Use of Lithotripsy in a Calcified Left Internal Mammary Artery Graft

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Videos are available online with the article at CathLabDigest.com

Video 1. Coronary angiogram showing severe stenosis with eccentric, focal calcification at the LIMA ostium.

Video 2. Coronary angiogram after successful Shockwave intravascular lithotripsy and stenting.

Abstract

Obstructive, calcified left internal mammary arterial (LIMA) graft disease is uncommon. Optimal calcific lesion preparation techniques in arterial bypass conduits are limited, especially given the risks and contraindications in arterial bypass conduits with the use of atherectomy. We report a case of an ostial, calcified LIMA stenosis that was treated successfully by employing intravascular lithotripsy (Shockwave Medical) in a novel location.

History of Presentation

A 66-year-old female presented to our emergency department with 1 week of progressive dyspnea on exertion along with reported exertional chest pain, cough, orthopnea, wheezing, and bilateral leg swelling. Despite compliance with hemodialysis for chronic kidney disease stage V (CKD V), her last dialysis session was terminated prematurely due to severe chest pain. Her physical examination revealed tachypnea with apparent respiratory distress, having a saturation of 90% on room air, bilateral lower lung field crackles, and bilateral pedal edema. Her vital signs were otherwise normal.

Medical History

The patient's past medical history included CKD V on hemodialysis, insulin-dependent diabetes mellitus, hypertension, hyperlipidemia, chronic obstructive pulmonary disease (COPD), obstructive sleep apnea, peripheral arterial disease with prior left lower extremity intervention and left carotid endarterectomy, prior transient ischemic attack, chronic systolic congestive heart failure, and known coronary artery disease (CAD) prior surgical history of 4-vessel coronary artery bypass grafting (CABG) with an atrial septal defect closure 8 years ago. The CABG grafts performed in 2013 included a left internal mammary to the left anterior descending (LAD) coronary artery, a saphenous vein graft (SVG) to the right posterior descending artery (PDA), and a sequential SVG to obtuse marginal (OM) 2 and OM3. Her prior medical regimen included clopidogrel, nitroglycerin (transdermal patch), metoprolol, amlodipine, rosuvastatin, hydralazine, bumetanide, metolazone, and levothyroxine.

Differential Diagnosis

The patient's presenting symptoms and examination were consistent with acute coronary syndrome in conjunction with and/or exacerbated by acute-on-chronic systolic congestive heart failure.

Investigations

An electrocardiogram showed normal sinus rhythm without any specific ST-T changes or any significant changes from prior electrocardiograms.

Laboratory parameters revealed BNP 981 pg/mL, creatinine 5 mg/dl, BUN 48 mg/dl, D-dimer 1.04 ug/ml FEU, and hs-Trop-I peaked at 119 ng/L. Chest x-ray revealed cardiomegaly. A computed tomography pulmonary angiogram of the chest showed no pulmonary embolism. Transthoracic echocardiogram revealed a left ventricular ejection fraction (LVEF) of 20% (previously was 35-40%), severely reduced LV systolic function, mild concentric left ventricular hypertrophy, basal posterior wall, basal lateral wall, and basal inferior wall kinetic abnormalities, and an elevated pulmonary artery systolic pressure of 54 mmHg. The patient also received oral aspirin, intravenous bumetanide, and bi-level noninvasive respiratory support, as well as her other home medications.

A diagnostic right heart catheterization revealed high Fick cardiac output/cardiac index, severe pulmonary hypertension (70/27, [40 mmHg]), moderate to severely elevated left-sided filling pressures (left ventricular end-diastolic pressure [LVEDP] 28 mmHg), pulmonary capillary wedge pressure (24 with V-waves to 40 mmHg), and moderately elevated right-sided filling pressures. A diagnostic left heart catheterization revealed severe, multivessel native CAD. Bypass graft anatomy revealed severe graft disease in the ostial LIMA to LAD (80% stenosis with moderate-severe calcification; Figure 1A, Video 1) and mid-distal SVG to OM2-OM3 (mid 80%, distal 99% diffuse stenosis, thrombus, diffuse calcification; Figure 2). There was also mild to moderate non-obstructive disease of the SVG to the right PDA. The ostial LIMA lesion was validated with the administration of intracoronary nitroglycerin and later with intravascular ultrasound (IVUS) (Figure 1B), as well as by the observation of severe balloon compression during the interventional procedure, as described below.

