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Case Report
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How Should I Treat Underexpanded Coronary Stents due to Severe Coronary Calcification?

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Background

With aging society, one of the more challenging obstacles in Percutaneous Coronary Interventions (PCI) are Calcified Coronary lesions (CAC). CAC may impede stent delivery [1], limit balloon [1] and stent expansion [2] which result in lower Minimal Stent Area (MSA), cause uneven drug distribution [3,4], and even hinder wire advancement. Lower MSA and stent under-expansion are associated with adverse outcomes, including stent thrombosis, restenosis, and Major Adverse Cardiac outcomes (MACE) [5,6].

In order to effectively manage such lesion's, dedicated technologies have been developed.

Rotational (RA) and Orbital Atherectomy (OA) are the devices mainly used to ablate superficial calcium in the coronary artery. Using coronary lithotripsy, lesion modification is achieved by pulsatile mechanical energy delivered to calcified lesions. The result is an amplified effect in calcified tissues and a much weaker impact on healthy tissue. Unlike rotational or orbital atherectomy, IVL can affect deeper tissues which enables the modification of calcified plaque behind a stent. Furthermore, IVL does not produce particles that embolize, therefore less slow-flow phenomena can be seen.

In this setting we discuss the clinical case in which an IVL was required to treat underexpanded coronary stents due to severe CAC.

Case Presentation

A 58-year-old male patient was electively admitted to our hospital's Cardiology Department with stable angina and two coronary plaques in two major vessels showing on coronary tomography. He has an active history of smoking 40 cigarettes per day and hypertension.

Coronary angiography revealed extensively calcified Left Anterior Descendent (LAD) coronary artery with critical calcified lesions in the middle tract. Lesion preparation was done using Non-Compliant Balloon (NCB) 2.5 mm × 20 mm followed by a Drug-Eluting Stent (DES) implantation 2.75 mm × 38 mm (Figures A-C).

DES was sub-optimally expanded after standard deployment compared with nominal sizes. Post-dilatation using 2.75 mm × 12 mm NCBs following 3 mm × 6 mm NCB and 3.25 mm × 8 mm NCB was performed.

Unfortunately, LAO cranial view still demonstrated DES underexpansion. In this setting Rotational Atherectomy RA and OA were contraindicated for intrastent treatment. At the contrary Intravascular Lithotripsy (IVL) was indicated.

IVL balloon 3.0 mm × 12 mm was easy delivered to the desired location over a 0.014 guidewire.

Once the position was confirmed, the IVL balloon was inflated to 4 atm using a 1:1 water and contrast mixture, then by pressing the button on the delivery catheter, 10 pulsed electrical impulses were delivered up within 10 s (one pulse per second). Successively the IVL balloon was inflated further to 6 atm and 80 totally pulses were applied (eight cycles). Thereafter LAO cranial view showed DES fully expanded.

Discussion

Intravascular coronary lithotripsy is useful in more challenging scenarios. One of the promising potential indications in the treatment of in-stent restenosis associated with calcium and underexpanded DES with underlying calcification. Patients with severe stent underexpansion due to CAC are at a higher risk of stent failure and future adverse events. Underexpanded stents

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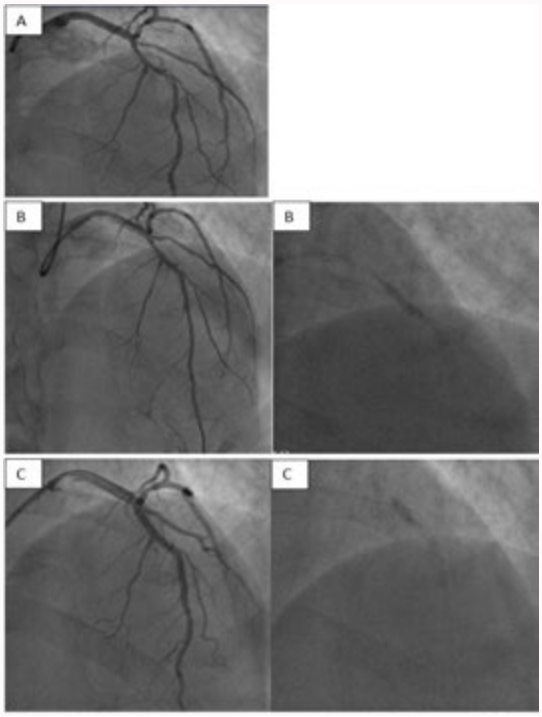

Figures A-C: A) LAO cranial view demonstrating severe LAD stenosis. **B)** LAO cranial view demonstrating LAD stenosis with under expansion of 2.75 mm × 38 mm DES. **C)** LAO cranial view demonstrating adequate DES expansion.

are currently being treated with off-label use of other atherectomy devices [7,8].

Nevertheless, the effectiveness of those techniques is limited by the presence of metallic struts, and deeper calcifications remain unaffected, and the risks of procedural complications and stent damage are unpredictable. Conversely, the circumferential sonic waves of coronary IVL have the advantage of extending beyond stent struts and are thus capable of disrupting and fracturing deeper calcium deposits. Several case reports have supported the use of the technology for optimizing stent expansion without complications [9,10].

Nevertheless, the efficacy of the system in lesions previously treated with multiple layers of the stent has not been demonstrated, and its impact on the stent backbone, polymer integrity, and drug elution is unknown.

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