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EDITORIAL COMMENT

Who Should Undergo Chronic Total Occlusion Percutaneous Coronary Intervention?

The EXPLORation Continues*

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Chronic total occlusion (CTO) percutaneous coronary intervention (PCI) has been growing by leaps and bounds in recent years, fueled by advances in techniques, equipment, and underpinning clinical evidence (1). A major gap, however, has been the lack of randomized controlled trials comparing CTO PCI with medical therapy (2).

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In this issue of the *Journal,* Henriques et al. (3) make a landmark contribution to the field by reporting results of their randomized controlled trial of CTO PCI versus medical therapy, the EXPLORE (Evaluating Xience and Left Ventricular Function in Percutaneous Coronary Intervention on Occlusions After ST-Segment Elevation Myocardial Infarction) trial. EXPLORE enrolled patients who underwent primary PCI for ST-segment elevation acute myocardial infarction (STEMI) and who were found to have concomitant CTO. Such patients are at increased risk for short-term and long-term adverse cardiac events and would therefore be expected to derive benefit from CTO PCI. Patients were randomized to CTO PCI or medical therapy alone within 7 days. Core laboratory adjudicated procedural success was 73%. At 4 months, left ventricular ejection fraction and left ventricular end-diastolic volume were similar in the 2 study groups, although patients who underwent PCI of left anterior descending coronary artery CTO had significantly higher ejection fractions compared with those patients who were treated with medical therapy alone.

At first glance, the study results appear disappointing because CTO PCI did not improve left ventricular function and dimensions. However, interpretation of the study results should take into account several findings. First, the success rate was relatively low. An approximately 90% success rate can be achieved at experienced centers around the world (1), although success rates remain low among less experienced centers (4). Second (and to some extent related to the first issue), the completeness of revascularization achieved in the CTO PCI group is unclear and could still be relatively low despite CTO PCI attempts. Complete revascularization has been linked to improved long-term outcomes as compared with incomplete revascularization, and the presence of CTO has been shown to be the strongest predictor of incomplete revascularization (5). Moreover, several studies (that did not enroll patients with CTOs) showed improved outcomes with multivessel revascularization after presentation with STEMI. Third,

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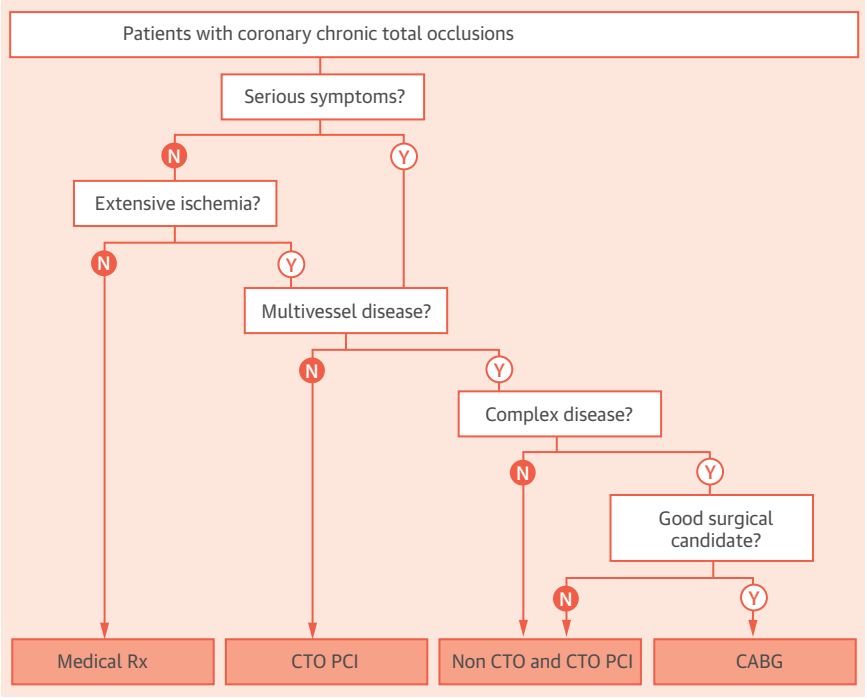
4 months may not be long enough to achieve myocardial recovery (additional recovery was observed at 14 months in 1 study [6]). Fourth, <75% transmurality does not necessarily mean viability: the lesser the extent of transmural enhancement, the higher is the likelihood of improvement (7). Fifth, regional wall motion was not evaluated at baseline and follow-up to determine interval changes. Sixth, given the higher than anticipated ejection fraction and lower success rate, the power of the study was low, even though numerically the ejection fraction of the 2 groups was nearly identical. Seventh, stent patency was not verified at follow-up: high rates of stent failure could result in poor left ventricular function recovery. Eighth, only patients with STEMI were included. Patients with STEMI represent a minority of patients currently undergoing CTO PCI and results could be different in patients with stable angina or patients with non-ST-segment elevation acute coronary syndromes.

Should the negative EXPLORE study results decrease our willingness to offer and perform CTO PCI? The answer remains "It depends." It depends on why CTO PCI is considered (i.e., the potential benefit to the patient), and it depends on who performs the procedure.

If the goal of CTO PCI is to improve left ventricular systolic function and remodeling in patients with STEMI who have concomitant CTO (i.e., similar to patients enrolled in the EXPLORE study), the answer for most patients would be "no," with the possible exception of patients with left anterior descending coronary artery CTOs, who derived benefit in the exploratory EXPLORE subgroup analysis. However, if the goal is to improve symptoms, the answer in most cases would be "yes" (**Figure 1**), as long as the patient understands the indications for, potential benefits of, and risks of the procedure. Symptom relief remains the most common reason for CTO PCI referral, and CTO PCI has been shown (in observational studies, but not in randomized controlled studies) to improve angina (2), dyspnea, refractory arrhythmias, and even depression significantly (8). The threshold for performing coronary revascularization including CTO PCI should be considerably higher for patients without symptoms, although patients with large

FIGURE 1 Revascularization Options for Patients With Coronary CTO



Algorithm for determining the need for coronary revascularization in patients with coronary chronic total occlusion (CTO); the algorithm assumes expertise in both surgical and percutaneous coronary revascularization. Chronic total occlusion percutaneous coronary intervention (PCI) and coronary artery bypass graft surgery (CABG) surgery are both treatment options. CABG surgery is preferred for patients with multivessel complex disease, and PCI (including CTO PCI) is preferred for patients with simple multivessel or single-vessel disease. N = no; Rx = treatment; Y = yes.