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REVIEW TOPIC OF THE WEEK

Revascularization of Chronic Total Occlusions

Time to Reconsider?

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ABSTRACT

Up to 20% of all coronary angiograms reveal coronary chronic total occlusions (CTOs). The lack of robust type A evidence with hard clinical outcomes on the benefits of CTO revascularization has hampered attempts to develop recommendations regarding the optimal management of CTOs. This review presents issues surrounding CTO revascularization within the framework of the appropriate use criteria ratings. Appropriate use criteria ratings downgrade CTO percutaneous coronary intervention revascularization relative to non-CTOs and to surgical revascularization. Specific aspects of CTO revascularization include ischemic burden, impact of revascularization on quality of life, risks in CTO revascularization, and the importance of complete revascularization. Contemporary data suggest CTO revascularization may have substantial impact on patient outcomes; thus, revascularization should likely be held to similar criteria as nonocclusive lesions. However, additional large clinical trial data are required to more definitively determine CTO revascularization guidelines. (J Am Coll Cardiol 2014;64:1281–9) © 2014 by the American College of Cardiology Foundation.

Coronary chronic total occlusions (CTOs), a distinct subset of coronary artery disease (CAD), are defined on invasive angiography as coronary arteries with either absent or minimal anterograde blood flow for >12 weeks duration. In recent years, coronary CTO management has become increasingly important in routine practice and a focus for pre-clinical and clinical research (1–3). This interest is stimulated by the prevalence of CTOs (nearly 20% of all coronary angiograms) (4); yet, there is a paucity of data on how best to manage the need for revascularization and the preferred modality (coronary artery bypass grafting surgery [CABG] or percutaneous coronary intervention [PCI]).

Critics of CTO revascularization generally perceive that symptoms are rare and are easily controlled by medications and that revascularization frequently supplies infarcted left ventricular (LV) myocardium that would not benefit. Empirically, physicians treat CTOs and nonocclusive coronary stenosis differently, evident from relatively low rates of overall revascularization compared with medical therapy and substantially less PCI than CABG. Only approximately 35% of CTOs are currently treated by revascularization (either CABG or PCI) (4). In CTO patients, only about one-third of PCI attempts are directed toward the CTO artery; non-CTO arteries are preferentially targeted (4). In these multivessel CTO patients, surgical revascularization of the CTO artery is variable, with published reports ranging from 69% to 89% (4,5). For CTO patients who had a revascularization strategy recommended, CABG is the mainstay by a nearly 3:1 ratio (4). In contrast, observational studies suggest that approximately 60% of patients with nonocclusive chronic stable ischemic disease undergo revascularization, with PCI as the modality almost twice as often. This review examines the rationale for this distinct treatment of CTO lesions, concentrating

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ABBREVIATIONS AND ACRONYMS

AUC = appropriate use criteria

CABG = coronary artery bypass grafting

CAD = coronary artery disease

CR = complete revascularization

CTO = chronic total occlusions

IR = incomplete revascularization

LV = left ventricle/ventricular

MACE = major adverse cardiac event(s)

PCI = percutaneous coronary intervention

QOL = quality of life

on 2 key clinical decision points: first, whether to revascularize; and second, which modality. We hope to provide a framework to facilitate discussion between physicians and patients and to improve decision-making for these complex patients.

REVASCULARIZATION DECISION MAKING IN CAD WITH CTO

To facilitate clinical decision-making, an expert panel representing the views of major American cardiovascular organizations developed appropriate use criteria (AUC). A formal document outlining 180 clinical scenarios graded by whether revascularization was appropriate, uncertain, or inappropriate was initially published in 2009 (6), and most recently updated in 2012 (7). According to the AUC's conceptual framework, a revascularization procedure would be considered appropriate if its expected benefits in terms of survival or health outcomes (symptoms, functional status, and/or quality of life [QOL]) exceed its expected risks by a sufficiently wide margin (7). The AUC classifies patients on the basis of symptom severity, findings on pre-procedural stress testing, and anatomic location and extent of coronary stenosis. The only modifier of coronary anatomy included in the current AUC is the lesion being a CTO; other forms of anatomic complexity are not considered. The implicit assumption is that for the same lesion location, symptom severity, and ischemic burden, a CTO differs from a non-CTO, either due to the perceived benefit of revascularization or the harm of the procedure. We will examine this rationale in detail.

