

Case Report

IVUS-guided RotaShock PCI with SoniCracker for an eruptive calcified nodule in the left anterior descending artery: A challenging case report from Rajavithi Hospital, Thailand

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Abstract

Severely calcified coronary lesions remain among the most challenging subsets in percutaneous coronary intervention (PCI). Calcified nodules are an uncommon but clinically important form of coronary calcification associated with device-delivery difficulty, stent underexpansion, procedural failure, and adverse outcomes. Rotational atherectomy modifies superficial calcium and facilitates device crossing but has limited ability to fracture deep calcium, whereas intravascular lithotripsy (IVL) can fracture deep calcium but may be difficult to deliver across tight, undilatable lesions. The aim of this case report was to describe a 72-year-old Thai man with chronic coronary syndrome and multivessel coronary artery disease who had a previously unsuccessful balloon angioplasty for a heavily calcified proximal-to-mid left anterior descending artery (LAD) lesion. One month later, staged PCI was performed using an intravascular ultrasound (IVUS)-guided RotaShock strategy. Rotational atherectomy with a 1.5-mm burr was performed first to facilitate device delivery. Post-atherectomy IVUS demonstrated extensive superficial and deep circumferential calcium with a prominent protruding calcific mass consistent with an eruptive calcified nodule phenotype. SoniCracker IVL was subsequently performed, producing multiple calcium fractures on repeat IVUS. Two drug-eluting stents were implanted and optimized under IVUS guidance, resulting in satisfactory stent expansion and apposition with a minimum stent area of 10.5 mm² and final Thrombolysis in Myocardial Infarction (TIMI) grade 3 flow without procedural complications. This case demonstrates the immediate technical feasibility of a complementary rotational atherectomy-plus-IVL strategy for a complex, balloon-undilatable calcified LAD lesion and illustrates the role of intravascular imaging in guiding sequential calcium modification.

Keywords: Coronary calcification, calcified nodule, intravascular imaging, rotational atherectomy, intravascular lithotripsy

Introduction

Coronary artery calcification is increasingly encountered during contemporary percutaneous coronary intervention (PCI) because of aging populations and the growing prevalence of diabetes mellitus, chronic kidney disease, and other cardiovascular risk factors [1,2]. Severe coronary calcification is associated with impaired device delivery, inadequate lesion expansion, stent



underexpansion, and worse short- and long-term clinical outcomes [1,2]. Calcified nodules are relatively uncommon but a particularly challenging phenotype of coronary calcification. Histopathologically, they consist of disrupted calcific plates with protruding nodular calcium extending into the vessel lumen, frequently resulting in marked luminal narrowing and resistance to conventional balloon angioplasty [3]. When eruptive, these lesions often exhibit extensive superficial and deep calcium, making adequate plaque modification difficult with a single calcium-modification device [3].

Intravascular imaging has become indispensable for evaluating lesion morphology, defining calcium distribution, and selecting the optimal calcium-modification strategy [4-7]. Rotational atherectomy primarily ablates superficial calcium and facilitates device crossing but has limited ability to fracture deeper calcium. Conversely, intravascular lithotripsy (IVL) generates acoustic pressure waves that preferentially fracture deep calcium while minimizing vessel trauma through low-pressure balloon inflation [4-7]. However, IVL devices may not cross severely stenotic or undilatable lesions without prior plaque modification. The combination of rotational atherectomy and IVL, commonly referred to as the RotaShock strategy, has recently emerged as a complementary approach for treating complex calcified coronary lesions. Rotational atherectomy creates an initial lumen for device delivery, whereas IVL further modifies residual deep calcium, improving vessel compliance and facilitating optimal stent expansion [8-15].

The aim of this case report was to report a complex balloon-undilatable proximal-to-mid left anterior descending artery (LAD) lesion in which post-atherectomy intravascular ultrasound (IVUS) demonstrated a protruding calcific mass consistent with an eruptive calcified nodule phenotype and extensive superficial and deep circumferential calcium. The lesion was treated using an IVUS-guided RotaShock strategy incorporating SoniCracker IVL. Although rotational atherectomy followed by IVL has been described previously, this case illustrates the use of SoniCracker-based IVL as part of a mechanism-based sequential calcium-modification strategy in this lesion phenotype.

