JACC: CASE REPORTS VOL. 30, NO. 5, 2025

CORONARY, PERIPHERAL, AND STRUCTURAL INTERVENTIONS

TECHNICAL CORNER

Side-Branch Intravascular Lithotripsy for an Uncrossable Chronic Total Occlusion

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ABSTRACT

This case describes percutaneous coronary intervention of a chronic total occlusion of the right coronary artery at the RV marginal bifurcation that was wire-uncrossable until plaque modification with side branch intravascular lithotripsy into the right ventricular marginal allowed crossing. (JACC Case Rep. 2025;30:103175) © 2025 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Chronic total occlusions (CTOs) represent one of the most challenging subsets within complex high-risk interventional procedures in interventional cardiology. These lesions are particularly challenging owing to morphologic lesion characteristics often associated with significant calcification, which has been proven to be an independent predictor of procedural success and complications.[1-3] CTO lesions with significant calcium are technically more challenging, requiring operators to be well-trained in dissection re-entry and retrograde techniques that are associated with higher risk and require more expertise. Even in experienced hands, however, some lesions cannot be crossed with a wire owing to an impenetrable proximal cap and result in procedural failure.

LEARNING OBJECTIVES

- To understand the use of side branch IVL for proximal cap modification in CTO
- To learn about different modalities for calcium modification in this case

HISTORY OF PRESENTATION AND MEDICAL HISTORY

A 76-year-old man was referred from his community cardiologist for a diagnostic coronary angiogram owing to symptomatic Canadian Cardiovascular Society class 3 angina. His comorbidities include type 2 diabetes mellitus, atrial fibrillation, and hypercholesterolemia.

INVESTIGATIONS

An initial angiogram via the right radial approach revealed mild coronary disease in the left system and a subtotally occluded dominant right coronary artery (RCA) with a calcified nodule in its mid segment. There was no significant obstructive disease in the left circulation. An initial attempt to cross the lesion using standard coronary wires including polymer jackets was unsuccessful and the plan was for the

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

Manuscript received September 10, 2024; revised manuscript received November 7, 2024, accepted November 18, 2024.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2024.103175

JACC: CASE REPORTS, VOL. 30, NO. 5, 2025
MARCH 5, 2025:103175

ABBREVIATIONS AND ACRONYMS

CTO = chronic total occlusion

ELCA = excimer laser coronary atherectomy

IVL = intravascular lithotripsy

IVUS = intravascular ultrasound

RCA = right coronary artery

patient to have a trial of guideline-directed medical therapy.

Owing to ongoing symptoms, a repeat angiogram was performed 1 year later and demonstrated a CTO of the mid RCA with a J-CTO score of 3 and evidence of Rentrop 2 collateralization from the left system (Figure 1, Video 1). The decision was made to proceed with percutaneous coronary intervention.

MANAGEMENT

Dual access was obtained using an 8-F AL1 guide in the RCA via the right femoral artery under ultrasound guidance, alongside a 6-F JL3.5 guide for the left coronary system via the radial artery. For optimal support, a 7-F Trapliner and a Turnpike Spiral 135 cm were also used. We started with an antegrade wire escalation strategy using a Pilot 50, followed by a Gaia Third and despite escalating to a high penetration wire of 14-G, we were unable to cross the calcified proximal cap (Figure 2A). A workhorse wire was subsequently placed in the adjacent RV branch and intravascular lithotripsy (IVL) with a 3.0-mm balloon with 80 pulses was performed to modify the proximal cap (Figure 2B). We were then able to easily cross the lesion with a Gaia Third wire. Unfortunately, a turnpike spiral and LP catheters would not cross proximal cap. As a result, we used an excimer laser coronary atherectomy (ELCA) with a 0.9-mm catheter to further modify the lesion (Figure 3).

