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Case Report

Intravascular Lithotripsy and Microaxial Percutaneous Left Ventricular Assist Device for Complex and High-Risk Percutaneous Coronary Intervention

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ABSTRACT

Intravascular lithotripsy (IVL) is emerging as a novel, effective, easy-to-perform, and safe therapy for plaque modification in calcified lesions. So far, data on its use and outcomes mostly derives from stable patients with moderate angiographic complexity. Here we report on a case in which IVL was performed in the context of a high-risk intervention involving calcified lesions of the left main bifurcation and proximal left anterior descending, which required mechanical support with a percutaneous left ventricular assist device. This guaranteed hemodynamic stability and optimal lesion preparation, which allowed achieving a good angiographic result and clinical outcome.

RÉSUMÉ

La lithotripsie intravasculaire (LIV) émerge comme un nouveau traitement, efficace, facile à réaliser et sûr dans l'élimination de la plaque des lésions calcifiées. Jusqu'à ce jour, les données sur son utilisation et ses résultats cliniques proviennent surtout de patients stables dont la complexité à l'angiographie est modérée. Nous présentons ici le cas d'un patient qui a subi une LIV dans le contexte d'une intervention à risque élevé concernant des lésions de bifurcation calcifiées sur le tronc commun de l'artère coronaire gauche et sur l'artère interventriculaire antérieure proximale, qui a nécessité la mise en place par voie percutanée d'un dispositif d'assistance ventriculaire gauche. Cela a permis d'assurer une stabilité hémodynamique et une préparation optimale des lésions, et d'obtenir de bons résultats angiographiques et cliniques.

A 71-year-old woman with diabetes, who had undergone coronary artery bypass surgery with a single left-internal-mammary-artery-to-left-anterior-descending (LIMA-LAD) graft, presented with unstable angina. Critical, calcified distal left main (LM; Medina 1-1-1), and proximal LAD disease was observed (Fig.1, A-D). The LIMA-LAD graft presented significant disease proximal to the anastomosis, which had been performed on the very apical LAD, thus limiting effective back-perfusion of proximal and mid-LAD branches (Fig. 1, E and F). Echocardiographic assessment demonstrated a left ventricular ejection fraction of 35% and elevated filling pressures. Because of these factors and the high risk of redo coronary artery bypass surgery, the heart team recommended to pursue percutaneous coronary intervention (PCI) on the LM bifurcation and proximal LAD.

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See page 940.e6 for disclosure information.

In light of the high-risk anatomy and the need for aggressive plaque-modification techniques, mechanical support with Impella CP (Abiomed, Danvers, Massachusetts) was established through the left femoral artery. A 7-Fr XB 3.5 was advanced through the right femoral artery. The LAD and circumflex were wired, and the proximal LAD was dilated with 1.25-mm semicompliant and 3.0-mm noncompliant (NC) balloons. Severe underexpansion was observed (Fig. 2A). Intravascular lithotripsy (IVL; Shockwave Medical, Santa Clara, California) was subsequently performed. Sixty pulses with a 3.5-mm Shockwave were administered, with acceptable balloon expansion (Fig. 2B). Twenty additional pulses were administered at the distal LM. The proximal LAD and LM were subsequently treated with 3.5-mm NC and scoring balloons, which achieved good expansion (Fig. 2C). Intravascular ultrasound (IVUS) confirmed adequate plaque modification (Fig. 2D). The procedure was then completed with the implantation of 2 drug-eluting stents on the LM-LAD-circumflex (double-kissing crush technique) and 1 on the proximal LAD. A good result was observed (Fig. 2, E and F). Impella was removed immediately, and the patient was discharged after an uneventful stay.

Calcified plaques are associated with procedural challenges and suboptimal outcomes of PCI. These include impaired

