RETROGRADE APPROACH FOR CHRONIC TOTAL OCCLUSIONS: THE IMPORTANCE OF EXPERIENCE AND PROCTORSHIP

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ABSTRACT

Recanalisation of chronic total occlusions has remained suboptimal in the field of percutaneous coronary intervention (PCI). Hopes for a better outcome have been raised since its introduction and evolvement of new techniques, including retrograde approach. Along with conventional antegrade approaches this technique led to a success rate of more than 90% in experienced and chronic total occlusion-dedicated centres. This article focuses on contemporary retrograde approach strategy and the importance of experience and proctorship in PCI of coronary chronic total occlusions (CTO).

Keywords: Chronic total occlusion, retrograde approach, coronary angioplasty.

INTRODUCTION

Chronic total occlusions (CTO) are common in contemporary interventional cardiology practice with an incidence of up to 30% of patients with angiographically significant coronary artery disease.1 Antegrade approach success rate in dedicated CTO centres is usually between 65-70%.[2,3] A major improvement in CTO percutaneous coronary interventions (PCI) was the introduction of the retrograde technique, which allows the advancement of a guidewire in a coronary segment distal to occlusion through collateral vessels. The retrograde CTO PCI technique was initially published in 1990 by Kahn and Harzler,[4] who performed balloon angioplasty of a left anterior descending coronary artery (LAD) CTO through a saphenous vein graft (SVG). In 1996, Silvestri et al.[5] described retrograde stenting of the left main stem through a SVG, whereas the first attempt of retrograde PCI through septal and epicardial collateral was described in 2006.[6] Widespread use of retrograde approach for CTO recanalisation in the last few years reached a high success rate of approximately 80% to nearly 100%, in experienced centres.[7]

It has been shown that CTO recanalisation improves angina status, left ventricular function, survival, and reduces the risk of ventricular arrhythmias.[8,9] In particular, meta-analysis reported by Joyal et al.[8] demonstrates that during a 6-year follow-up, patients in whom CTO PCI was successful had significant reduction in recurrent angina compared to patients with an unsuccessful procedure.

Although several studies have shown an improved survival rate in patients with PCI of CTO,[8] the overall benefit of recanalisation of CTO is still limited by the deficiency of randomised controlled trials comparing CTO PCI with medical therapy, or with coronary artery bypass graft surgery. However, two randomised trials are currently ongoing. The first is the Drug-Eluting Stent Implantation Versus Optimal Medical Treatment in Patients With Chronic Total Occlusion

(DECISION-CTO), evaluating whether, compared to optimal medical therapy, CTO PCI will reduce the composite endpoint of all-cause death, myocardial infarction, stroke, and any revascularisation 3 years after randomisation. The second is the European Study on the Utilization of Revascularization versus Optimal Medical Therapy for the Treatment of Chronic Total Coronary Occlusions (EURO-CTO) trial, which has a primary endpoint of death or non-fatal myocardial infarction during a follow-up of to 36 months.[10]

ACCESS ROUTE AND TECHNICAL SET-UP

Bilateral arterial access is mandatory for CTO recanalisation attempt. Both femoral and radial access have been shown to be effective.[11,12] A combination of radial and femoral access is very attractive and is most frequently performed in order to reduce bleeding complications. Adequate heparinisation is necessary, particularly to prevent the potentially lethal complication of thrombosis of donor vessels. For this reason, it is recommended to check the activated clotting time (ACT) every 30 minutes during the procedure and maintain ACT in range of more than 300 seconds.[12] An advantage of heparin is the reversibility of its effect in case of complications (i.e. perforation), in contrast to bivaluridin and GP IIb/IIIa inhibitors where usage is not advisable in CTO PCI, and may lead to delayed pericardial effusion and tamponade even in minor perforations.

With regard to the technical set-up of the procedure, passive support with coaxial alignment or ability to actively introduce the guiding catheter (over the guidewire and the balloon) into the coronary artery for active support is essential. All retrograde techniques require excellent guiding support, and for the retrograde limb, the use of short guide catheters (90 cm guide catheters) is highly recommended to facilitate wire externalisation.

