

# Progress in the Retrograde Approach for Chronic Total Coronary Artery Occlusion: A Case With Successful Angioplasty Using CART and Reverse-Anchoring Techniques 3 Years After Failed PCI via a Retrograde Approach

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After the introduction of the retrograde approach in percutaneous coronary intervention for chronic total occlusion (CTO), different kinds of strategies and techniques have been developed in order to achieve final success. However, it has not been fully demonstrated whether these strategies and techniques can really improve the final result. We observed one case, for which the initial attempt of the retrograde approach for a CTO lesion was unsuccessful despite the successful approach of a retrograde guidewire to the lesion, and with the second retrograde approach 3 years later being eventually successful by using various kinds of strategies and techniques. This case clearly demonstrates how the final success through the retrograde approach can be achieved by using a combination of the improved strategies and techniques for CTO lesions.

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**Key words:** COLL, collaterals; OCCL, total occlusions; PCI, percutaneous coronary intervention

## INTRODUCTION

Percutaneous coronary intervention (PCI) for chronic total occlusion (CTO) lesions remains one of the major challenges in Interventional Cardiology. Previous studies have shown the importance of revascularization of CTO lesions, with improvement in anginal symptoms, exercise capacity, left ventricular function, and long-term survival [1–4]. In spite of improvements in guidewires, devices, and operators' techniques in the last 20 years, success rates of PCI for these lesions is still suboptimal [2,5,6]. In this regard, the retrograde approach is considered as one of the most promising current techniques [5,7–12].

The retrograde approach was first introduced by Kahn and Hartzler in 1990 [13] and was described by way of the occluded site being approached with a guidewire via a retrograde route through a bypass graft or a collateral channel from any other related patent coronary artery. Since then, different kinds of strategies have been developed in order to achieve recanalization of CTO lesions via the retrograde route [14]. However, it has not been fully elucidated whether the introduction of these strategies can actually improve the final outcome.

We observed one case, for which the initial attempt of the retrograde approach for a CTO lesion was

unsuccessful despite the successful approach of a retrograde guidewire to the lesion, and it was eventually successful by utilizing several different kinds of strategies 3 years later. This case shows how the final success through the retrograde approach was achieved by using the combination of improved strategies and techniques for CTO lesions.

## CASE REPORT

A 69-year-old man with effort angina was referred to our hospital for the second attempt of PCI for a CTO lesion after a failed attempt in another institution in 2003. The initial attempt in our hospital was per-

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formed in May 2004. The target lesion was a CTO lesion of 2.0 cm in length in the proximal right coronary artery (RCA). The RCA ostium showed complex intimal dissection, which had occurred during the previous PCI attempt in the other institution. The distal RCA was well filled through the rich collateral channels of the left circumflex artery via the left atrial branch.

### Initial Attempt of the Retrograde Approach

Initially, the antegrade approach was employed by using a 7Fr SAL-0.75 guiding catheter (Launcher<sup>®</sup>, Medtronic, USA) with contra-lateral angiography. Since a Magic FA<sup>®</sup> guidewire (Japan Life Line, Japan) with a Tornus<sup>®</sup> microcatheter (Asahi Intecc, Japan) could not pass through the CTO lesion, the retrograde approach was instead utilized. By using a 6Fr EBU 3.5 guiding catheter (Launcher) engaged in the left coronary artery, a Whisper-MS<sup>®</sup> guidewire (Abbott, USA) was passed through the left atrial branch into the RCA distal to the CTO lesion with support by a Maverick<sup>®</sup> 1.50-mm over-the-wire (OTW) balloon (Boston Scientific, USA). After the guidewire and the OTW balloon reached the distal part of the CTO lesion, the guidewire was exchanged to a Magic FA followed by a Magic-Ex<sup>®</sup> (Japan Life Line), and after subsequent failure, it was finally switched to a Conquest-Pro<sup>®</sup> guidewire (Asahi Intecc) in order to try and cross the lesion into the proximal true lumen via the retrograde route, which was again unsuccessful. In view that these retrograde guidewires could only reach the subintimal space proximal to the CTO lesion, the antegrade approach was used again while keeping the retrograde guidewire in the subintimal space as a landmark. However, all available stiff guidewires were unable to pass through the lesion successfully, and the patient had to be managed by optimal medical treatments.

