

Retrograde Approach for Coronary CTO

A promising strategy for successful revascularization.

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Although percutaneous coronary intervention (PCI) is now widely attempted for revascularization of coronary chronic total occlusions (CTO), procedural success still depends highly on successful wiring through CTO lesions. In many cases, antegrade wiring fails to cross CTO lesions. However, the retrograde approach to wiring can overcome the limitations of the conventional antegrade approach and helps to achieve a successful recanalization via a collateral vessel that connects with the distal target vessel.

Retrograde wiring was first performed via a bypass graft and was initially reported in 1990.¹ This approach is basically a combination of using the retrograde collateral route combined with retrograde wire-crossing techniques. A wire is advanced in a retrograde fashion through the collateral channel of an appropriate opened artery to the distal end of the total occlusion. The retrograde wiring requires the use of collateral channels that can be performed via one of the following routes: a bypass graft, an epicardial channel, or an intraseptal channel (septal collateral). After successful passage of the wire through a collateral channel, one of several techniques must be utilized to finally lead the antegrade wire to the distal true lumen: the retrograde

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wire-crossing technique, kissing-wire technique, knuckle-wire technique, or CART (controlled antegrade and retrograde subintimal tracking) technique.

COLLATERAL ROUTE

Bypass Grafts

Even in the drug-eluting stent era, we sometimes encounter an untreatable diseased bypass graft, such as a severely degenerated saphenous vein graft. In such cases, it is necessary to open a native coronary artery (usually completely obstructed) to improve long-term outcome. Despite the poor suitability of the graft for PCI, it can be used as a channel for wire passage using the retrograde approach. A completely blocked vein graft should not be used for this technique. In some cases, an arterial graft could also be used for the retrograde conduit.



Figure 1. A case example using a retrograde approach via an epicardial collateral. The first attempt to open the proximal right coronary artery (RCA) CTO failed because of severe bending in the proximal RCA (A). There was a large enough collateral from the left circumflex artery (LCx) to advance a catheter through it (B). A retrograde approach was used to initiate the second attempt. A hydrophilic soft wire was advanced through the collateral with a microcatheter (C), and it easily reached the distal true lumen of the CTO (D). The wire was then changed to a stiff wire and was carefully advanced into the occlusion. Finally, the entire length of the occlusion was successfully negotiated retrogradely (retrograde wire-crossing technique) (E). The final angiographic result after stenting (F).

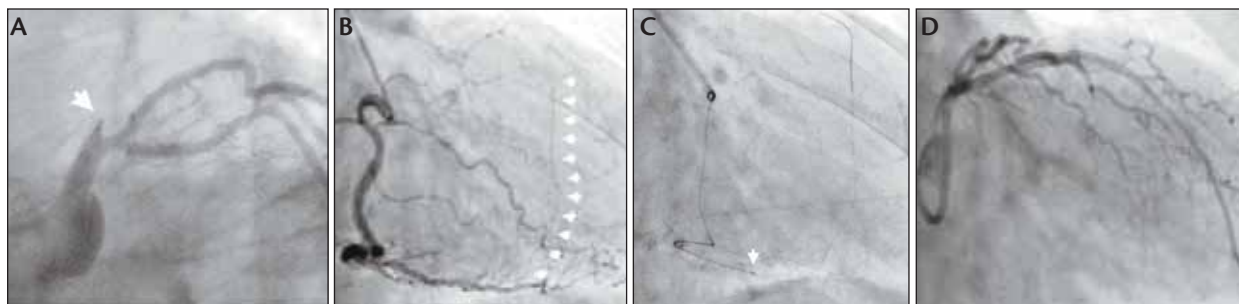


Figure 2. A case example using a retrograde approach via the septal channel. The proximal left anterior descending artery (LAD) was completely blocked, with good septal collateral channels from the RCA (A,B). One of the septal channels had a continuous connection to the LAD (B, arrows), which was easily negotiated using a hydrophilic soft wire supported by a microcatheter (C, arrow). The final angiographic result after stenting (D).

