EDITORIAL COMMENT

Are We Ready for a New Paradigm Shift in Percutaneous Revascularization of Chronically Occluded Vessels With Well-Developed Collaterals? From Leaving ‘Em All to Stenting ‘Em All*

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Coronary chronic total occlusion (CTO) is found in up to 20% of the patients undergoing coronary angiography and represents one of the remaining challenges for interventional cardiologists (1). Failure of attempted percutaneous coronary intervention (PCI) of CTO is high, up to 35%; more than 40% of CTO are not attempted and are treated either with medical therapy or with coronary artery bypass graft (1,2). Successful CTO recanalization remains an important clinical need because cardiac and all-cause mortality increases up to 3 × to 4 × in patients with persistent occlusion (2,3). Patients treated with successful PCI of CTO have better survival than do patients with unsuccessful procedures (3). Yet, this clinical benefit is not uniform, and in some successfully revascularized patients, clinical outcome remains worse than in patients undergoing PCI of non-CTO lesions (4,5). This corroborates the concept that CTO represents a marker of a more advanced atherosclerotic disease in high-risk patients, often presenting with several other comorbidities. These CTO facts are calling for accurate risk stratification and better selection of patients who would benefit the most from revascularization (6).

THE PRESENT STUDY

In this issue of JACC: Cardiovascular Interventions, Jang et al. (7) investigated the impact of CTO revascularization on clinical outcome of patients with either angina or documented ischemia. They confirmed that, even with well-developed collateral circulation to the myocardium subtended by the coronary occlusion, revascularization by PCI or coronary artery bypass graft, compared with patients managed conservatively, improves cardiac mortality and major adverse cardiac events. These findings are interesting, though not unexpected. First, angina relief and/or reduction of ischemia in the corresponding myocardial territory should represent the main goal of percutaneous revascularization of CTO (Class IIa, Level of Evidence: B) (8). Undoubtedly, PCI of CTO leads to an improvement in angina, normalization of functional tests, and improvement of left ventricular function (3–5,9). In addition, patients with CTO vessels subtending large areas of myocardial ischemia or viability do certainly benefit from successful revascularization (10). Patients included in Jang’s study undergoing revascularization fulfill these criteria as they have either angina or documented ischemia, CTO was often located in the left anterior descending artery, and left ventricular ejection fraction was preserved. Second, Werner et al.
previously demonstrated that even well-developed collaterals as assessed by angiography are not able to fully replace anterograde blood flow and restore flow reserve and therefore can hardly prevent myocardial ischemia. Importantly, presence of collaterals to CTO territory represents a condition that is necessary though not sufficient to predict the presence of viable/ischemic myocardium. On one side, well-developed collaterals are inversely correlated with the degree of transmural injury (12), but on the other side, the pressure drop in the distal vasculature after the occlusion of the artery is the main trigger of collateral formation (13), implying that large collaterals can develop to a myocardial territory with limited residual ischemia or viability.

Some limitations of the present study should be recognized. This is a retrospective observational study with no independent evaluation of the angiographic metrics and adjudication of the events. Event under-reporting cannot be excluded. No matter how sophisticated the statistical analysis or how experienced and unbiased the evaluating cardiologist might be, opportunities for selection bias in the decision-making process remain (e.g., those patients with more favorable anatomical and angiographic features were attempted with PCI, whereas the others deferred to medical therapy or were sent to surgery). In selected patients, experienced operators have reported success rates higher than 90%, using newer devices and more advanced techniques (e.g., retrograde approach). In the present series, the reported success rate of 80% is more likely to reflect a real-world situation in most catheterization laboratories. Whether the results in these patients would have been even better with higher PCI success rate remains to be addressed and balanced with associated higher complication rates.

**PRACTICAL IMPLICATIONS**

When managing a patient with CTO, should we guide the revascularization on the presence and extent of myocardial ischemia or on the presence of collaterals? In patients with stable coronary artery disease, a percutaneous revascularization strategy guided by the presence of ischemia and performed with new-generation drug-eluting stents has been associated with improved clinical outcome (14,15). The FAME-2 (Fractional Flow Reserve Versus Angiography for Multivessel Evaluation-2) trial has recently confirmed this concept in a randomized cohort of stable patients showing that when PCI of large vessels is guided by the presence of reversible ischemia (i.e., fractional flow reserve measurement) along with the best medical therapy, the clinical outcome of these patients is improved up to 2 years as compared with those of patients treated with medical therapy only (16). Irrespective of the benefit from correcting the ischemic substrate, a theoretical advantage for the patient might derive by having the occluded vessel open, the “open artery” hypothesis. As is often observed in practice, the reopened CTO can provide a safety net of collaterals in case of atherosclerosis progression to another vessel, including the collateral-donor vessel to the previously occluded one. Recent data investigating the impact of CTO of the right coronary artery in patients undergoing PCI of the left main coronary artery support this observation. The survival rate was 2-fold higher in patients without residual occlusion of the right coronary artery as compared with the rate in patients with permanent right coronary artery occlusion (2).

Last but not least, no matter how consistently the available observational data support revascularization of CTO, one has to realize that all evidence available thus far needs to be confirmed by the 2 ongoing randomized clinical trials: EuroCTO (A Randomized Multicentre Trial to Evaluate the Utilization of Revascularization or Optimal Medical Therapy for the Treatment of Chronic Total Coronary Occlusions) and EXPLORE (Evaluating Xience V and Left Ventricular Function in Percutaneous Coronary Intervention on Occlusions After ST-Evaluation Myocardial Infarction) trial (17). While awaiting the ultimate answer, we can continue to manage these patients with caution, basing clinical decisions on guideline recommendations, spiced with a good dose of common sense. From this perspective, the presence of well-developed collaterals to the occluded territory would militate in favor of stenting ’em rather than leaving ’em.

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**REFERENCES**

3. Hoye A, van Domburg RT, Sonnenschein K, Serruys PW. Percutaneous coronary intervention...


