

Case report

Optimizing stent deployment in severe coronary calcification: intravascular lithotripsy in a circumferential left anterior descending artery lesion. A case report

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ABSTRACT

Severe coronary artery calcification reduces vessel compliance and predisposes to failed predilatation and stent underexpansion; intracoronary imaging is therefore essential to guide and verify lesion preparation. We report a 61-year-old man with hypertension and angina. Coronary CT angiography showed extensive circumferential calcification of the left anterior descending artery (LAD). Coronary angiography revealed a 60% stenosis in the proximal-to-mid LAD, and intravascular ultrasound (IVUS) confirmed 360° circumferential calcium, a minimum lumen area of 3.35 mm², and failure of predilatation with a non-compliant balloon. Intravascular lithotripsy was performed using a 3.25 × 12 mm balloon, delivering 60 pulses at 6 atm. IVUS subsequently showed deep calcium fractures, enabling implantation of a drug-eluting stent and achieving 97% stent expansion, a final minimum lumen area of 12.56 mm², and an optimal angiographic result. This case highlights the role of intravascular lithotripsy integrated with intracoronary imaging in restoring vessel compliance and achieving adequate stent expansion in circumferential calcification that is not amenable to dilation with conventional strategies.

Keywords: Coronary Artery Calcification; Percutaneous Coronary Intervention; Lithotripsy; Ultrasonography, Interventional; Drug Eluting Stents; Coronary Artery Disease (Source: MeSH-NLM).

RESUMEN

Optimización del stent en calcificación coronaria severa: litotricia intravascular en una lesión circunferencial de la arteria descendente anterior. Reporte de un caso

La calcificación coronaria severa condiciona baja *compliance*, predilatación fallida e infraexpansión del stent; la estrategia debe apoyarse en la imagen intracoronaria para seleccionar y verificar la preparación de la lesión. Se presenta un varón de 61 años con hipertensión y angina. La tomografía coronaria mostró calcificación extensa y circunferencial de la arteria descendente anterior. La angiografía evidenció estenosis del 60% en el segmento proximal-medio; el ultrasonido intravascular (IVUS) confirmó calcio 360° con área luminal mínima de 3,35 mm² y fracaso de balón no complaciente. Se realizó litotricia intravascular con balón de 3,25 x 12 mm (60 pulsos a 6 atm), documentándose fracturas profundas del calcio en IVUS y permitiendo la implantación de un stent farmacológico con expansión del 97% y área luminal mínima final de 12,56 mm², con resultado angiográfico óptimo. Este caso ejemplifica el rol de la litotricia intravascular integrada a la imagen intracoronaria para recuperar la distensibilidad y alcanzar la expansión adecuada del stent en calcificación circunferencial no dilatada con estrategias convencionales.

Palabras clave: Calcificación de la Arteria Coronaria; Intervención Coronaria Percutánea; Litotricia; Stents Liberadores de Fármacos; Enfermedad de la Arteria Coronaria (Fuente: DeCS-BIREME).

Introduction

In contemporary percutaneous coronary intervention (PCI), intracoronary imaging guidance is the standard of care for calcified lesions, enabling characterisation of calcium (arc, thickness, and length), prediction of the mechanical response, selection of a calcium modification technique, and assessment of stent expansion and apposition. The ACC/AHA/SCAI guidelines recommend its use in complex coronary anatomy, and current evidence supports its superiority over angiographic guidance alone ^(1,2). To support decision-making, an intravascular ultrasound (IVUS)-derived calcium score has been proposed to estimate the risk of stent underexpansion and guide the need for calcium modification before implantation, particularly in segments with a large calcium arc and substantial calcium length. This complementary tool should be integrated with clinical judgement and imaging findings ⁽³⁾. In this context, intravascular lithotripsy (IVL) is an option for balloon-crossable lesions with circumferential or thick calcium that are resistant to non-compliant balloon dilatation. IVL induces fractures in intimal and medial calcium at low pressures, restoring vascular compliance ^(2,4-7).

