

Three-dimensional reverse CART by rotation-overlap method: CLARP manoeuvre



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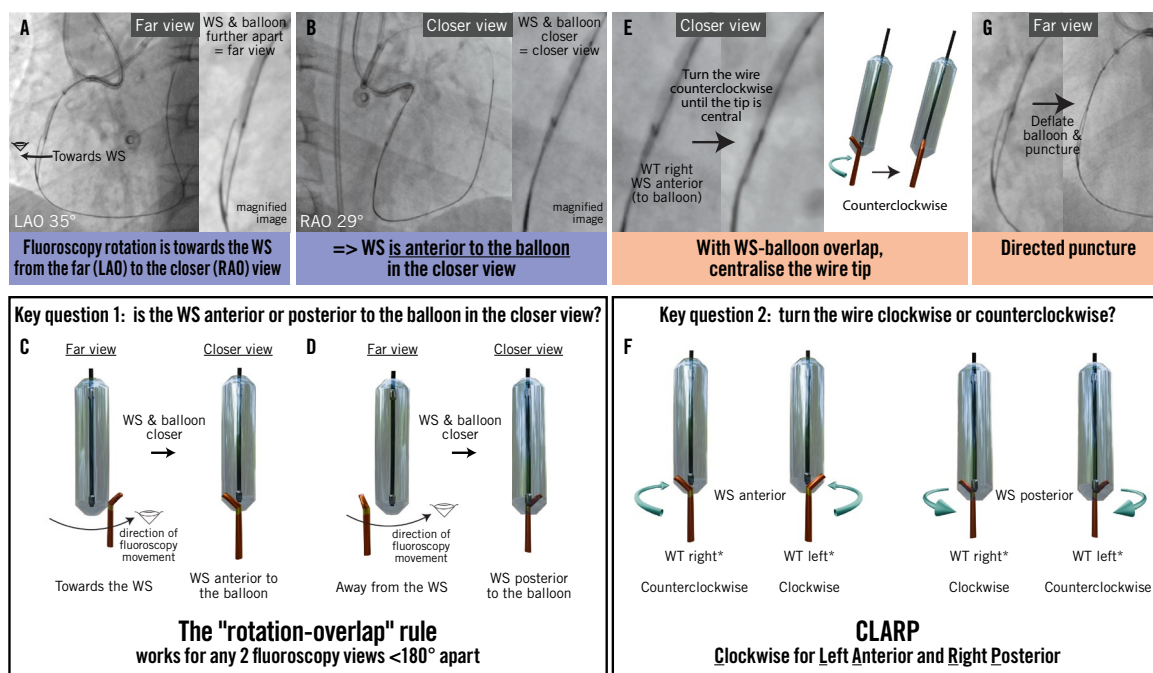


Figure 1. Three-dimensional reverse CART by the rotation-overlap method. A, B) The LAO view with greater WS-balloon separation is the far view, while RAO is the closer view. As fluoroscopy moves “towards the WS” (from far to closer), the WS is anterior to the balloon in the RAO (closer) view by the “rotation-overlap” rule (see C and D). C) The rotation-overlap rule applies to any two fluoroscopic views <180° apart, where the WS and balloon appear closer in one view compared to the other (far view). If fluoroscopy rotation is “towards the WS” (from the far view to the closer view), the WS is anterior to the balloon in the closer view. D) If fluoroscopy rotation is “away from the WS” (from the far view to the closer view), the WS is posterior to the balloon in the closer view. E) Use a closer view with a satisfactory WS-balloon overlap. With the WT pointing right and the WS anterior, rotate counterclockwise until the WT is centralised to precisely target the balloon. F) Correct wire rotation based on the WS position and the WT direction (4 scenarios), guided by the “CLARP” mnemonic (Clockwise for Left Anterior and Right Posterior). G) Verify the WT direction in the far view, deflate the balloon, and advance the wire without rotation to puncture the antegrade space. *Right/left are from the patient’s perspective. CART: controlled antegrade and retrograde tracking; LAO: left anterior oblique; RAO: right anterior oblique; WS: wire shaft; WT: wire tip

