Reverse Wire Technique for Angulated Side Branches

A detailed description of how to perform the reverse wire technique (and its new variations), anatomic considerations, and potential complications.

By Evandro Martins Filho, MD

In practical settings of percutaneous coronary intervention (PCI), one very challenging situation is obtaining access with a guidewire to a side branch with marked angulation. Typically, this situation is mostly encountered in the treatment of bifurcation lesions, in which safe guidewire placement in both vessel limbs is a key step for PCI success.

Furthermore, access to steep angulated side branches also may be needed to reach collateral channels for retrograde chronic total occlusion (CTO) PCI, or more often to access side branches after crossing CTOs with involvement of a bifurcation at the distal cap.

WHY I DO IT

Initially, access to extremely angulated side branches is attempted by classical wiring techniques: first, by changing the tip of the guidewire shape, and second, by operators commonly performing guidewire exchanges looking for different wire properties that may facilitate wiring.

Despite the effort and operator skill in some anatomic scenarios, regular wiring techniques are not enough to allow access in very angulated side branches and thus can be a cause of PCI failure.

Nowadays, there are straightforward strategies using different microcatheters with different designs, such as angulated catheters (eg, SuperCross [Teleflex]), double-lumen catheters (eg, Sasuke [Asahi Intecc USA, Inc] or Twin-Pass [Teleflex]), or deflectable catheters (eg, Venture [Teleflex] or Swift Ninja [Merit Medical]).

Balloon angioplasty of the main branch to modify access to the side branches should be considered as the last resort due to its risk of dissection and flow compromise.

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If everything fails, we still have strategies to overcome these challenges, the reverse wire technique (RWT) was developed to allow a more efficient and less time-consuming wiring process in challenging situations.

HOW I DO IT

The RWT was first reported in 2008 by Kawasaki et al and the original method used a guidewire with a hairpin curve, which was delivered beyond the bifurcation alone.[1] The hairpin wire was inserted in the guide catheter and pushed distally to the targeted side branch. Gentle pull back and torquing allowed reverse wiring of the side branch.

This novel technique was improved in 2013 by Watanabe et al utilizing the support of a dual-lumen microcatheter (DLC) and has subsequently become a common technique among PCI operators.[2] In 2015 and 2018, Nomura et al published several tips to improve the use of this so-called *DLC facilitated RWT*.[3,4]

The first step of this technique involves the delivery of the reverse wire (RW) system (hairpin wire and DLC, as a unit) to the targeted bifurcation (Figure 1).

However, most cases exhibit significant stenosis proximal to the bifurcation, which often hampers the delivery of the RW system. A sharply curved RW system (Figure 2B) is easier to pass the stenosis as compared to

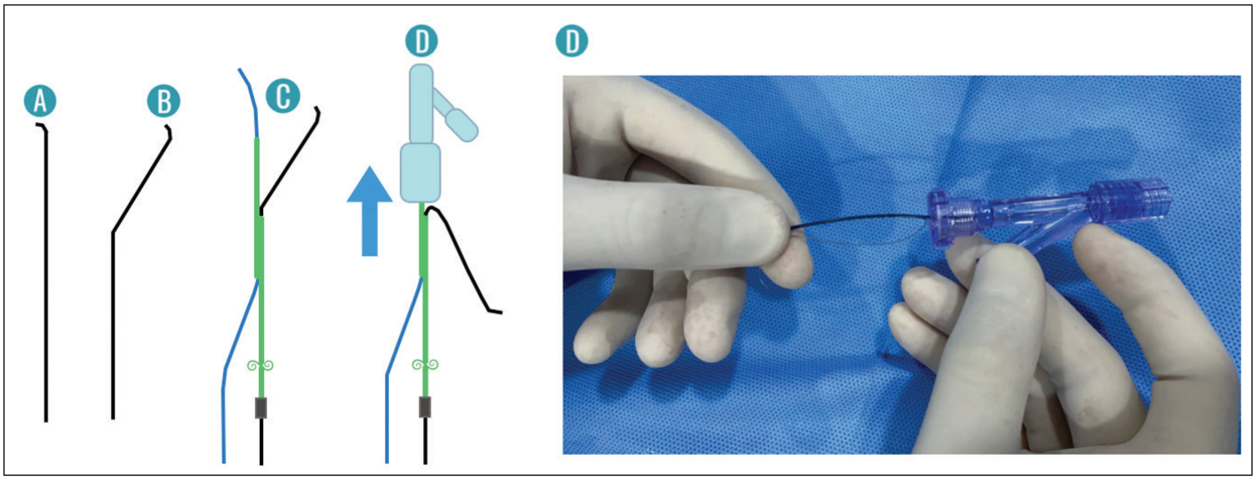

Figure 1. Forming the hairpin wire shape and delivering with DLC help (A-C). Insertion of the system in the Y connector (D).