CROSSING COLLATERALS AND RETROGRADE TECHNIQUES

Before starting the procedure, angiographic analysis of collateral channels (CC) is crucial. Assessment of CC is based on the Werner's classification: CC0=no continuous connection between donor and recipient artery; CC1=continuous, thread-like connection; and CC2=continuous, small side branch-like size of the collateral throughout its course.[13] There are two types of CC: septal and epicardial. Retrograde wiring of a septal collateral is preferred over wiring of an epicardial collateral, because septal collaterals are usually not very tortuous and have multiple branches.[14] The major limitation to septal wire advancement is a severe tortuosity, not the size of the collaterals. With increasing experience and performance, we have learned that a straight, faintly visible or even invisible septal CC can often be crossed.[15] It is easier to advance a wire through septal collaterals from the LAD to RCA in comparison to the opposite situation, because of the frequent tortuosity at the RCA end of the septal collaterals.[16] In contrast to septal CC, the leading prerequisite for epicardial CC crossing is the adequate size, but not the extent of tortuosity. With Corsair Microcatheter, tortuosity of epicardial CC, usually longer than septal, is not a limitation.[15] Epicardial CC should be used only if no septal CC are suitable. This approach comes from the fact that epicardial rupture is a more serious complication than septal rupture, and that the epicardial use is more often associated with procedural ischemia.15 Two techniques of septal collaterals crossing are commonly used: the first, 'septal surfing' technique where septals are crossed in a blind fashion without contrast guidance, and the second, in which the collateral continuity assessment was performed with tip contrast injection via a microcatheter.[17] Dedicated hydrophilic-coated polymer jacket floppy wires with small distal tip loads as Sion (Asahi Intec) and Fielder FC/XT (Asahi Intecc), and <1 mm, 30–45 degree bend at its distal tip, are workhorse wires for collateral crossing. For epicardial collaterals, the Sion guidewire (Asahi Intecc) allowed high success and low perforation rates.14 Collateral crossing is facilitated with microcatheter support. Currently, the microcatheter of choice is the Corsair catheter (Asahi Intecc) – an over-the-wire hydrophilic catheter composed of eight thin wires – which provides exceptional CC tracking and crossing as well as retrograde guidewire control.[14]

After successful collateral wiring there are three options for crossing the occlusion: 1) retrograde true lumen puncture, 2) antegrade crossing using the 'just marker' or ''kissing wire'' technique; and 3) various dissection techniques.[14]

Retrograde True Lumen Puncture

The same hydrophilic wire used to cross the collateral is advanced to the lesion, supported with a microcatheter or over-the-wire (OTW) balloon and CTO is crossed retrogradely. In some cases, this wire must be replaced with a tapered tip or stiffer CTO-dedicated guidewire, such as Miracle series, UltimateBross or Confianaza Pro series

