

Current Retrograde Approach to CTO PCI

How to open chronic total occlusions via collateral channels.

BY MASAHIKO OCHIAI, MD, FACC, FSCAI

In 1990, the first report of retrograde approach for chronic total occlusion (CTO) was published, in which the retrograde wire crossing technique was applied via a degenerated saphenous vein graft.¹ More than 10 years later, septal collaterals are considered to be potential channels for retrograde approach. Moreover, complex bilateral intervention techniques, such as the controlled antegrade and retrograde subintimal tracking (CART) and the reverse CART, are now widely used.²⁻⁴ This article discusses novel information and therapeutic concepts that have been clarified recently.

IMPORTANCE OF SEPTAL DILATATION

The techniques for the retrograde approach are classified into four categories: (1) the kissing-wire technique (ie, to advance an antegrade stiff wire toward a retro-

grade one, which is a clear landmark of distal true lumen), (2) the retrograde wire crossing technique, (3) the CART technique, and (4) the reverse CART technique. Because the kissing-wire technique does not achieve high success rates for complex CTOs, one of the other three techniques can be employed. Therefore, the delivery of an over-the-wire (OTW) balloon having a diameter consistent with that of the coronary segment distal to the occlusion is mandatory when conventional devices are used. Current fluoroscopy systems allow the visualization of collateral channels measuring 250 to 300 μm (0.25–0.3 mm) in diameter. The 190-cm Fielder XT guidewire (Abbott Vascular, Santa Clara, CA) is a polymer-coated wire with a distal tip tapered to .009 inches (0.25 mm) that can follow such microcollaterals. Knowledge of the crossing profiles of currently available microcatheters and balloons is essential for a successful

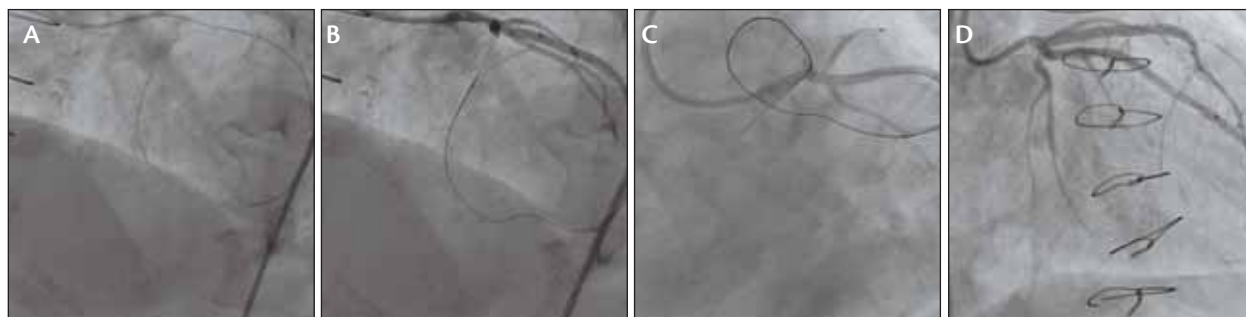


Figure 1. Retrograde approach via an epicardial collateral from the left circumflex to the diagonal branch with a Channel Dilator for a proximal LAD CTO after bypass surgery. Tip injection from a Channel Dilator (A). Successful delivery of a Fielder FC wire (Abbott Vascular) and a Channel Dilator (B). Successful retrograde wire-crossing technique with a retrograde Confianza Pro (Abbott Vascular) (C). Final results after implantation of two drug-eluting stents (D).