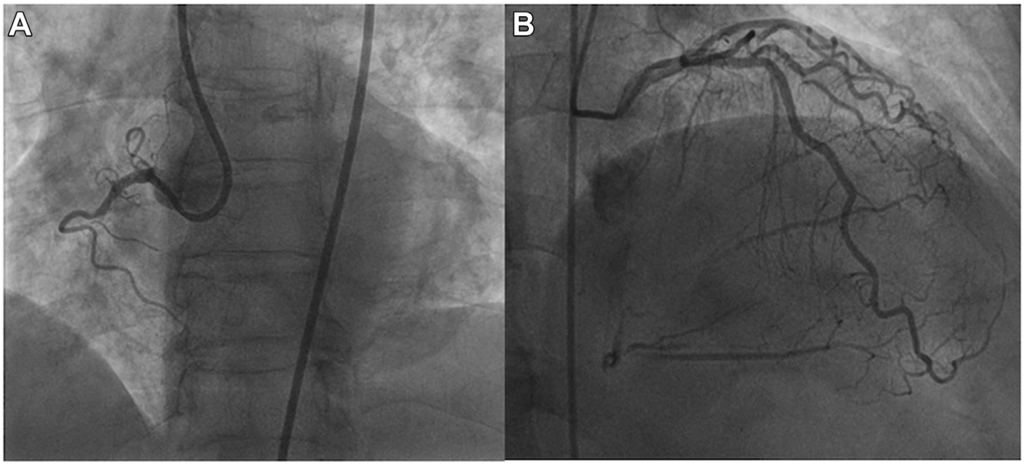
We were then able to cross the lesion with 2.0 and 2.5 noncompliant balloons. However, these balloons would not expand (Figure 4) and further balloons would not cross after this. We therefore elected to perform rotational atherectomy with a 1.5-mm burr (Video 2). Subsequent intravascular ultrasound (IVUS) examination revealed significant calcium and extensive calcified nodules that did not respond to noncompliant balloons, prompting further plaque modification with a 4.0-mm IVL catheter (Figures 5 and 6, Video 3).

After this, a 3.5-mm drug-eluting stent was deployed in the distal RCA and this was overlapped with three additional 4.0 mm drug-eluting stent proximally (Figure 7). IVUS evaluation after percutaneous coronary intervention demonstrated significant distal stent under-expansion (Figure 8, Video 4). This was further optimized using a 3.5-mm OPN balloon, achieving great results (Figure 9, Video 5).

DISCUSSION

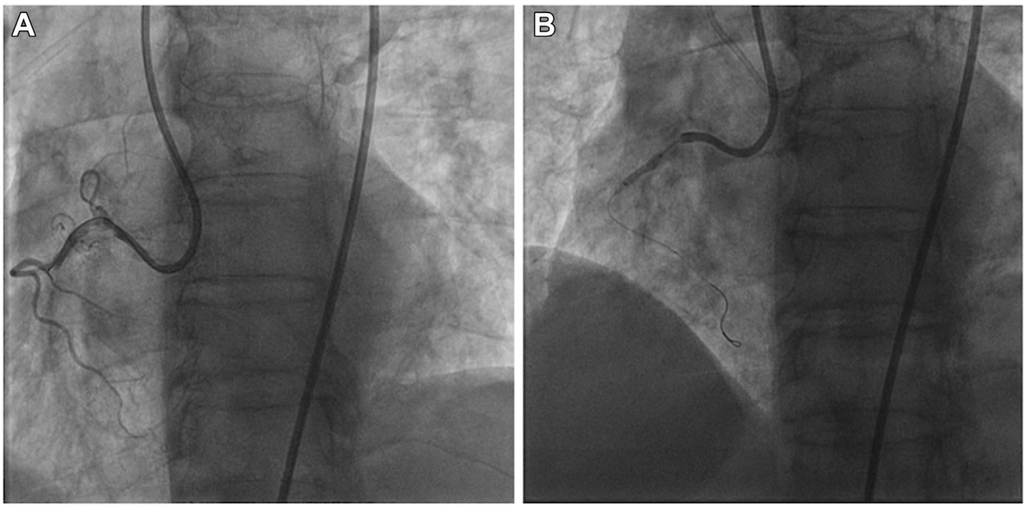
This case highlights an approach to the wire uncrossable lesion owing to calcification (Figure 10). Side branch IVL to modify the proximal cap seems to

FIGURE 1 Initial Angiogram



(A) Chronic total occlusion of right coronary artery. (B) Collaterals from left system.

