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EDITORIAL COMMENT

Chronic Total Occlusion PCI

Is This the Ultimate Test of the Importance of Complete Revascularization?*

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Chronic total occlusions (CTOs) represent one of the last major technical challenges for percutaneous coronary intervention (PCI). Recently, there have been major technological improvements in CTO recanalization including the introduction of the retrograde approach (1). These improvements have resulted in a current CTO success rate of 90%. Furthermore, newer drug-eluting stents contribute to more durable results. Despite these technological improvements, universal adoption of extensive CTO PCI is low except at a small number of specialized centers. The reasons for this low rate include concerns regarding procedure risk, time, and radiation exposure (patient and operator) as well as special operator training to acquire skills that may be difficult to maintain for low-volume operators (2). However, intellectually, the nagging question remains: Is there a clinical benefit of CTO PCI, particularly as it relates to mortality reduction?

In considering the potential importance of CTO revascularization, there is increasing concern regarding the impact of "residual" myocardial ischemia on PCI long-term outcome. If one subscribes to the importance of eliminating ischemia, then CTO revascularization becomes more important (3). The ischemic potential of the myocardium supplied by total occlusion is complex. Specific factors include the following: Is the CTO artery supplied by collaterals? Are the collaterals "sufficient" to prevent ischemia? Are the collaterals arising from a vessel with a significant lesion? Are there other significant lesions in vessels supplying other areas of the myocardium not involving the CTO vessel? Is there documented ischemia in the CTO distribution and how extensive is the ischemia? What is the status of left ventricular function? Is there really optimal medical therapy for all patients with CTO to prevent ischemia? Most importantly, what is the patient's cardiovascular risk profile and how effectively is it being addressed? Thus, current CTO PCI success potentially provides a new opportunity to address our concept regarding the benefit of limiting/eliminating ischemia.

Unfortunately, CTO PCI outcome studies that might shed light on some of these basic ischemic questions are often biased by a common study design of comparing successful with failed CTO PCIs. Such comparisons potentially add bias, which is impossible to statistically reconcile, in assessing the comparative advantages or disadvantages of the time, expense, and risk of achieving a high level of CTO PCI success.

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In this issue of *JACC: Cardiovascular Interventions*, Lee et al. (4) report their longitudinal experience over 11 years of consecutive CTO procedures with a median follow-up of 4.6 years. Successful CTO PCIs required treatment with drug-eluting stents (53.9% newer generation). The analyzed population included a total of 1,004 successful CTO procedures and 169 failed CTO procedures. Post-PCI coronary artery bypass surgery (CABG) was performed in 33 patients, complicating the analysis due to a disproportionate number of bypass operations (0.4% vs. 16.7%; $p < 0.001$) in the failed CTO group. Furthermore, two-thirds of CABGs were performed within the first 30 days, but only 4 were performed on the day of the CTO procedure, supporting a low rate of serious procedure-related events. However, the authors point out that the overall complication rate for failed PCI

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CTOs is lower than in many earlier studies in which lower primary CTO success rates were associated with higher complication rates. Although the 2 groups showed few systemic differences, the failed CTO group had more cases of renal failure and more target vessel revascularization procedures. Most interesting is the fact that in the successful CTO PCI arm, those patients who underwent complete revascularization compared with those who did not despite a successful CTO PCI had similar outcomes. The authors appear to speculate that the overall extent of revascularization versus residual ischemia may be the most important outcome, and successful CTO PCI may provide that advantage in some cases. On multivariate analysis, a failed CTO was not a risk for mortality, but was a risk for target vessel revascularization and CABG.

How can one reconcile these results with those of multiple studies suggesting improved survival outcomes for successful PCI with complete revascularization (5)? First, there was a high success rate for PCI CTO compared with older studies, reflecting experience, skill, and improved technical equipment, which reduce complications in the failed PCI group. The smaller size of the failed PCI group leads to a smaller population size in the failure group compared with the much larger success group, potentially confounding a comparative analysis.

Last, in view of the fact that Lee et al. (4) reported a relatively high rate of early surgical revascularization in the failed PCI group, one supposes that CABG was performed in either the most symptomatic patients or those with the greatest potential for ischemia. If this supposition is correct, this could help to explain apparent discordant results compared with other CTO PCI studies showing better outcomes for successful CTO patients. Importantly, more revascularization procedures, regardless of PCI or CABG, are consistent with the growing emphasis on the importance of complete revascularization, likely achieved in this study by the effective use of adjunctive CABG in the failed PCI group. Although the study of Lee et al. (4) does not completely answer the question of the importance of eliminating ischemia, greater completeness of revascularization increased by CABG for failed CTO PCI would be in keeping with the growing emphasis on the importance of complete revascularization.

In summary, given the expense, risk, and management issues related to CTO PCI in optimal coronary disease management, continued retrospective comparative trials of successful versus unsuccessful CTO PCIs seem unlikely to define the value of this technology. It appears time to seriously initiate plans for a randomized trial.

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