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REVIEW ARTICLE

Reverse Wiring Technique (RWT), An Essential Skill in Complex Percutaneous Coronary Intervention

Taslima Afroz[1], Tunaggina Afrin Khan[2], Md. Afzalur Rahman[3]

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In our day-to-day practical settings of percutaneous coronary intervention (PCI), we sometimes encounter difficulty in introducing a guidewire (GW) to the markedly angulated side branch (SB), and the reverse wire technique is considered as a last resort to overcome such a situation. It involves the use of a guidewire with a hairpin curve, which is delivered beyond bifurcation alone. The RWT was first reported in 2008 and has since been improved with the support of a dual lumen microcatheter (DLC), making it a common technique among PCI operators.[1] The first step of this technique involves the delivery of the reverse wire system to the target bifurcation. It's important to note that this technique requires careful consideration of the anatomic features of the bifurcation and the lesion's characteristics.[2] Angiographic predictors of difficult side branch wiring (Figure 1) 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 as well as severe stenosis at the side branch ostium; and flow less than TIMI 3 in the side branch.

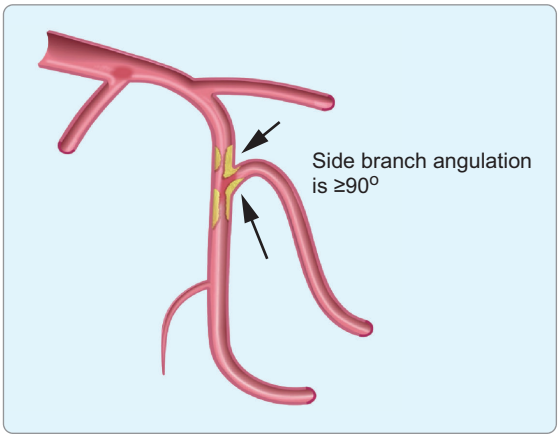

Figure 1: *Characteristic causing difficulties in side branch wiring: steep angulated side branch with tortuosity at the proximal main vessel, severe stenosis at the side branch ostium and calcification.*[6]

Who are the suitable candidates for RWT?

The bifurcation angle is very important factor during PCI of bifurcation lesion. The side branch that exhibits both a smaller take-off angle and a larger carina angle (type B), (Figure 5) is the most suitable candidate for the RWT technique. However, most cases exhibit significant stenosis proximal to the bifurcation, which often hampers the delivery of the reverse wire system. Because the sharply curved reverse wire system is easier to pass the stenosis as compared to the roundly curved system, we recommend a sharp curve should be adopted for this technique. On the other hand, it is sure that device delivery is much easier on the guide wire with a round curve as compared to that with a sharp curve.[3] Therefore, it is important to modify the details of this procedure on a case-by-case basis according to the lesion's characteristics. 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.[4]

Steps of Reverse Wire Technique (RWT)[3]: Here are the steps involved in performing the RWT:

1. Delivery of the Reverse Wire System:
    - The first step involves delivering the reverse wire (RW) system, which consists of a hairpin-shaped guidewire and a dual-lumen microcatheter (DLC), to the targeted bifurcation (Figure 2)

1. Specialist, Department of Cardiology, United Hospital Ltd. Dhaka, Bangladesh .
2. Associate Consultant, Department of Cardiology, United Hospital Ltd. Dhaka, Bangladesh.
3. Senior Consultant, Department of Cardiology, United Hospital Ltd. Dhaka, Bangladesh.

Address of Correspondence: Dr. Taslima Afroz, Specialist, Department of Cardiology, United Hospital Ltd. Dhaka, Bangladesh. Email: tafroz0171@gmail.com, Phone no 01716665103

- The reverse wire system is easier to pass through significant stenosis proximal to the bifurcation with a sharp curve, but device delivery is easier with a round curve (Figure 3).
- The hairpin wire is inserted into the guide catheter and pushed distally to the side branch
- The DLC provides support and stability during the procedure.
- Forming the Hairpin Wire Shape: The hairpin wire shape is formed by bending the guidewire.
- The RW system (hairpin wire + DLC) is advanced to the targeted bifurcation.