FIGURE 2 **IVL in Adjacent RV Branch to Modify Uncrossable Proximal Cap**



(A) Uncrossable proximal cap. (B) Intravascular lithotripsy balloon in the right ventricular branch.

be safe and was effective in this case. This technique, which was previously described by Elshaba et al,[4] is proven to facilitate antegrade wiring.

Forward-facing IVL may be a significant future advance in the CTO tool box.

IVL is a straightforward yet effective balloon technology that uses pulsatile sonic pressure waves, converting them into mechanical energy to fracture calcific plaque.[5] This enabled penetration of the proximal cap with an intermediate stiffness wire.

Additional therapies for balloon uncrossable lesions were highlighted in this case with the use of

FIGURE 3 **Successful Antegrade Crossing of Lesion and Excimer Laser Coronary Atherectomy therapy**

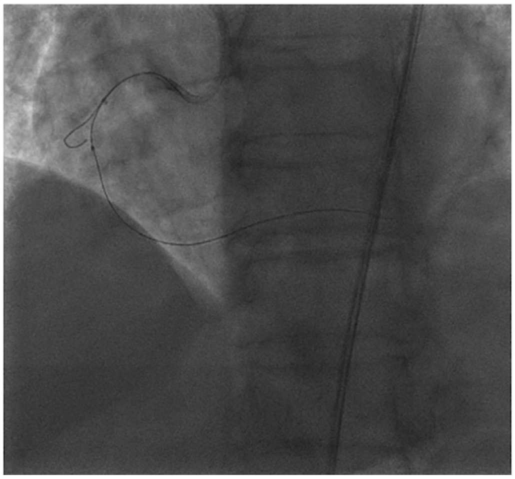


FIGURE 4 **Significant Wasting Noted With 2.0 Noncompliant Balloon**

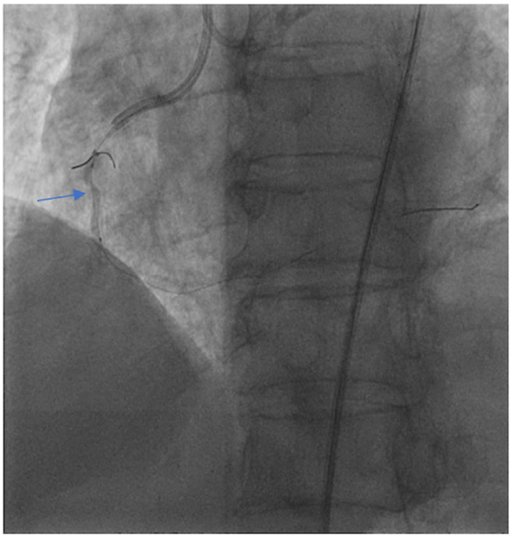
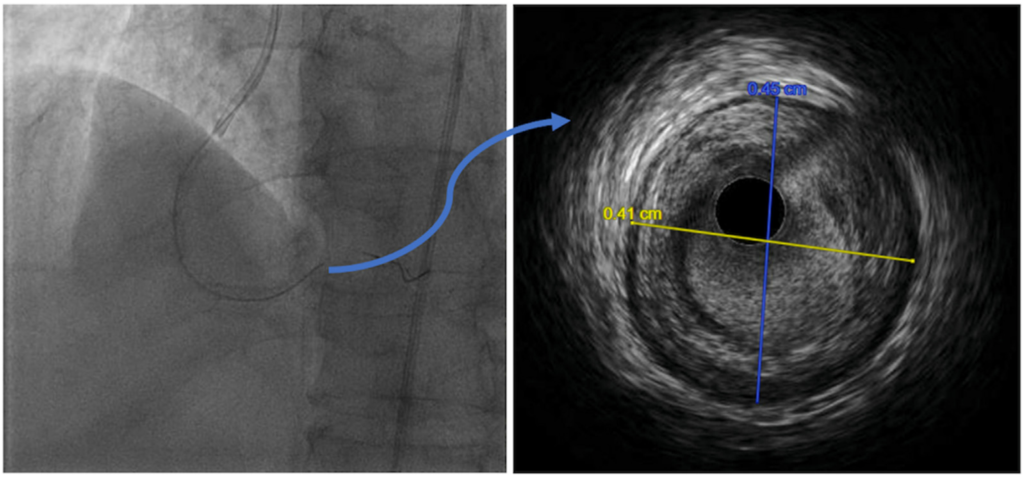