Reverse controlled antegrade and retrograde tracking (reverse CART) is the dominant crossing technique in a retrograde chronic total occlusion (CTO) intervention. Incorporating a three-dimensional (3D) wiring method into contemporary (directed) reverse CART can enhance the effective penetration force of the retrograde wire tip towards the antegrade space by (1) ensuring consistent and precise wire tip direction, (2) minimising wire manipulation to preserve virgin territory, which is crucial for retrograde wire support and control, and (3) enabling the safe use of higher penetration wires.

The “rotation-overlap” method offers a simplified 3D wiring approach that does not require orthogonal projections¹. When applied to directed reverse CART, this method consistently and precisely guides the retrograde wire tip towards the antegrade balloon with a single wire rotation. We will demonstrate the 3D reverse CART procedure step-by-step through this case.

A patient with refractory angina was referred for right coronary artery CTO intervention. Bilateral angiography revealed a diffusely diseased distal vessel (**Moving image 1**). Antegrade wiring with a Fielder XT-A (ASAHI INTECC) entered the extraplaque space, prompting a switch to a retrograde approach. After crossing the septal collateral, the retrograde wire entered the CTO segment intraplaque. To establish a connection, we performed 3D reverse CART using an antegrade 2.5 mm balloon and a retrograde Conquest Pro 12 wire (ASAHI INTECC) with the following steps:

- 1) Obtain two fluoroscopic views with different degrees of wire shaft (WS) and balloon separation: a far view (**Figure 1A**) and a closer view (**Figure 1B**). Orthogonal views are not needed.
- 2) Adjust the closer view for WS and balloon overlap.
- 3) Determine the WS anterior/posterior relationship to the balloon in the closer view by noting the direction of fluoroscopy rotation (towards or away from the WS) from the far to the closer view (see rotation-overlap rule in **Figure 1C** and **Figure 1D**). In this case, fluoroscopy moves towards the WS from the left anterior oblique (LAO; far) to the right anterior oblique (RAO; closer), making the WS anterior to the balloon in the RAO (closer) view (**Figure 1B**, **Moving image 2**).
- 4) With the wire tip pointing right and the WS anterior to the balloon in the closer view, counterclockwise rotation until the wire tip is centralised will direct it towards the balloon (**Figure 1E**, **Moving image 3**). The “CLARP” mnemonic

(Clockwise for Left Anterior and Right Posterior) aids in remembering the correct wire rotation (**Figure 1F**).

- 5) Confirm the wire tip direction in the far view. Deflate the balloon and advance the retrograde wire without rotation to puncture the antegrade space (**Figure 1G**, **Moving image 4**).

The retrograde wire was successfully externalised. The angiographic result was satisfactory after stenting (**Moving image 5**).

In summary, we present the 3D reverse CART technique, which enhances the consistency, precision, and effective penetration of the retrograde wire towards its target while minimising unnecessary manipulation in the periwire territory. Utilising a clear fluoroscopic endpoint, this method can work without the need for 1:1 wire torque transfer. It can be performed with flexible fluoroscopic projections, enabling seamless integration into contemporary reverse CART workflows with minimal additional steps. This technique has the potential to improve the efficiency, safety, and success of reverse CART procedures.

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Conflict of interest statement

The authors have no conflicts of interest to declare.

Reference

1. Leung C, Ho CB, Wong I, Fong E, Lee MKY, Chan AKC. “Rotation Overlap Method” for 3D Wiring in Chronic Total Occlusion. *JACC Case Rep.* 2025;30:102937.

Supplementary data

Moving image 1. Baseline angiogram.

Moving image 2. Resolve wire shaft-balloon relationship in the closer view.

Moving image 3. Determine “clockwise” versus “counterclockwise” to centralise the wire tip.

Moving image 4. Directed puncture of the antegrade space.

Moving image 5. Final angiographic result.

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