



Use of Intravascular Ultrasound for Wire-Crossing in Retrograde CTO PCI

13

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Intravascular ultrasound (IVUS) is a very important tool for retrograde CTO intervention. Currently, the reverse CART technique rather than the classic CART technique is used as the main guidewire passage technique for retrograde CTO recanalization (Fig. 13.1) [1, 2]. The IVUS is almost indispensable for its safe and successful performance [3, 4]. When the microcatheter arrives at the distal landing zone of the CTO using a retrograde approach, antegrade and retrograde guidewire should be manipulated to reach as close as possible within the CTO segment [5]. At this time, if the IVUS is inserted into the CTO segment through an antegrade guidewire, the position of antegrade and retrograde guidewires in the CTO segment can be confirmed [3]. If the IVUS catheter is difficult to enter into the CTO segment, it may be possible to enter by expanding the space within the CTO segment using a small balloon of about 1.0–1.5 mm. IVUS provides various information on guidewire location, CTO lesion size, plaque components, and calcium distribution. Such information may minimize complications such as vascular injury, rupture, or subintimal dissection in retrograde CTO interventions [6].

Reverse CART technique is a method for retrograde passage of guidewire through the CTO

segment space that underwent antegrade balloon dilatation. IVUS can be used to evaluate the current position of the retrograde guidewire. The location of the guidewire within the CTO segment can be roughly classified into four categories (Figs. 13.1, 13.2, 13.3, and 13.4). First, both guidewires are present in an intraluminal space. Second, antegrade guidewire is positioned in an intraluminal space, and retrograde guidewire is positioned in a subintimal space. Third, antegrade guidewire is positioned in a subintimal space, and retrograde guidewire is positioned in an intraluminal space. Fourth, both exist in a subintimal space.

The operator should choose the appropriate strategy for each situation. If both guidewires are present in the intraluminal space (Fig. 13.1), the reverse CART may be performed immediately. In the second situation, the antegrade guidewire is positioned in the intraluminal space, and the retrograde guidewire is positioned in the subintimal space (Fig. 13.2); the antegrade guidewire can be carefully moved downward to further increase the guidewire entry length to the true lumen and redirect the retrograde guidewire toward the antegrade guidewire, or reverse CART can be performed immediately. In the third situation, antegrade guidewire is positioned in the subintimal space, and retrograde guidewire is positioned in the intraluminal space (Fig. 13.3); IVUS guidance allows the retrograde guidewire to enter a more proximal CTO segment. At this time, the

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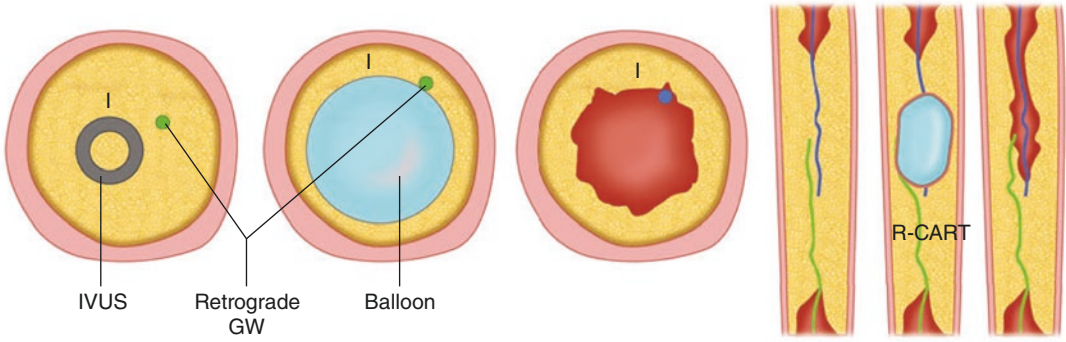


Fig. 13.1 If both guidewires are present in the intraluminal space, the reverse CART may be performed immediately. *IVUS* intravascular ultrasound, *GW* guidewire,

R-CART reverse controlled antegrade and retrograde subintimal tracking, *I* intima

