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STATE-OF-THE-ART REVIEW

Update in the Percutaneous Management of Coronary Chronic Total Occlusions

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ABSTRACT

Percutaneous coronary intervention (PCI) for chronic total occlusions (CTOs) has been rapidly evolving during recent years. With improvement in equipment and techniques, high success rates can be achieved at experienced centers, although overall success rates remain low. Prospective, randomized-controlled data regarding optimal use and indications for CTO PCI remain limited. CTO PCI should be performed when the anticipated benefit exceeds the potential risk. New high-quality studies of the clinical outcomes and techniques of CTO PCI are needed, as is the expansion of expert centers and operators that can achieve excellent clinical outcomes in this challenging patient and lesion subgroup. In the current review the authors summarize the latest publications in CTO PCI and provide an overview of the current state of the field. (J Am Coll Cardiol Intv 2018;■:■–■) © 2018 the American College of Cardiology Foundation. Published by Elsevier. All rights reserved.

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ABBREVIATIONS AND ACRONYMS

CABG = coronary artery bypass grafting

CTA = computed tomography angiography

CTO = chronic total occlusion

IVUS = intravascular ultrasound

MACE = major adverse cardiac events

MT = medical therapy

OMT = optimal medical therapy

PCI = percutaneous coronary intervention

Chronic total occlusion (CTO) percutaneous coronary intervention (PCI) is a rapidly evolving area of interventional cardiology. We sought to provide an update on current concepts in CTO PCI and a critical review of the recently published data.

CTOs: INCIDENCE AND EPIDEMIOLOGY

CTOs are found in 16% to 52% of patients who undergo coronary angiography and are found to have coronary artery disease (1-3). In the SCAAR (Swedish Coronary Angiography and Angioplasty Registry) registry, the prevalence of CTO among patients with at least one 50% luminal coronary stenosis was 16.1% (14,441 of 89,872 patients) (4). In a Canadian single-center registry the prevalence of a CTO was 20%: PCI was performed in 9% of these patients, 34% had coronary artery bypass grafting (CABG), and 57% were treated with medical therapy alone (5).

WHEN SHOULD CTO PCI BE PERFORMED?

CTO PCI should be performed when the anticipated benefits (which depend on the patient's baseline clinical condition and the likelihood of success) exceed the potential short- and long-term risks (**Central Illustration**) (6).

CTO PCI BENEFITS: RANDOMIZED STUDIES. Currently, symptom improvement is considered the main benefit of CTO PCI, despite criticisms that there is limited supportive prospective randomized-controlled clinical trial data: indeed, only 3 randomized-controlled trials have been reported to date, only 1 of which has been published (7).

The EXPLORE (Evaluating Xience and Left Ventricular Function in Percutaneous Coronary Intervention on Occlusions After ST-Elevation Myocardial Infarction) trial enrolled 304 patients who underwent primary PCI for acute ST-segment elevation acute myocardial infarction and had a coexisting non-infarct-related artery CTO. Patients were randomized to CTO PCI versus medical therapy alone. CTO PCI success was 73%. Cardiac magnetic resonance imaging performed after 4 months showed similar left ventricular ejection fraction and left ventricular end-diastolic volume in the 2 study groups (7).

The DECISION-CTO (Drug-Eluting stent Implantation versus optimal Medical Treatment in patients with ChronIc Total OccluSION) trial (NCT01078051) was presented at the 2017 American College of Cardiology meeting. The DECISION-CTO trial randomized 834 patients with coronary CTOs (many of whom also had multivessel disease) to optimal medical therapy (OMT) alone versus OMT + CTO PCI. Patients in the OMT and the OMT + CTO PCI group had similar clinical outcomes during a median follow-up of 3.1 years. The study has several limitations, such as suboptimal primary endpoint selection, high rate of non-CTO PCI (73% of the study patients had multivessel disease in both groups), early termination before achievement of target enrollment, high crossover rates (18% in the OMT alone group underwent CTO PCI), and mild baseline symptoms in both study groups.

The EuroCTO (A Randomized Multicentre Trial to Evaluate the Utilization of Revascularization or Optimal Medical Therapy for the Treatment of Chronic Total Coronary Occlusions) trial (NCT01760083) was presented at the 2017 EuroPCR meeting. Due to slow enrollment, the study ended prematurely after randomizing 407 patients instead of the planned 1,200. In contrast to DECISION-CTO trial, non-CTO lesions were treated before enrollment in the study. Compared with patients randomized to medical therapy only, patients randomized to CTO PCI had more improvement in angina frequency at 12 months ($p = 0.009$) as assessed by the Seattle Angina Questionnaire.

CTO PCI BENEFITS: OBSERVATIONAL STUDIES. Several observational, uncontrolled studies have suggested clinical benefit with CTO PCI, by improving angina, dyspnea, depression, exercise capacity, and risk for arrhythmias.

Despite the limitation of comparing successful with failed CTO PCIs, the OPEN-CTO (Outcomes, Patient Health Status, and Efficiency in Chronic Total Occlusion Hybrid Procedures) registry analyzed 1,000 consecutive patients undergoing CTO PCI with the hybrid approach (**Figure 1**) using standardized questionnaires. A 10.8-point (95% confidence interval: 6.3 to 15.3) improvement in the quality-of-life domain of the Seattle Angina Questionnaire was observed among successful versus unsuccessful procedures ($p < 0.001$) (8). Similar results have been shown in multiple prior studies and meta-analyses (9), which have also reported lower mortality among successful versus failed CTO PCIs (9). Several studies have assessed the long-term outcomes of CTO PCI as compared with medical therapy, reporting lower incidence of major adverse cardiac events with CTO PCI (10,11), even among patients with well-developed collateral circulation (12). However, all retrospective studies are subject to selection bias.