COMMENTARY

CTO-PCI: An Emerging New Subspecialty in Interventional Cardiology

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Percutaneous coronary intervention (PCI) of coronary chronic total occlusions (CTOs) represents the most technically challenging lesions in contemporary interventional cardiology.1-5 Despite the absence of randomized trials comparing outcomes of CTO-PCI against medical therapy or coronary artery bypass graft (CABG), a growing body of evidence suggests that successful percutaneous CTO revascularization relieves symptoms, improves left ventricular systolic function, reduces the need for surgical coronary bypass, and (especially in the context of complete coronary revascularization) improves survival.1-4 While some clinical studies do not show a clear benefit to CTO-PCI, even those neutral studies do not demonstrate a negative impact associated with CTO-PCI procedures.6

Despite the benefit of CTO recanalization, the CTO attempt rates in the United States (US) have remained disappointingly low. A recent examination of the National Cardiovascular Data Registry confirmed this sobering finding. Over a 3-year period, CTO-PCI represented 3.8% of the total PCI volume, and had lower procedural success (59% vs 96%, P<.001) and higher adverse event rate (1.6% versus 0.8%; P<.001) compared with non-CTO PCI. Of note, only 8 operators were reported to perform more than 50 CTO-PCI procedures per year and almost 20% of participating sites never performed CTO-PCI. Concerns regarding low success rates, unacceptably high complication rates, increased procedural time and resource utilization, and prohibitively high cost associated with CTO-PCI may account for these findings.1-7 However, a closer look at the available data from expert centers challenges these misconceptions.

When CTO-PCI is part of a comprehensive complex and higher-risk indicated patient (CHIP) program and performed in a systematic way (similar to the concept of a transcatheter aortic valve replacement program), CTO-PCI can be safe, efficient, economically sound, and associated with high procedural success rates.8 During the first year after development of a CTO program with dedicated CTO operators, and implementation of quality and performance guidelines, the overall CTO success rate was 85.6%. In-hospital adverse outcomes included: death 0.6%; emergency bypass surgery, 0.6%; tamponade, 0.6%; myocardial infarction, 1.9%; and transient nephropathy, 1.2%. Compared with patients undergoing non-CTO PCI, procedural and total costs per patient were significantly higher among the CTO cohort, but the contribution margins were comparable ($5173 ± 12,052 vs $5730 ± 8958; P=.58).8 Reports from US multicenter registries have demonstrated excellent procedural outcomes at high-volume centers. The technical and procedural success rates were 85.5% and 84.2%, respectively. The mean procedural time, fluoroscopy time, and contrast utilization were 113 ± 61 minutes, 42 ± 29 minutes, and 294 ± 158 mL, respectively. Major complications occurred in 1.8% of patients.9

How are these excellent results achieved? A major breakthrough in CTO-PCI in the US was the development and implementation of the “hybrid algorithm” — an attempt to standardize a reproducible and teachable approach to CTO-PCI.10 Avoidance of ad hoc CTO-PCI is fundamental to this algorithm, since meticulous study of the angiogram and preprocedural planning is essential for successful outcomes.8 CTO operators must be expert in all available CTO angioplasty techniques (antegrade wire escalation, antegrade dissection and reentry, and retrograde wire escalation and dissection reentry). The procedure starts with “dual” or simultaneous contralateral injections in order to carefully assess four angiographic parameters: (1) proximal cap ambiguity; (2) distal vessel quality and branching; (3) lesion length; and (4) presence or absence of “interventional” collaterals that may be used for retrograde CTO recanalization. The operator can decide on the initial strategy that will provide the safest, most efficient, and most effective way to recanalize the CTO, as well as alternative strategies if the initial approach fails. The operator can switch from one strategy to another in order to complete the procedure successfully in a reasonable timeframe.50 Recent reports from centers after adopting the hybrid approach have shown further improvements in success rates (91%) while maintaining acceptable complication rates (1.8%).11 Undoubtedly, these procedures are time consuming and require longer fluoroscopy time and greater radiation and contrast utilization, but with increased operator experience, there are favorable trends toward reduction of these requirements.12 Despite the ability to readily transmit the hybrid approach to new operators and centers, CTO-PCI is associated with a steep learning curve. Indeed, in multivariable models, years since initiation of CTO-PCI at each center was an independent predictor of procedural success.9 This is especially relevant in the most complex subset of CTO-PCI involving the application of the retrograde approach.13 Case selection and proctoring are both fundamental to early implementation of the hybrid approach to CTO-PCI. Even in high-volume CTO-PCI centers with experienced CTO operators, the practice of two operators participating in CTO is emerging.

In this context, the article by Vo et al in this month’s Journal of Invasive Cardiology demonstrated that a single operator can learn CTO-PCI techniques with a high success rate and
acceptable complication rates. After appropriate education and proctoring, the operator performed 50 CTO-PCIs on 48 consecutive patients over a 6-month period. Successful CTO recanalization was achieved in 92% of cases, with low rates of major complications. These results were achieved despite high complexity of the CTO lesions, which had an average J-CTO score >2. Additionally, a primary retrograde approach was used in 33%, and multiple strategies were implemented in 50% of cases. Considering the complexity of CTO-PCI, are these results surprising? Despite the inherent difficulty of CTO-PCI, in recent years, with the adoption of a standardized approach, CTO-PCI success rates in expert centers are above 90%, with very acceptable complication rates. This important study demonstrates that the excellent results seen in expert centers can be translated to new operators and CTO teams, across settings including community hospitals and tertiary or academic centers.

In the modern era, CTO-PCI has emerged as a new subspecialty of interventional cardiology, with specialized equipment, methodology, and expertise. Modern CTO operators have set a new benchmark for CTO success rates of above 90%. With appropriate training and dissemination of the hybrid approach to new operators in the academic as well as community setting, this goal can be accomplished.

References


