in occlusive in-stent restenosis are highlighted in the algorithm. Both the parallel wire technique and dissection re-entry with the Stingray system have been included as options when the initial antegrade wire passage fails. Intravascular ultrasound-guided wiring along with limited subintimal tracking and re-entry are included as final options in the algorithm. Finally, the algorithm incorporates guidance on when to stop the procedure. It is hoped that this algorithm will serve as the basis for future CTO percutaneous coronary intervention proctoring and training. (J Am Coll Cardiol Intv 2017;10:2135–43) © 2017 by the American College of Cardiology Foundation.

Chronic total occlusions (CTO) represent one of the most challenging lesion subsets in patients undergoing percutaneous coronary intervention (PCI). Historically CTO PCI was associated with significantly lower success rates and increased adverse events compared with PCI for other lesion subsets (1). Recently there has been a rapid and continuous evolution of CTO equipment and techniques that has driven greater procedural success and improved clinical outcomes. Despite this, success

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ABBREVIATIONS AND ACRONYMS

CART = controlled antegrade and retrograde tracking

CCTA = coronary computed tomography angiography

CTO = chronic total occlusion

ISR = in-stent restenosis

IVUS = intravascular ultrasound

J-CTO = Japan-CTO Score

PCI = percutaneous coronary intervention

rates remain variable (2) with the best outcomes being reported in centers with dedicated CTO programs and high-volume CTO operators (3–5).

The landmark work by Brilakis et al. (2) describing a percutaneous treatment algorithm for crossing CTO, now commonly referred to as the hybrid algorithm, has become the basis of discussion and reference for CTO PCI worldwide. This algorithm emphasized the importance of dual injections for CTO PCI angiography, promoted careful review and a standardized approach to the evaluation of the coronary angiogram, used the angiographic characteristics to guide selection of the initial strategy, and encouraged early conversion to an alternative crossing strategy if the initial crossing strategy failed. The algorithm has been shown to enhance success rates in complex CTO lesions and to be reproducible and teachable. The same authors are also to be credited with executing a remarkable and efficacious proctoring program that has radically altered the landscape of CTO intervention in North America and Europe (6–8).

Although there are many excellent recommendations within the hybrid algorithm, there has been infrequent adoption of the hybrid algorithm in the Asia Pacific region where most of the world's population resides. This is caused in part by the traditional wire-based CTO teaching that is dominant in the region, and limited access to the CrossBoss and Stingray system (Boston Scientific, Marlborough, Massachusetts), which eliminates the antegrade dissection re-entry arm of the hybrid algorithm. Other factors, such as lower rates of coronary artery bypass grafting (3,9), have also likely contributed to the differences in CTO PCI approaches seen in the Asia Pacific region.

The Asia Pacific CTO club, a group comprised of 10 high-volume CTO operators who are recognized as leaders in CTO intervention in their respective countries, was motivated by the hybrid authors to propose a new algorithm for CTO PCI that would be relevant and applicable globally. This algorithm allows for differing skill sets and equipment availability and contains practical teachings for CTO PCI. It is hoped that this algorithm will serve as the basis for future CTO PCI proctoring and training.

JAPAN-CTO SCORE, CASE SELECTION, AND PROCTORING

Mastering retrograde techniques and the use of the CrossBoss and Stingray system requires training and experience. Although these techniques can be taught it is unlikely that operators will become proficient in all techniques unless they perform a large volume (>50 cases per year) of CTO PCI. However, many skilled PCI operators can perform CTO PCI using antegrade wire escalation techniques with a high degree of success if appropriate cases are selected. We therefore propose an algorithm incorporating the Japan-CTO (J-CTO) score to guide the selection of which cases should be attempted by nonexpert CTO operators and which cases should be referred or performed with the assistance of a proctor (**Figure 1**).

The J-CTO score was derived from the J-CTO (Multicenter CTO Registry of Japan) registry cohort to predict the probability of successful guidewire crossing within 30 min and is the most widely accepted measure of CTO complexity (10). The J-CTO score is determined by assigning 1 point for each of the following independent predictors of this endpoint: blunt entry stump, calcification, bend >45°, occlusion length >20 mm, and previous failed attempt. The summation of all points accrued is then used to stratify lesions into 4 difficulty groups: easy (J-CTO score of 0), intermediate (score of 1), difficult (score of 2), and very difficult (score of ≥3). As the J-CTO score increases, procedural efficiency and overall success rates fall (10–13).

In the original study a J-CTO score of ≥2 was associated with a <50% chance of successful wire crossing within 30 min (10). A subsequent study performed in the United States by hybrid operators demonstrated that as the J-CTO score increased, the use of the retrograde approach increased markedly with the retrograde approach being the successful approach in 34% of those with a J-CTO score ≥2 compared with only 5% in those with a J-CTO score of <2 (13). We therefore recommend that for cases with a J-CTO score ≥2, operators relatively early in their CTO PCI experience or with a limited range of CTO skills should either seek the assistance of a proctor or refer the case to a CTO expert. A CTO expert can be defined as an operator who has performed at least 200 CTO PCIs, has mastered all the available techniques, and who can achieve a ≥85% success rate in unselected clinically indicated cases.

Proctoring is a powerful tool to improve CTO PCI skills. Sharma et al. (14) found the impact of proctoring to be particularly useful in patients with J-CTO scores of ≥2 with success rates improving from 49.5% to 70.7%. We encourage nonexpert CTO operators to seek proctoring for complex cases where possible and recommend that all retrograde and antegrade dissection re-entry cases should be proctored until the operator has gained competency in these techniques.