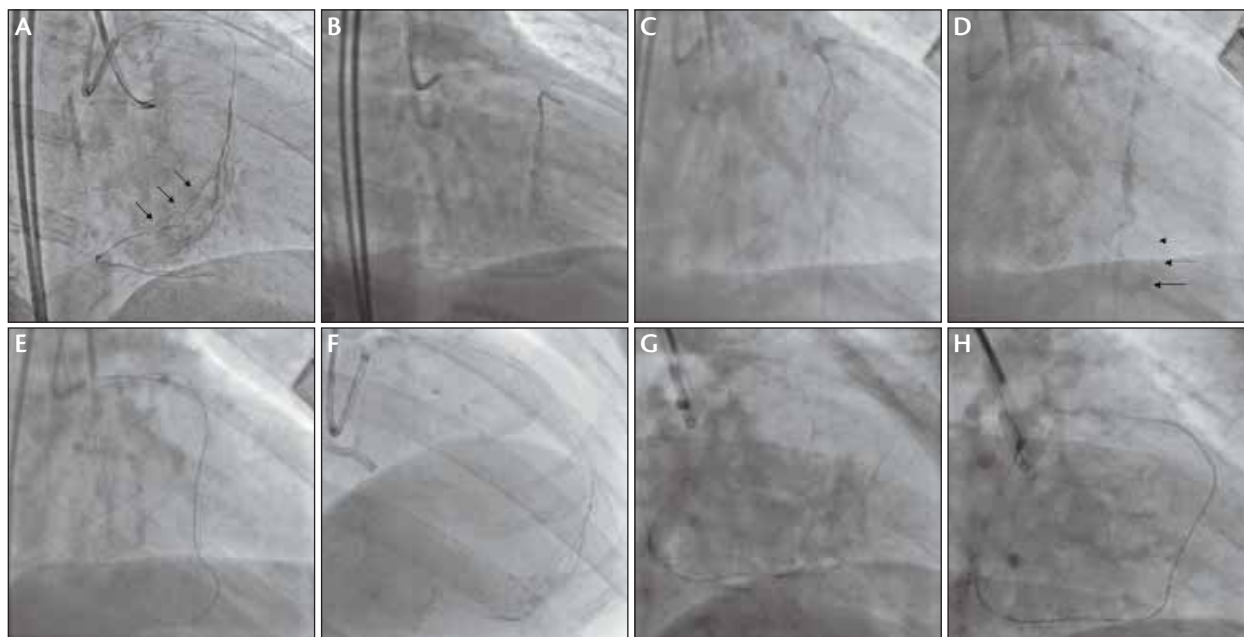


Figure 2. Anatomical classification of septal collateral channels. Type 1 (A). Type 2 (B). Injection of contrast medium into the proximal segment of a septal branch did not clearly show any collateral channels (C), but a superselective injection revealed type 2 channels (D), which can be tracked with a Fielder XT (E). Type 3 (F). Type 4 (G), which can be tracked with a Fielder XT (H).

procedure. The tip size of representative microcatheters is 0.6 mm (1.8 F) for the Finecross (Terumo Corporation, Tokyo, Japan), 0.76 mm (2.3 F) for the Transit (Cordis Corporation, Warren, NJ), and 0.67 mm (2 F) for the Excelsior (Boston Scientific Corporation, Natick, MA). These are considerably larger than the 0.4-mm distal tip of the Ryujin OTW balloon (Terumo Corporation), which has the smallest diameter in Japan. Although no scientific study has been conducted to assess the smallest collateral channel that can be followed with a Fielder XT, we can estimate the collateral vessel diameters to be very small because they often cannot be crossed with a microcatheter after successful wiring. The purpose of septal dilatation is to allow subsequent delivery of a balloon that is equal in diameter to the coronary segment distal to the occlusion. For example, the balloon profiles of the Ryujin OTW balloon catheter series are 0.67 mm for the 1.25-mm balloon, 0.76 mm for the 2-mm balloon, and 0.81 mm for the 2.5-mm balloon. The diameter of a collateral after septal dilatation with a 1.25-mm balloon at 3 atm is reported to be approximately 0.8 mm by optical coherence tomography. Considering the specifications of these balloons, it is thus possible to deliver a 2.5-mm balloon. Successful delivery of a larger-diameter balloon allows diverse therapeutic strategies to be employed subsequently. Thus, when a wire has been passed through a septal collateral, it is important to immediately exchange the microcatheter used for wire manipulation with a

1.25-mm balloon and perform septal dilatation.