2. Reverse Wiring of the Side Branch (Figure 4):

- After advancing the RW system beyond the bifurcation, the DLC is pulled back proximally.
- This gentle pullback and torquing allow for reverse wiring of the side branch.
- The goal is to achieve efficient and less time-consuming wiring in challenging anatomical variations.[6]

3. Considerations and Tips:

- The RWT is particularly useful when regular wiring techniques fail to access in extremely angulated (Figure 5) side branches.[5]

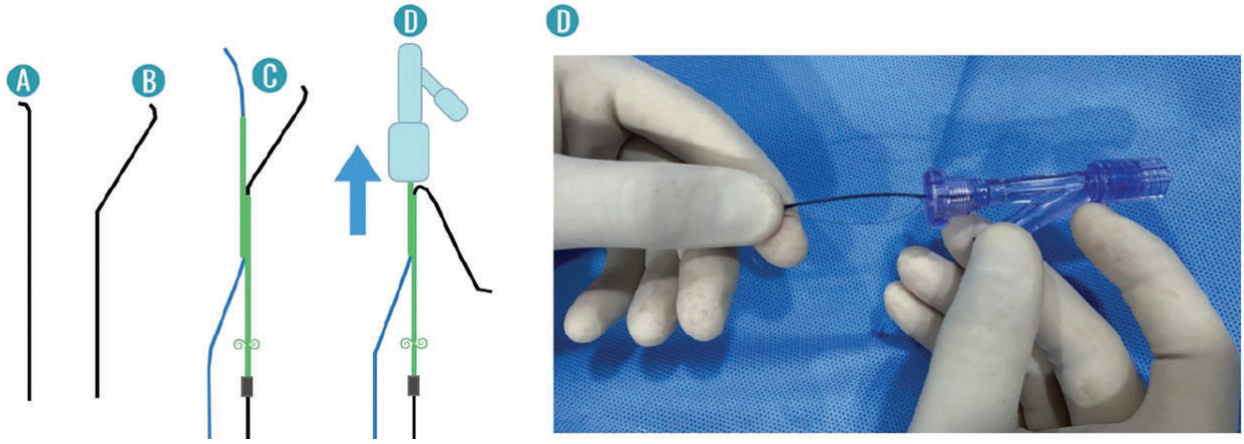

Figure 2: *Forming the hairpin wire shape and delivering with DLC help (A-C) insertion of the system in the Y connector (D).*[3]