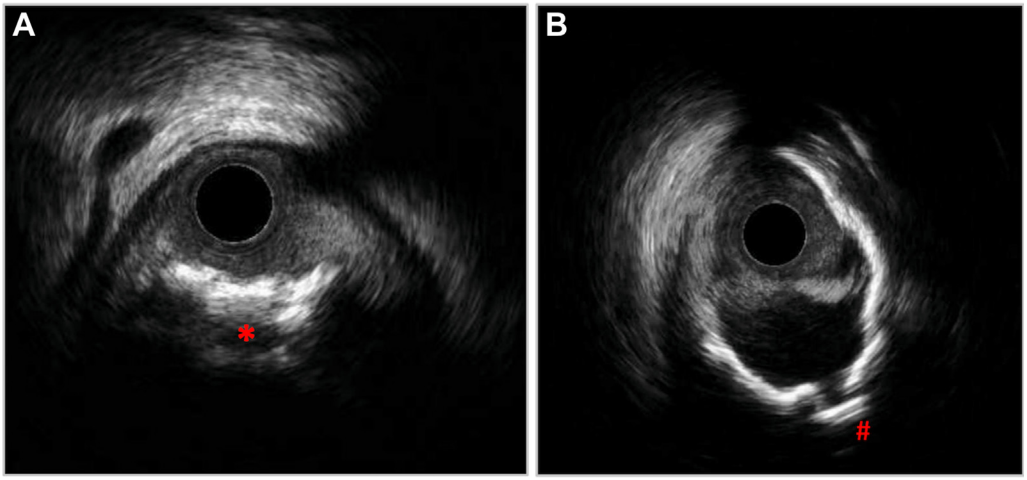
FIGURE 5 Distal Reference on Intravascular Ultrasound of approximately 4.0 mm in diameter



ELCA. ELCA uses light amplification by stimulated emission of radiation, or LASER, to modify and ablate tissues via disruption of molecular bonds.[6] ELCA has a main advantage of being compatible with various guidewires, making it a versatile tool.

