

Should we give into temptation and attempt all chronic total occlusions?

“The decision-making process of whom to undergo chronic total occlusion percutaneous coronary intervention, should pass through a rational analysis, taking into account clinical and anatomical factors and operator’s experience.”

Keywords: chronic total occlusion • clinical indications • percutaneous coronary intervention

Chronic total occlusion (CTO) is defined as the presence of thrombolysis in myocardial infarction (TIMI) flow 0 within an occluded coronary segment of greater than 3 months standing [1]. It represents a frequent coronary lesion subset encountered in everyday catheterization laboratory practice. Indeed, CTOs were present in 18% of patients with significant coronary artery disease and no prior coronary artery bypass graft [2], and Christofferson *et al.* [3] reported a CTO prevalence as high as 52% in a Veteran’s Affairs population with significant coronary artery disease. Nowadays, clear evidence has been established regarding the benefits of CTO recanalization [4–6]. Although in the past decades coronary artery bypass graft was considered to be the gold standard for treating CTO lesions [3], recently, thanks to the significant improvements in equipment and techniques [7,8], CTO percutaneous coronary intervention (PCI) has become a more attractive and fashionable choice, as compared with surgery [2]. However, a question remains looking for an answer: should we give into temptation and attempt all CTO lesions in cath lab?

Proofs in literature

The decision-making process of whom to undergo CTO PCI, should pass through a rational analysis, taking into account clinical and anatomical factors and operator’s experience. In fact, current guidelines [9] carry a Class IIa for CTO PCI in “patients with appropriate clinical indications and suitable anatomy is reasonable when performed by operators with appropriate expertise”.

Symptom status, anti-ischemic medication, viability and ischemic burden are important factors which should be taken into consideration during the assessment of a patient candidate for a CTO revascularization. Indeed, Canadian Cardiovascular Society angina class >II, high-risk findings on non-invasive testing and/or optimal medical therapy in some combination are generally considered to be appropriate indications.

The key objectives of CTO recanalization include symptom relief (not only angina), increase in exercise capacity and improvement of quality of life. In a meta-analysis by Joyal *et al.* [10], patients with successful CTO recanalization had significant reduction in angina recurrency at 6-year follow-up, as compared with patients in whom the procedure failed (odds ratio 0.45). The FACTOR trial showed that procedural success was independently related to not only angina relief, but also improved physical function and enhanced quality of life as assessed by the Seattle Angina Questionnaire [11]. Notably, these reported benefits were only observed in symptomatic patients at baseline [11]. However, the low rate of anti-ischemic medication prescribed in the latter study (calcium channels inhibitors 13%, nitrates 38%, β -blockers 73%) could represent a bias favoring the difference observed between successfully and unsuccessfully recanalized patients [11]. Maximal anti-anginal medical therapy is defined as the use of at least two classes of therapies to reduce anginal symptoms [12]; for a CTO patient an assumption in anti-anginal medication prescription, according to patient tolerance,

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could postpone the need for revascularization and even avoid it in some cases.

On the other hand, functional imaging tests are important tools, for making the decision to attempt or not a CTO. Indeed, CTO recanalization is indicated in the presence of objective evidence of viability/ischemia in the territory of the occluded artery of more than 10%, as shown by the current guidelines on myocardial revascularization [12]. In addition to scintigraphy prognostic value [13], the interest in cardiac MRI has increased in recent years. Baks *et al.* [14] correlated myocardial viability by cardiac MRI before and 5 months after PCI with improvements in left ventricular systolic function. Moreover, scar burden assessment by delayed-enhancement MRI was able to predict improvement in segmental wall thickening, particularly in those with <25% transmural extent of infarction (21 ± 15 to $35 \pm 25\%$; $p < 0.001$) [15].

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The decision to revascularize a CTO lesion also passes through a careful analysis of anatomical features. Although right coronary artery is the most commonly involved vessel, Safley *et al.* [15] showed that 5-year survival rates were only significantly extended in the successful PCI of left anterior descending CTO (88.9 vs 80.2%; $p < 0.001$). In the presence of three-vessel disease and/or left main involvement (high SYNTAX score), surgical revascularization remains the reliable alternative able to ensure good outcome [12]. On the other hand, the presence of heavy calcifications, vessel tortuosity and

collateral circulation may be important in determining not only who can benefit from recanalization but also the approach to adopt. In this respect, Morino *et al.* [16] described the so-called J-CTO for grading lesion difficulty; this latter was able to predict the probability of successful guidewire crossing within 30 min [16].

There is no doubt that operator's experience impacts on the outcome. Indeed, Thompson and colleagues [17] have shown a clear added value of high-operator CTO-specific case volume, particularly in retrograde approach, improving technical success of CTO PCI without adversely impacting patient outcomes. However, experience should never mean unwisdom.

Conclusion

In conclusion, despite the recent advances in techniques and equipment and the importance of a complete revascularization [18], the answer of the title question is definitely no, even for experienced operators. Indeed, the decision making process for PCI of a CTO lesion should pass through a rational and wise balance between the expected benefits and the procedural risk. Moreover, we should not forget that optimal medical therapy and surgery still belong to the therapeutic armamentarium for CTO patients.