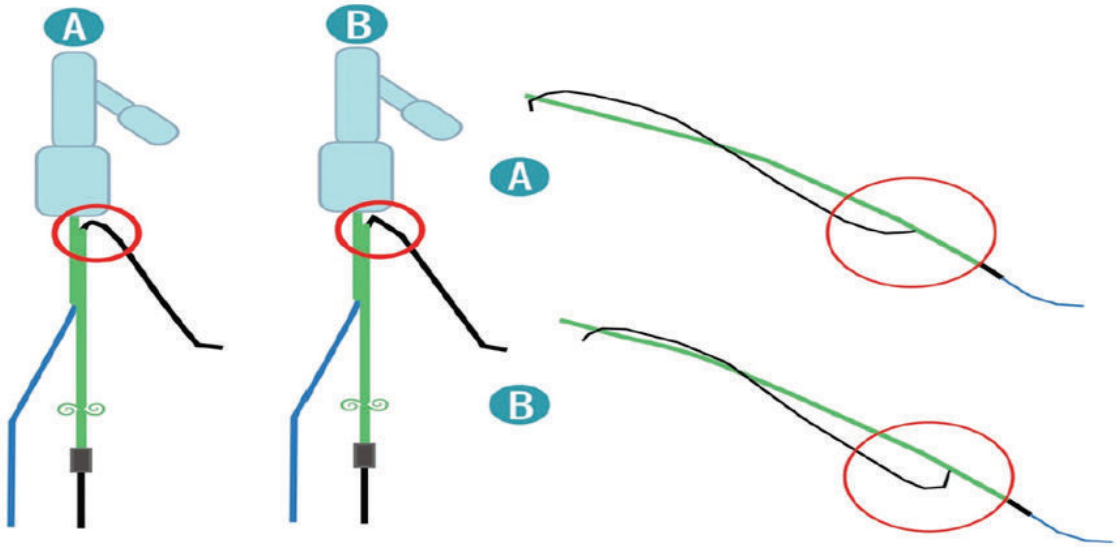

Figure 3: *Bend shapes of the hairpin guidewire used for the RWT are shown in panel A (round curve) and panel B (sharp curve).*[3]

- Other strategies, such as using different microcatheters (angulated, double-lumen, or deflectable), should be attempted first.[4,6]
- Briefly, the reverse guidewire technique requires making a reverse bend in a coronary guidewire about 3 cm from its distal tip. After advancing the guidewire using a Crusade dual port microcatheter (Figure 6) in the distal main vessel, the Crusade microcatheter is pulled back proximally. The guidewire is then manually steered back into the side branch with some rotation.[7]

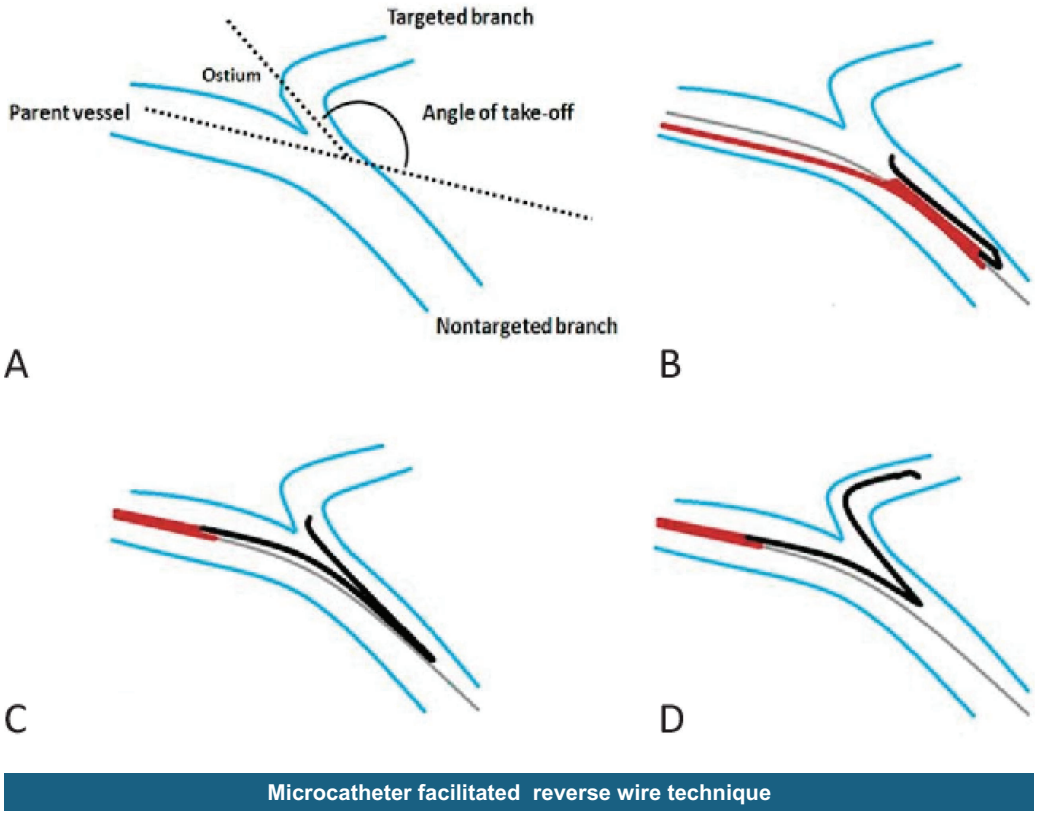

Figure 4: *Micro catheter facilitated revers wire technique.*[3]

