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CASE REPORT

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Intracoronary Lithotripsy in Percutaneous Treatment of Calcific Left Main Coronary Stenoses

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ABSTRACT

Adequate plaque preparation in heavily calcific left main coronary stenoses is mandatory to ensure adequate stent implantation. Intravascular lithotripsy (IVL) is a potential alternative to atherectomy techniques for this purpose. The authors present 2 cases treated with IVL in a successful manner in the left main coronary artery. (J Am Coll Cardiol Case Rep 2019;1:46–9) © 2019 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/).

Severe coronary calcification constitutes a major challenge for percutaneous coronary interventions (PCI) in left main (LM) coronary artery stenoses. Plaque ablation techniques such as rotational atherectomy and intracoronary laser are seldom used in the LM for several reasons, including: 1) major modification of PCI workflow or lack of operator experience; 2) large mismatch between atherectomy burr or laser catheter and LM dimensions; 3) concerns about no-reflow in a large myocardial territory; and 4) lack of evidence about its net clinical benefit (1). Intravascular lithotripsy (IVL) is a recently introduced calcific plaque modification technique that can circumvent these shortcomings. The IVL system consists in a dedicated balloon with integrated lithotriptors that are connected to a high-voltage power source. Acoustic energy, generated by ultrashort sparks within the fluid-filled balloon, is transferred to the calcific plaque causing spall fracture, shear stress, superfocusing, squeezing, cavitation, and fatigue (2). Although IVL has demonstrated to be effective in causing in-depth modification of calcific stenoses, available information on its value in the LM is currently missing (1). In this paper, we report our initial experience with IVL in the context of calcific LM coronary stenoses.

LEARNING OBJECTIVES

- Intravascular lithotripsy can be considered for plaque preparation in patients with calcific LM stenoses.
- Plaque preparation with IVL can be performed while both LAD and LCX are wired, performing shorter balloon inflations to minimize myocardial ischemia.
- In-depth modification of calcific plaque can be performed with up to 4.0-mm IVL balloons with low risk of associated no-reflow phenomenon.

LM DISEASE CASE

A 91-year-old woman with arterial hypertension, dyslipidemia, and obesity was admitted for non-ST-segment elevation myocardial infarction. The electrocardiogram showed dynamic changes due to ST-segment depression in V_2 to V_5, I, and aVL leads and normal left ventricular ejection fraction.

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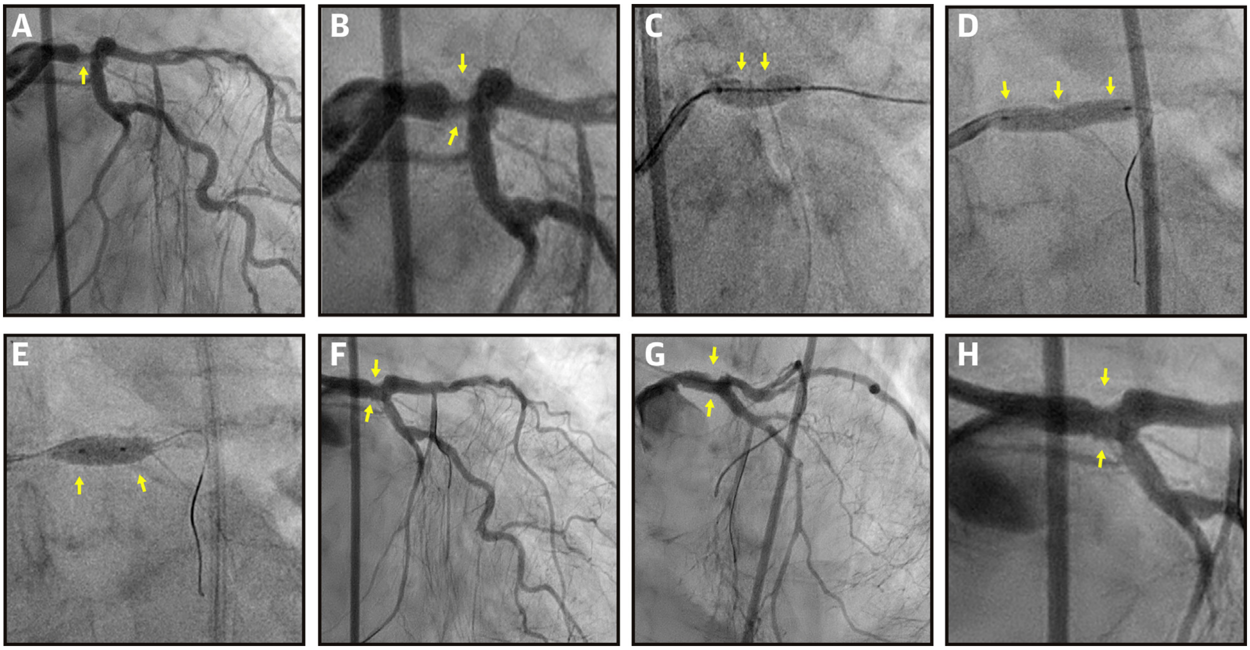
FIGURE 1 Severe Calcified Stenosis in Distal LM