Septal rupture is the chief complication of septal dilatation procedures. Channel rupture does not result from dilatation itself if it is done with a 1.25-mm balloon at approximately 3 atm (or with a 1.5-mm balloon at approximately 2 atm). Channel rupture is generally thought to result from the excessive kinking of a septal channel when a balloon is pushed through under excessive resistance (most common with the type 2 septal collaterals). To prevent rupture, the use of guidewires that provide good support such as the Fielder FC and XT (Abbott Vascular) is fundamentally important. Minimization of friction between the septal vessel walls and the balloon is also important to avoid kinking. For this purpose, it is best to dilate the entire septal channel irrespective of the apparent diameter of the vessel and its resistance. In the author's clinical experience, septal dilatation can be performed successfully in approximately 85% to 90% of patients. Septal dilatation will probably fail if the collateral channel is too small for even the tip of a 1.25-mm Ryujin OTW balloon (0.4 mm) to be inserted. Asahi Intecc (Nagoya, Japan) is now developing a special microcatheter, tentatively named the Channel Dilator. According to the author's preliminary personal experience, the successful delivery of this device and dilatation of septal channels have been achieved in more than 95% of the patients. Moreover, this device can be applied in tiny epicardial collaterals as well (Figure 1).¹⁻⁴

ANATOMICAL CLASSIFICATION OF SEPTAL COLLATERAL CHANNELS

Accurate visualization of septal collateral channels requires the insertion of a microcatheter for superselective injection of contrast medium. If septal collateral channels can be classified anatomically to understand their characteristics, the selection of appropriate collaterals will be facilitated. Based on the author's clinical experience, septal collaterals can be classified into four types.

Type 1

Type 1 collaterals flow from the first or second septal branch toward a site near the bifurcation of the segment posterior lateral (PL) branch and posterior descending (PD) branch. In the 30° right anterior oblique view, they flow gently from the upper right toward the lower left (Figure 2A). In the 45° left anterior oblique view, they curve convexly toward the left ventricle. They are commonly used for the retrograde approach to treat CTOs of the right coronary artery (RCA). A collateral entering the PL branch is also classified as this type and only arises from the first septal branch (Figure 2A). For some CTOs without a retrograde stump at the bifurcation of the PL and PD, intervention via the PL should be attempted. In such cases, we need to locate this channel.

Type 2

Type 2 collaterals arise from the first septal branch or from relatively large distal septal branches. In the 30° right anterior oblique view, they curve toward the apex before entering the PD (Figure 2B). In the 45° left anterior oblique view, they curve concavely toward the right ventricle. They are commonly used for retrograde access to CTOs of the RCA. At times, these channels can only be visualized by superselective contrast injection (wedged injection) (Figure 2C and 2E). Once they have been identified by contrast injection, it is best to perform wiring carefully in a direction that avoids premature ventricular contractions by using a Fielder XT with the tip bent as little as possible. Before such polymer jacket wires with stronger support as the Fielder FC or XT became available, type 2 channels were easily kinked when a balloon was pushed in during septal dilatation, frequently leading to septal rupture. The availability of specialty

wires and development of the concept of total septal dilatation have dramatically improved the success rate of septal dilatation. This type of channel is most commonly used for CTOs of the left anterior descending (LAD) artery as well.

Type 3

Type 3 septal collaterals connect the relatively distal LAD and the PD (Figure 2F). It is possible to use these channels for CTOs of both the RCA and LAD. If well developed, these channels rarely branch, and this facilitates wiring. Particularly for CTOs of the LAD, we should use these channels if identified because enough space can be expected to achieve delivery of an OTW balloon 15 to 20 mm in length.

