**CASE REPORT**

**Simplified Dual-Lumen Catheter-Facilitated Reverse Wire Technique for Markedly Angulated Collateral Channel Entry in Retrograde Chronic Total Occlusion Intervention**

Kaize Wu, MD, Bingzheng Luo, MD, Zehan Huang, MD and Bin Zhang, PhD

**Summary**

The retrograde approach has significantly improved the success rates in complex coronary total occlusion (CTO) lesions. It has also become the predominant and important strategy in CTO recanalization. However, unsuccessful crossing of the collateral channels is the strongest predictor of retrograde failure, and adverse collateral channel morphology, including large channel entry angle, could reduce the success rate of collateral channel crossing. Reverse wire technique (RWT) was specifically developed for bifurcation lesions with an extremely angulated side branch, and nowadays, this can be achieved by the support of a dual-lumen catheter (DLC). We report a novel method named “simplified dual-lumen catheter-facilitated RWT” to facilitate markedly angulated collateral channel entry in retrograde CTO intervention. This new technique is simplified by making the reverse bend with the support of a DLC in the aorta instead of outside the guiding catheter, which is feasible, effective, and safe for markedly angulated collateral channel entry in retrograde CTO percutaneous coronary intervention (PCI).

(Int Heart J 2021; 62: 416-421)

**Key words:** Crusade catheter, Coronary artery disease, Recanalization, Safety, Feasibility

Chronic coronary total occlusion (CTO) intervention remains one of the main challenges in percutaneous coronary intervention (PCI). The retrograde approach has significantly improved the success rates in complex CTO lesions and has also become the predominant and important strategy in CTO recanalization.1,2) However, unsuccessful crossing of the collateral channels is the strongest predictor of retrograde failure.3) Adverse collateral channel morphology, including large channel entry angle, could reduce the success rate of collateral channel crossing. Reverse wire technique (RWT) was specifically developed for bifurcation lesions with an extremely angulated side branch,4) and nowadays, this can be achieved by the support of a dual-lumen catheter (DLC).5) However, few data exist regarding RWT to support collateral channels crossing in retrograde CTO PCI.

Hence, in this study, we propose a novel method referred to as "simplified dual-lumen catheter-facilitated RWT" to facilitate markedly angulated collateral channel entry in retrograde CTO intervention. This new technique consists of the following three steps: (1) dragging the guiding catheter into the ascending aorta (AA) after inserting a guidewire (GW) into the main vessel (MV) (Figure 1A); (2) advancing a DLC into the AA and inserting a guidewire into the AA by a length of 30 mm from the guidewire tip through the over-the-wire (OTW) port of the DLC (Figure 1B, C); (3) advancing the DLC into the MV to bend the guidewire in the AA with a reverse curve at a 30-mm point from the tip of the guidewire (Figure 1D); (4) simultaneously advancing the reverse wire (RW) and DLC into the distal MV (Figure 1E, F); and (5) pulling back the DLC and accurately inserting the RW into the target collateral channel (Figure 1G-J). Different from the conventional microcatheter-facilitated RWT, this new technique was simplified by achieving the reverse bend with the support of a DLC in the aorta instead of outside the guiding catheter. A representative case of this streamlined technique is reported as follows.

**Case Report**

A 54-year-old man who previously failed to recanalize RCA in-stent CTO was admitted to our hospital. The patient complained of severe angina, which seriously affected his quality of life. However, he refused to undergo coronary artery bypass grafting. As there is evidence that...
PCI for CTO revascularization can lead to a significant improvement in the health status of patients with stable angina, we performed PCI on the patient. His previous history included hypertension and diabetes mellitus. An electrocardiogram revealed ST-segment depression in the inferior leads, whereas an echocardiogram revealed satisfactory LV systolic function. Stress testing showed evidence of severe reversible myocardial ischemia in the inferior wall in the RCA territory. A coronary angiogram showed a proximal RCA in-stent CTO (J-CTO score of 5 points). An epicardial collateral from the atrioventricular branch of the circumflex artery (AVCx) to the posterolateral ventricular (PLV) branch of the RCA was favorable but with a markedly angulated entry (Figure 2). PCI via the retrograde approach was performed for the recanalization of the RCA in-stent CTO.