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References

- 1 Sianos G, Werner GS, Galassi AR *et al.* Recanalisation of chronic total coronary occlusions: 2012 consensus document from the EuroCTO club. *EuroIntervention* 8(1), 139–145 (2012).
- 2 Fefer P, Knudtson ML, Cheema AN *et al.* Current perspectives on coronary chronic total occlusions: the Canadian Multicenter Chronic Total Occlusions Registry. *J. Am. Coll. Cardiol.* 59, 991–997 (2012).
- 3 Christofferson RD, Lehmann KG, Martin GV *et al.* Effect of chronic total coronary occlusion on treatment strategy. *Am. J. Cardiol.* 95, 1088–1091 (2005).
- 4 Galassi AR, Tomasello SD, Costanzo L, Campisano MB, Barrano G, Tamburino C. Long-term clinical and angiographic results of Sirolimus-Eluting Stent in Complex Coronary Chronic Total Occlusion Revascularization: the SECTOR registry. *J. Interv. Cardiol.* 24(5), 426–436 (2011).
- 5 Galassi AR, Tomasello SD, Crea F *et al.* Transient impairment of vasomotion function after successful chronic total occlusion recanalization. *J. Am. Coll. Cardiol.* 59(8), 711–718 (2012).
- 6 Galassi AR, Boukhris M, Tomasello SD *et al.* Long term clinical and angiographic outcome of the mini-STAR technique as a bail out strategy for percutaneous coronary intervention of chronic total occlusion. *Can. J. Cardiol.* doi:10.1016/j.cjca.2014.07.016 (2014) (Epub ahead of print).
- 7 Galassi AR, Tomasello SD, Costanzo L *et al.* Mini-STAR as bail-out strategy for percutaneous coronary intervention of chronic total occlusion. *Catheter. Cardiovasc. Interv.* 79(1), 30–40 (2012).
- 8 Tomasello SD, Giudice P, Attisano T, Boukhris M, Galassi AR. The innovation of composite core dual coil coronary guide-wire technology: a didactic coronary chronic total occlusion revascularization case report. *J. Saudi Heart Assoc.* 6(4), 222–225 (2014).

- 9 Levine GN, Bates ER, Blankenship JC *et al.* 2011 ACCF/AHA/SCAI Guideline for Percutaneous Coronary Intervention. A report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines and the Society for Cardiovascular Angiography and Interventions. *J. Am. Coll. Cardiol.* 58, e44–e122 (2011).
- 10 Joyal D, Afilalo J, Rinfret S. Effectiveness of recanalization of chronic total occlusions: a systematic review and meta-analysis. *Am. Heart J.* 160(1), 179–187 (2010).
- 11 Grantham JA, Jones PG, Cannon L, Spertus JA. Quantifying the early health status benefits of successful chronic total occlusion recanalization: results from the FlowCardia's Approach to Chronic Total Occlusion Recanalization (FACTOR) trial. *Circ. Cardiovasc. Qual. Outcomes* 3(3), 284–290 (2010).
- 12 Patel MR, Dehmer GJ, Hirshfeld JW, Smith PK, Spertus JA. ACCF/SCAI/STS/AATS/AHA/ASNC/HFSA/SCCT 2012 Appropriate use criteria for coronary revascularization focused update: a report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, Society for Cardiovascular Angiography and Interventions, Society of Thoracic Surgeons, American Association for Thoracic Surgery, American Heart Association, American Society of Nuclear Cardiology, and the Society of Cardiovascular Computed Tomography. *J. Am. Coll. Cardiol.* 59(9), 857–881 (2012).
- 13 Galassi AR, Werner GS, Tomasello SD *et al.* Prognostic value of exercise myocardial scintigraphy in patients with coronary chronic total occlusions. *J. Interv. Cardiol.* 23(2), 139–148 (2010).
- 14 Baks T, van Geuns RJ, Duncker DJ *et al.* Prediction of left ventricular function after drug-eluting stent implantation for chronic total coronary occlusions. *J. Am. Coll. Cardiol.* 47(4), 721–725 (2006).
- 15 Safley DM, House JA, Marso SP, Grantham JA, Rutherford BD. Improvement in survival following successful percutaneous coronary intervention of coronary chronic total occlusions: variability by target vessel. *JACC Cardiovasc. Interv.* 1(3), 295–302(2008).
- 16 Morino Y, Abe M, Morimoto T *et al.* Predicting successful guidewire crossing through chronic total occlusion of native coronary lesions within 30 minutes: the J-CTO (Multicenter CTO Registry in Japan) score as a difficulty grading and time assessment tool. *JACC Cardiovasc. Interv.* 4(2), 213–221 (2011).
- 17 Thompson CA, Jayne JE, Robb JF *et al.* Retrograde techniques and the impact of operator volume on percutaneous intervention for coronary chronic total occlusions an early U.S. experience. *JACC Cardiovasc. Interv.* 2(9), 834–842 (2009).
- 18 Tamburino C, Angiolillo DJ, Capranzano P *et al.* Complete versus incomplete revascularization in patients with multivessel disease undergoing percutaneous coronary intervention with drug-eluting stents. *Catheter. Cardiovasc. Interv.* 72(4), 448–456 (2008).