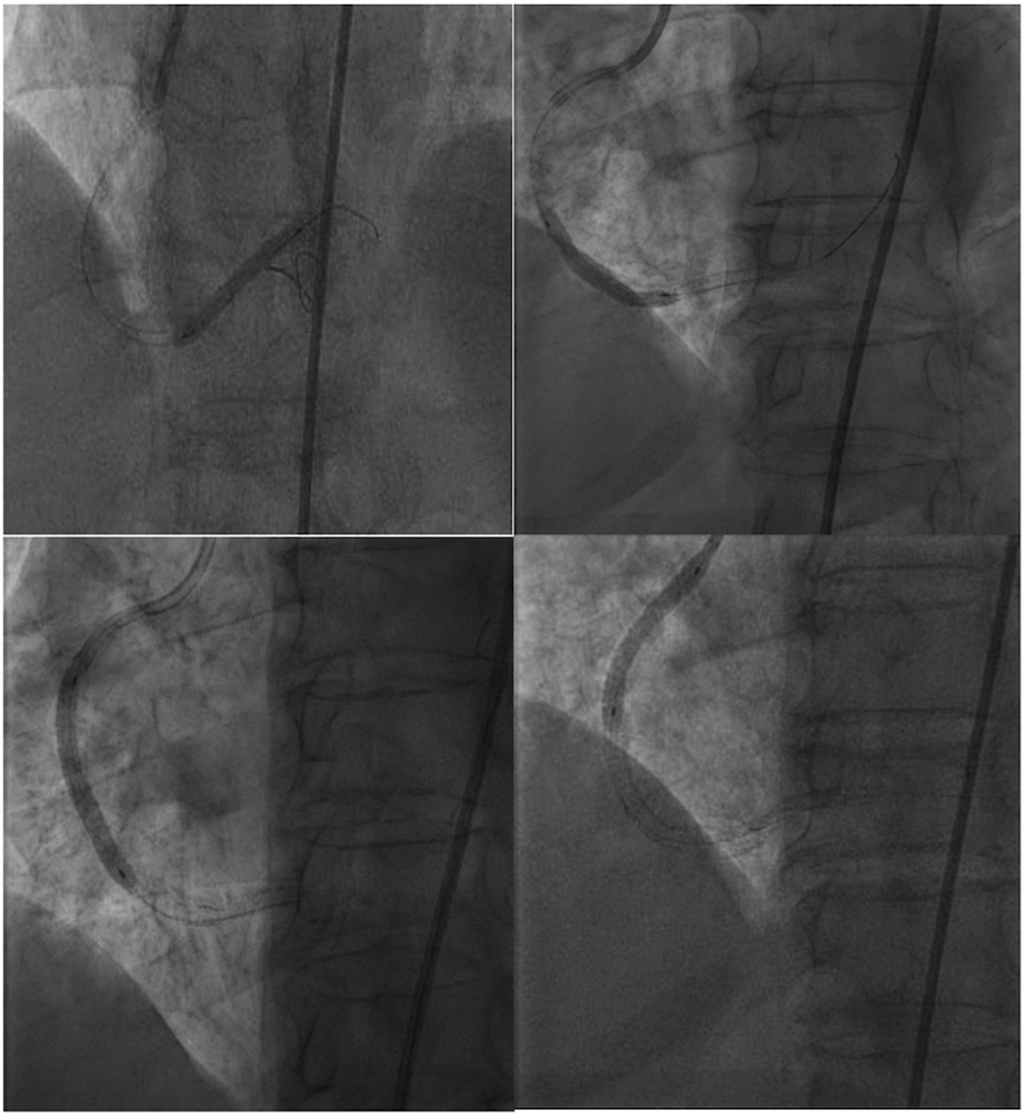
In addition, we used rotational atherectomy with a 1.5-mm burr for further calcified plaque modification. IVUS offered valuable insights into the underlying plaque characteristics and vessel dimensions, guiding subsequent interventions. Underscoring the importance of IVUS, it revealed previously unappreciated calcified nodules, prompting tailored balloon selection for optimal plaque modification.

FIGURE 6 Significant Calcification and Successful Calcium Modification Observed on IVUS



(A) Calcified nodule (*). (B) A 270° arc of calcium and evidence of fracture (#) after ELCA and rotablation. ELCA = excimer laser coronary atherectomy.