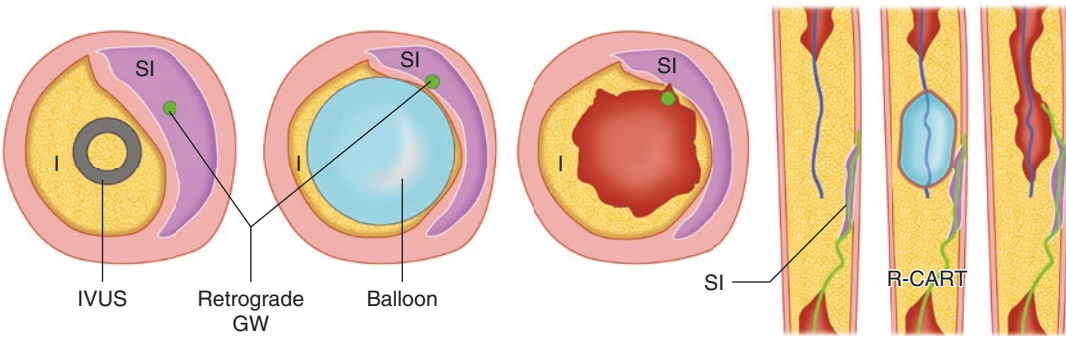


Fig. 13.2 The antegrade guidewire is in the intraluminal space, and the retrograde guidewire is in the subintimal space. In this situation, the antegrade guidewire can be carefully moved downward to further increase the guidewire entry length to the true lumen and redirect the retro-

grade guidewire toward the antegrade guidewire, or reverse CART can be performed immediately. *IVUS* intravascular ultrasound, *GW* guidewire, *R-CART* reverse controlled antegrade and retrograde subintimal tracking, *I* intima, *SI* subintima

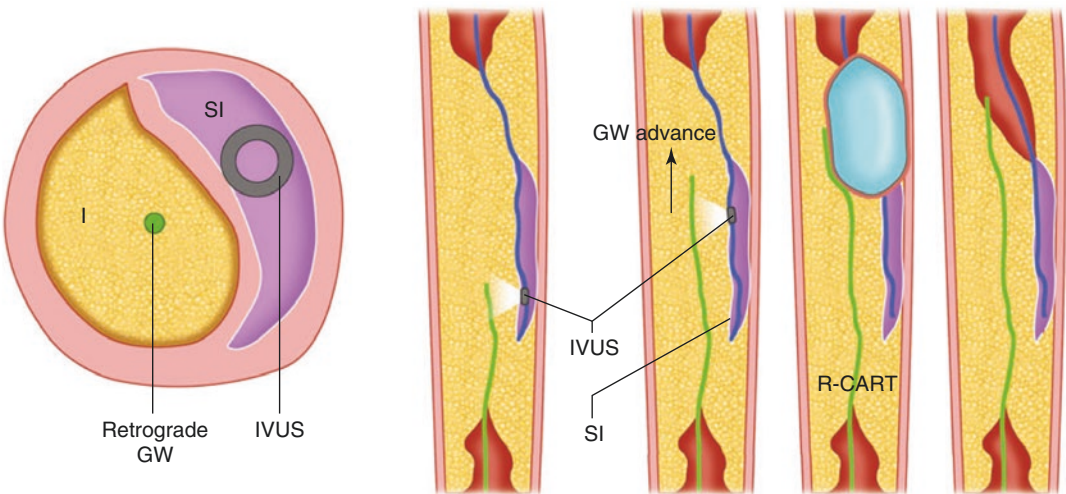


Fig. 13.3 Antegrade guidewire is in a subintimal space, and retrograde guidewire is in an intraluminal space. *IVUS* guidance allows the retrograde guidewire to enter a more proximal CTO segment. At this time, the retrograde

guidewire should be sufficiently rigid and controllable to allow free torque control. *IVUS* intravascular ultrasound, *GW* guidewire, *R-CART* reverse controlled antegrade and retrograde subintimal tracking, *I* intima, *SI* subintima

