Which parameters are important before attempting chronic total occlusions recanalization?

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Even in the era of advanced skills of operators of chronic total occlusions (CTO) combined with new sophisticated technologies and devices, percutaneous coronary interventions (PCI) of CTO remain challenging. These procedures are technically complex. Thus, the risk of failure and complications is very dependent on technical skills of the operator and vary from study to study. There are also some controversies, fortunately year by year less frequent, mainly due to the sharing of knowledge in the cardiology community, creating appropriate indications for CTO revascularization [1, 2]. Finally, there are still some uncertainties regarding benefits of the CTO procedure, but the growing number of studies reporting good procedural, functional and, most importantly, a positive effect on long-term outcome, shifts the balance toward benefits. Despite the lack of randomized trials, in a recent meta-analysis of 25 studies published from 1990 to 2014 with 28,486 patients (29,315 CTO PCI procedures) with a mean follow-up of 3.11 years (range 6 months to 12 years) Christakopoulos from the E. Brilakis group elegantly showed that successful CTO PCI compared with failed procedures are associated with a lower risk of death, stroke and coronary artery bypass grafting and less recurrent angina pectoris [3].

When dealing with CTO we should take into account two very important aspects – the technical aspect and the impact of prognosis of the patients. If the qualification for the procedure is proper, according to the angiographic point of view, the chance of success is greater. Moreover, if the patient has a proper clinical indication (i.e. a sufficient amount of ischemia or viability) both aspects may lead to a better outcome during the procedure and follow-up.

In the previous issue of Advances in Interventional Cardiology, Baykan *et al.* tried to find factors which adversely influence the success rate of CTO PCI [4]. After analysis of 173 procedures they concluded that bridge collaterals, severe calcification and tortuosity, tandem/multiple occlusions were independent predictors of unsuccessful CTO revascularization, while the presence of micro-channels was a predictor of success. The Turkish authors reported a 83.2% success rate, acceptable but slightly lower than that presented by highly specialized CTO centers. Some of the predictors of success are similar to variables used in the J-CTO score (calcification, tortuosity, tandem and multiple occlusions may correspond to long occlusions), some not, but this could be due to statistical analysis in relatively small groups of patients. Surprisingly, the J-CTO score was not an independent predictor of success, although it was significantly higher (2.3 vs. 1.9; p = 0.006) in the failure group. Very disturbing is the high rate of reported complications (23 patients, 13.3%), but it may depend on the definition of coronary dissections in 16 patients as complications without specifying which kinds of dissection were included (donor vessel in retrograde?, proximal part of the vessel in antegrade?). Complications specific for CTO PCI, i.e. coronary perforations occurred in 6 (3.5%) cases and 1 (0.6%) cardiac tamponade, are consistent with other reports [5, 6].

The most popular index used in classification of the severity of CTO is the J-CTO score. This index was introduced by Morino in 2011 and originally was developed to predict the likelihood of successful guidewire crossing within 30 min [7]. Independent angiographic predictors of failure (each given 1 point) that made up the J-CTO score included prior failed attempt, angiographic evi-

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dence of heavy calcification, bending within the occluded segment, blunt proximal stump, and occlusion length > 20 mm. Chronic total occlusions were then graded as easy, intermediate, difficult and very difficult (J-CTO scores of 0, 1, 1, and ≥ 3 respectively) (Table I). Since then, the J-CTO score has been found to predict overall likelihood of CTO PCI success. High J-CTO scores have been shown to correlate with lesion complexity, and may account for the paradox of a stagnant CTO PCI success rate over time, which was due to intervening on increasingly complex CTO [8, 9]. The J-CTO score is easy to calculate. It is also a widely used, validated, preprocedural clinical and angiographic scoring system to assess lesion complexity. Recently Tanaka *et al.* showed that, in addition to crossing times, the J-CTO score appears to correlate with long-term success [10].