Case

Clinical presentation and prior revascularization

A 72-year-old Thai man with hypertension and dyslipidemia presented with chest pain on exertion and was diagnosed with chronic coronary syndrome. Coronary angiography demonstrated triple-vessel coronary artery disease: non-significant left main disease; heavily calcified 90–95% stenosis involving the proximal-to-mid left anterior descending artery (LAD), with ectatic change in the mid LAD; heavily calcified 60–70% stenosis of the mid left circumflex artery (LCx); and heavily calcified 30–40% stenosis of the proximal right coronary artery (RCA), with chronic total occlusion of the posterior descending artery receiving collateral flow from the left coronary system (**Figure 1A-D**).

Since the patient declined coronary artery bypass grafting (CABG), percutaneous revascularization was pursued. An initial plain old balloon angioplasty (POBA) attempt of the LAD was unsuccessful because the lesion was balloon-undilatable; despite repeated inflation with a 2.0×15 mm semi-compliant balloon, a 2.5×12 mm non-compliant balloon subsequently ruptured after multiple inflations (**Figure 1E-F**). Repeat PCI of the LAD was performed one month later using an intravascular imaging-guided RotaShock strategy.

On admission, blood pressure was 135/62 mmHg, heart rate was 88 beats/min with an irregular rhythm, respiratory rate was 16 breaths/min, body temperature was 36.5°C, and physical examination was otherwise unremarkable without signs of heart failure. Electrocardiography demonstrated atrial fibrillation at approximately 60 beats/min with poor R-wave progression (**Figure 2A**). Chest radiography showed cardiomegaly without pulmonary congestion (**Figure 2B**). Transthoracic echocardiography revealed a preserved left ventricular ejection fraction of 70%, hypokinesia of the anterior and anteroseptal walls, and mild mitral regurgitation.