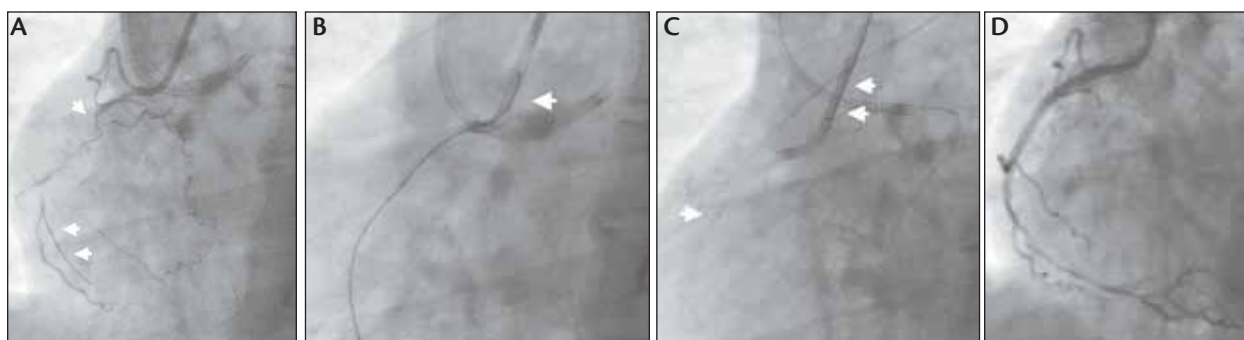


Figure 3. A case example using the retrograde wire-crossing technique. The proximal RCA was completely blocked, with a diffused diseased distal true lumen (A), so that the retrograde approach was performed. A hydrophilic soft wire supported by a 1.5-mm over-the-wire balloon was successfully advanced into the distal true lumen via a septal channel (A, arrows). The wire was then changed to a stiffer one. Finally, retrograde wire crossing was successfully achieved, and the wire was advanced into the RCA guiding catheter (B). The wire was then trapped by using a 2.5-mm balloon (C, arrows) to provide a better back-up force for the 1.5-mm balloon advancement into the occlusion retrogradely. The final angiographic result after stenting (D).

Epicardial Collaterals

CTOs of RCAs often receive collaterals from the LCx via epicardial channels. Also, in cases of RCA or LAD CTO, anterior and posterior descending arteries are sometimes connected directly by collateral channels. When an epicardial collateral channel is large enough to receive a balloon or microcatheter, it can be used as a channel for the retrograde approach (Figure 1). These epicardial channels commonly comprise challenging anatomy, such as a corkscrew or highly tortuous configuration, so that the wire crossing is difficult and has a risk of causing perforation. However, careful wire handling associated with the use of a microcatheter to stretch and straighten the proximal tortuosity of the channel may make it possible to achieve a successful retrograde wire passage. The most important issue is vessel diameter of the epicardial channel. Also, stenoses in these channels should never be dilated because this can cause severe perforation. When the channel is the only donor artery to a viable CTO region, the wiring

procedure may transiently occlude this collateral and cause an ischemic event.

Septal Perforator

More recently, the retrograde approach using septal collateral channels has been introduced to treat CTOs of the RCA or LAD.² In CTOs of the RCA or LAD, the anatomical course of the principal collateral is predominantly a septal connection (between septal perforators of anterior and posterior descending arteries). Also, a continuous septal connection is found in more than 80% of cases (Figure 2).³ Compared to epicardial collaterals, the septal channel is a shorter route to the recipient vessel and has a less-tortuous anatomy. Furthermore, although it looks like a tiny channel, the septal channel can be dilated using a small balloon (1.25 mm to 1.5 mm) with very low pressure (up to 2 atm) to advance a catheter through it with no major adverse clinical events.² Although overdilatation of septal branches may cause perforation into the ventricles,