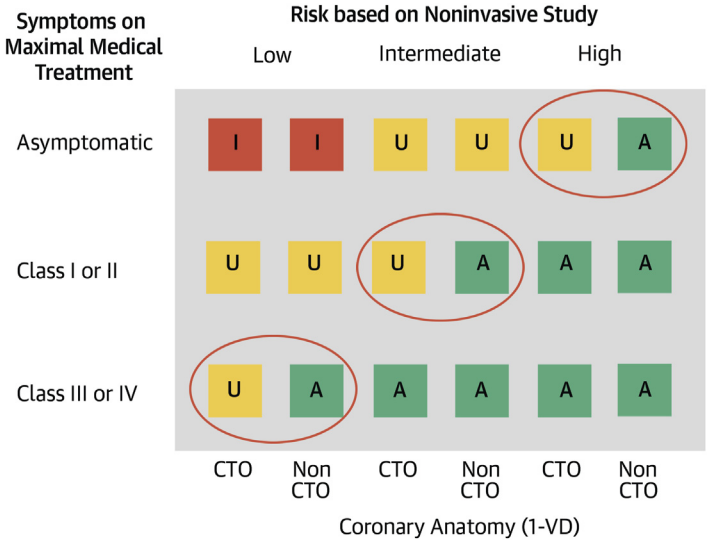
There are 2 broad clinical revascularization scenarios involving CTOs: isolated CTOs or multivessel disease.

ISOLATED ("LONE") CTO

Clinical indications 23 to 27 specifically approach single-vessel CTOs, making different recommendations for CTO and nonocclusive lesions (**Central Illustration**) for the same symptom severity, lesion location, extent of ischemia, and intensity of medications (7). In several scenarios, CTO revascularization is downgraded compared with non-CTO vessels ("uncertain" in CTO from "appropriate" in non-CTO, and "inappropriate" in CTO from "uncertain" in non-CTO), supporting a more conservative approach to revascularization of CTOs relative to non-CTOs. The document does not clearly state why CTO revascularization was discouraged. However, the conceptual framework presented earlier suggests that the rationale is the elevated risk due to the procedure's complexity, balanced against their uncertain benefits. Several points should inform this decision as to whether CTOs should be considered separately from non-CTOs in revascularization decisions:

DO PATIENTS WITH CTO HAVE ISCHEMIA? The AUC heavily emphasize ischemic burden and suggest that revascularization is appropriate in cases with large territories of ischemia, even without symptoms. It is important to dismiss the common misconception that CTOs overwhelmingly supply infarcted myocardial territories not prone to ischemia. In the Canadian CTO registry, LV function was normal (grade 1) in 50% of patients, and only 17% had significantly reduced LV function (grade 3 to 4), with electrocardiographic evidence of infarction in only one-third of patients (4).

The evaluation of myocardial ischemia can be challenging (8); indeed, invasive assessment of ischemia through fractional flow reserve (FFR) is increasingly preferred, given studies showing clinical benefit with revascularization decisions on the basis of FFR results (9). Using FFR, Sachdeva et al. (10) showed that every CTO evaluated in their series was



CENTRAL ILLUSTRATION Appropriate Use Rating in CTOs and in Non-CTOs in Single Vessel Disease

Appropriate use ratings in single-vessel disease chronic total occlusions (CTOs) and in non-CTOs, according to symptoms and risk in noninvasive study. Differences in recommendations between CTOs and non-CTOs are labeled with **red circles**. A = appropriate; I = inappropriate; U = uncertain. 1-VD = single vessel disease. Adapted with permission from Patel et al. (7).