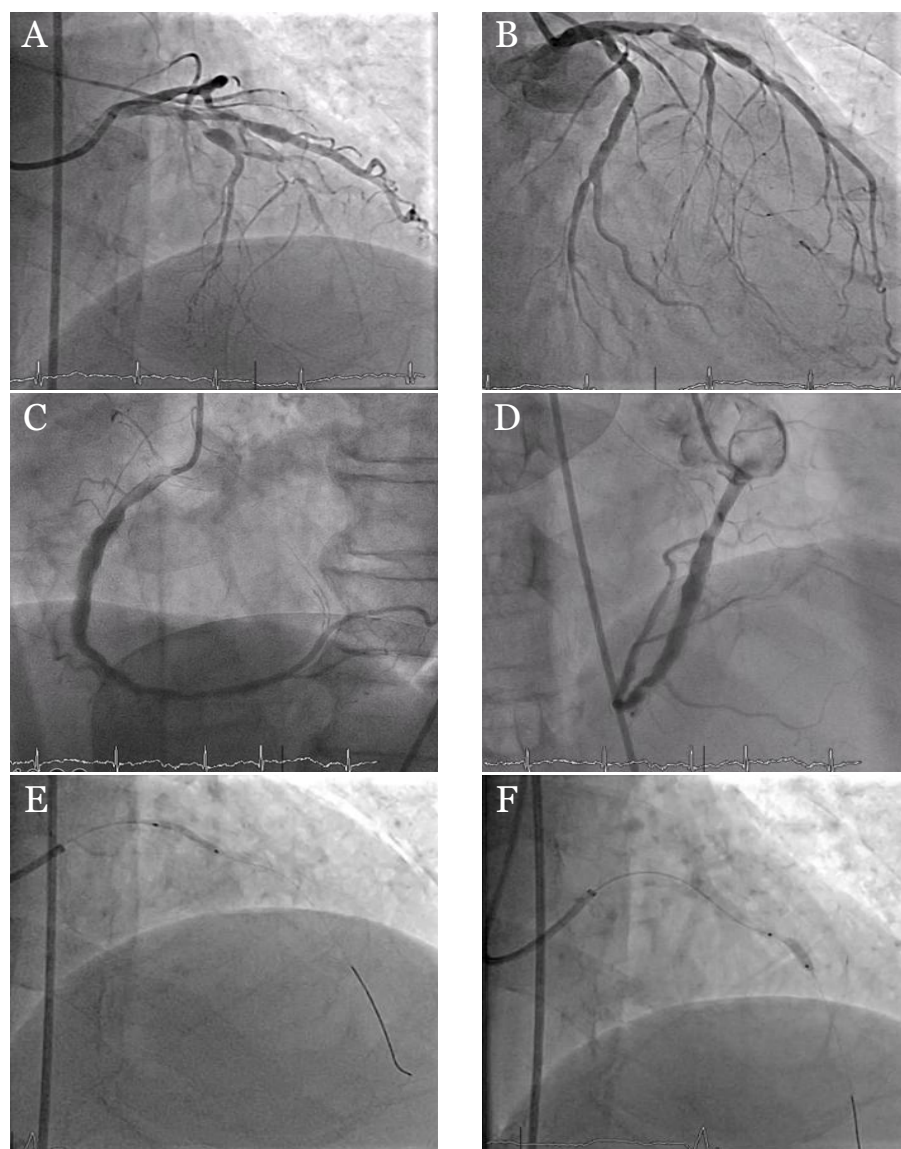


Figure 1. Baseline coronary angiography and failed balloon angioplasty of a severely calcified left anterior descending artery (LAD) lesion. (A-B) Non-significant left main disease; heavily calcified 90–95% stenosis involving the proximal-to-mid LAD with ectatic change in the mid LAD; heavily calcified 60–70% stenosis of the mid left circumflex artery (LCx). (C-D) Heavily calcified 30–40% stenosis of the proximal right coronary artery (RCA) with chronic total occlusion of the posterior descending artery receiving collateral flow from the left coronary system. Failed balloon angioplasty of the proximal-to-mid LAD. The lesion remained undilatable despite repeated inflation with a 2.0×15 mm semi-compliant balloon (E), followed by rupture of a 2.5×12 mm non-compliant balloon after multiple inflations (F).

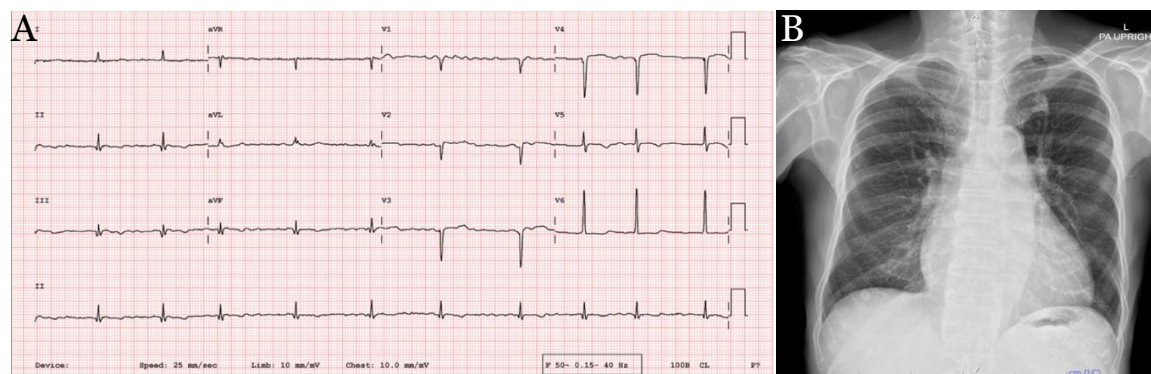


Figure 2. Baseline electrocardiography and chest radiographic findings. (A) Electrocardiography demonstrates atrial fibrillation at approximately 60 beats/min with poor R-wave progression. (B) Chest radiography indicates cardiomegaly without pulmonary congestion.