A 7-Fr AL1.0 guiding catheter was engaged to the RCA via the right radial artery and a 7-Fr XB3.5 guiding...
catheter to the left coronary artery via the right femoral artery. The antegrade wire was advanced into the false CTO segment. Subsequently, we initiated the retrograde approach via the selected epicardial collateral. Attempts to use a Sion black guidewire (Asahi Intecc Co., Aichi, Japan) to be advanced into the epicardial collateral were made but were unsuccessful. This is because of the challenging angulation between the AVCx and the epicardial collateral. Therefore, we attempted to perform “simplified dual-lumen catheter-facilitated RWT” to overcome this case of unusual anatomy.

First, a Runthrough NS guidewire was inserted into the AVCx, and the XB3.5 guiding catheter was dragged to the AA (indicated by a white arrow). Next, a DLC (Crusade catheter; KANEKA Corp., Osaka, Japan) alone was advanced into the AA, and the Fielder XT-R (Asahi Intecc Co., Ltd., Aichi, Japan) was inserted into the AA by a length of 30 mm from the guidewire tip via the OTW port of the DLC (indicated by a white arrow). Then, the DLC was advanced into the left main artery, and the Fielder XT-R was bent in the AA with a reverse curve at a 30-mm point from the tip of the guidewire (indicated by a white arrow). D-F: The Fielder XT-R and DLC were simultaneously advanced into the distal AVCx (indicated by a white arrow). (Figure 3A). Then, the DLC was advanced into the left main artery, and the Fielder XT-R was bent in the AA with a reverse curve at a 30-mm point from the tip of the guidewire (Figure 3C). Thereafter, the Fielder XT-R and DLC were simultaneously advanced into the distal AVCx (Figure 3D-F). The DLC was gently pulled back, and then the Fielder XT-R was also slowly withdrawn until the wire successfully entered the target epicardial collateral (Figure 4A-C). Subsequently, the DLC was changed to the microcatheter (FineCross, Terumo, Japan), and a guidewire (Sion black, Asahi Intecc Co., Ltd., Aichi, Japan) successfully tracked through the epicardial collateral (Figure 4D-F). The procedure was completed by the retrograde chronic total occlusion intervention (Figure 5). Finally, the RCA CTO was successfully recanalized without perforation of the epicardial collateral channel or other complications.
Discussion

We present the use of a simplified dual-lumen microcatheter-facilitated RWT for facilitating markedly angulated collateral channel entry in retrograde CTO PCI. Nomura, et al. suggest the use of a polymer jacket hydrophilic-coated GW with a preshaped sharply curved tip for the dual-lumen microcatheter-facilitated RWT in PCI for markedly angulated bifurcated lesions. In addition, Canova, et al. described a similar case using a GW preshaped as a “swan neck” to engage the side-branch ostium. The difference between the present case and the above cases is that, the polymer jacket hydrophilic-coated GW was directly bent in the aortic sinus by advancing the DLC to create a reverse curve shape at a 30-mm point from the tip instead of preshaping the GW. Recently, Hasegawa, et al. have reported the “streamlined RWT” to overcome the difficulty in delivering RW beyond the severe stenosis of bifurcation, which is characterized by advancing a DLC alone beyond the stenosis and inserting a preshaped GW into a nontarget side branch distal to the bifurcation to make a reverse loop. The differences between our method and this novel method are as follows:

1. The “streamlined RWT” is mainly for complex bifurcation lesions, whereas the present method is for markedly angulated collateral channel entry in retrograde CTO intervention. (2) A preshaped RW outside the guiding catheter is not required. (3) After failed attempts with the polymer jacket hydrophilic-coated GW by the support of the DLC, the DLC and GW are withdrawn to the guiding catheter, and then the GW is directly bent in the aortic sinus by advancing the DLC to create a reverse loop at a 30-mm point from the tip. Consequently, the advantages of our method include convenience and efficiency. Therefore, this simplified RWT could help us save time and effort in accomplishing angulated collateral channel access in retrograde CTO PCI, even for the treatment of bifurcated lesions. Similar to the conventional microcatheter-facilitated RWT, the reverse bend is currently recommended to be made at a 3-cm point from the guidewire tip. Moreover, a polymer jacket hydrophilic-coated guidewire is the optimal guidewire selection. In our case, the Fiedler XT-R wire (Asahi Intecc Co., Ltd., Aichi, Japan) was selected.

However, this technique has a disadvantage, i.e., making the reverse bend in the aorta and then advancing

Figure 4. A-C: The DLC (indicated by a white arrow) was gently pulled back, and then the Fielder XT-R (indicated by a black arrow) was also slowly withdrawn until the wire entered the target epicardial collateral. D-F: The DLC was changed to the microcatheter (FineCross, Terumo, Japan), and a guidewire (Sion black, Asahi Intecc Co., Ltd., Aichi, Japan) (indicated by a black arrow) tracked successfully through the epicardial collateral.
the DLC and the RW into the MV may result in the dissection of the donor vessel. Thus, awareness and vigilance of the potential dissection and skillful manipulation are required.

**Conclusion**

The simplified dual-lumen catheter-facilitated RWT is feasible, effective, and safe for markedly angulated collateral channel entry in retrograde CTO intervention.

**Acknowledgments**

We express our gratitude to all the coordinators who contributed to the recruitment in our center.

**Disclosure**

Conflicts of interest: Nothing to report.

**References**

1. Kampaolitis D, Michael TT, Brilakis ES, et al. Retrograde coronary chronic total occlusion revascularization: procedural and in-hospital outcomes from a multicenter registry in the United States. JACC Cardiovasc Interv 2012; 5: 1273-9.
2. Tsuchikane E, Yamane M, Mutoh M, et al. Japanese multicenter registry evaluating the retrograde approach for chronic coronary total occlusion. Catheter Cardiovasc Interv 2013; 82: E654-61.
3. Rathore S, Katoh O, Matsuo H, et al. Retrograde percutaneous recanalization of chronic total occlusion of the coronary arteries: procedural outcomes and predictors of success in contempo-
4. Kawasaki T, Koga H, Serikawa T. New bifurcation guidewire technique: a reversed guidewire technique for extremely angulated bifurcation—a case report. Catheter Cardiovasc Interv 2008; 71: 73-6.
5. Watanabe S, Saito N, Bao B, et al. Microcatheter-facilitated reverse wire technique for side branch wiring in bifurcated vessels: an in vitro evaluation. EuroIntervention 2013; 9: 870-7.
6. Werner G, Martin-Yuste V, Hildick-Smith D, et al. A randomized multicentre trial to compare revascularization with optimal medical therapy for the treatment of chronic total coronary occlusions. Eur Heart J 2018; 39: 2484-93.
7. Nomura T, Kikai M, Hori Y, et al. Tips of the dual-lumen microcatheter-facilitated reverse wire technique in percutaneous coronary intervention for markedly angulated bifurcated lesions. Cardiovasc Interv Ther 2018; 33: 146-53.
8. Canova P, Satogami K, Fiocca L, et al. Successful PCI of a bifurcation lesion using “Reverse Wire” technique with a dual-lumen microcatheter. Cath Lab Digest 2019; 27.
9. Hasegawa K, Yamamoto W, Nakabayashi S, et al. Streamlined reverse wire technique for the treatment of complex bifurcated lesions. Catheter Cardiovasc Interv 2019; 96: E287-91.