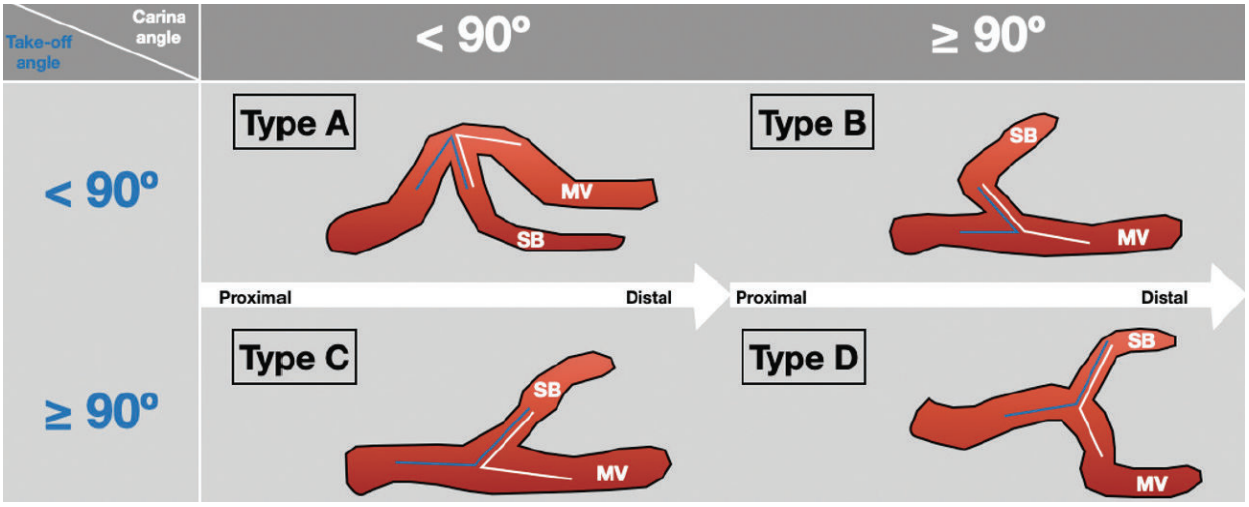

Figure 5: *Bifurcations can be classified into four types according to their take-off and carina angles. Type B bifurcation is the most suitable candidate for the RWT.*[4]