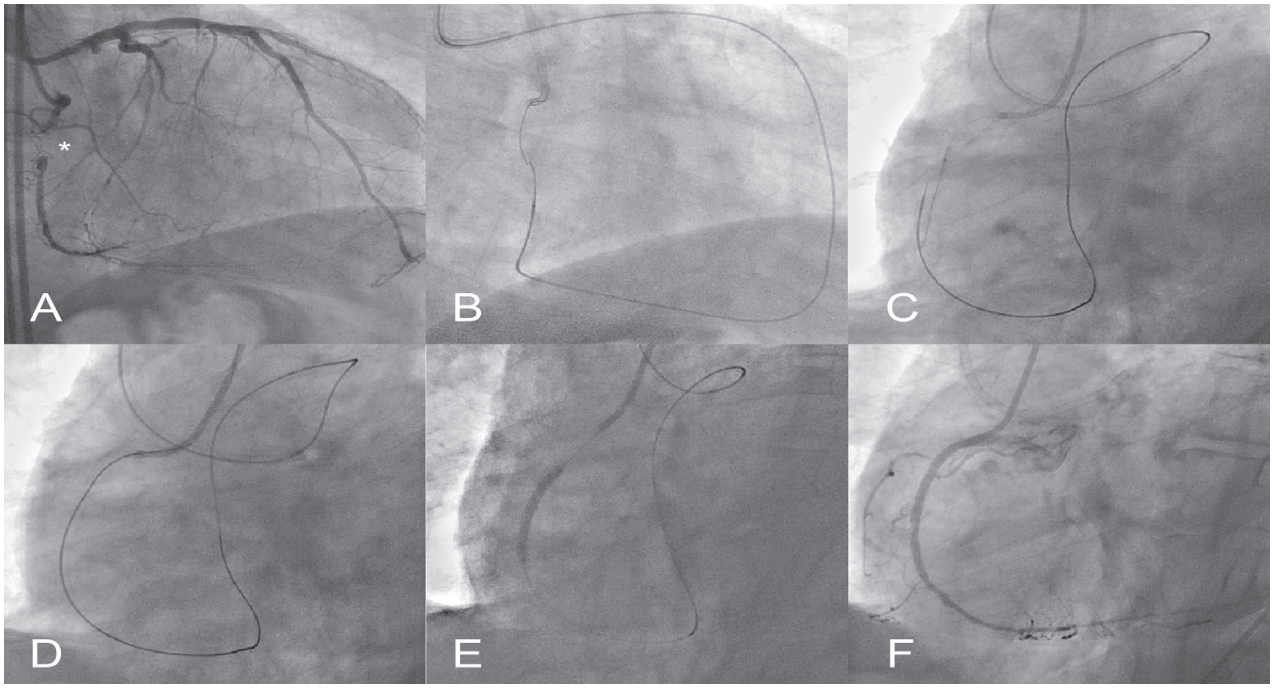

Figure 1. An example of the reverse-CART technique, in patients with two failed previous attempts of antegrade recanalisation with parallel wire technique.
Panel A: Simultaneous dye injection reveals occlusion of the right coronary artery well collateralised via septal collaterals from left anterior descending artery;
Panel B: Retrograde wire (Fielder FC) easily reached the distal cup supported by Corsair microcatheter. Different retrograde wires (including Cofianza Pro 12) could not negotiate proximal true lumen. Tips of the antegrade and retrograde wires meet at the proximal cap of the occlusion;
Panel C: Inflation of the balloon (Mini Track 2.0 x 20 mm) introduced over the antegrade wire in order to 'break' proximal cap of the occlusion;
Panel D: Retrograde wire (Confianza 12 Pro) enters the true lumen and antegrade guiding catheter, followed by Corsair. Retrograde wire is removed and replaced with 300 cm long wire which is externalised;
Panel E: Corsair is withdrawn at the level of septal collaterals, which allowed lesion predilatation and stent implantation using externalised guide wire;
Panel F: Final result.

(Asahi Intec). Retrograde wire crossing to proximal true lumen can be facilitated with antegrade intravascular ultrasonography (IVUS).[18] This is a fundamental retrograde technique with success rate of approximately 40%,[19] based on the fact that the distal cap of occlusion may be softer, with less calcification than the proximal cap. After crossing with a retrograde guidewire occlusion site into the proximal true lumen, a microcatheter is advanced over the retrograde guidewire into the antegrade-guiding catheter. This enables externalisation of the retrograde-dedicated wire (RG3, Asahi Intecc) through the antegrade-guiding catheter, followed by routine antegrade angioplasty over the externalised wire. This manoeuvre could be facilitated by the various trapping techniques (trapping wire or trapping retrograde microcatheter). One modification of wire externalisation is the recently published Rendezvous method[20] which allows retrograde and antegrade microcatheter connection within the mild curvature of the antegrade catheter. In the next step, antegrade guidewire is inserted through the bridging connection of the two aligned microcatheters, from antegrade to the retrograde microcatheter, and proceeded beyond the occluded site. When the antegrade guidewire is positioned into the distal portion of the donor vessel, the retrograde guidewire with microcatheter is gently retracted.