Other investigators try to use coronary computed tomography angiography (CCTA) to improve on the J-CTO score [11]. Opolski *et al.* reported on a CCTA-derived scoring system in a cohort of 240 CTO PCI lesions from 4 European centers. They assigned 1 point for each independent predictor of successful guidewire crossing within 30 min. The points are then assumed to yield the CT-RECTOR score. Chronic total occlusions lesions were categorized as easy (score 0), intermediate (score 1), difficult (score 2), and very difficult (score > 3). In this study, independent predictors of failure derived from CCTA analysis included occlusion length > 20 mm, multiple occlusions, blunt stump, bending, and severe calcification in the CTO segment. Clinical predictors of failure included a previously failed attempt at percutaneous revascularization and duration of CTO > 12 months or unknown duration of occlusion. Using this score, the probability of successful guidewire crossing within 30 min for each group (from easy to very difficult) was 95%, 88%, 57% and 22% respectively. We should remember that the use of CCTA is very limited although it can reliably visualize CTO length, morphology and composition; moreover, there is no evidence to suggest that it helps in increasing the success rate. Accordingly to the EuroCTO Club consensus, CCTA can be recommended for complex CTO lesions with an expected success rate < 50% and in cases of repeat procedures after initial CTO recanalization failure [5]. The decision to revascularize a CTO is a clinical one, on the basis of symptoms, myocardial viability, and patient preference, and should not be based on the ease or difficulty of the case. As such, the CT-RECTOR score is useful in identifying highly complex cases that should be avoided by operators early in their CTO PCI learning curve and referred to expert centers [12].

In our opinion in 2016 still the J-CTO score is most useful in grading the severity of CTO, and its simplicity provides particular utility in daily clinical practice. Of course, analysis of one's own material is important, as presented by Baykan *et al.*, and also has a role in the learning process, helping in understanding which factors can influence the success rate.

In recent years a new benchmark for CTO success rates over 90% has been established. Anatomy dictates how and who should perform the CTO PCI, not whether the CTO PCI should be attempted. Similarly, lesion complexity no longer dictates the feasibility of CTO PCI, but the strategy for successful CTO revascularization. According to the opinion of Walsh and Hanratty, the key elements for successful CTO PCI are the following: 1) the development of a program with full team involvement and moving away from *ad hoc* CTO PCI; 2) physician and staff education to help understand lesion complexity, techniques and objectives that have procedural safety as the central core; 3) learning from live or recorded cases and workshops to enhance understanding of equipment and techniques; and 4) proctoring – preferably with the proctor able to scrub-in for the case to move beyond technically challenging or potentially limiting steps in the procedure and thus allow the host physician to gain hands-on experience in all aspects of the CTO PCI, particularly the parts of the procedure that may not have been reached otherwise [13].

One of the authors of this commentary, as a member of EuroCTO Club, has also been involved in teaching and training for many years. In our opinion the goal should be to increase the total number of patients offered a CTO PCI rather than focusing on marginal increases in success rates in expert and specialized centers. Thereby,

Table I. J-CTO Score sheet

Parameter	0 points	1 point	Explanation
Entry shape	Tapered	Blunt	Entry with any tapered tip or dimple indicating direction of true lumen is categorized as tapered
Calcification	Absent	Present	Regardless of severity, 1 point is assigned if any evident calcification is detected within CTO segment
Bending	≤ 45°	> 45°	Any tortuosity separated from the CTO segment is excluded from this assessment
Occlusion length	< 20 mm	≥ 20 mm	Using good collateral images, try to measure "true" distance of occlusion, which tends to be shorter than the first impression
Re-try lesion	No	Yes	Re-try lesion is lesion previously attempted to recanalize but failed

J-CTO score sheet by Morino et al. [7]. Points indicate difficulty of recanalization: 0 points – easy, 1 point – intermediate, 2 points – difficult, 3 or more points – very difficult.

a greater total number of patients will be treated, leading to a reduction in symptoms and an improved quality of life and, most important, improving the prognosis for a much broader cohort of CTO patients. This year we can see some light at the end of the tunnel, confirming the efficacy of our efforts. According to unpublished data of the Association of Cardiovascular Interventions of the Polish Cardiac Society (ACVI), during the first 6 months of 2014 in Poland 601 CTO procedures were performed, with a 54% success rate. This efficacy has remained stable during the past years. But the data from 2015 are very satisfactory, showing an increase of the overall success rate in CTO procedures in Poland up to 68%. We believe that in the future this trend will be preserved and our efforts in education of interventional cardiologists will lead to better prognosis of our patients.

Conflict of interest

The authors declare no conflict of interest.

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