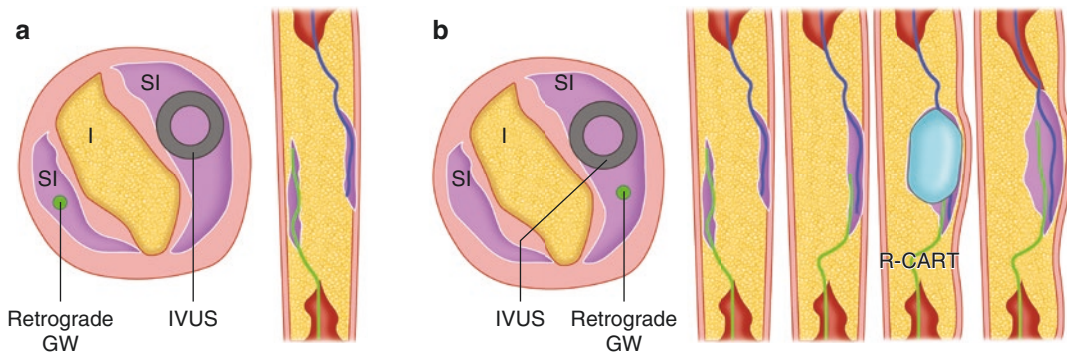


Fig. 13.4 Both guidewires are present in the subintimal space. In this situation, the treatment strategy should be different depending on whether the two guidewires are in the same subintimal space or in completely different subintimal spaces. If two guidewires are in close proximity to the same subintimal space, you can try reverse CART using a balloon of sufficient size (a). However, if two

guidewires are located far away from each other in a completely different space, it is more likely that the retrograde guidewire will reach the nearest possible space under the supervision of the IVUS and finally complete the reverse CART (b). *IVUS* intravascular ultrasound, *GW* guidewire, *R-CART* reverse controlled antegrade and retrograde subintimal tracking, *I* intima, *SI* subintima

retrograde guidewire should be sufficiently rigid and controllable to allow torque control. In the last situation where both guidewires are present in the subintimal space (Fig. 13.4), the treatment strategy should be different depending on whether the two guidewires are in the same subintimal space or in different subintimal spaces. If two guidewires are in close proximity to the same subintimal space, the operator can try reverse CART using a balloon of sufficient size (Fig. 13.4a). However, if two guidewires are located far away from each other in a completely different space, it is more likely that the retrograde guidewire must reach the closest possible space under IVUS supervision and complete the reverse CART (Fig. 13.4b).

If it is confirmed that the two guidewires are located in the same intimal or subintimal space by IVUS or in the close space through a rotational angiogram, the reverse CART technique can be completed by selecting an appropriate size balloon. If the size of the antegrade balloon is small or recoil of the subintimal space occurs after balloon dilation, passage of the retrograde guidewire becomes difficult. Interpretation of IVUS inserted through the antegrade guidewire is helpful in choosing the appropriate balloon size for the size of the vessel and is helpful in determining repeat balloon dilatation or balloon size escalation when recoil occurs.

Despite the reverse CART technique, the retrograde guidewire passage may not be achievable due to the lack of backup support, poor guidewire manipulation, and excessive calcification or bending of CTO segment. In this situation, stent-assisted reverse CART can be performed (Fig. 13.5) [7]. It involves deployment of a stent within the antegradely dissected plane to create open target for retrograde guidewire crossing. At this time, the distal end of the stent should be placed in the same space of the two guidewires, and IVUS helps to determine the proper size, length, and position of the stent.

Currently, contemporary reverse CART technique is one of the preferred technologies (Fig. 13.6). This technique is based on the minimal expansion of the CTO segment using a small antegrade balloon and manipulation of the retrograde guidewire to target it. For the successful result, the retrograde guidewire must have the ability to work as the operator's intention. The Gaia series is preferred guidewire for contemporary reverse CART technique [8]. This technique can reduce unnecessary subintimal space expansion, arterial injury, and the length of subintimal stenting in the CTO segment. This technique can be applied easily if the antegrade balloon is located at the center of the CTO segment (Fig. 13.6a), but it can be applied even if the antegrade balloon is located at the edge of the CTO vessel (Fig. 13.6b).

Fig. 13.5 Stent-assisted reverse CART. Despite the reverse CART technique, the retrograde guidewire passage may not be able because of the lack of backup support, poor guidewire manipulation, or excessive calcification or bending of CTO segment. In this situation, stent-assisted reverse CART can be performed. It involves deployment of a stent within the antegrade dissected plane to create open target for retrograde guidewire crossing. At this time, the distal end of the stent should be placed in the same space of the two guidewires, and IVUS helps to determine the proper size, length, and position of the stent