Staged PCI procedure

The patient underwent IVUS-guided PCI using a RotaShock strategy. A RotaWire guidewire (Boston Scientific Corporation, Maple Grove, MN, USA) was advanced into the LAD, followed by rotational atherectomy with a 1.5-mm burr at 180,000 rpm for eight runs (**Figure 3A**). A microcatheter was subsequently advanced to facilitate wire exchange after rotational atherectomy.

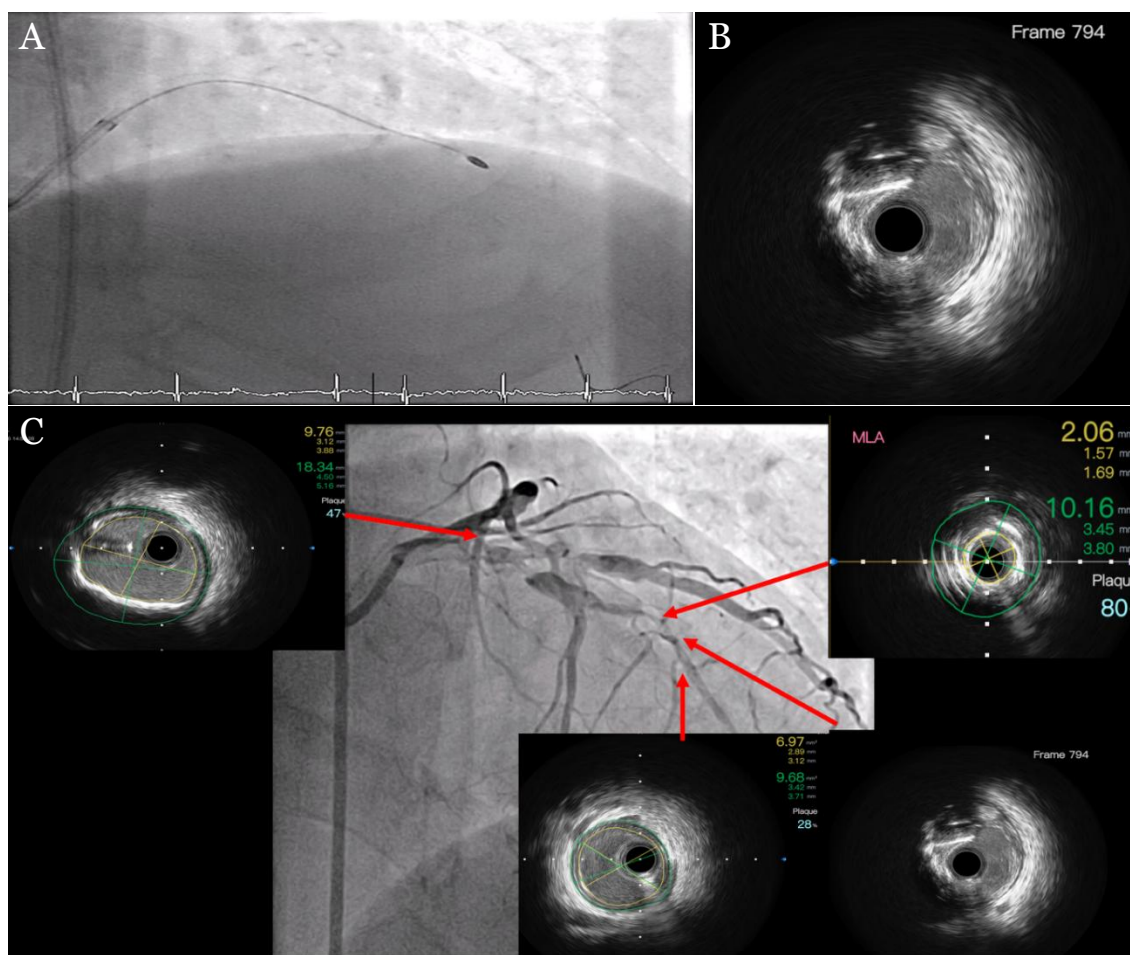


Figure 3. Rotational atherectomy and post-atherectomy intravascular ultrasound (IVUS) assessment of the calcified left anterior descending artery (LAD) lesion. (A) A RotaWire guidewire was advanced into the LAD, followed by rotational atherectomy with a 1.5-mm burr at 180,000 rpm for eight runs. (B) Post-atherectomy IVUS image showing a prominent protruding calcific mass consistent with an eruptive calcified nodule phenotype. (C) Post-atherectomy IVUS demonstrated mixed plaque with extensive superficial and deep circumferential calcium in the mid LAD. Vessel diameters measured approximately 2.75–3.0 mm in the distal and mid LAD and 3.5–4.0 mm in the proximal LAD.