Type 4

Type 4 septal collaterals run from the proximal part of the PD to a septal branch located relatively distal to the middle LAD. In the 30° right anterior oblique view, they flow gently from the lower left to the upper right. They can be used to access CTOs of the LAD, but they are infrequently detected (Figure 2G and H).

STRATEGIES AFTER SUCCESSFUL SEPTAL DILATATION: INDICATIONS FOR THE RETROGRADE WIRE CROSSING VERSUS CART TECHNIQUES

What strategies should be used when the delivery of a balloon matching the diameter of the coronary segment distal to the occlusion is possible after successful septal dilatation? PCI via the retrograde approach still often has to be performed in a novel way from the early phase of the procedure. Our real procedures in the

catheterization lab are not standardized in detail. Actually, they are quite different depending on the anatomy of each CTO. However, attempts to standardize strategies in some way or other will eventually lead to improvement of devices and the discovery of optimal strategies. The Fielder FC and XT guidewires and establishment of the concept of total septal dilatation led to a dramatic improvement in the success rate of septal dilatation since August 2006. Since that time, the author has

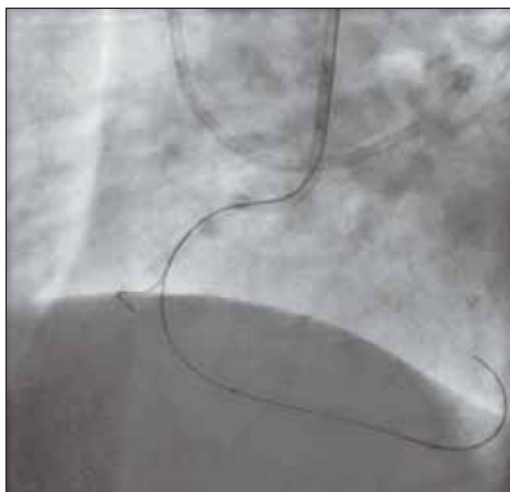


Figure 3. Anchoring of a retrograde wire within an antegrade guide catheter.

attempted the retrograde wire-crossing technique first with a Fielder FC or an XT used to pass through the septal channel under coaxial anchoring with an OTW balloon pressurized at several atmospheres inside the coronary segment distal to the occlusion. These wires can easily cross some CTOs that are neither very old nor very long, especially CTOs of the LAD. If this method fails, the author bases the selection of subsequent strategies primarily on the morphology of the coronary segment proximal to the CTO.

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When the proximal end of a CTO is flush (ie, without a stump) (Figure 2A), the author attempts the retrograde wire crossing first with a Miracle Bros 3g and then with a Confianza Pro. The tips of these stiff wires should have a double bend as in the conventional antegrade approach.⁵ These wires are advanced by controlled drilling under repeated multidirectional monitoring after placement of a floppy wire in the proximal coronary artery. The floppy wire in the proximal coronary artery serves as a useful landmark when we manipulate a retrograde stiff wire. When using a Confianza Pro wire, care must be taken not to direct the tip toward the greater curvature of the bend in the occluded vessel whenever possible. If it is necessary to advance the wire toward the greater curvature while changing direction, it should be advanced with minimum force only for a short distance. When a Confianza Pro is unable to cross the lesion retrogradely, switching to a Confianza Pro 12g rarely leads to success. Torque transmission of a Confianza Pro 12g is not as good as a Confianza Pro in retrograde approach. The author believes that, when the retrograde wire-crossing technique has failed even with a Confianza Pro, this strategy should be abandoned. Other strategies should be utilized, including the CART or reverse CART technique. For example, if the retrograde balloon has penetrated the CTO to some extent, the antegrade wire does not need to be present in the true lumen but rather only needs to be in a false lumen (ie, within the vessel), so that the CART technique may be attempted by advancing this wire. When insertion of an antegrade balloon into the false lumen is possible and the retrograde wire tip is near the antegrade balloon, retrograde wire crossing can also be

attempted after inflating this antegrade balloon to disrupt the vascular structure (the reverse CART technique). Intravascular ultrasound (IVUS) guidance can be used for the passage of retrograde wire as well, although there can be significant limitations given the crossing profiles and tip lengths of currently available IVUS catheters. In other words, the choice of strategies varies considerably among patients and among operators at this stage.