the roundly curved system (Figure 2A) and should be adopted as the standard for this technique. On the other hand, device delivery after wiring is achieved is much easier on the guidewire with a round curve as compared to that with a sharp curve. Therefore, it is important to modify the details of this procedure on a case-by-case basis according to the lesion characteristics.[3]

For the DLC facilitated RWT, a reverse sharp curve of approximately 40º is made in a polymer jacketed guidewire at a point approximately 3 cm from the tip (preferably at the transition point of the radiopaque wire segment) (Figure 1B). The guidewire is then backloaded into the over-the-wire (OTW) lumen of the DLC outside the guide catheter before being fixed in place in the DLC so that the reverse bend is located just distal to the exit port of the OTW lumen of the DLC (Figure 1D). The RW system is then inserted through the hemostatic valve into the guide catheter by softly folding the guidewire and advancing it into the main vessel up to the target bifurcation (Figure 1). After advancing the RW system distally beyond the bifurcation, the DLC is pulled back proximally. The guidewire is then manually steered back into the side branch. Some rotational guidewire manipulation is required to direct the tip of the guidewire into the ostium of the side branch. The DLC is then removed using the balloon trapping method and a new flexible microcatheter is advanced OTW beyond the reverse curve into the side branch.

In 2020, Hasegawa et al introduced another refinement of this technique that is called the *streamlined RWT* (SRWT) in which instead of delivering the RW system to the vessel distally (which is cumbersome in some anatomies), the hairpin wire is formed inside the coronary tree using a distal non-targeted side branch as shown in Figure 3 and 4.[5]

There are some advantages of the SRWT method when compared with a conventional RWT or DLC-facilitated RWT. First, delivery of the RW system is more effective because in SRWT the DLC needs to be delivered alone through the stenosis, instead of the DLC and RW being delivered together. Balloon dilation of the stenosis is rarely needed. In conventional RWT or facilitated DLC RWT, lesion modification with balloon dilatation is sometimes required to make space for the passage of the RW and DLC, thus the risk of vessel damage is increased. Second, if the RW manipulation to allow wiring into the targeted side branch was unsuccessful, the wire can be easily removed from the DLC and reshaped or exchanged to another wire and the hairpin quickly formed again inside the coronary. On the other hand, during DLC facilitated RWT, both the DLC and RW should be completely removed from the guiding catheter and everything started over from the beginning.

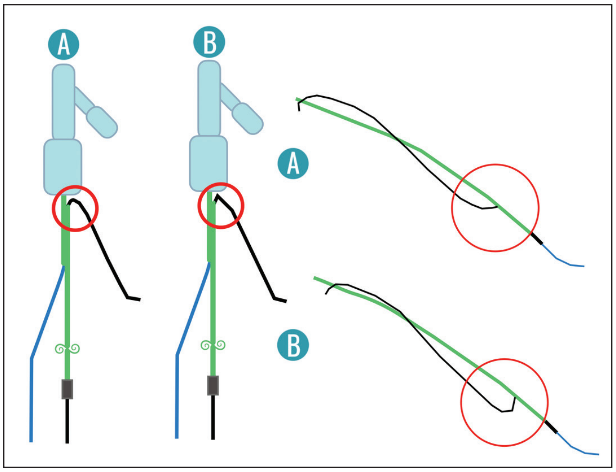

Figure 2. Bend shapes of the hairpin guidewire used for the RWT are shown in panel A (round curve) and panel B (sharp curve).

This new technique has enabled us to easily deliver a RW through severe stenosis, minimizing the risk of vessel