IVUS was performed after rotational atherectomy. It demonstrated mixed plaque with extensive superficial and deep circumferential calcium in the mid LAD and a prominent protruding calcific mass causing catheter contact, consistent with an eruptive calcified nodule phenotype. Pre-atherectomy IVUS could not be performed because the critical stenosis prevented the IVUS catheter from crossing the lesion; therefore, definitive characterization of the original lesion morphology before atherectomy was limited. Vessel diameters measured approximately 2.75–3.0 mm in the distal and mid LAD and 3.5–4.0 mm in the proximal LAD (**Figure 3B** and **C**).

A 3.5×15 mm SoniCracker IVL balloon (Shanghai Lifan Boyuan Medical Technology Co., Ltd., China) was inflated to 6 atm, and six treatment cycles of 10 pulses each were delivered from the proximal to mid LAD (**Figure 4A**). Repeat IVUS demonstrated multiple calcium fractures throughout the treated segment with satisfactory luminal gain (**Figure 4B**).

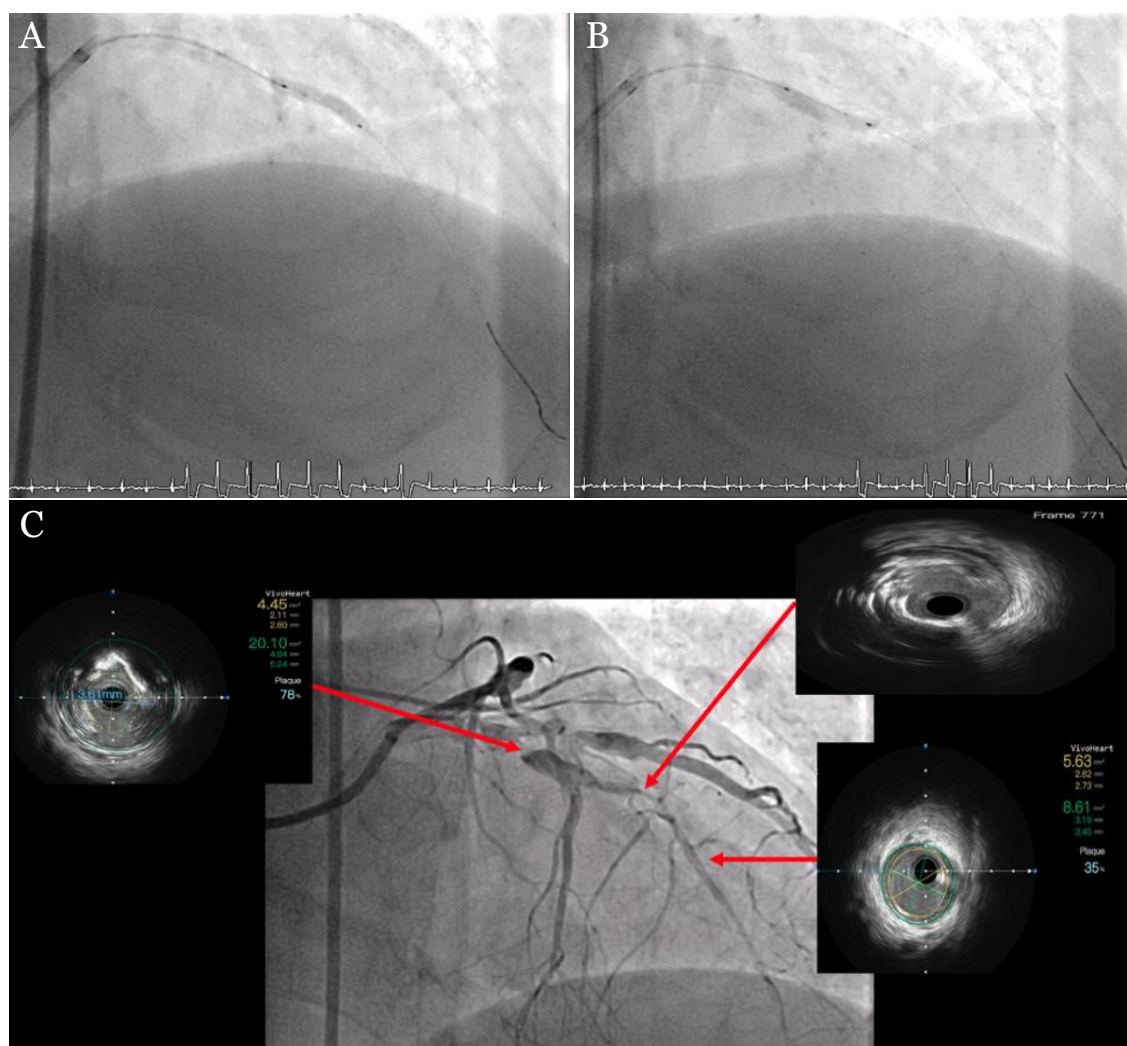


Figure 4. Intravascular lithotripsy and calcium fracture assessment by intravascular ultrasound (IVUS). (A-B) A 3.5×15 mm SoniCracker intravascular lithotripsy (IVL) balloon was inflated to 6 atm, and six treatment cycles of 10 pulses each were delivered from the proximal to mid left anterior descending artery (LAD). (C) IVUS demonstrated multiple calcium fractures throughout the treated segment with satisfactory luminal gain.