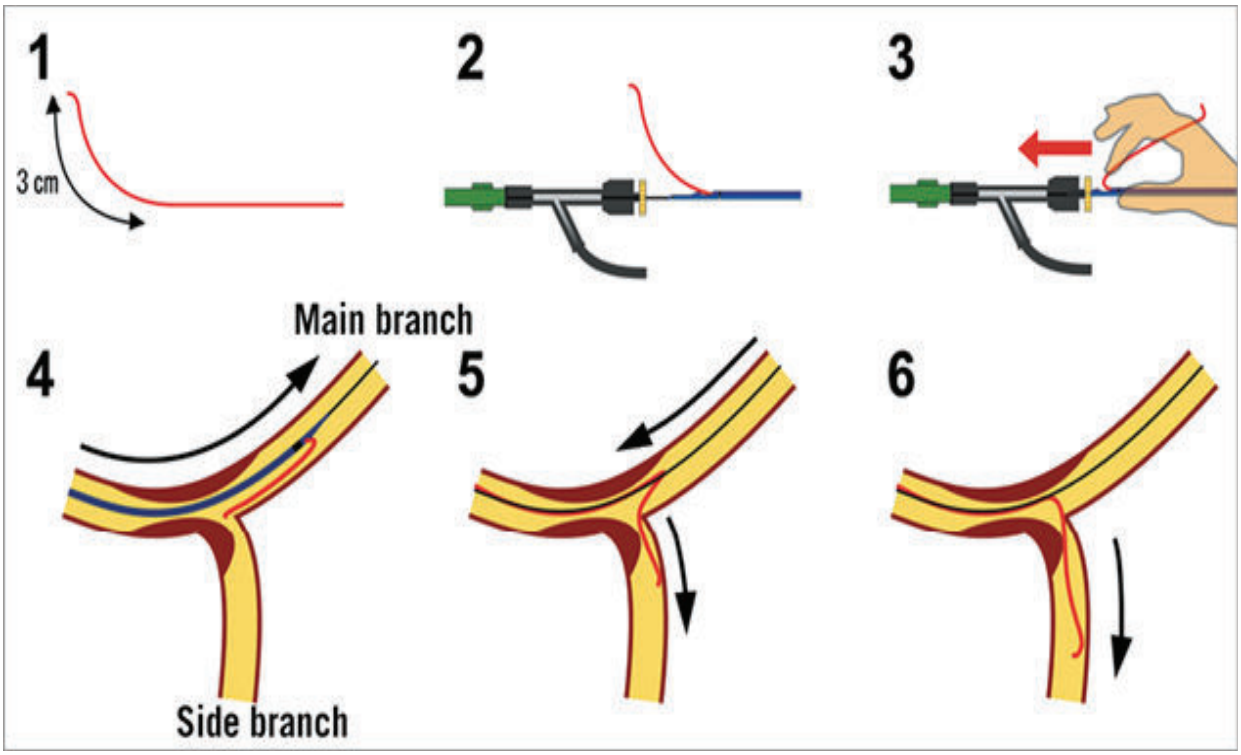

Figure 6: *Diagrammatic representation of the various steps of the reverse wire technique. 1) Making a reverse bend at a point 3 cm from the guidewire tip. The guidewire should be a polymer-jacket hydrophilic guidewire. The reverse bend should be a smooth round curve. 2) The guidewire is inserted into the second port of the Crusade dual port microcatheter. 3) The reverse wire system is advanced into the Y connector by softly folding the guidewire. 4) The reverse wire system is advanced beyond the bifurcation lesion through the guidewire placed in the main branch. 5) After pulling back the Crusade catheter proximal to the bifurcation lesion, the guidewire is carefully pulled back and steered into the side branch. Some rotations may be required for advancing the tip of the guidewire to the side branch. 6) The guidewire is advanced into the angulated side branch by slowly pulling back the guidewire.*[8]

BAT technique

This procedure presents a difficulty in straightening the reversed bend due to a lack of intentional control of the RW, therefore, failing in an attempt of wire insertion into the side branch (SB). In that case, a novel technique "BTS (balloon-trap straightening) technique" which is a simple and effective method (Figure 7) to accomplish SB access, even during the treatment of complex bifurcated lesions.[8]

(A) Delivering the reverse wire (RW) system beyond the lesion.

(B) Inserting RW into target branch.

(C) Removing double lumen catheter. Inserting balloon into bifurcation.

(D) Inflating the balloon in the lesion to trap the guidewire.

(E) Pulling out the RW carefully.

(F) RW was successfully unfolded.

(G) Inserting micro catheter.

(H) Trapping micro catheter and advance the guide wire to the distal.

(I) Advance the micro catheter to the distal.

What are the potential complications of RWT?

