

## Retrograde approach to chronically occluded coronary arteries – a step forward in CTO PCI

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**Keywords:** coronary chronic total occlusion • retrograde approach

Coronary chronic total occlusion (CTO), defined as occlusion of part of a coronary artery with TIMI 0 flow of estimated duration longer than 3 months, is observed in 15–30% of diagnostic coronary angiograms [1]. CTOs remain challenging lesions for interventional cardiologists, and have been called the ‘last frontier’ due to lower success rates, and the greater experience needed to properly and safely perform procedures successfully. Revascularization of CTOs is associated with long procedure time and increased exposure to radiation and contrast. Despite the lack of randomized trials, successful revascularization of CTO relieves the symptoms of ischemia, reduces the need for surgical coronary bypass and improves ventricular function. The effects of revascularization on mortality in majority of studies are positive, even neutral studies have not found that CTO-percutaneous coronary intervention (PCI) procedures themselves have a negative impact on mortality [2–5]. Interest in CTO has been rising, as shown by increases in the number of publications on this topic each year.

Many techniques and devices have been introduced into clinical practice to improve the effectiveness of CTO revascularization [6]. One of the most important and popular techniques is the retrograde approach, nowadays widely used, first described in 1990 by Kahn and Hartzler [7]. The first report of retrograde crossing via septal collaterals was published in 2006, starting the modern era, rapidly evolving with the introduction of specialized equipment [8]. The retrograde approach is based on the characteristics

of the occlusion, with the distal cap being softer than the proximal cap, and the occlusion more frequently tapered and less frequently ambiguous, better allowing the wire to cross the occlusion. The introduction of advanced CTO techniques (mainly retrograde) has allowed the treatment of highly complex lesions; although the overall success rate did not substantially improve in the last few years, this has been counterbalanced by the increased rate of treatment of complex lesions [9].

The newly published 2014, European Guidelines for revascularization do not regard this technique as a first-line approach, generally reserving this method for revascularization after previous failed attempts [10]. EuroCTO club guidelines, however, are more realistic, suggesting that this technique can be attempted not only for the second attempt after antegrade failure, but as strategy of choice for very complex CTOs with an expected antegrade success rate <50%.

The EuroCTO Club guidelines, based on recent trends in practice, also suggest the use of the retrograde technique after short antegrade failures, aimed at reducing procedure duration, contrast consumption and radiation exposure [1]. However, until more data become available, this approach should be reserved for very experienced operators. In our opinion, the retrograde approach can be used after antegrade crossing failure or as the initial approach, especially in patients with ambiguous proximal caps, ostial and long occlusions, occlusions with severe proximal tortuosity or calcification, CTO vessels that are difficult to engage and occlusions



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involving a distal major bifurcation. In our series more than half of the retrograde group (62.5%) had previously undergone an antegrade approach unsuccessfully, with the J-CTO score in 82.9% of patients in the retrograde group assessed as  $\geq 3$  [11]. The success rate of CTO PCI is increasing and in very experienced centers could reach above 90%; moreover, complication rates were shown to be comparable when using the retrograde technique and contemporary antegrade techniques [12,13]. Our personal experiences, based on EuroCTO Club recommendations, indicate the importance of starting with the proctor, performing 25 such procedures as a second operator and 25 under supervision prior to becoming an independent operator, with sufficient experience in antegrade CTO PCI (>300 CTOs, >50 CTOs/year) [1].

Recently, the radial approach became preferable to the femoral approach during percutaneous interventions. In our routine practice for CTOs PCI, the femoral approach is preferred, it results in better support and higher success rates. In our center most PCI procedures are performed using the radial approach, but for CTOs PCI with radial approach is limited to patients with femoral access problems. This femoral approach strategy is widely used in practice. A recently published systemic retrospective analysis showed that the rate of crossover to femoral access ranged from 0 to 5.8% [8]. The ability of radial guiding catheters to accommodate the equipment, and the learning curve for operators are important [14].

CTO procedures are more complex than PCI of critical lesions. Many scenarios during retrograde PCI should be considered. Although procedures should be carefully planned, operators should be prepared for surprises, know basic techniques, be familiar with some tips and tricks and be prepared to use intravascular ultrasound (IVUS) in case of doubt. Success arises from adequate filming of the CTO during angiography and appropriate planning of the procedure. Many techniques and devices are used in the antegrade approach for CTO revascularization. The development of the retrograde approach has provided more opportunities for using old and creating new techniques. First, a retrograde advanced wire can be used as a landmark for the wire from the antegrade approach, with the distal wire identifying the true lumen of the artery (kissing wire technique). The basic technique used is controlled antegrade and retrograde subintimal tracking (CART). The retrograde advanced wire enters a false lumen and is enlarged by inflation of the balloon, allowing the antegrade wire to advance to this lumen and to ultimately reach the true lumen. More popular, reverse-CART is a variant of the CART technique, in which the antegrade wire reaches the false lumen and the balloon is advanced

in antegrade manner to enlarge the space, which can be entered by the retrograde advanced wire. Another technique is the rendez-vous method which uses two microcatheters advanced in an ante- and retrograde manner, allowing the antegrade wire to advance to the distal part of occluded artery [15]. In addition to these new techniques several devices dedicated to CTO have been introduced, starting with the Corsair microcatheter and wires dedicated to crossing the collaterals and ultimately leading to the Fielder FC, Sion, Sion-Black and Fielder XT-R (all Asahi Intecc) wires dedicated to these approaches. Work is proceeding on new equipment, including new wires and new microcatheters, such a Caravel (Asahi – not currently available in Europe), which is expected to be introduced in the near future.

Our experience indicates that noninvasive cardiologists, but importantly also invasive cardiologists, have insufficient knowledge about CTOs procedures, making them ineligible to properly qualified to CTOs procedures, and properly perform CTOs PCI [16,17]. We have attempted to disseminate this knowledge, in order to cooperate with other centers and to establish rules to send patients to more experienced centers when warranted. Along with the Association of Cardiovascular Interventions (AISN) of the Polish Cardiac Society, we have proposed that patients with J-CTO score of 0–1 could be treated in any center, but those with J-CTO score  $\geq 2$  should be treated by an experienced CTO operator, defined as someone who has performed >300 CTOs and >50 CTOs/year, or referred to a specialized center. CTO-PCI has emerged as a new subspecialty in interventional cardiology, with specialized equipment, methodology and expertise [18]. Moreover, in some countries reimbursement for CTO treatment is an important issue.

In our personal opinion, the retrograde technique is both effective and safe if performed by experienced operators in experienced centers. Most challenging for the invasive cardiologist, not a CTO operator, is the proper qualification for the procedure and knowledge when to send the patient to a specialized center. J-CTO score may be very helpful. In addition, the safety of the patients, operators and all staff members is crucial. No procedure is 100% effective and knowing when to stop a procedure is very important.

Long-term outcomes after successful retrograde procedure have been very good. Results from the ERCTO Registry showed that, after a mean follow-up period of  $24.7 \pm 15.0$  months in a group of 1395 patients with 1582 CTO lesions, the revascularization rate was 8.7% in patients who underwent successful procedure [19].

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