(A, B) Basal angiogram with severe calcified stenosis in distal left main (LM) (Medina classification: 1-0-0) **(arrows)**. **(C)** Intravascular lithotripsy was performed in LM to left anterior descending artery with a 3.5-mm balloon **(arrows)**. Pulse delivery was carried out in a stationary manner (5 pulses each), with successful result. **(D)** A 3.5 × 18 mm drug-eluting stent was implanted in LM to left anterior descending **(arrows)**. **(E)** Proximal optimization technique with 4.5 × 8 mm noncompliant balloon was performed **(arrows)**. **(F to H)** Angiogram post-stenting with adequately luminal gain without associated complications **(arrows)**.

Angiography showed a severely calcified stenosis of the distal LM (Figure 1). Percutaneous treatment was agreed during a Heart Team discussion. The procedure was performed using a right femoral artery approach, with 6-F extra back up 3.5 guide catheter. After wiring the left circumflex (LCX) and left anterior descending (LAD) arteries, the LM stenosis was treated with a 3.0-mm IVL balloon, with a total of 80 pulses applied over shorter, separate balloon inflations (5 pulses each) to prevent myocardial ischemia. Full expansion of the 3.0-mm balloon at 4 atm, as judged in 2 orthogonal views, was achieved. Without further balloon dilation, a 3.5 × 18 mm drug-eluting stent was implanted from LM to LAD and post-dilated in the LM with a noncompliant (NC) 4.5-mm balloon with a good result. The procedure was well tolerated, and the patient completed an uneventful hospital stay. At a follow-up of 8 days, the patient remained free of angina. This case illustrates how the use of IVL allowed safe treatment of a severely calcified LM lesion while protecting the LCX with good hemodynamic tolerance. The calcium modification obtained allowed an appropriate stent expansion.

DISTAL LM DISEASE CASE

A 94-year-old woman with arterial hypertension was admitted for non-ST-segment elevation myocardial infarction. The electrocardiogram showed dynamic changes due to ST-segment depression in V_2 to V_5 leads and ST-segment elevation in the aVR lead. The left ventricular ejection fraction was normal. Angiography showed a severely calcified stenoses in distal LM stem, with ostial and diffuse disease in LAD and LCX (Medina classification: 1-1-1). After a Heart Team discussion, she was referred for LM PCI guided by intravascular ultrasound. The procedure was performed using the right femoral artery, with a 7-F extra back up 3.5 guide catheter, using intracoronary ultrasound imaging with coregistration with angiography to guide and optimize the intervention. After advancing a guidewire to the LAD, a double lumen microcatheter was needed to wire the LCX artery. The LM stenosis was then treated over the LCX wire with a 3.5-mm IVL balloon, with 40 energy pulses delivered over short, separate balloon inflations to prevent myocardial ischemia. Then, the ostium of the LAD was treated with a 2.5-mm IVL balloon, delivering a total of

