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Editorial

High Stakes: CTO-PCI in the Post-CABG Patient

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See article by Azzalini et al., pages 310–318 of this issue.

Chronic total occlusions (CTOs) represent a technically challenging subset of obstructive coronary lesions that are found in approximately one-third of patients with atherosclerotic coronary disease.[1] While CTO percutaneous coronary intervention (PCI) techniques and specialized equipment continue to evolve, the so-called "hybrid approach" algorithm has quickly gained favour, offering a success rate of more than 80%.[2-8]

There has been much recent interest in the literature in predicting procedural success with a view to improving patient selection and the informed consent process. Indeed, according to a quick count, no less than 5 clinical scores have been evaluated in CTOs to various extents, including patients with previous coronary artery bypass graft (CABG).[9-19] In addition to scores on the basis of regional registries (**Re**gistry of **C**rossBoss and **H**ybrid Procedures in Fr**a**nce, the Neth**e**rlands, Bel**g**ium and United Kingdom [RECHARGE] in Europe,[20] **Pro**spective **G**lobal **Regi**stry for the **S**tudy of **C**hronic **T**otal **O**cclusion Intervention [PROGRESS-CTO] in the United States,[14,15] and Japanese Chronic Total Occlusion [J-CTO] score in Japan[9,10,21]), these include scores more familiar to the non-CTO operator (**Syn**ergy Between Percutaneous Coronary Intervention With **Tax**us and Cardiac Surgery [SYNTAX] Score[11]) as well as scores that rely on advanced imaging techniques (**C**omputed **T**omography **Re**gistry of **C**hronic **T**otal **O**cclusion **R**evascularization [CT-RECTOR][12,18]). Overall, however, these scores have tended to perform modestly in external validation studies, assessed using the area under the receiver operating curve method (approximately 0.6-0.7 depending on the study and outcome of interest). Reasons for this include the evolution of PCI techniques and equipment over time, the establishment of dedicated high-volume CTO operators and centres, in addition to differences in approach to CTO PCI in different regions.

In this issue of the *Canadian Journal of Cardiology*, Azzalini et al. report on the performance of the J-CTO as well as the RECHARGE scores in an international cohort representing > 7 years (2009-2017) of CTO procedures by high-volume operators.[22] With a median clinical follow-up of 377 days, the authors were able to report on the utility of both scores with regard to predicting procedural success and complications, as well as long-term outcomes. The RECHARGE score builds on the J-CTO score by including 2 additional variables: CABG status and the quality of the "landing zone" for CTO PCI.[20,22] Like previous studies, however, the predictive performances of the scores were modest (0.62-0.67) and there was no significant improvement with use of the slightly more complex RECHARGE score. (Qualitatively, however, the RECHARGE score appeared to show a slightly better "dose-response"-type relationship with procedural success as well as complications compared with the J-CTO score.) Despite this, it was the RECHARGE score and not the J-CTO score that won out as a multivariate predictor of target vessel failure (TVF; a composite of cardiac death, target vessel myocardial infarction, and ischemia-driven target vessel revascularization) during follow-up, along with stent length and not using a drug-eluting stent.

Why did the RECHARGE score outperform the J-CTO score as a predictor of long-term outcome when it did not in terms of earlier metrics of CTO PCI success? Although it is possible that some of the advantage resulted from the fact that the RECHARGE score was developed in a European hybrid-approach registry and most of the centres in this cohort likely use a similar algorithm, it stands to reason that 1 or both of the additional criteria in the RECHARGE score add far more incremental value with regard to long-term outcomes than upfront success. For example, the quality of the landing zone, although its consideration might correlate with procedure

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duration by influencing initial CTO approach, might arguably not add incremental information with regard to the ultimate likelihood of procedural success when other variables are considered. However, the quality of the landing zone might be more likely to influence an outcome such as TVF. (It should be noted that the quality of the landing zone was not included as a candidate variable in the multivariate regression by Azzalini et al.,[22] and whether the RECHARGE score would still be an independent predictor of TVF if it had remains an open question.)