This case illustrates the practical application of the current standard of care: systematic integration of guideline-recommended intracoronary imaging, use of an IVUS-based risk stratification approach to identify a high-risk phenotype (circumferential calcium extending over a long segment), and selection of IVL for lesion preparation after a suboptimal response to non-compliant balloons, followed by imaging confirmation of calcium modification and optimisation of stent implantation ⁽¹⁻³⁾.

Case report

A 61-year-old man with hypertension receiving regular treatment presented with a several-month history of Canadian Cardiovascular Society class III exertional angina. At initial assessment, haemodynamic parameters and cardiovascular examination were unremarkable. Electrocardiography showed sinus rhythm with no ischaemic changes, and transthoracic echocardiography showed preserved left ventricular function.

Given the clinical suspicion of significant coronary artery disease, coronary computed tomography (CT) angiography was performed. This showed extensive circumferential calcification in the proximal left anterior descending artery (LAD), extending into the mid segment and forming a concentric calcium ring (**Figure 1**). Given this high-risk CT finding, the patient was referred for cardiac catheterisation to define the coronary anatomy and plan treatment. Coronary angiography confirmed a calcified lesion with approximately 60% stenosis in the proximal-to-mid LAD.

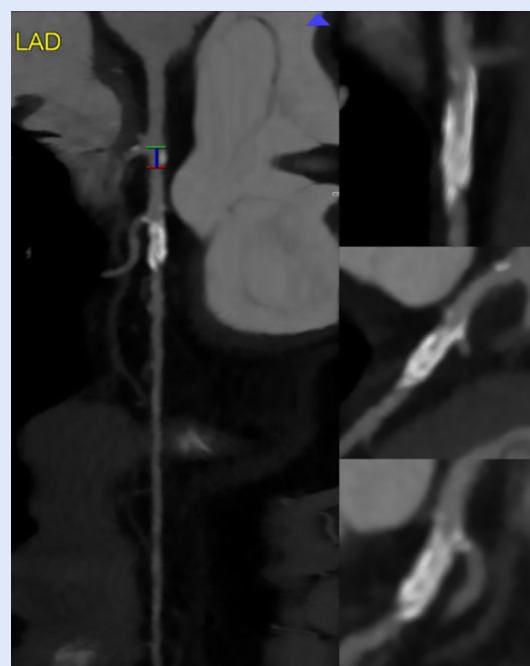


Figure 1. Coronary computed tomography showing extensive circumferential calcification of the proximal left anterior descending artery.

IVUS was performed to quantify lesion severity and guide procedural planning. It showed 360° circumferential calcium and a minimum lumen area (MLA) of 3.35 mm² in the proximal segment (**Figure 2A**), consistent with the angiographic stenosis (**Figure 2B**). Predilatation with a 2.5-mm non-compliant balloon at 14 atm produced no substantial luminal gain, with clear balloon constraint by the calcium ring (**Figure 3B**). The IVUS-derived calcium score was ≥ 2 , based on a calcium arc $\geq 270^\circ$ extending over > 5 mm. This threshold is associated with a high risk of stent underexpansion and therefore indicated the need for calcium modification before implantation.

Given the resistance to balloon dilatation and the intravascular imaging findings, IVL was selected for plaque modification. A 3.25 x 12-mm SONICO-CX balloon (Spectrummedics) was advanced, and 60 pulses were delivered at 6 atm. Post-IVL IVUS showed multiple hyperechoic lines consistent with calcium fractures, including deep fractures within the circumferential calcium ring, together with increased distensibility of the treated segment (**Figure 3A**). A drug-eluting stent was then implanted and postdilated. Final IVUS showed 97% stent expansion, an MLA of 12.56 mm², and adequate apposition (**Figure 4A**). Angiography confirmed an optimal result, with no residual stenosis or complications (**Figure 4B**).