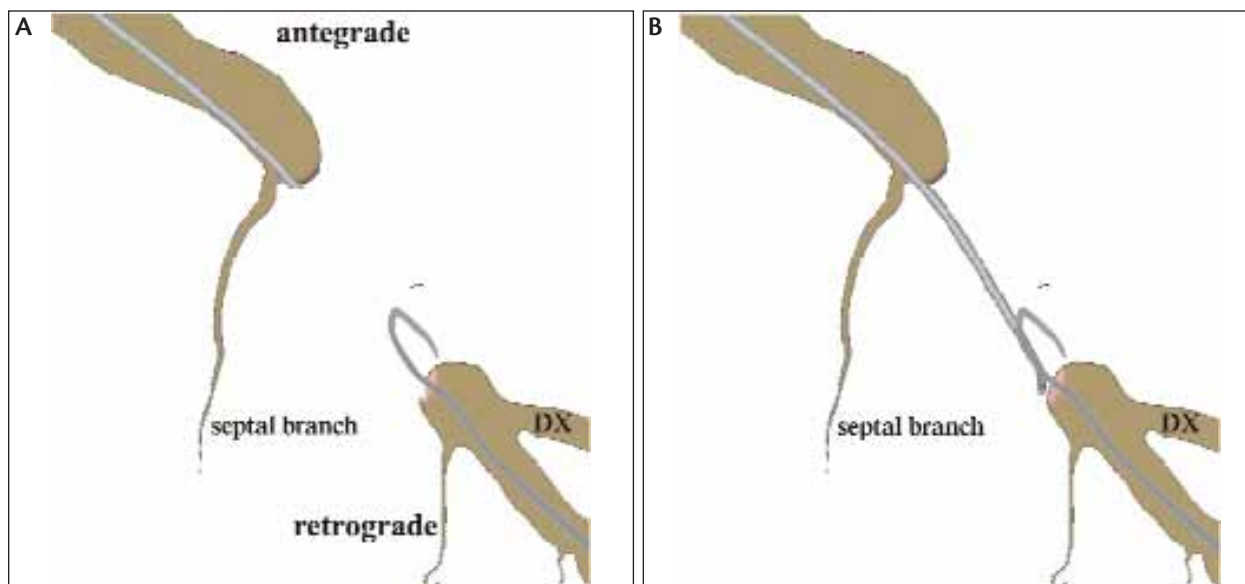


Figure 4. The knuckle-wire technique. Mid-LAD CTO (A). A retrograde wire as a knuckle wire is advanced into the distal end of the occlusion to make a crack in the subintimal space. (B) The antegrade wire coming through the subintimal space can then be aligned to the retrograde wire.

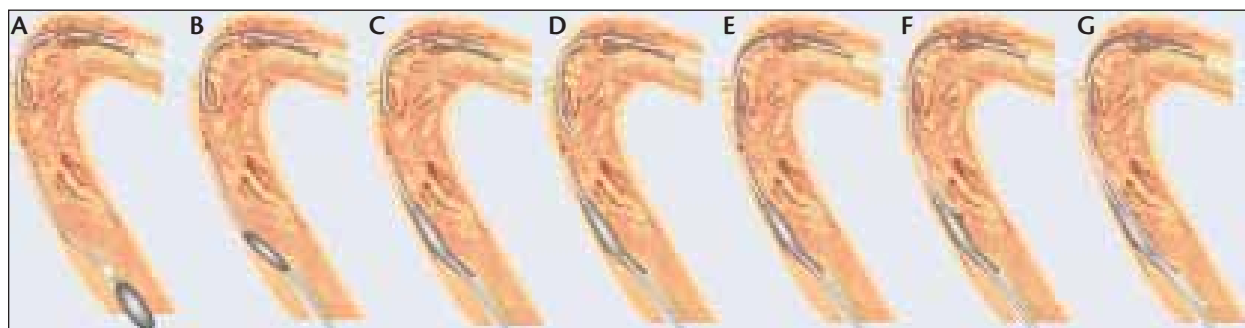


Figure 5. Concept of the CART technique. Once the antegrade wire goes into the subintimal space, another balloon system is advanced retrogradely, if possible (A). The retrograde wire is intentionally advanced into the subintimal space (B), and the balloon is inflated to expand the space (C). The antegrade wire is then advanced (D). Basically, the subintimal space is easily connected so that the antegrade wire easily goes into the retrogradely created subintimal space (E,F) and negotiates the occlusion (G). The notable mechanism of the CART technique is the creation of the subintimal space limited within the CTO lesion.

these connections rarely require additional treatment. However, the conflict between the catheter and septal vessel wall during advancement of the catheter sometimes causes a hematoma inside the septum. To reduce this conflict, dilatation of the entire septal channel should be conducted after successful wire passage.

In all collateral routes, a hydrophilic soft wire (eg, Asahi Fielder, Abbott Vascular, Redwood City, CA; or Whisper Wire, Abbott Vascular) should be used to negotiate the collateral channel with the support of a microcatheter (eg, Transit, Cordis Corporation, a Johnson & Johnson company, Warren, NJ) or a small (1.25 mm or 1.5 mm) over-the-wire balloon. The retrograde wire is then often changed to a stiffer wire to be

advanced into CTO lesions after the successful passage of a catheter through the collateral channel into the target vessel. At this point, there are several options of wiring technique for subsequent successful antegrade wire crossing.

