Antegradne Approach to Stumpless Chronic Total Occlusion of Ostial Left Anterior Descending Artery: First Using a Side Branch Cutting Technique

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Case Report

The approach to a chronic total occlusion (CTO) still remains one of the most technical challenges in percutaneous coronary intervention (PCI). CTO lesions with a blunt entry point, calcification, and failure of a previous approach, are the independent predictors of CTO-PCI failure. Here we report a successful antegrade approach for reattempted CTO-PCI of a left anterior descending artery (LAD) with unknown, calcified ostium. We used a novel side branch cutting technique, combined with intravascular ultrasound-guided wiring and parallel wire techniques. Considering the ramus artery as a side branch and dilating it with a cutting balloon was a crucial part of the strategy for achieving overall procedural success using this approach. This is the first report describing a side branch cutting technique in CTO-PCI. The combined application of multiple antegrade techniques, using the latest devices, might provide an effective and safe approach for complex CTO-PCI.

Case presentation

A 66-year-old man with a history of hypertension and hypercholesterolemia was admitted to our hospital, complaining of worsening effort dyspnea over five months. Three months previously, angiography had been performed at another hospital and showed ostial LAD-CTO with an unknown ostium, while there was no significant stenosis in the left circumflex or right coronary artery. At that time, CTO-PCI was attempted unsuccessfully.

After admission, laboratory tests showed no significant alterations of cardiac biomarkers. Stress myocardial perfusion imaging was performed, revealing severe left anterior and lateral wall ischemia (Figure 1A). Coronary computed tomography confirmed LAD-CTO with an unclear and
calcified ostium, grade 3 collateral flow from the distal posterolateral artery to the proximal LAD, and a first diagonal branch that could be visualized; unfortunately, the collaterals were severely tortuous (Figure 1B, 1C). Therefore, initially we planned to reattempt an antegrade approach. To provide strong support, an 8F XB 3.75 and a 6F left Amplatz1 guiding catheter (Cordis Corporation) were inserted to the bilateral femoral arteries for antegrade and retrograde access, respectively.

Since we were unable to identify the location of the ostial LAD by bilateral angiography (Figure 1D), a 40 MHz Atlantis IVUS catheter (Boston Scientific) was inserted into the proximal ramus artery (RA).
The proximal diameter of the RA was estimated to be about 2.5-3.0 mm, and the calcified LAD ostium was identified at the right side of the RA (Figure 2A, 2B). We kept the IVUS transducer in the proximal RA, where the entry point to the LAD-CTO could be visualized clearly. Attempts were made to puncture the entry point with different wires successively (SinoBlue, XT-R, Gaia1st, Gaia2nd, Asahi Intecc), but failed owing to the calcification of the entry point (Figure 2C). We inflated a $2.5 \times 12$ mm NC Quantum balloon (Boston Scientific) in the proximal RA at 16 atm, aiming to loosen the tissue at the LAD-CTO entry point, but this was unsuccessful. A $2.5 \times 10$ mm Flextome cutting balloon (Boston Scientific) was then introduced and inflated at 6 atm. The IVUS image showed that a small dissection had been made in the proximal RA, but the maneuver failed to loosen the entry point tissue (Figure 2D). Therefore, we inflated

Figure 2. A. The intravascular ultrasound (IVUS) catheter is introduced to the proximal ramus artery (RA) to identify the entry point of the chronic total occlusion in the LAD. B. Severe calcification in the proximal RA; the LAD ostium is on the right side of the RA. C. Failure to puncture the entry point under IVUS guidance. D. A dissection is made in the RA by a 2.5 mm cutting balloon, but fails to loosen the entry point tissue.
a 3.0 × 10 mm Flextome balloon at 6 atm. The IVUS image showed a focal dissection in the proximal RA, which had loosened the entry point tissue significantly (Figure 3A). At this point, we made another attempt to puncture the entry point with a Gaia₁st wire (Tip: 0.26 mm, 1.5 g) supported by a corsair catheter (Asahi Intecc). The wire punctured the entry point successfully and was advanced to the mid LAD (Figure 3B, 3C).