### Second Attempt of the Retrograde Approach

Since the patient had Canadian Cardiovascular Society class 2 angina, the second retrograde attempt at our institution (the third PCI attempt for the patient) was performed in September 2007. The patient's anatomy was unchanged compared to that visualized in 2004. A 7Fr EBU-3.5SH-90CM and a SL1.0-SH guiding catheter (Launcher) were engaged in the left and right coronary arteries through the bi-femoral approach, respectively (Fig. 1).

By using the combination of an X-treme<sup>®</sup> guidewire (Asahi Intecc) and a Finecross<sup>®</sup> microcatheter (Terumo) respectively, the arterial lumen distal to the CTO lesion was successfully reached through the left atrial branch via the left circumflex artery. By



**Fig. 1.** Bilateral coronary angiography in left anterior oblique view shows the occlusion (white arrow) in the mid segment of the right coronary artery with bridging collaterals. The artery distal to the CTO lesion was filled by the left atrial branch from the circumflex artery and septal branch from the left anterior descending artery.

exchanging the system to a combination of a Conquest-Pro guidewire and a Maverick 1.5-mm OTW balloon, penetration of the occlusion was attempted. However, the occluded segment was so hard that a coaxial anchoring balloon technique with the inflation of a OTW balloon at the distal entry point of the CTO lesion was required, and successful crossing by a stiff guidewire into the subintimal space parallel to the true lumen proximal to the CTO lesion was eventually achieved. Even after exchanging the guidewire to stiffer types such as the Miracle-12<sup>®</sup> or Conquest-Pro 12 guidewires (Asahi Intecc), their navigation into the proximal true lumen could not be achieved.

At this point, the CART technique was performed [7] and a Ryujin<sup>®</sup> 2.5-mm OTW balloon (TERUMO) was introduced retrogradely. The balloon was inflated in the distal part of the CTO lesion to create a large false lumen, which was connected with the true lumen distal to the CTO lesion (Fig. 2). Following this balloon inflation, the antegrade guidewire (Conquest-Pro) was easily passed into the subintimal space to then reach the distal true lumen (Fig. 3). Although passage of the Maverick 1.5- to 15-mm OTW balloon over the antegrade guidewire was attempted after successful passage of the antegrade guidewire distal to the true lumen, the antegrade balloon could never be passed due to the severe resistance within the hard CTO lesion. The previous Ryujin 2.5-mm OTW balloon was

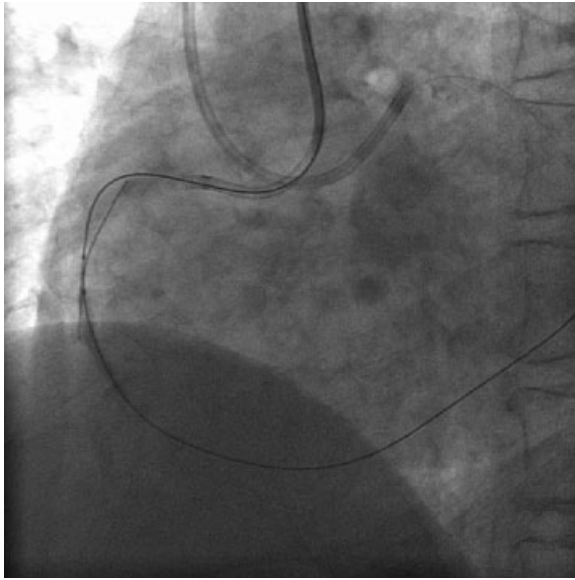


Fig. 2. While the antegrade and retrograde wires were left in the subintimal space, the retrograde balloon was dilated in the distal fibrous cap of the occluded lesion (CART technique).