WIRING TECHNIQUE

Retrograde Wire-Crossing Technique

Sometimes, the retrograde wire is easily advanced through the entire CTO lesion to the proximal true lumen of the CTO target vessel (Figure 1). By using the current wires dedicated for CTO (eg, Asahi Miraclebros, Abbott Vascular), this technique is successful in approximately 30% of cases with the retrograde approach. Because this

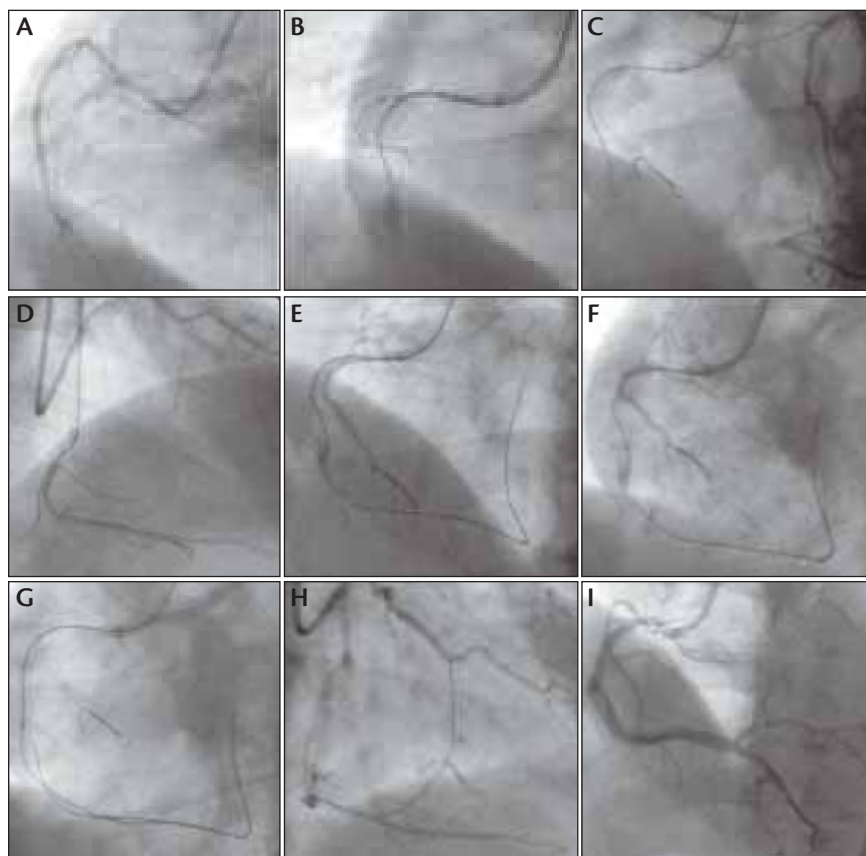


Figure 6. A case example using the retrograde approach via a septal collateral combined with the CART technique. The first attempt to negotiate the RCA CTO failed. It was a very long occlusion reaching the distal bifurcation (A,C). During the second attempt, parallel wiring technique under the anchoring wire was also unsuccessful and easily made a subintimal space (B). The retrograde approach was then attempted. After selective contrast injection in a proximal septal branch, a hydrophilic soft wire was carefully advanced through the septal branch, which finally reached the posterior descending artery (D). The entire septal channel was dilated by a 1.25-mm over-the-wire balloon, and then the channel was successfully negotiated by the balloon to change the wire to a stiffer one. The wire was then intentionally advanced into the subintimal space retrogradely (E). After balloon inflation in the distal part of the CTO (F), the antegrade wire easily went into the same subintimal space (G) and was successfully advanced into the posterior descending artery (H). The final angiographic result after spot stenting in the proximal and distal part of the CTO (I). In this case, the midportion of the CTO did not require stenting because the intravascular ultrasound examination confirmed large lumen area.

technique is the simplest, it should be the first technique attempted in all retrograde approaches. When it is successful, the wire should be advanced deeply into the antegrade guiding catheter or aorta. In the former situation, the retrograde wire can be trapped inside the guiding catheter by a percutaneous transluminal coronary angioplasty balloon to provide super extra back-up force to advance a 1.5-mm balloon retrogradely and dilate the CTO lesion (Figure 3). Usually, the antegrade wire is then

easily negotiated through the lesion. However, when this is unsuccessful, there is some risk of creating a subintimal space extending from the distal CTO vessel to the proximal true lumen of the CTO, which may cause dissection and an adverse event when the CTO is located in the proximal part of the left coronary artery. In such instances, a bilateral wiring approach must be used.

