

EDITORIAL COMMENT

# Progress in Predicting Chronic Total Occlusion Recanalization\*



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Given its historically low procedural success rate, chronic total occlusion (CTO) percutaneous coronary intervention (PCI) has long been considered the Achilles' heel of percutaneous revascularization. Recent years, however, have witnessed significant progress in the field. Indeed, the adoption of novel strategies coupled with dedication and perseverance of pioneering operators has increased CTO PCI success rates in expert hands from 50% to 90% (1). Techniques that expanded recanalization options, including antegrade and retrograde subintimal tracking, that were originally mastered by Japanese interventionalists have been adopted and streamlined in North America.

Despite these advances, PCI continues to be an underused treatment option for CTO lesions (1). There are 3 main reasons for this. First, the indications for CTO PCI remain controversial. On the one hand is the argument that a total occlusion (particularly with collaterals) is a relatively stable situation, whereas on the other hand, observational data suggest that patients with nonrevascularized CTOs have worse outcome than those with non-CTO disease or with revascularized CTOs, possibly due to the "double jeopardy" of territory if the collateral donor vessel develops an occlusion (2). Presently, CTO PCI carries a lower Appropriate Use Criteria score than non-CTO PCI for similar clinical and angiographic scenarios (3). The second reason for the underuse of CTO PCI relates to concerns about procedural and radiation safety, and increased resource utilization. The third reason is the low procedural success rates among non-expert CTO operators

and the inability to predict procedural success. As with any new and complex procedure, high success rates require extensive training, advanced skillsets, and a high procedural volume. These reasons have limited the wide applicability and dissemination of advanced techniques to the larger general interventional community. A simple clinical and angiographic score to predict procedural success would allow operators to quickly assess the risk-benefit ratio of CTO PCI.

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PROGRESS CTO is a prospective registry of CTO PCI performed at limited high volume expert CTO centers across the United States. In this current issue of *JACC: Cardiovascular Interventions*, Christopoulos et al. (4) report data from the PROGRESS CTO (Prospective Global Registry for the Study of Chronic Total Occlusion Intervention) registry and attempt to identify a scoring system that can predict success of PCI. They included 762 real-world patients, 35% of whom had had prior bypass surgery and 66%, prior PCI. Procedural success rate was 93%. Multivariable analysis identified 4 factors that were independently associated with failure to achieve technical success: proximal cap ambiguity, lack of interventional collaterals, tortuosity, and attempting a left circumflex CTO. Each factor was assigned 1 point, with the PROGRESS score representing the total number of points. The PROGRESS score was derived from two-thirds of the cohort and validated on the remaining third. It was moderately predictive of a successful procedure with a derivation c value of 0.78 and the validation c value of 0.72.

Thus far, the Multicenter CTO Registry of Japan (J-CTO) score had provided clinicians with a lesion complexity score and likelihood of successfully wiring the lesion within 30 min (5). The J-CTO score is the sum of 5 predictors of failure: blunt proximal cap, excessive tortuosity, long occlusion (>20 mm), presence of calcification in the CTO segment, and prior failed PCI attempt.

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Does the PROGRESS score offer an improvement over the J-CTO score? Will it replace the J-CTO score in the modern practice? The new PROGRESS score has the following advantages: 1) it includes only 4 variables instead of the 5 variables in J-CTO; 2) 1 of the variables of the J-CTO score, a prior unsuccessful PCI, can be unreliable as it depends on the experience of the prior operator; and 3) unlike the J-CTO score, the PROGRESS score is derived from and applies to the more contemporary hybrid CTO PCI approach. The hybrid approach proposes a procedural algorithm based on the proximal cap of the CTO, the distal vessel quality and the suitability of collateral vessels, allowing the operator to start with either an antegrade or retrograde crossing strategy and rapidly switch back and forth between the 2 strategies in the same setting as needed (6). Potential limitations of the PROGRESS score include the definition of “absence of interventional collaterals,” which can be subjective and dependent on operator experience, and the low number of failed procedures in the derivation cohort.

The authors should be commended for comparing the predictive accuracy of the J-CTO score to the PROGRESS score. They found that overall the J-CTO score performed similarly to the PROGRESS score, with perhaps even better accuracy for predicting procedural success at lower scores. An important feature of the J-CTO score, which is quite simple and widely used, is its prognostic value (7). It will be interesting to evaluate the prognostic value of the PROGRESS score with respect to outcomes, particularly that variables such as circumflex location of the CTO or absence of interventional collaterals may not portend adverse prognosis per se.

Although we suspect that the new PROGRESS-CTO score will be commonly used in clinical practice, the J-CTO score will continue to be an important tool in assessing lesion complexity and predicting outcomes.

However, both scores have been derived from registries collected from high-volume and experienced operators. To what extent the scores apply to the general interventional community is not clear. External validation in a larger CTO registry is warranted.

The authors should be congratulated for their efforts in creating and maintaining the PROGRESS CTO registry. Given the complexities of designing a large randomized controlled trial, such registry data shed important light on the state of the field and inform clinical care. The PROGRESS and J-CTO scores, by predicting procedural success, can help physicians and patients set PCI expectations in the context of alternative options such as medical therapy, bypass surgery, and enhanced external counter-pulsation therapy. Innovation in pharmacotherapy, cell therapy, and transvenous coronary sinus reducer technology among others will add to traditional revascularization options for treatment of angina and ischemia.

Given the prolonged learning curve and resources required in performing CTO PCI, such procedures should continue to be performed by highly trained operators at tertiary care centers. Dedicated CTO PCI registries would continue to improve our understanding of the procedure and track quality metrics including appropriate indication, procedural success rates, complication rates, radiation dose, and contrast volume, as well as cost. Ongoing efforts to improve CTO PCI techniques and lessons learned from registries such as PROGRESS CTO will guide clinicians to provide the best options to our patients.

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