FIGURE 7 Overlapping Drug-Eluting Stent Deployment

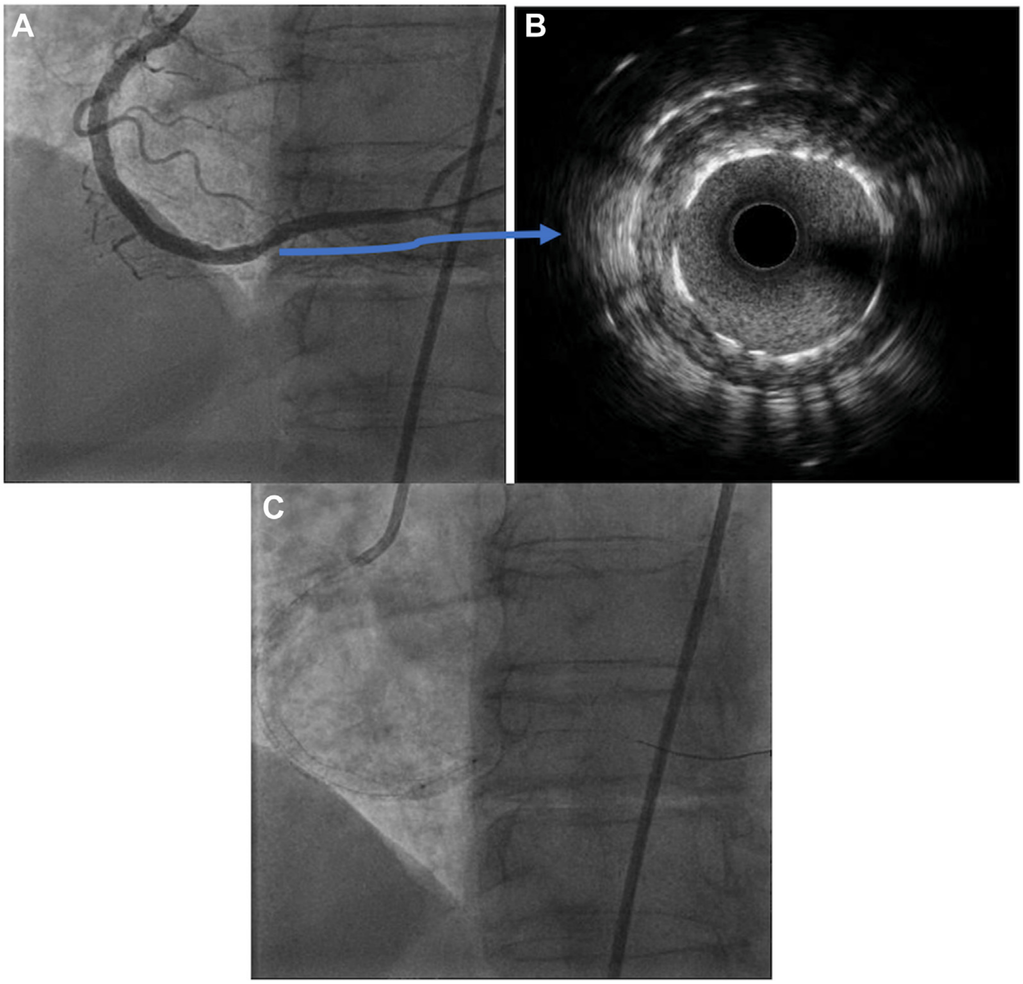


CONCLUSIONS

Wire-uncrossable lesions represent the toughest challenges in CTO percutaneous coronary intervention. Our case demonstrates how side branch IVL is an effective technique for modifying the proximal cap. It also illustrates how the strategic application of innovative technologies can facilitate successful revascularization of a wire-uncrossable lesion.

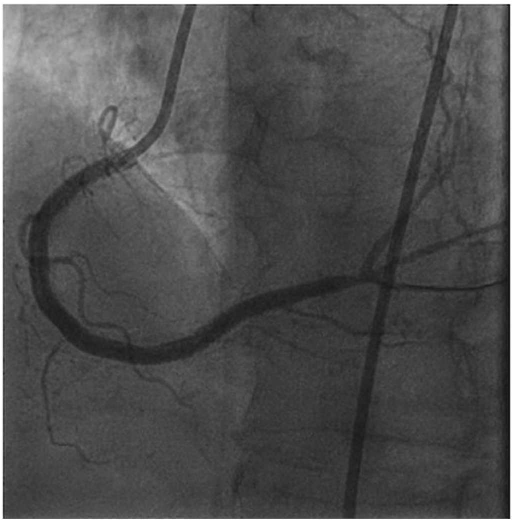
JACC: CASE REPORTS, VOL. 30, NO. 5, 2025
MARCH 5, 2025:103175

FIGURE 8 **Stent Underexpansion Treated With OPN Balloon**



(A) Wasting noted in the distal stent. (B) intravascular ultrasound demonstrating stent underexpansion. (C) Post-dilatation with a 3.5-mm OPN balloon.