Antegrade Crossing

In this technique, the purpose of the retrograde wire is to mark distal true lumen and to assist anterograde wire crossings without contrast injection.[21] On the other hand, the kissing wire implies antegrade and retrograde wire management to the meeting point followed with antegrade wire progression to distal true lumen.[21]

Dissection Techniques

A crucial step forward in CTO procedures and retrograde approach was the development of dissection techniques. In 2005, Katoh presented the Controlled Antegrade and Retrograde Subintimal Tracking (CART)[22] technique establishing the new era of retrograde CTO recanalisation.

The CART technique involves passing the balloon along with the guidewire in the false lumen at the distal CTO site, and the balloon is inflated to create sufficient space in the false lumen. Then the antegrade wire can be introduced into this space, aiming to reach the distal true lumen through the space created by the retrograde balloon.[22] The dedicated microcatheters for collateral crossing decreased the necessity for septal dilatation, allowing the reverse CART technique to become the most utilised in the modern era[23] (Figure 1). The principle is similar to the CART technique, with the difference being that subintimal space is created by the antegrade balloon dilatation, which facilitates crossing the occlusion with the retrograde wire. Intravascular ultrasound guidance in reverse-CART techniques introduced by Japanese authors Ge et al.[24] can also be used with significant reduction in the amount of contrast, procedure time and radiation dosage.

COMPLICATIONS

Thrombosis or dissection of the donor artery, collateral perforation or occlusion, and PCI equipment entrapment are unique and potentially life-threatening complications, related to retrograde CTO PCI. Donor artery injury can be caused during repeated attempts to wire the collateral vessel, especially if the retrograde guidewire is not supported by a microcatheter or OTW balloon during manipulations.[25] Removal and exchange of the microcatheter or wire externalisation could result in a suction of the guide catheter with dissection of the donor artery, followed by global ischemia and haemodynamic deterioration. For this reason, careful manipulation of the guide catheter with constant pressure monitoring is required, as well as avoiding the engagement of extensively diseased donor coronary artery. The second retrograde CTO PCI-specific complication is collateral perforation or occlusion. Although tamponade has been reported after septal perforation,[25] this complication is without serious consequences in most cases. On the contrary, epicardial collateral perforation could lead to rapid tamponade, requiring urgent pericardiocentesis. Entrapment of the PCI equipment has usually been described in septal collaterals when septal dilatation was not performed and in attempt for retrograde stent delivery.[26]

IMPORTANCE OF EXPERIENCE AND PROCTORSHIP

According to 2012 EuroCTO club consensus document,[12] all interventional operators should have adequate theoretical knowledge for appropriate patient selection, and the practical experience in order to avoid common CTO PCI mistakes. It is also suggested that more than 300 antegrade procedures and minimal number of 50 CTOs per year, should be done prior to beginning retrograde attempts. Before starting retrograde CTO procedure, operators should gain experience and be proficient in anterograde CTO PCI. Understanding of material, familiar use of specific CTO wires and microcatheters, as well as the knowledge of antegrade techniques is necessary.

Learning curve for the retrograde technique should be a deliberate, stepwise process including operator dedication and persistence, proctoring and continuing medical education.[27] Its steep learning curve and initially low success rates will improve with time, practice and increasing experience.[27] Proctorship and discussion with highly experienced retrograde operators, of each specific case, especially unsuccessful, should be particularly emphasised in this process. Adoption of the retrograde approach in CTO PCI is indisputable, and dependent on enthusiasm, dedication, persistence, and support from local environment and management. On a practical level, careful patient selection and analysis, operator experience, material and specific technique utilised, as well as the management of complications, are true predictors of the success of the procedure.[27-29] Recently we have demonstrated that adequate training and international proctorship for this complex and demanding technique are a necessity and a prerequisite in achieving high overall success rates, with acceptable complication rates and excellent long-term survival.[17] On-site training, close dialogue with skilled retrograde operators are also associated with improved procedure outcome.[27]

CONCLUSION

The outcome of this approach and strategy is that retrograde approach, with widespread use of novel devices and techniques, has reached success rate of 90-95% in complex CTOs, very close to the success rates of non-occlusive CTO PCI.

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