Higher long-term mortality was found in patients with highly angulated lesions. Furthermore, a steep angle is significantly associated with the risk of abrupt vessel closure, SB occlusion, and higher failure rate to recross the SB after MV stenting.[9] It is important to keep in mind that in bifurcation PCI with a difficult steep angulated side branch it is strongly recommended to proceed with a two-stent technique

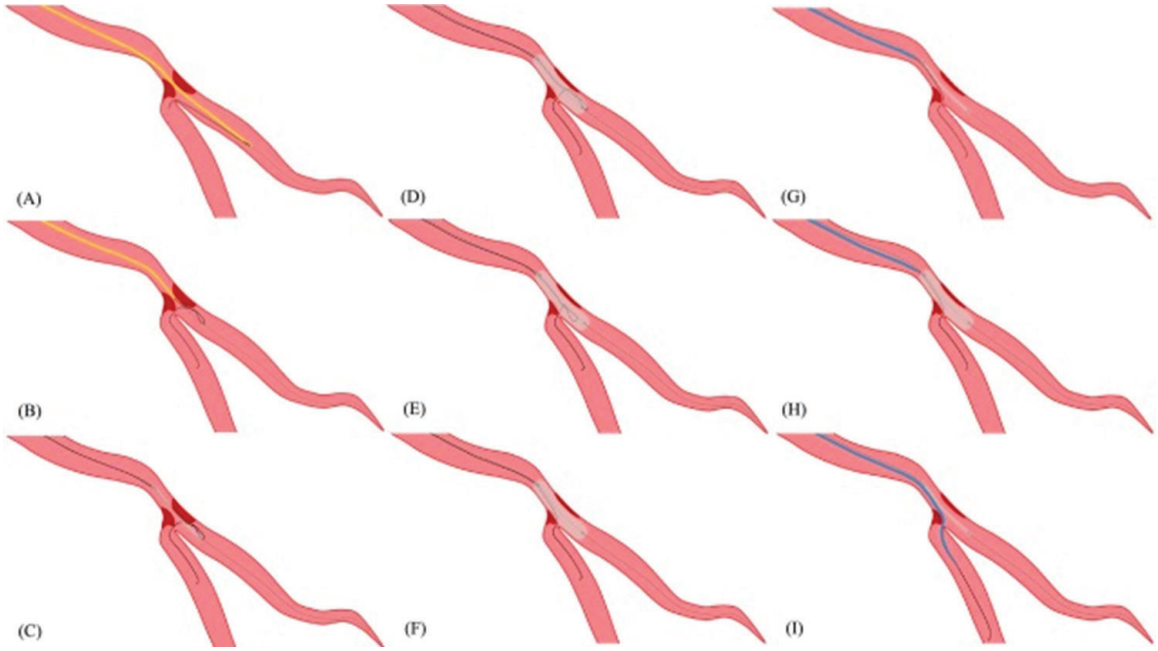

Figure 7: *Balloon-trap straightening (BTS) technique.*[10]

(first stent in the angulated side branch) because provisional stenting may cause side branch compromise and make further side branch access across struts impossible.[10] The reverse wire technique (RWT) is a valuable method used during percutaneous coronary intervention (PCI) to access side branches with marked angulation. While it can be effective, there are potential complications associated with this technique:[11]

1. **Vessel Damage and Dissection:**
    - In conventional RWT or facilitated DLC RWT, lesion modification with balloon dilatation is sometimes required to create space for the passage of the reverse wire (RW) and dual lumen microcatheter (DLC).
    - However, balloon angioplasty of the main branch to modify access to the side branches carries a risk of vessel damage and dissection.
2. **Flow Compromise:**
    - When using the RWT, there is a possibility of compromising blood flow in the main branch or side branch due to wire manipulation.
    - Operators must be cautious to avoid excessive force or torque during the procedure.
3. **Prolapse into Non-Targeted Branches:**
    - Wiring for side branches with extremely angulated take-offs can be challenging.
    - If a conventional wiring technique is used, the wire may prolapse into non-targeted branches, leading to suboptimal results.
4. **Operator Skill and Experience:**[12]
    - The success of RWT depends on the operator's skill and familiarity with the technique.
    - Inexperienced operators may encounter difficulties or complications during the procedure.

Conclusion

We should remember that the RWT should be considered as a last resort when other strategies fail to access extremely angulated side branches. Despite the potential complications, it remains a valuable tool in overcoming challenging anatomical scenarios during coronary interventions.

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