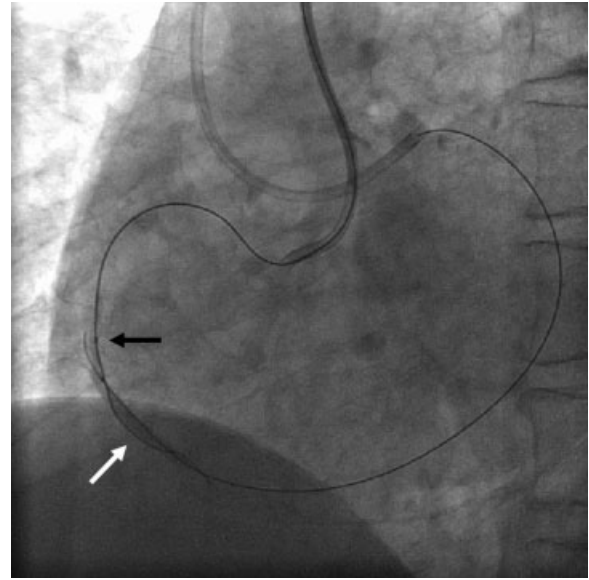


Fig. 4. Reverse anchoring technique: The antegrade wire was anchored by retrograde balloon dilatation (white arrow) to get strong back up support. By using this technique, the antegrade balloon was passed and dilated within the lesion (black arrow).

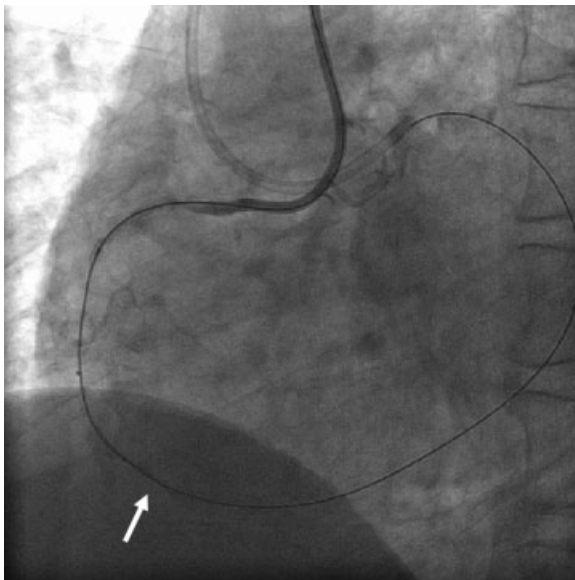


Fig. 3. An antegrade wire reached the distal true lumen (white arrow).

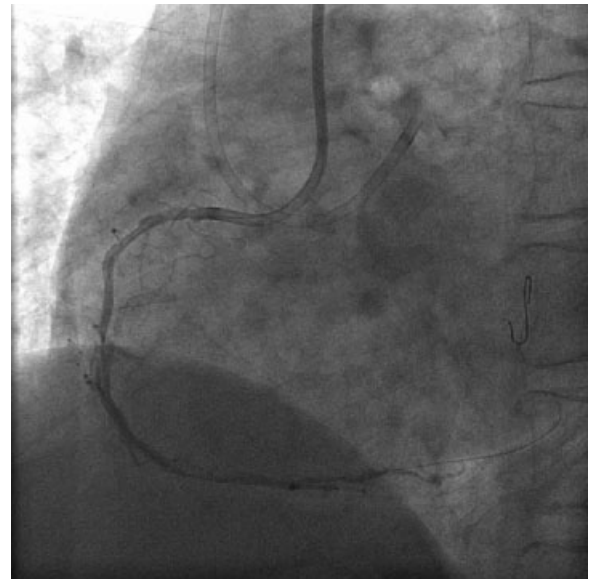


Fig. 5. After removal of the retrograde system, the right coronary angiography showed the antegrade wire within the true lumen.

reinflated in the distal part of the CTO lesion to anchor the antegrade guidewire (reverse anchoring technique). This maneuver provided a strong back up support for the antegrade guiding catheter and facilitated the successful crossing of the antegrade balloon (Fig. 4). After the lesion was dilated using antegrade balloons (Fig. 5), three Cypher<sup>®</sup> stents (Johnson & Johnson, USA) were implanted, yielding a good final result (Fig. 6).

## DISCUSSION

The retrograde approach is considered to be one of the most promising techniques to facilitate the success rate of PCI for CTO lesions, and currently several strategies and techniques have been introduced [14].



**Fig. 6.** Right coronary angiography showed the optimal final result after three sirolimus-eluting stent implantations.

