RESEARCH PAPER

Seeing Beyond The Wire : Intraluminal Navigation with IVUS in CTO PCI

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ABSTRACT

Background: Chronic total occlusion (CTO) percutaneous coronary intervention (PCI) remains one of the most technically demanding procedures in interventional cardiology. Procedural success is highly dependent on accurate guidewire tracking; however, angiography alone is often insufficient to distinguish intraluminal from subintimal wire passage, potentially leading to dissection, perforation, or inappropriate stent deployment. Intravascular ultrasound (IVUS) provides real-time, high-resolution cross-sectional imaging that enables precise assessment of wire position and plaque morphology.

Case Presentation: We report a case of a 46-year-old male with triple-vessel coronary artery disease, including proximal right coronary artery (RCA) CTO, who underwent elective CTO PCI. Multiple antegrade wiring attempts raised concern for subintimal tracking. IVUS guidance confirmed true lumen navigation, enabling safe lesion preparation and optimal stent deployment. Final angiography demonstrated TIMI III flow without complications.

Conclusion: This case highlights the critical role of IVUS in confirming intraluminal guidewire position during complex CTO PCI. IVUS-guided PCI enhances procedural safety, optimizes stent placement, and should be considered standard practice in anatomically ambiguous or high-risk CTO lesions..

Keywords: Chronic total occlusion, IVUS, CTO PCI, intraluminal wiring, imaging-guided PCI.

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INTRODUCTION

Percutaneous coronary intervention for chronic total occlusion (CTO PCI) represents one of the most complex subsets of contemporary coronary interventions. Despite advances in guidewire technology and dedicated CTO techniques, procedural failure and complications remain significant, particularly in lesions with ambiguous proximal caps, diffuse disease, or extensive calcification. One of the principal challenges in CTO PCI is ensuring true lumen guidewire passage. Angiography, a two-dimensional luminographic modality, frequently fails to reliably differentiate intraluminal from subintimal wire tracking.

Intravascular ultrasound (IVUS) offers high-resolution, cross-sectional visualization of the vessel lumen and arterial wall, allowing accurate assessment of guidewire position, plaque composition, vessel size, and landing zones. Accumulating evidence demonstrates that IVUS-guided CTO PCI is associated with higher technical success rates, reduced complications, and improved long-term outcomes compared with angiography-guided approaches. We present a case illustrating the pivotal role of IVUS in confirming intraluminal wire navigation during complex RCA CTO PCI.

CASE PRESENTATION

Clinical History and Presentation

A 46-year-old male with a history of hypertension and heart failure with mildly reduced ejection fraction (left ventricular ejection fraction 46.9%) presented with recurrent exertional angina. He had experienced multiple prior hospitalizations despite optimal medical therapy. Coronary angiography revealed triple-vessel coronary artery disease, consisting of a proximal CTO of the right coronary artery (RCA), a critical 99% stenosis in the mid left anterior descending artery (LAD), and severe stenosis of the left circumflex artery (LCx). The RCA demonstrated diffuse disease extending from the ostium to the distal segment, with bridging collaterals originating from the sinus node branch. The proximal cap morphology was ambiguous, making angiographic assessment of wire position challenging.

Given persistent symptoms and anatomical suitability, the patient was scheduled for elective CTO PCI of the RCA.

Procedural Details

An antegrade approach was selected. Initial wiring attempts were performed using a Runthrough NS Hypercoat guidewire, followed sequentially by Miracle 3 and Miracle 6 guidewires, with microcatheter support. Despite apparent distal progression on angiography, multiple failed attempts raised suspicion of subintimal wire passage. Distal contrast injection through the microcatheter suggested possible side-branch entry rather than true lumen tracking.

After cautious proximal balloon dilatation using a 2.0 × 12 mm balloon at incremental pressures, distal vessel visualization improved. A second guidewire (Asahi Sion Blue) was advanced toward the distal RCA; however, angiographic confirmation of true lumen position remained uncertain.

To resolve this ambiguity, IVUS imaging was performed using an OptiCross 3.0F catheter advanced over the second guidewire. IVUS demonstrated that the guidewire was located within the true lumen, with visualization of calcified

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and fibrotic plaque components. The first wire was observed entering the acute marginal branch, while the IVUS-guided wire maintained intraluminal position toward the distal RCA.

Following IVUS confirmation, lesion preparation was performed with a 3.0 × 20 mm balloon at stepwise inflation pressures. Two sirolimus-eluting drug-eluting stents were subsequently deployed: a 3.5 × 20 mm stent in the mid-to-distal RCA and a 4.0 × 35 mm stent in the proximal-to-mid RCA. Final angiography demonstrated optimal stent expansion and apposition with restoration of TIMI III flow. No procedural complications occurred, despite a high radiation dose (dose-area product 76,871 Gy·cm²).

DISCUSSION

This case underscores several important aspects of contemporary CTO PCI. First, angiographic appearance alone may be misleading in assessing guidewire position, particularly in long, calcified, or ambiguous CTO lesions. Subintimal wiring may appear acceptable angiographically yet predispose to vessel perforation, extensive dissection, or inappropriate stent deployment.

Second, IVUS provided decisive real-time confirmation of intraluminal wire navigation in this patient, allowing the operator to proceed with confidence. Beyond wire position verification, IVUS enabled detailed assessment of plaque morphology and vessel dimensions, guiding appropriate stent sizing and landing zone selection. This imaging-guided strategy likely contributed to the favorable procedural outcome and absence of complications.

Recent studies and meta-analyses have demonstrated that IVUS-guided CTO PCI is associated with higher procedural success and lower rates of major adverse cardiac events compared with angiography-guided interventions. Contemporary guidelines from the European Society of Cardiology advocate the use of intravascular imaging in complex coronary interventions, including CTOs with ambiguous anatomy.

CONCLUSION

Intravascular ultrasound plays a crucial role in modern CTO PCI by enabling accurate confirmation of intraluminal guidewire tracking, optimizing stent deployment, and reducing procedural risk. In complex or angiographically ambiguous CTO lesions, IVUS guidance should be strongly considered as a standard component of the interventional strategy to improve both immediate and long-term outcomes..

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