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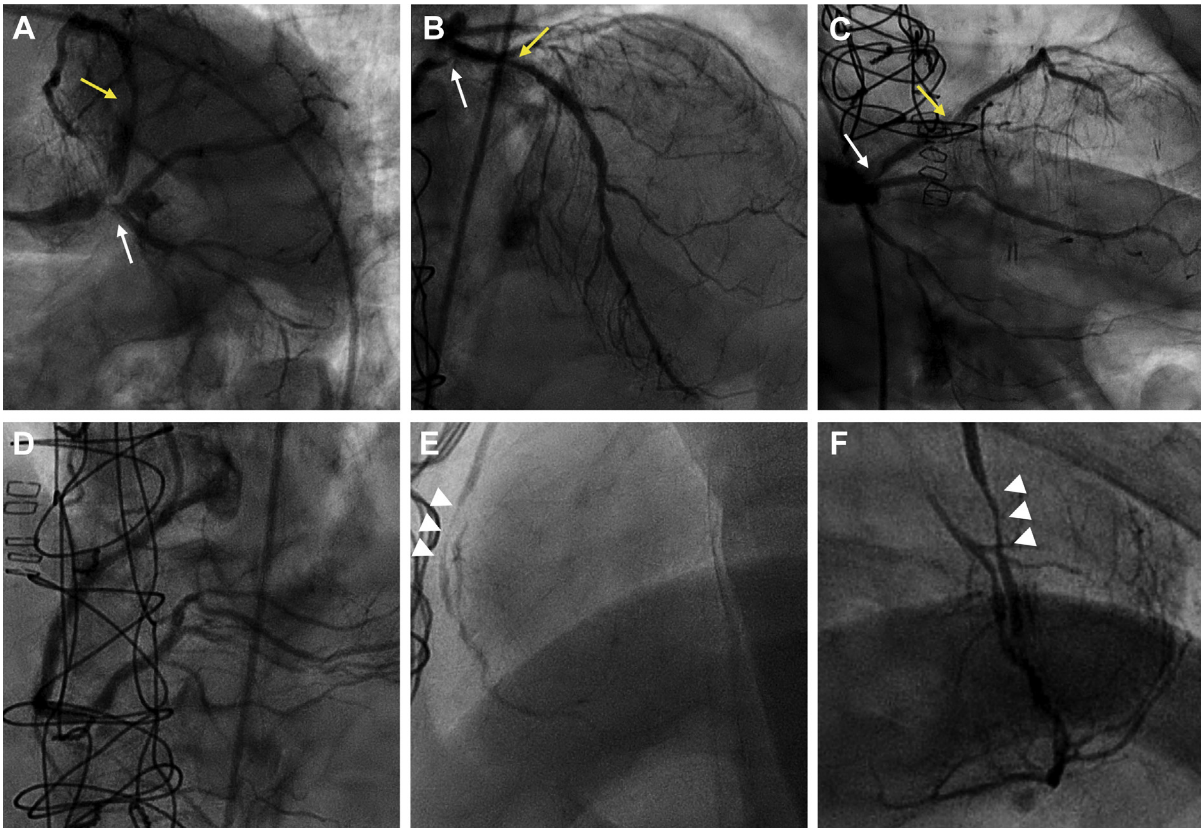

Figure 1. (**A-C**) Critical calcified distal left main stenosis (**white arrows**) and proximal left anterior descending (LAD) disease (**yellow arrows**). (**D**) Diffusely diseased right coronary artery, with no significant stenosis. (**E, F**) The left internal mammary artery is anastomosed on the apical LAD and presents long significant disease proximal to the anastomosis (**arrowheads**).

stent crossing and drug-delivery/elution, disruption of drug/polymer from the stent platform, reduced stent expansion, and apposition.[1] Previously available therapies to tackle calcified lesions include NC, super high pressure, and cutting/scoring balloons, as well as rotational, orbital, and laser atherectomy[2] All these devices have, however, intrinsic limitations. Specifically, balloon dilatation is limited by guidewire bias (which concentrates dilatation force onto noncalcified areas) or insufficient radial force (which prevents full expansion). Atherectomy techniques are complex to perform and associated with non-negligible rates of complications.[2] Moreover, none of these technologies is able to modify periadventitial calcium and therefore might still provide insufficient plaque modification.

Coronary IVL represents a novel alternative to perform plaque modification in severely calcified segments.[1] In our case, IVL was chosen in consideration of the presence of critical left main bifurcation disease involving 3 major branches and the concerns of side-branch dissection possibly associated with rotational atherectomy. Mechanical support with Impella was indicated because of the need of prolonged Shockwave balloon inflations in the LM and proximal LAD. Indeed, each 10-pulse train of IVL lasts 10 seconds, and usually (as in our case) several trains are necessary to modify the calcified plaques effectively. Moreover, after these 10-second trains delivered at 4 atmospheres, additional balloon inflation at 6 atmospheres is required. As such, in our case, approximately 2 minutes (eight 10-pulse trains plus further balloon inflation) of no-flow in the LM-LAD system were induced. In a patient with severe left ventricular dysfunction and decompensated heart failure, this probably would have led to hemodynamic compromise had mechanical support not been established. IVL represents a less stress-inducing therapy for the hemodynamics of high-risk patients compared with rotational atherectomy, which has a number of significant limitations (eg, inability to protect side branches) and complications (eg, hypotension due to slow-flow, atrioventricular block, and perforation). Further studies should evaluate the role of IVL in complex and high-risk PCI.