The hospital course was uneventful. At the 30-day and 60-day follow-up assessments, angina had substantially improved, and no major adverse cardiovascular events were recorded.

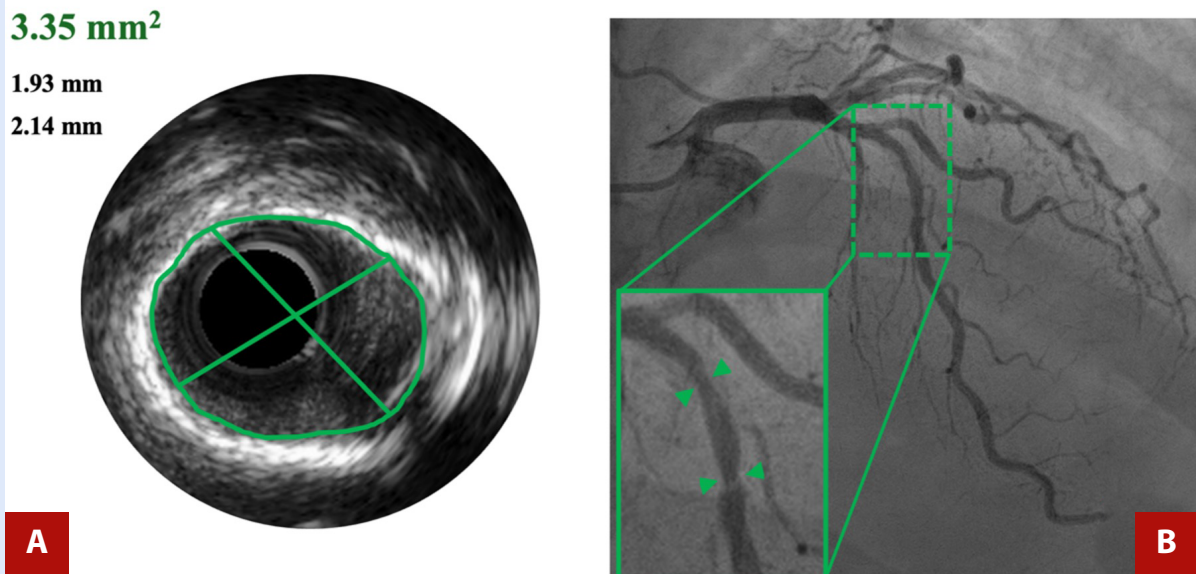


Figure 2. (A): Intravascular ultrasound showing severe 360° circumferential calcification in the proximal left anterior descending artery. **(B)** Coronary angiography showing significant stenosis involving the proximal and mid segments of the left anterior descending artery.

Discussion

The combination of a 360° calcium ring and failed conventional predilatation defines a phenotype at high risk of stent underexpansion and, consequently, short-term and long-term adverse events. In this setting, plaque

modification using techniques that extend beyond the capabilities of non-compliant balloons is necessary ^(1,2,4,8). In our case, IVUS guidance provided three elements crucial to procedural success. First, it delineated calcium extent and thickness to guide selection of the appropriate lesion preparation technique ⁽²⁾. Second, it enabled quantification of the MLA and incorporation of a calcium-based risk score