However, bilateral angiography from two orthogonal views showed that the Gaia₁st was in the false lumen (Figure 3D). Subsequently, the false lumen was dilated with a 2.0 × 15 mm sprint balloon (Medtronic LTD) at 4 atm and the IVUS catheter was advanced into it (Figure 4A). Under real time IVUS guidance, a parallel Gaia₂nd wire was introduced (Tip: 0.28 mm, 4.5 g), supported by a crusade microcatheter (characteristic double lumen for bifurcation or parallel wiring,

Figure 3. A. A focal dissection is created in the RA by a 3.0 mm cutting balloon and the entry point tissue is loosened. B. The entry point is punctured successfully under IVUS guidance. C. Right anterior oblique and cranial view shows that the Gaia₁st wire appears to be in true lumen. D. However, the left anterior oblique and cranial view shows that the Gaia₁st wire is in false lumen.
KANEKA). Ultimately, the Gaia_{2nd} was advanced into the distal LAD, and bilateral angiography confirmed it was in the true lumen (Figure 4B). The Gaia_{2nd} was then exchanged for a SinoBlue, and the distal and proximal LAD were dilated. IVUS images confirmed that the Gaia_{2nd} was in true lumen, whereas the Gaia_{1st} was in the subintimal space and caused a large hematoma in the proximal LAD (Figure 4C, 4D). Two Xience Prime stents (Abbott Vascular), 3.5 × 15 mm and 2.5 × 15 mm, were implanted from the ostial to mid LAD. Final IVUS images showed that the stents were expanded well, while no stenosis was observed at the ostia of the left circumflex artery or RA (Figure 5A-5D).

The patient has been followed up for three months, is currently receiving regular medical therapy, and is free of chest pain and dyspnea.

Figure 4. A. Dilation of the false lumen with a 2.0 mm balloon so that the IVUS catheter may be inserted. B. The distal part of the Gaia_{2nd} wire is in true lumen. C. Confirms that the Gaia_{2nd} wire is in true lumen at position a, whereas the Gaia_{1st} wire is in the subintimal space. D. A large subintimal hematoma at position b, caused by the Gaia_{1st} wire.
Discussion

According to the J-CTO study and other previously published reports, CTO lesions with blunt entry, calcification, previous approach failure, length >20 mm, or bending >45° are independent predictors of CTO-PCI failure.9-11 The antegrade approach to CTO-PCI still poses some technical challenges in complex lesions. The most common reason for failure is the failure of the guide wire to cross the CTO segment successfully. Combined application of several antegrade techniques could improve the success rate of complex CTO-PCI.12

In general, bilateral angiography may help to identify an entry point to the CTO, despite it being stumpless; however, it was unsuccessful in this case. In such situations, IVUS guidance can identify the entry point of the CTO, allowing it to be punctured.

Figure 5. A, B. The final result after stenting. C, D. IVUS images show no compromise of the RA and left circumflex artery ostia after stenting.
by wires;\textsuperscript{13-14} moreover, after a small balloon is inflated in the false lumen, IVUS can be used to guide the manipulation of a parallel wire.

Under IVUS guidance, however, the calcified ostium of the CTO prevented the puncture of the entry point. We thus considered the RA as a side branch and, after a non-compliant balloon failed, inflated a cutting balloon to make a dissection in the RA, loosening the entry point tissue significantly. We were finally able to puncture the entry point successfully. In this condition, the characteristic design of the cutting balloon has other advantages over non-compliant balloons: low pressure dilation minimized the lesions of the side branch, creating benign type A and focal dissections, while loosening the entry point tissue significantly. Overall, the use of this novel side branch technique was a crucial strategy in treating this type of case.

The parallel wire technique is very useful when the first wire enters false lumen.\textsuperscript{15} In general, the second wire should be stiffer and more torqueable. In this case, we selected a Gaia\textsubscript{2nd} wire, which was tapered, stiffer, and hydrophilic-coated.

In conclusion, this novel side branch cutting technique could be used effectively and safely in CTO-PCI, especially for a CTO with the morphology of a calcified and unknown ostium. The combined application of multiple antegrade techniques and the latest devices might provide an effective and safe approach for complex CTO-PCI cases, where a retrograde approach is not feasible.

References