The other additional variable in the RECHARGE score deserves more extensive discussion. CTOs are even more prevalent in CABG patients (60%-90%).[23,24] Indeed, it has been suggested that CABG itself might lead to accelerated native vessel lesion progression, resulting in an increase in the rate as well as complexity of CTOs.[23-25] The upshot of this would appear straightforward: increased CTO complexity would be expected to be associated with reduced procedural success and an increased complication risk. Indeed, the J-CTO score appears to perform approximately as well as the RECHARGE score in this regard, but falls short in terms of predicting long-term outcomes, suggesting that it is not just the failure to recanalize the CTO[24,26] that is predicting TVF. Although some of the comparative shortcomings of the J-CTO score in long-term prognostication might well be explained by consideration of landing zone quality, as discussed previously, it is possible that CABG status is itself informative with regard to the long-term risk of TVF beyond lesion complexity.

CABG patients are typically older with more comorbidities than CABG-naive patients, even among patients with CTOs.[22,24,27,28] CABG status might therefore be a marker of increased mortality and morbidity risk not captured in other elements of the RECHARGE or J-CTO scores. Moreover, although rare, perforation requiring intervention is definitely not unheard of in post-CABG patients,[22,29,30] and there is the suggestion of a so-called "legacy effect" of CTO PCI complications on outcomes out to 1 year.[29,31] (It is not clear if this legacy effect is partly due to a lower rate of successful recanalization because of aborted PCI.) Despite this, there is a not uncommon false assumption among some operators that post-CABG patients are (at least relatively) protected from such complications. It is therefore at least plausible that some operators in the cohort reported by Azzalini et al.[22] were more willing to engage in more advanced, aggressive recanalization techniques in post-CABG patients with an associated increased risk of early complications and later TVF. CABG status might therefore also be a surrogate marker of increased inherent risk of the revascularization technique above and beyond coronary anatomic considerations. (It should also be noted that previous CABG surgery precludes rapid, safe sternotomy in the case of a PCI complication.)

Would RECHARGE have been an independent predictor of long-term events if procedural complications were part of the multivariate model? Perhaps not, but this does not diminish the importance of the results of this report to our mind. First, procedural complications are arguably a step in the causal pathway between CABG status and TVF and, therefore, should be excluded from the model. In addition, the multivariate model reported by Azzalini et al. includes only those clinical and procedural characteristics that are, to a large extent, knowable before the procedure.[22] Total stent length can be reasonably predicted from diagnostic angiography and using a drug-eluting stent is a simple clinical choice that can be easily decided ahead of time, whereas the occurrence of a complication such as tamponade cannot be so precisely predicted. As such, acknowledging that a drug-eluting stent is now the default stent in nearly all cases, a combination of the RECHARGE score and predicted total stent length would seem to the best predictor of the risk of TVF during follow-up that is available at the time of informed consent before the CTO PCI procedure.

Although questions remain and the generalizability of the performance of this predictive model to populations treated by less experienced CTO operators is unknown, a few conclusions appear clear. First, post-CABG patients are a high-risk CTO population, in terms of procedural complications as well as long-term event-free survival.[22,27,28] Second, major complications, including perforation and tamponade, can occur in a postcardiotomy patient and the ready availability of experienced teams able to rapidly intervene in such cases is critical.[22,29-31] For these reasons, it would appear reasonable to recommend that CTO PCI for post-CABG patients be preferentially performed in highly experienced centres, particularly if advanced techniques are required, such as a retrograde approach.

As a final thought, because of the complexity and risk of intervening on CTOs in CABG patients, the day might well come when the decision to refer patients with multivessel disease for surgery—including CTOs—will not be as straightforward as it once was.[32] Although interventionalists now by and large accept that intermediate SYNTAX score[33] multivessel anatomy might be appropriate for PCI, many will still more readily consult cardiac surgery than consider a referral to a CTO operator if a CTO is present. Although some of this tendency might be driven by what services are available locally, with our current understanding of the evolution of critical lesions (CTOs as well as non-CTOs) after bypass,[24,25] the optimal time for an attempt at CTO PCI is likely before CABG, not after, particularly if the SYNTAX score is not high or if the proportion of the SYNTAX score attributable to the CTO is elevated (> 0.5).[23] Because of the complexity of clinical decision-making in patients who present with CTOs, referral of such patients to formalized complex PCI programs with a heart team approach is likely to be beneficial.

Disclosures

The authors have no conflicts of interest to disclose.

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