If any type of guidewire can be advanced into the antegrade guide catheter after successful retrograde wire crossing or the reverse CART, it is an ideal situation for subsequent procedures. The reason is that the retrograde wire can be anchored in the antegrade guide catheter with a balloon, providing strong backup support (Figure 3). In most cases, it is possible to pass a retrograde balloon through the CTO. After this, two different techniques may be used. While dilating the CTO with the retrograde balloon, a soft polymer jacket wire with minimum friction such as a Fielder FC wire can be advanced antegradely through the resultant channel with the support of a microcatheter. Alternatively, the retrograde balloon is advanced into the antegrade guide catheter, and the wire used for retrograde wire crossing is exchanged for a 300-cm wire. If a 300-cm wire is advanced from the retrograde balloon, it will arrive inside the antegrade guide catheter and then will advance further to the contralateral femoral artery sheath, after which the tip can be taken out of the patient (the retrograde wire externalization technique). A microcatheter is then attached to the tip of this wire and advanced. If the microcatheter is advanced while pulling on the retrograde balloon, the microcatheter crosses the CTO (because the occlusion has already been dilated with the retrograde balloon). If the 300-cm wire that was introduced retrogradely is then removed and a conventional floppy wire is inserted through the microcatheter, successful antegrade wiring has been achieved. With regard to this retrograde wire externalization technique, a soft and slippery polymer jacket wire such as a 300-cm Fielder FC is the easiest to use.

After successful retrograde crossing with a stiff wire, it sometimes cannot be advanced into the antegrade guide catheter. In such cases, the wire is advanced as deep into the ascending aorta as possible, enhancing backup support to allow the retrograde balloon to cross the CTO. Sometimes, a new 1.25-mm balloon is required for retrograde crossing. Once retrograde balloon crossing has been achieved, the balloon can be inflated and a Fielder FC advanced antegradely, as mentioned previously. When

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the retrograde balloon cannot pass through the CTO, a snare may be required to pull the tip of a retrograde wire into the antegrade guiding catheter.

If the proximal end of the CTO has a stump, the CART technique is easier to attempt. The antegrade wire should always be used with a support device. The distance between the tip of the antegrade support device and the retrograde balloon should be made as short as possible. Less than 20 mm is desirable for completion of the CART technique, even with a stiff wire such as a Confianza Pro. If the two devices can be positioned to overlap, an antegrade Fielder FC can frequently be advanced into the space created by dilatation of a retrograde balloon.

With regard to the selection of support devices, the microcatheter has the merits of clear tip visibility and good tracking. The lack of support can be supplemented by using the anchor balloon technique if there is a side branch proximal to the occlusion. Alternately, an OTW balloon can provide particularly strong backup support for wire manipulation while it is inflated in the segment proximal to the CTO (the coaxial anchoring technique). If the antegrade OTW balloon can be overlapped with a retrograde balloon, a channel can be created for communication by inflating them simultaneously (the hugging balloon technique). When delivery of an antegrade support device into the CTO is difficult, a Tornus 2.6-F catheter (Asahi Intecc) can be used to break down hard tissue, and then the Tornus 2.6 F is changed again into a microcatheter or an OTW balloon. Due to development of the trapping technique (to inflate an RX balloon inside the guiding catheter to fix the wire), it is now very easy to exchange the support devices while the wire position is maintained. ■

Masahiko Ochiai, MD, FACC, FSCAI, is Professor, Division of Cardiology and Cardiac Catheterization Laboratories, Showa University Northern Yokohama Hospital, Yokohama, Japan. He has disclosed that he holds no financial interest in any product or manufacturer mentioned herein. Dr. Ochiai may be reached at +81 45 949 7000; mochiai@med.showa-u.ac.jp.

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