Two BioMatrix Alpha drug-eluting stents (Biosensors International Group, Ltd., Singapore) were then implanted: a 3.5×29 mm stent from the proximal to mid LAD at 8 atm and a 2.75×24 mm stent in the mid LAD at 10 atm (**Figure 5A** and **5B**). The stents were further optimized with post-dilation using a 4.0×12 mm non-compliant balloon in the proximal LAD and a 3.5×21 mm non-compliant balloon in the mid LAD, both inflated to 20 atm. Balloon sizing was guided by IVUS-derived vessel dimensions, with larger proximal post-dilation corresponding to the larger proximal LAD diameter.

Final IVUS demonstrated satisfactory stent expansion and apposition with a minimum stent area of 10.5 mm². Because a reliable reference lumen area for calculation of relative stent expansion was not available, percentage stent expansion was not reported. Final angiography showed no significant residual stenosis and preserved Thrombolysis in Myocardial Infarction (TIMI) grade 3 flow (**Figure 5C**).

Postprocedural course and follow-up

The patient had an uneventful postprocedural course and was discharged in a hemodynamically stable condition. Given his atrial fibrillation and recent complex PCI, antithrombotic therapy consisted of warfarin, clopidogrel, and aspirin for 1 week, followed by warfarin plus clopidogrel for up to 12 months, with lifelong warfarin thereafter. At 3-month follow-up, the patient's exertional chest pain had subsided, and he remained hemodynamically stable.