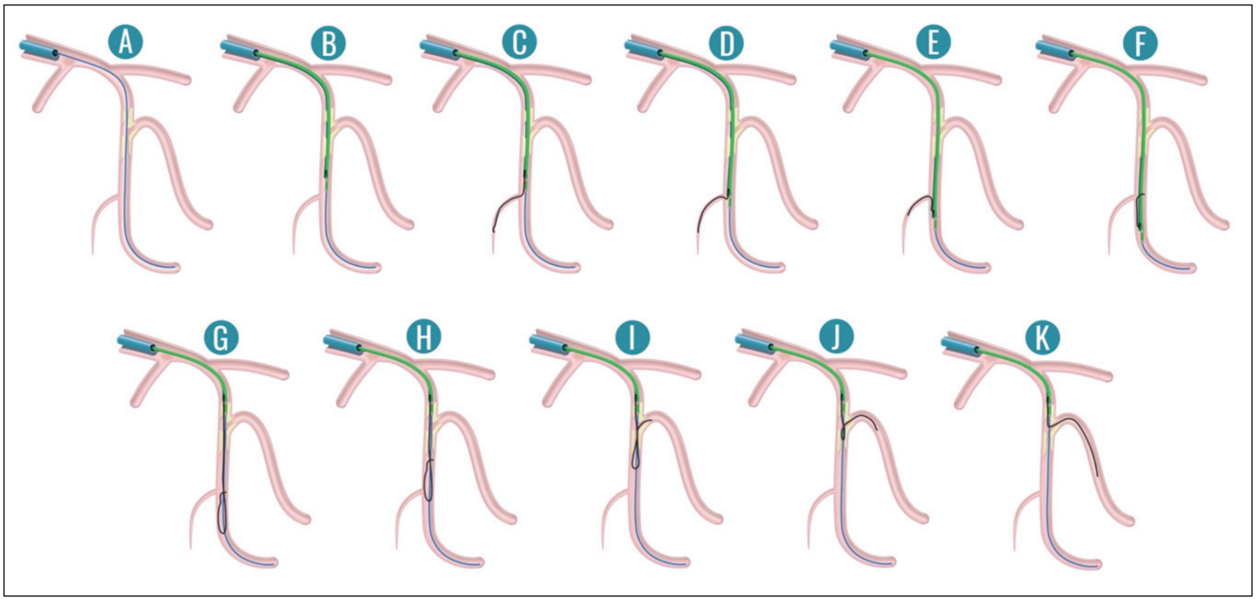

Figure 3. SRWT scheme. A workhorse guidewire is inserted in the main vessel (A). The DLC is advanced by its Rx port through main vessel wire (B). A second guidewire is advanced through OTW DLC port and engages a nontargeted distal side branch (eg, septal branch) (C). The DLC is firmly pushed distal to allow the wire to buckle and form the hairpin shape inside the coronary tree (D-F). The DLC is pulled back proximally from the targeted difficult angulated side branch (the DLC can be also pulled back together with the RW as a unit) (G). The hairpin wire is pulled back very gently and with minimal torque movements adjusted to engage and cross the side branch ostia (H-K).

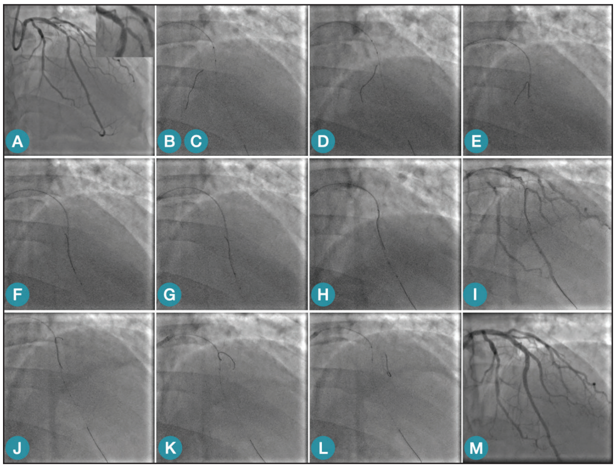

Figure 4. SRWT step-by-step in a LAD-diagonal bifurcation PCI. A LAD-diagonal bifurcation PCI with a difficult angulated side branch take off (A). A workhorse guidewire is inserted in the main branch, DLC advancement and wiring of a distal septal with a soft polymer jacketed wire (B, C). The DLC is firmly pushed distal to allow the wire to buckle and form the hairpin shape inside the coronary tree (D-G). The DLC and wire are pulled back gently as a unit to reach side branch (G, H). The hairpin wire is pulled back very gently and with minimal torque movements adjusted to engage and cross toward the distal side branch (H-L). Final result after IVUS-guided mini-crush stenting (M).

injury. It has become our standard "go-to" technique when RWT is needed (*see the video demonstration of the SRWT during a left anterior descending [LAD]-diagonal bifurcation PCI*).