Kissing-Wire Technique

In the kissing-wire technique (one of the bilateral approaches), the antegrade wire must be advanced forward into the CTO to reach the retrogradely advanced wire.⁴ However, it is not easy to align each inside the true channel because the true channel has multiple layers due to both plaque and neovascular channels.

Knuckle-Wire Technique

To make a crack inside the CTO lesion, the retrograde wire is advanced into the CTO as a knuckle wire. Usually, this knuckle wire can be advanced into the subintimal space so that the antegrade wire inside the subintimal space can be advanced and aligned to the retrograde wire (Figure 4). However, in this technique, the created subintimal space cannot be controlled, and sometimes an expanded subintimal dilatation occurs beyond the CTO lesion.

CART Technique

To minimize enlargement of the subintimal space at the CTO site, the CART technique has been recently introduced.⁵ Figure 5 illustrates the concept and sequential steps of the CART technique. The retrograde wire penetrates from the distal true lumen into the CTO and then into the subintimal space at the CTO site. After advancing a small balloon (1.5 mm to 2 mm) over the

retrograde wire into the subintima, the balloon should be inflated in the subintima to make a large crack. To keep this subintimal space open, the deflated balloon should be left in place. As a consequence, the antegrade wire advancing into the subintimal space is easily led into the crack created by retrograde balloon. The main advantage of this technique is the minimization of subintimal tracking only at the location of the CTO lesion. Hence, this technique is completely different from the STAR (subintimal tracking and re-entry) technique,⁶ and a better long-term outcome after implantation of a drug-eluting stent can be expected. Figure 6 shows a representative case successfully treated by a retrograde approach combined with the CART technique.

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Reverse-CART Technique

To conduct the CART technique, a retrograde balloon must be advanced into the CTO lesion to make a crack. However, this is not always possible because sometimes the complex morphology of the distal true lumen (ie, calcification or bending) obstructs the passage of the retrograde balloon. In such cases, the last alternative is the reverse-CART technique. In the reverse-CART technique, the creation of a subintimal crack is conducted by an antegrade balloon at the proximal part of the CTO lesion advanced through the antegrade wire inside the subintima. The retrograde wire then comes to the proximal true lumen. In other words, this technique is a retrograde wire-crossing technique through the subintima. There is some risk of unexpected subintimal dilatation antegradely beyond the CTO lesion caused by antegrade wiring through the subintima and/or antegrade balloon dilation.

In every kind of bilateral wiring technique, a tapered stiff wire should not be used as a retrograde wire because this kind of wire sometimes causes wire perforation retrogradely. Once successful antegrade wiring is achieved, ballooning and stent implantation should be performed antegradely.

CLINICAL IMPLICATIONS

It is acceptable to approach the CTO antegradely because the target vessel is already closed. However, the retrograde approach does pose a risk of serious or

fatal adverse events because a relatively nondiseased donor artery will be instrumented using many devices (guide catheter, wire, balloon, etc). If thrombus formation or coronary artery dissection occurs in the donor artery, it could be disastrous. Therefore, during the retrograde approach, very careful attention and care to the condition of the donor artery is mandatory. In my opinion, the first attempt for recanalization of a CTO should be conducted by the antegrade approach. If this method fails, the retrograde approach may be justified as the second attempt. However, in the CTO case having a diffused narrowing distal true lumen, it is very difficult to penetrate antegradely. In such cases, a retrograde approach may be considered as the first attempt when a reliable collateral route can be detected.

CONCLUSION

The retrograde approach has definitely increased the recanalization success rate in CTO PCI procedures. Now, top Japanese operators have an approximately 95% success rate in all CTO PCI procedures. However, to minimize procedural risk, it is still important to perform the procedure carefully and correctly. For this purpose, devices dedicated for a retrograde approach have been, and are being, developed. To negotiate a tricky collateral channel, a tapered hydrophilic soft tip wire has already been introduced. To advance through a septal channel without septal dilatation, a special microcatheter is currently under development but has not yet been made commercially available. In the near future, these new technologies will ensure and facilitate the procedural success of the retrograde approach. ■

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