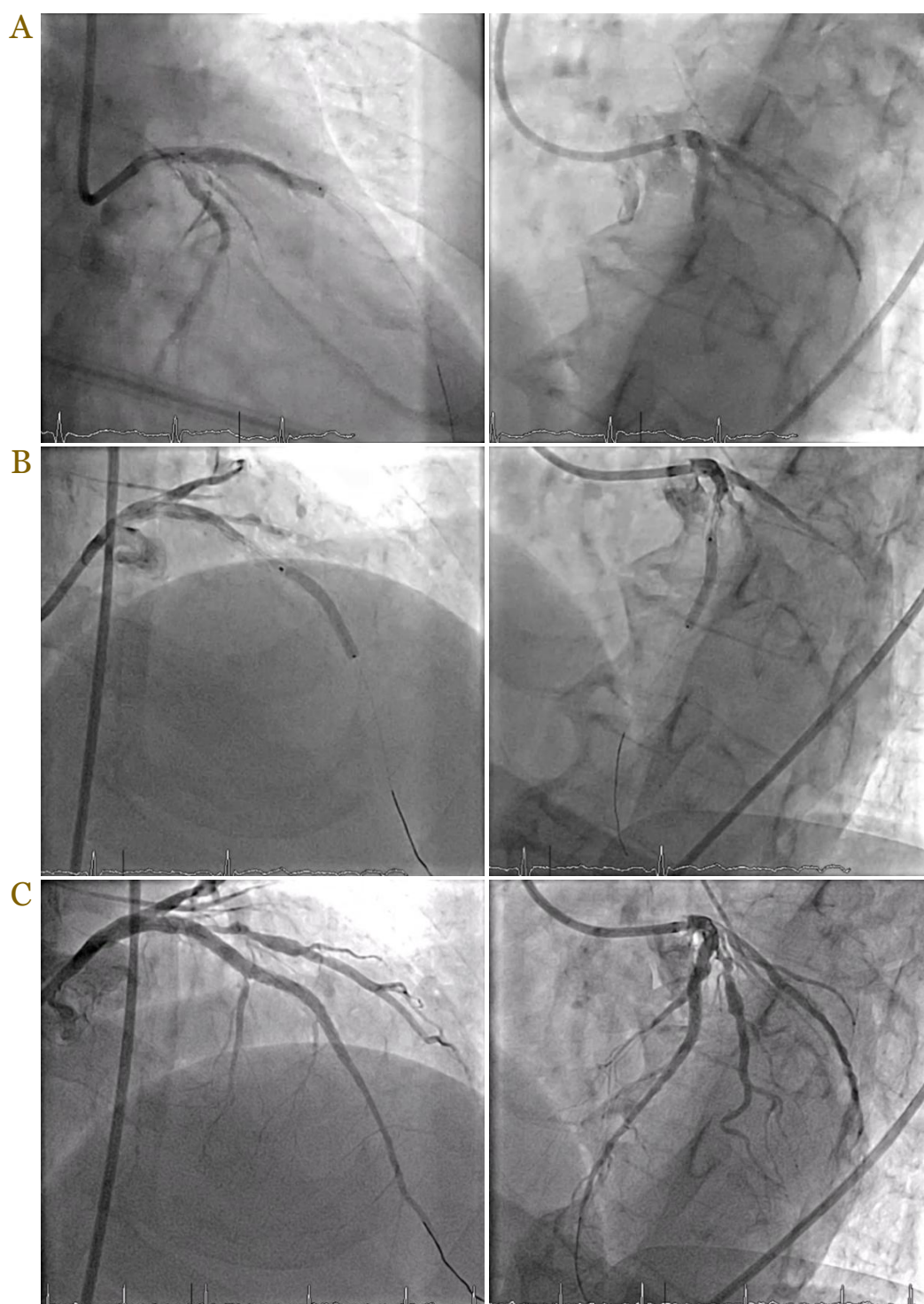


Figure 5. Drug-eluting stent implantation and final angiographic results. (A) A BioMatrix Alpha 3.5×29 mm drug-eluting stent was implanted from the proximal to mid left anterior descending artery (LAD) at 8 atm. (B) A BioMatrix Alpha 2.75×24 mm drug-eluting stent was implanted in the mid LAD at 10 atm. (C) Final post-stenting coronary angiography (CAG) showed no significant residual stenosis, with preserved Thrombolysis in Myocardial Infarction (TIMI) grade 3 flow.

Discussion

Severely calcified coronary lesions continue to represent one of the greatest technical challenges in PCI. In the present case, the lesion was resistant to conventional balloon angioplasty and had previously resulted in procedural failure, illustrating the limitations of standard lesion preparation in the presence of extensive coronary calcification. IVUS demonstrated not only severe circumferential calcium but also an eruptive calcified nodule with both superficial and

deep calcium, providing important mechanistic information that directly influenced procedural planning. Importantly, IVUS was obtained after rotational atherectomy; therefore, the original pre-atherectomy morphology could not be definitively classified, and the term eruptive calcified nodule is used here to describe the post-atherectomy IVUS phenotype.