ANATOMY

The characteristics causing difficulties in side branch wiring have not been completely identified in clinical studies but come from the experience of operators and/or leaders in the field of complex interventions. Angiographic predictors (Figure 5) of difficult side branch wiring are severe calcifications involving the proximal main vessel and/or ostial side branch; severe stenosis with a large plaque burden in the proximal main vessel; tortuosity in the proximal main vessel limiting guidewire manipulations, and consequently access to the side branch; severe stenosis at the side branch ostium; and flow less than TIMI 3 in the side branch.[6]

The side branch that exhibits both a smaller take-off angle and a larger carina angle (type B) is the most suitable candidate for the RWT technique (Figure 6).[3]

POTENTIAL COMPLICATIONS

It is important to highlight that in bifurcation PCI with a difficult steep angulated side branch it is strongly recommended to proceed with a two-stent technique

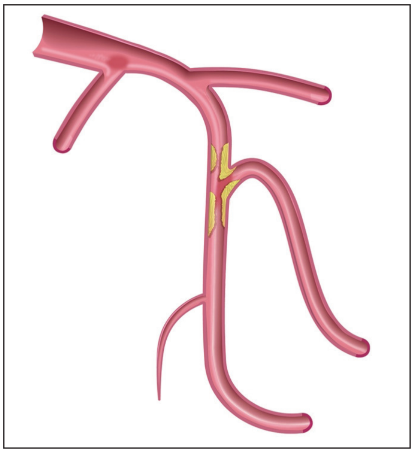

Figure 5. Characteristic causing difficulties in side branch wiring: steep angulated side branch with tortuosity at the proximal main vessel, severe stenosis at the side branch ostium and calcification.

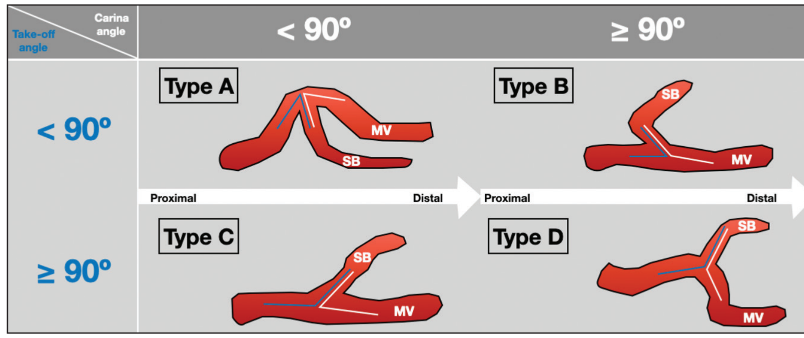

Figure 6. Bifurcations can be classified into four types according to their take-off and carina angles.[3] A type B bifurcation is the most suitable candidate for the RWT.

(first stent in the angulated side branch) because provisional stenting may cause side branch compromise and make further side branch access across struts impossible.

Many operators have advocated that in exceptional cases in very tight lesions at the main branch, lesion modification using balloon dilatation is required to make room for passage of the RW or DLC. It is important to be aware that this can result in vessel/bifurcation damage, leading to side branch occlusion caused by carina shift, plaque shift, or dissection. So, in selected cases, if dilatation is needed, we recommend the use of very small balloons (< 1.5 mm diameter).

We strongly recommend delivering the RW system without lesion modification (with "sharp bend") or switching to the novel SRWT which may prevent bifurcation damage.

For the SRWT, a side branch distal to the targeted bifurcation is necessary to accomplish this procedure. To insert a preshaped RW where the bending part is at radiopaque wire transition, the distance from the orifice of the targeted side branch to the end of the vessel should be > 30 mm. Shorter bending points (< 30 mm) can be attempted to adjust the RW to the patient anatomy but may be more cumbersome to achieve successful wiring. ■

MATERIALS REQUIRED FOR THE STREAMLINED REVERSE WIRE TECHNIQUE

Guide Catheters: Strong and supportive guide catheters (eg, XB/EBU curves for the left coronary artery and AL1/3DRCA/HS for the right coronary artery)

Microcatheters: DLCs (Twin-Pass and Twin-Pass Torque [Teleflex], Sasuke, FineDuo [Terumo Interventional Systems], ReCross [IMDS], NHancer RX [IMDS], Crusade [Kaneka])

Wires: 0.014-inch soft polymer jacketed wires (eg, Fielder FC [Asahi Intecc USA, Inc], Fielder XT-R/A [Asahi Intecc USA, Inc], Sion Black [Asahi Intecc USA, Inc], Samurai RC [Boston Scientific Corporation], Pilot 50 [Abbott], Whisper [Abbott]) or soft and hydrophilic coated nonpolymeric wires (eg, Sion [Asahi Intecc USA, Inc], Sion Blue [Asahi Intecc USA, Inc], Runthrough Hypercoat [Terumo Interventional Systems])

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