FIGURE 9 Final Angiographic Image



FUNDING SUPPORT AND AUTHOR DISCLOSURES

Dr Jolly has received institutional grants from Boston Scientific and honoraria from Penumbra, Teleflex, Boston Scientific, Shockwave and Abiomed. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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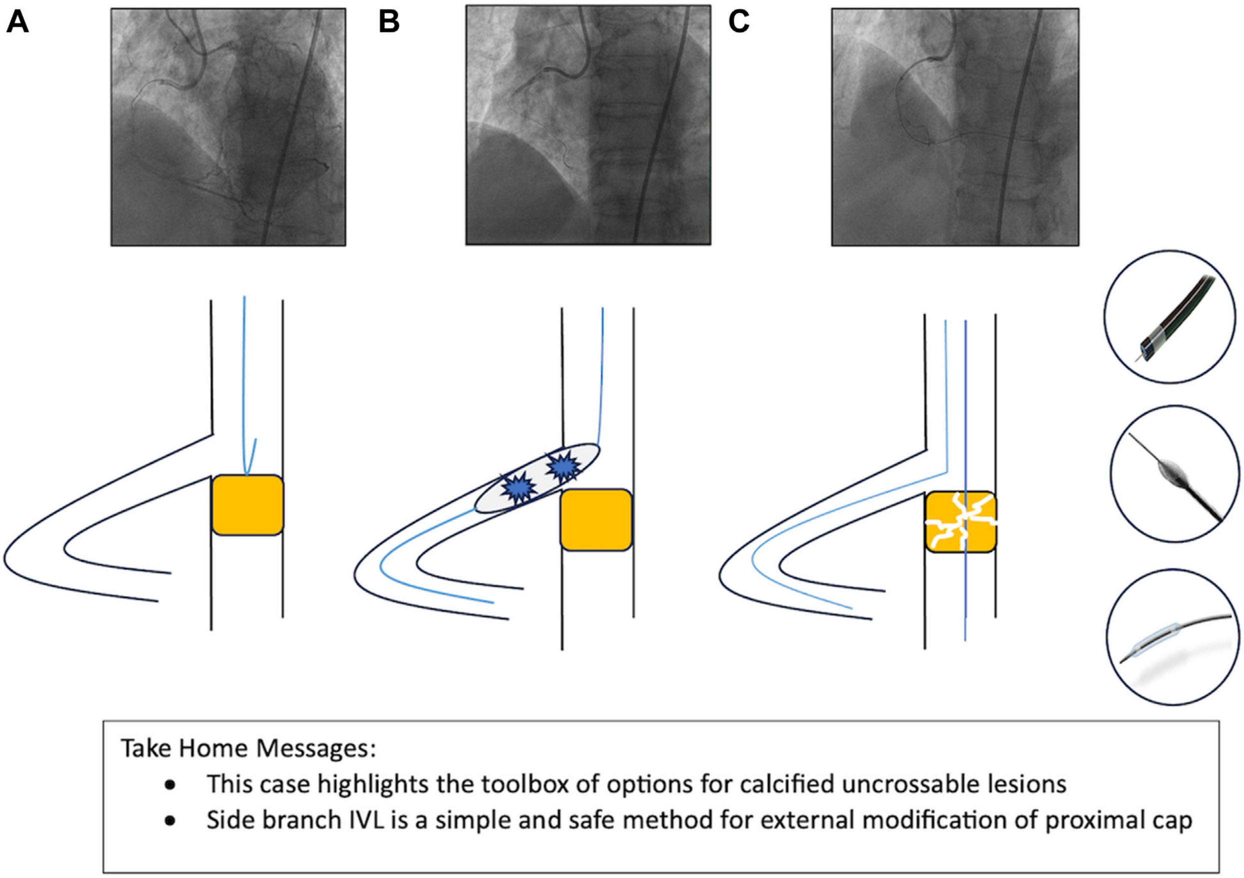
FIGURE 10 Illustration of Successful Antegrade Wiring Following Side Branch IVL Modification of an Uncrossable Proximal Cap



(A) Wire-uncrossable proximal cap. (B) Intravascular lithotripsy catheter in the right ventricular branch for proximal cap modification. (C) Successful antegrade wiring facilitating further calcium plaque modification.

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KEY WORDS chest pain, intravascular ultrasound, percutaneous coronary intervention

APPENDIX For supplemental videos, please see the online version of this paper.