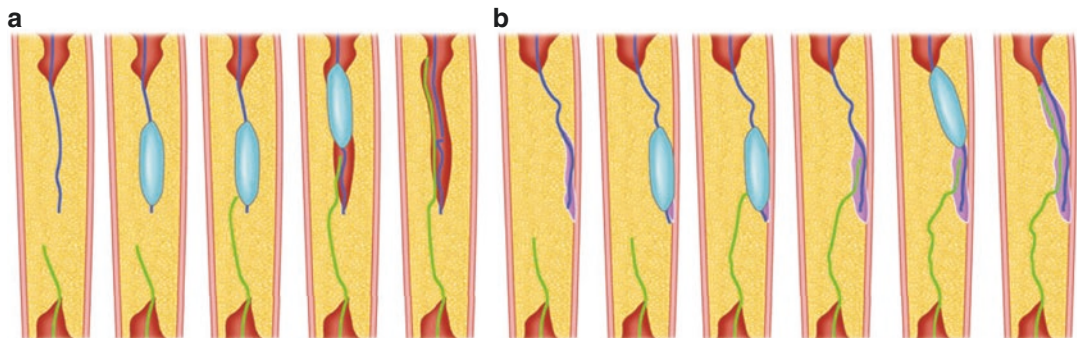
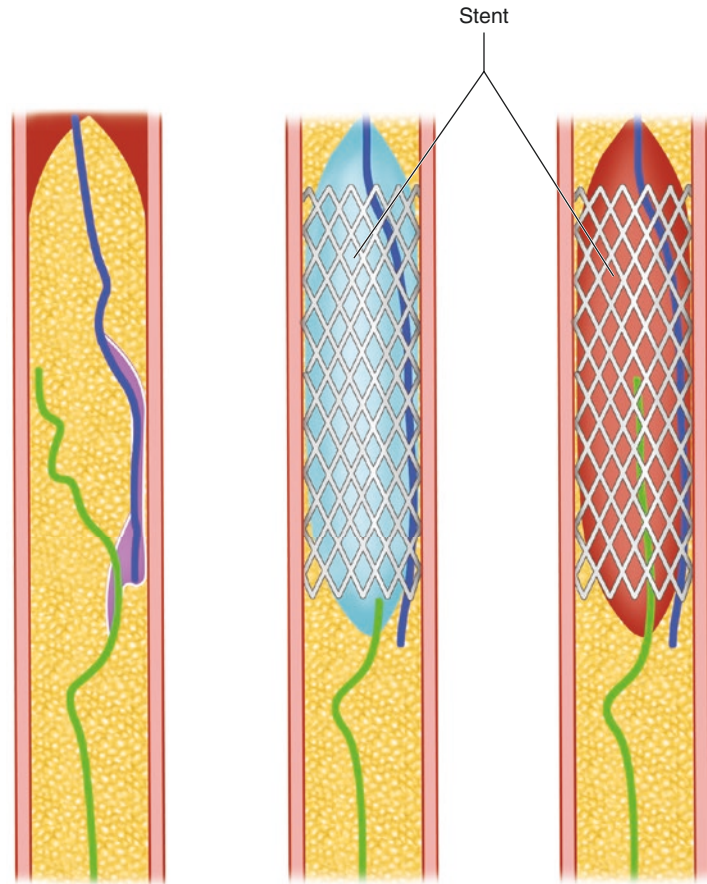


Fig. 13.6 Contemporary reverse CART technique. This technique minimally expands the CTO segment using a small antegrade balloon and manipulates the retrograde guidewire to target it. For the successful application of this method, the retrograde guidewire must have the ability to operate precisely and intentionally, and the Gaia series is the most appropriate. This can reduce unneces-

sary subintimal space expansion, arterial injury, and the length of subintimal stenting in the CTO segment. This method can be applied more easily if the antegrade balloon is located at the center of the CTO segment (a), but it can be applied even if the antegrade balloon is located at the edge of the CTO vessel (b)

Injecting contrast media through the antegrade guiding catheter should be avoided as far as possible, to avoid flow-induced subintimal dissection. IVUS provides very important clues in the selection of appropriate balloon and stent size. The distal location of the stent can be identified by the distal landing zone observed through contralateral injection, but often it is not possible to obtain sufficient information due to the poor visualization of distal landing zone or other reasons. In this situation, IVUS can be used to accurately identify the size and position of the distal landing zone for stent location [6, 9]. Confirmation of the position of the IVUS catheter in the cine angiogram can be used for determination of stenting location without injecting the contrast agent.

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