This case highlights the growing role of intravascular imaging in precision PCI. Rather than relying solely on angiography, IVUS enabled accurate characterization of calcium morphology, assessment of calcium distribution and vessel dimensions, selection of appropriate plaque-modification devices, and confirmation of adequate calcium fracture and final stent optimization. Such a mechanism-based approach has become increasingly important in the management of complex calcified lesions [4-7].

Rotational atherectomy remains an established technique for heavily calcified lesions because it preferentially ablates superficial calcium and improves device deliverability [1,8-10]. Nevertheless, rotational atherectomy alone frequently leaves substantial medial and deep calcium intact, which may continue to limit vessel compliance and predispose to inadequate stent expansion [1,8-10]. In the present case report, despite successful rotational atherectomy, IVUS demonstrated persistent deep circumferential calcium, supporting the need for additional plaque modification.

IVL complements rotational atherectomy by selectively fracturing deep calcium through circumferential acoustic pressure waves delivered at low balloon inflation pressures [1,11-13]. Compared with aggressive high-pressure balloon dilatation, IVL may reduce the risk of severe dissection, perforation, and uncontrolled vessel injury while improving lesion compliance [1,11-13]. However, the relatively bulky crossing profile of IVL balloons may preclude successful delivery in severely stenotic or undilatable lesions [1,13-15]. In this setting, rotational atherectomy serves as an effective adjunct by creating sufficient luminal gain to facilitate IVL crossing [8-25].

The sequential use of rotational atherectomy followed by SoniCracker IVL produced multiple calcium fractures on repeat IVUS and permitted implantation and optimization of two drug-eluting stents. Final IVUS showed satisfactory stent expansion and apposition with a minimum stent area of 10.5 mm², and final angiography demonstrated TIMI 3 flow. Recent prospective device-specific data have also reported procedural feasibility of the SoniCracker IVL system in severely calcified coronary lesions [16]. In the present case, rotational atherectomy primarily facilitated lesion crossing and IVL-balloon delivery, whereas IVL was used to modify residual deep and circumferential calcium.

Published experience with combined rotational atherectomy and IVL remains limited, and the present single case cannot establish the general safety or efficacy of the RotaShock strategy. Its distinctive feature is the use of SoniCracker IVL after rotational atherectomy in a lesion with a post-atherectomy IVUS phenotype consistent with an eruptive calcified nodule and extensive superficial and deep circumferential calcium. The case therefore provides a technical example of mechanism-based sequential calcium modification rather than evidence of superiority over other calcium-modification strategies.

Conclusion

This case demonstrates the immediate technical feasibility of combining rotational atherectomy and IVL for a severely calcified, balloon-undilatable LAD lesion. Rotational atherectomy facilitated lesion crossing and IVL-balloon delivery, whereas IVL produced additional fractures in residual deep and circumferential calcium. IVUS was useful for defining post-atherectomy calcium morphology, guiding device sizing, confirming calcium fracture, and assessing the final stent result. Further studies are required to determine the broader safety, efficacy, and optimal patient selection for this sequential strategy.

Ethics approval

Written informed consent was obtained from the patient for publication of this case report and accompanying images.

Acknowledgments

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Competing interests

The authors declare that there are no competing interests.

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Underlying data

Derived data supporting the findings of this study are available from the corresponding author on reasonable request.

Declaration of artificial intelligence use

An artificial intelligence (AI) tool, ChatGPT (OpenAI), was used during manuscript preparation solely for language refinement, including grammar, sentence structure, readability, and technical writing assistance. It was not used for data collection, data analysis, image interpretation, or generation of clinical conclusions. The author confirms that all AI-assisted processes were critically reviewed to ensure the integrity and reliability of the manuscript. The final decisions and interpretations presented in this article were solely made by the author.

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