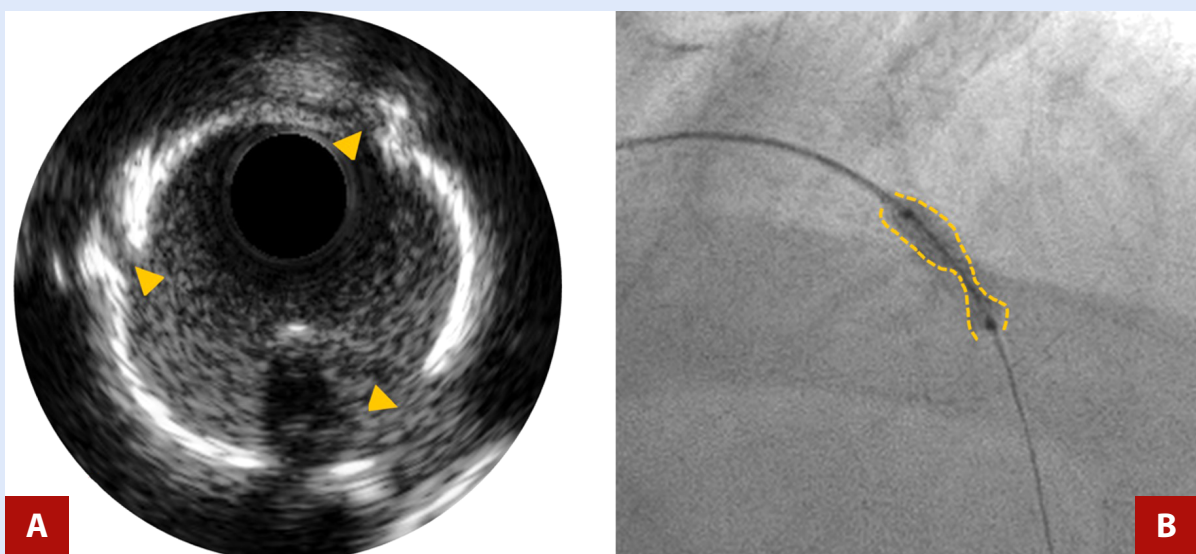


Figure 3. (A): Intravascular ultrasound showing calcium fractures and fragmentation after treatment with an intravascular lithotripsy balloon (yellow arrowhead). **(B)** Coronary angiography showing severe calcification that prevents full balloon expansion despite high-pressure inflation.

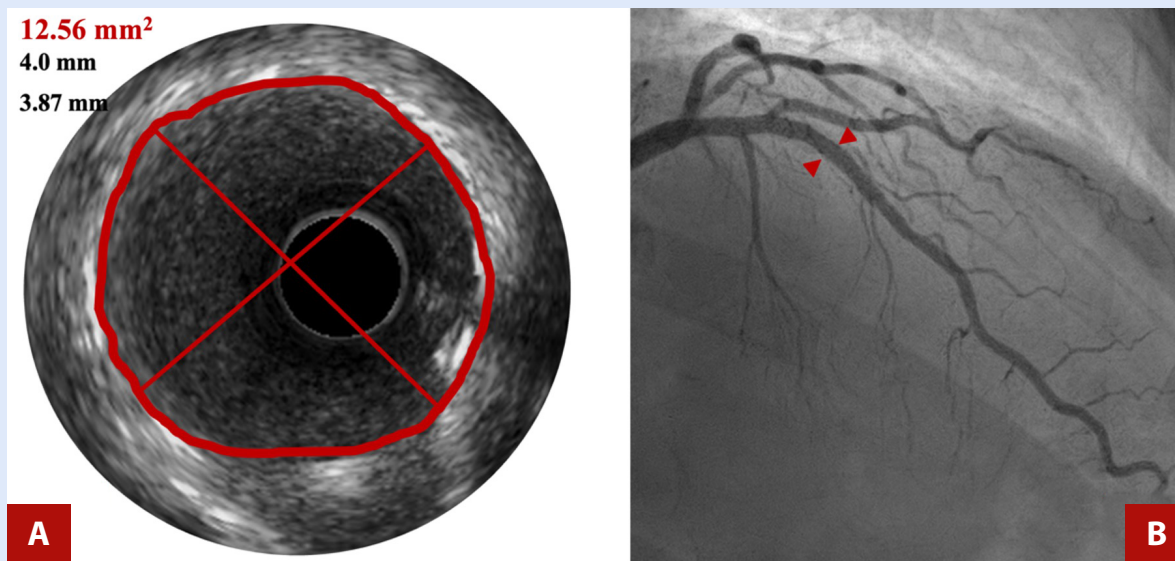


Figure 4. (A): Intravascular ultrasound showing a well-expanded and well-apposed stent. **(B)** Coronary angiography showing optimal stent expansion with no residual stenosis.

to predict the likelihood of underexpansion ^(2,3,6). Finally, postintervention imaging confirmed calcium fractures and optimisation of stent expansion and apposition ^(1,2,9).