However, it has not been fully demonstrated whether the introduction of these strategies and techniques can really improve the PCI success rate. In this context, the present case is considered to demonstrate how newly developed strategies and techniques contribute to an improved primary PCI success even through the retrograde approach.

This case was considered to be very difficult to achieve a procedural success, because the duration of the CTO lesion was at least 4 years at the time of the retrograde PCI in 2007 and the target lesion was visualized with bridging collaterals, which is a major predictor of procedure failure [15–17]. Moreover, PCI had previously failed when performed by one of the authors using several dedicated devices with both antegrade and retrograde approaches in 2004.

Failure to cross the lesions by a guidewire or a balloon catheter is the major reason for an unsuccessful PCI result for CTO lesions [3,18,19]. In this case, we utilized two different types of anchoring-balloon techniques. The first was the “coaxial” anchoring technique, in which the penetration ability of a guidewire is increased by inflating an OTW balloon catheter, through which the guidewire can be introduced. This technique was utilized in order to advance a stiff guidewire into the proximal subintimal space through a hard CTO lesion. The second was the “reverse” anchoring technique, where the tip of the antegrade guidewire, which has already passed through the CTO lesion, is fixed by the inflation of a retrograde balloon catheter. The anchoring of the guidewire provides a

strong support to enable passage of a balloon catheter through a hard CTO lesion. The original anchoring-balloon technique utilizes a balloon inflation in a side branch in order to pass the device through the lesion by increasing the backup support of the guiding catheter, which is then inserted through the same guiding catheter with the target devices [11,12]. The reverse anchoring technique is unique in that it uses a balloon inflation inserted from the contra-lateral guiding catheter. The reverse anchoring technique clearly contributed to the successful introduction of a balloon catheter in this case.

Why the final attempt at our institution was successful, despite two previous procedures having failed and the latter two having been performed by the same highly experienced PCI operator, should be considered. The improvement of the devices cannot be considered the main reason, since similar devices including stiff guidewires have always been utilized. Even after crossing a guidewire retrogradely into the subintimal space proximal to the CTO lesion, the proximal and distal lumina could not be connected at the first attempt. The CART technique, which was first published by Surmely et al. in 2006 [7] and had not been available during the first attempt in 2004, was ultimately effective to pass the guidewire from proximal to the distal true lumen in the final attempt.

The CART technique is required to penetrate an occluded lesion following success of the retrograde guidewire crossing through a collateral channel. Failure of the retrograde guidewire approach through a collateral channel or penetration has been observed in about 27% (12/45) of patients attempting the retrograde approach [14].

Since the antegrade guidewire should be passed through the complex false lumen created by the retrograde balloon dilatation in the CART technique, passage of the antegrade guidewire, which is recommended by using a torqueful guidewire such as a series of Miracle<sup>®</sup> or Conquest<sup>®</sup> types, may sometimes require antegrade balloon dilatation by using a reverse-anchoring technique that facilitates passage of an antegrade balloon into the lesion. Several reports describe that an antegrade guidewire could be passed through the false lumen, created by a retrograde balloon dilatation, distal to the true lumen in all patients on whom the CART technique was performed [7,14].

Since the CART technique requires the passage of a guidewire and balloon through the collateral channel filling a distal area of an occluded lesion, there is a potential complication such as myocardial ischemia caused by temporary occlusion of the collateral channel during the procedure. Fortunately, in this case the CART technique was performed without myocardial

ischemia, which may be a cause of abandonment of the procedure, since it was considered that the distal area of the occluded lesion was filled not only by the left atrial branch, which was used as a retrograde route, but also by the septal branch from the left anterior descending artery.

There is also the potential for injury of the collateral channel by the retrograde guidewire and balloon. Several reports describe that a hydrophilic coated guidewire with support of a microcatheter or a small size OTW balloon is recommended for navigation through tortuous collateral channels [9,10].

Careful manipulation of these devices is required especially when using the epicardial artery as a retrograde route, as in this case, since perforation or occlusion following injury of the collateral channel may result in cardiac tamponade or myocardial infarction.

In conclusion, the introduction of different strategies and techniques is contributing to an improved primary success in PCI for CTO lesions via the retrograde approach.

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