Disclosures

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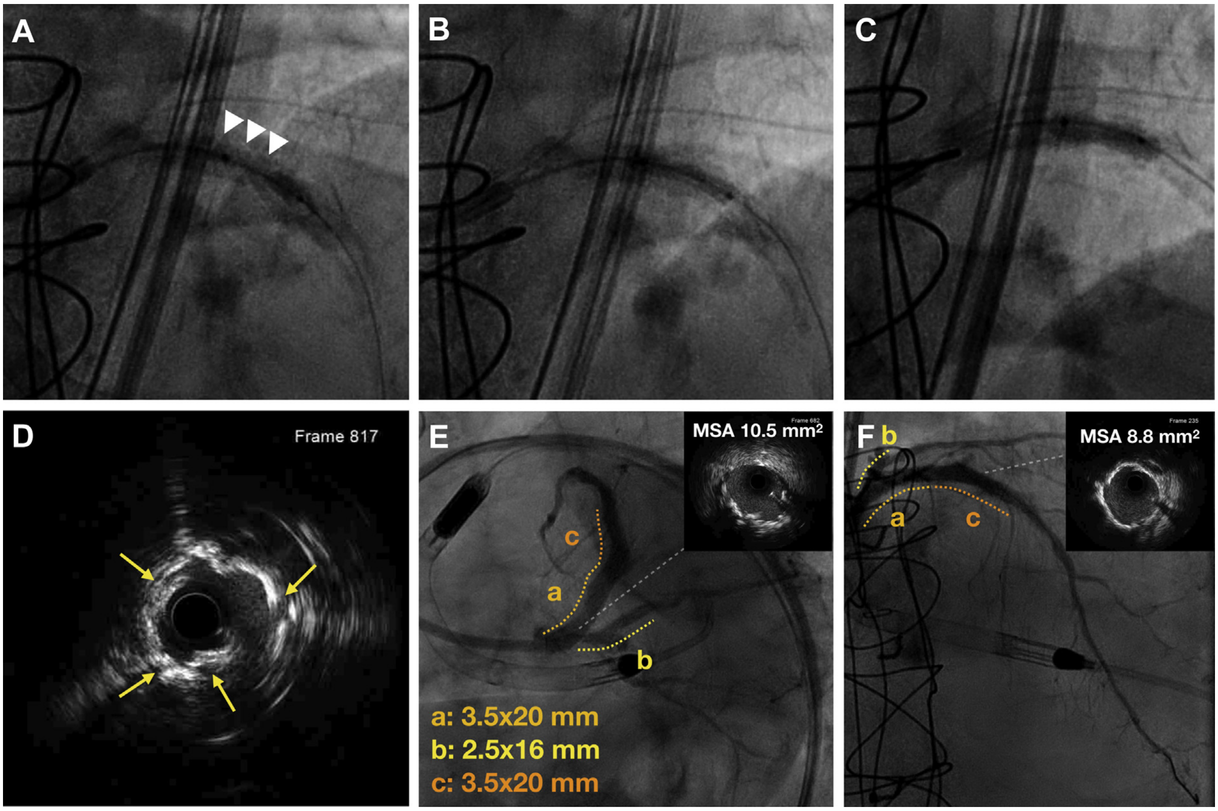

Figure 2. **(A)** Inadequate 3.0-mm noncompliant balloon expansion on the proximal left anterior descending (LAD; **arrowheads**). (**B**) Intravascular lithotripsy (IVL) with 3.5-mm Shockwave balloon: Acceptable balloon expansion is achieved after 60 pulses of IVL. (**C**) Full expansion of a 3.5-mm scoring balloon. (**D**) Intravascular ultrasound (IVUS) showing adequate plaque modification (**arrows point at calcium fractures**). (**E, F**) Good final angiographic and IVUS result after implantation of 2 drug-eluting stents on the left main-LAD and proximal circumflex-first marginal branch (DK crush), and another on the proximal LAD. MSA, minimal stent area.

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