This report illustrates rigorous implementation of international standards, whereby intracoronary imaging not only guides preparation of complex lesions but also provides quality assurance by documenting metrics associated with improved prognosis. In a balloon-crossable lesion with circumferential calcium and failed predilatation, IVL has a sound pathophysiological rationale: it induces fractures in intimal and medial calcium at low pressure, restoring vascular compliance ^(10,11). This strategy is strongly supported by evidence from the DISRUPT CAD studies. In DISRUPT CAD III ^(9,12), for example, IVL achieved procedural success in 92.4% of patients and freedom from major adverse cardiovascular events (MACE) at 30 days in 92.2%, with successful stent delivery in 99.2% and no perforations. The optical coherence tomography (OCT) substudy demonstrated substantial stent expansion and calcium fractures in approximately 67% of cases ⁽⁹⁾. Complementing these findings, the COCALP study evaluated the balloon type used in this case in severely calcified coronary lesions, reporting a procedural success rate of 97.4% and an in-hospital MACE rate of 1.9%. Calcium fractures were documented in 76.8% of the OCT subgroup, providing evidence specific to the technology used in this case and consistent with the aim of restoring compliance and optimising stent expansion ⁽¹³⁾.

The safety and effectiveness of IVL have been further supported by pooled analyses of the DISRUPT CAD studies, which showed no significant differences between

trials in 30-day MACE or procedural success, with a notably low incidence of serious angiographic complications ^(9,14). In specific populations, including Japanese patients, IVL also demonstrated non-inferiority to historical controls for safety and technical success, with no reported perforation or no-reflow ⁽¹²⁾.

Achieving ambitious luminal targets is crucial to optimising treatment of these lesions. In our patient, stent expansion reached 97%, with a final MLA of 12.56 mm², exceeding thresholds traditionally associated with prevention of restenosis in the left anterior descending artery ^(2,3,5). Comparison with other plaque modification techniques, such as rotational atherectomy (ROTA), highlights their differing mechanisms. Although ROTA is particularly effective for superficial ablation and facilitating lesion crossing, IVL provides deeper modification of the calcium ring, allowing more uniform and predictable stent expansion in concentric lesions ^(8,15,16).

This experience generates a testable hypothesis: in severely calcified, balloon-crossable coronary lesions with a large calcium arc, an IVUS-guided PCI approach incorporating formal calcium risk stratification to select IVL, compared with standard angiography-guided treatment alone, will significantly increase both the minimum stent area and postimplantation MLA while reducing early ischaemic events without compromising safety ^(1-7,9). This hypothesis can be tested using procedural outcomes and clinical outcomes at 30 days and 1 year.

In summary, for lesions characterised by circumferential calcium and failed predilatation, an IVUS-guided strategy incorporating IVL is rational, consistent with clinical practice

guidelines, and supported by the available evidence ^(1,2,9,12). Documentation of post-IVL fractures and achievement of favourable stent optimisation metrics in this case provide a strong technical rationale and support imaging-based algorithms to standardise decision-making and improve reproducibility in the treatment of complex calcified lesions ⁽¹⁻⁷⁾.

Ethical aspects

Informed consent was obtained from the patient. The case report was also approved by the institutional ethics committee.

Author contributions

FMQC: Conceptualisation, investigation, formal analysis, visualisation, writing-original draft, writing-review and editing.

CNR and TC: Validation, writing-review and editing.

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