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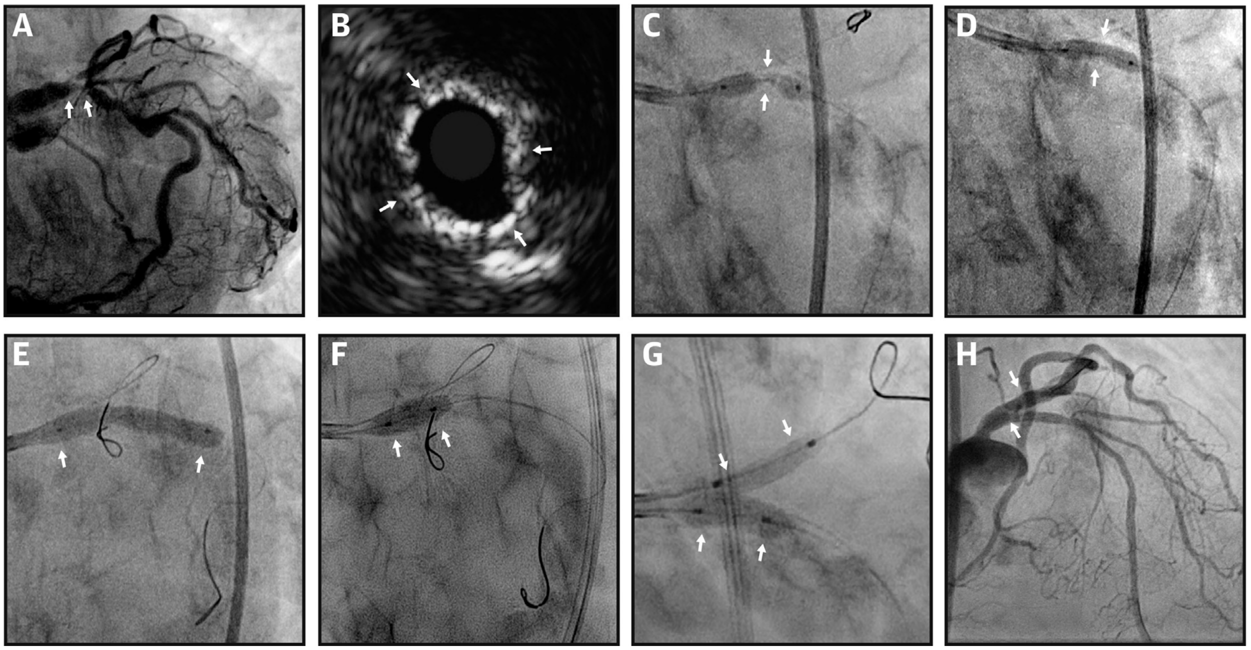
FIGURE 2 **Severe Calcified Stenoses in Distal LM With Ostial and Diffuse Disease in LAD and LCX**



(A) Severe and calcified stenoses in distal left main (LM), with ostial and diffuse disease in left anterior descending (LAD) and left circumflex (LCX) arteries (Medina classification: 1-1-1) **(arrows)**. **(B)** Intravascular ultrasound–guided percutaneous coronary intervention with evidence of severe concentric calcification with an arc >270º **(arrows)**. **(C, D)** Intravascular lithotripsy was performed in LM to LCX with 3.5-mm balloon **(arrows)** in staged pulses fashion with successful result. **(E)** A 4 × 28 mm drug-eluting stent was implanted in LM to LCX **(arrows)**. **(F)** Proximal optimization technique with 4.0 × 10 mm noncompliant balloon was performed **(arrows)**. **(G)** TAP technique with 2.75 × 12 mm drug-eluting stent to LAD and 4.0 × 10 mm noncompliant balloon **(arrows)**. **(H)** Angiogram post-stenting with good final result **(arrows)**.

60 pulses. In this case, flow to the LCX was preserved during balloon inflations, as the 2.5-mm IVL balloon did not occlude the LM. After successful plaque preparation, as judged by good angiographic expansion of both IVL balloons, T and protrusion stenting technique was performed. A 4.0 × 28 mm drug-eluting stent was implanted in LM to LCX, followed by proximal optimization technique with 4.0-mm NC balloon and kissing balloon dilation with 4.0-mm (LM to LCX) and 2.5-mm NC balloons (LM to LAD). A second 2.75 × 12 mm drug-eluting stent was successfully implanted toward the LAD using a T and protrusion technique (Figure 2). At a follow-up of 6 days the patient remained free of angina.

DISCUSSION

These 2 clinical cases illustrate the feasibility of using IVL to perform plaque preparation in the context of heavily calcific LM stenoses in 2 elderly patients. Previous studies with optical coherence tomography in patients treated with lithotripsy have contributed to understanding the mechanism of action IVL on calcific plaques, causing widespread calcium fractures that lead to a marked improvement in plaque compliance, as shown by the expansion of the balloon inflated at low pressure (4 atm) during IVL (1,3). Some specific advantages of lithotripsy for plaque preparation in the LM, compared with other plaque modification techniques, are the following: 1) it is a relatively simple technique with a short learning curve and is easy to integrate in the cath lab workflow; 2) it is operative in large vessels, with IVL balloons available up to 4 mm in diameter (significantly larger than rotational atherectomy burrs and laser catheters); 3) it allows the presence of 2 wires during plaque preparation, which is highly relevant given the large amount of subtended myocardium to both

LAD and LCX branches; and 4) it is associated with very low risk of no-reflow phenomenon. One of the potential drawbacks of IVL is that ischemia might develop during prolonged LM occlusion during energy delivery. However, we found that this can be successfully achieved by performing shorter runs of IVL, thereby decreasing the risk of myocardial ischemia. Intracoronary imaging is recommended, both as a guidance tool for IVL and to achieve optimal results of PCI in the LM.

CONCLUSIONS

IVL was safely performed in 2 patients with calcific LM stenosis, with optimal plaque preparation prior to stenting.

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KEY WORDS calcified coronary disease, intravascular lithotripsy, percutaneous coronary interventions