Management

Given the patient's complex anatomy with suboptimal hemodynamics, ad hoc percutaneous coronary intervention (PCI) was deferred in lieu of further heart team discussion and medical optimization. Her antiplatelet regimen was escalated from clopidogrel to ticagrelor, with a loading dose of 180 mg followed by 90 mg twice daily maintenance. She was scheduled for a series of extra hemodialysis/ultrafiltration sessions, leading to eventual percutaneous intervention several days later. Femoral access was employed in both diagnostic and intervention cases, given current and prior bilateral upper arm fistulas. Repeat pre-PCI LVEDP was improved at 23 mmHg. The LIMA to mid LAD ostial 75 to 80% stenosis with moderate to severe calcification was treated successfully with balloon angioplasty and intravascular lithotripsy (IVL) of a 3.5 mm x 12 mm C^2 balloon (Shockwave Medical), using 50 pulses. IVL was followed by placement of a Xience Skypoint 3.5 mm x 12 mm drug-eluting stent (DES) (Abbott Vascular) that was post dilated to >3.75 mm at high pressure, resulting in 0% residual stenosis and normal blood flow grade 3 (TIMI [Thrombolysis in Myocardial Infarction]) (Figure 3A, Video 2). The native proximal left circumflex artery (TIMI-2 flow pre, type C lesion) had diffuse calcification with a 95% stenosis that was treated successfully with a Diamondback 360° coronary orbital atherectomy system (CSI), balloon angioplasty, and Shockwave intravascular lithotripsy with a 3.5 mm x 12 mm C^2 balloon using 30 pulses, followed by placement of a Resolute Onyx 3.5 x 26 mm DES (Medtronic) extending back into the left main, and post dilated to >4 mm at high pressure, resulting in 0% residual stenosis with TIMI-3 flow. The OM2 had a 100% functionally occluded competitive vein graft with tortuous flow that was treated successfully with orbital atherectomy, balloon angioplasty, and placement of a Resolute Onyx 2.75 x 26 mm DES extending into the proximal circumflex. The stent was post dilated to high pressure with 0% residual stenosis and TIMI-3 flow post intervention (Figure 4). Intravascular ultrasound (IVUS) was employed for optimal equipment and stent sizing. IVUS also reaffirmed the true significant lesion in the ostia LIMA (Figure 1B, Figure 3B). The patient tolerated the procedure well and was transferred back to general cardiology care, with the addition of aspirin and ticagrelor to her previous medications.

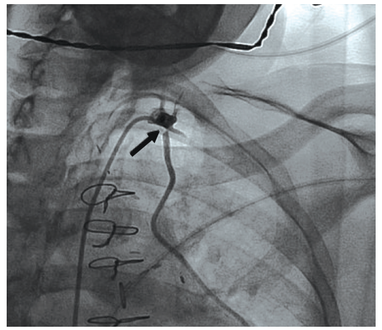

Figure 1A. Severe ostial stenosis with eccentric focal calcification (black arrow) LIMA to mid-LAD arterial graft.

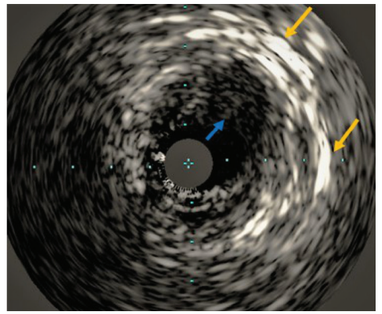

Figure 1B. Pre Shockwave intravascular lithotripsy intravascular ultrasound (IVUS) of left internal mammary artery (LIMA) ostia (blue arrow: intraluminal soft tissue plaque; yellow arrows: severe eccentric calcification of arterial wall).

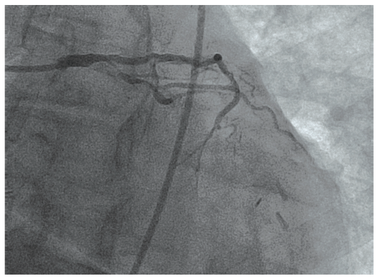

Figure 2. Severe, obstructive, native circumflex coronary artery disease.

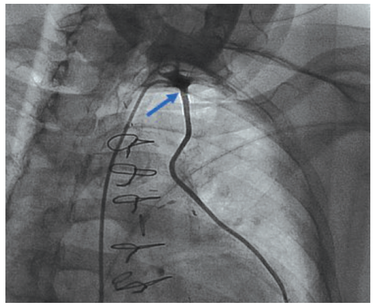

Figure 3A. LIMA to mid-left anterior descending (LAD) coronary flow restored (blue arrow) post Shockwave intravascular lithotripsy and stenting of the LIMA ostial stenosis.

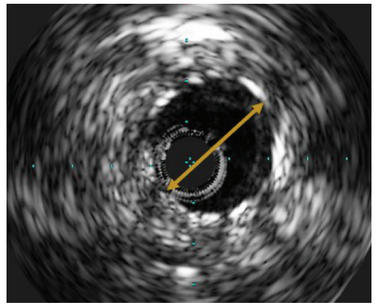

Figure 3B. Post Shockwave intravascular lithotripsy and stenting IVUS of the LIMA ostia (yellow arrow: stent deployed, well-apposed, expanded with no residual intraluminal plaque).

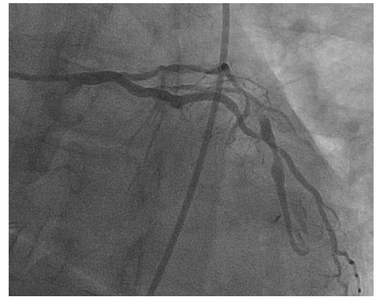

Figure 4. Revascularized native circumflex flow post Shockwave intravascular lithotripsy and drug-eluting stent placed in the native circumflex.

Discussion

The application of intravascular lithotripsy in the coronary space continues to gain as a result of clinical data and post-approval clinical experience, with the reaffirmation of IVL's efficacy and safety.[1-3] The landmark approval trials and much of the clinical experience up to this point have been focused in native coronary arteries. More recently, saphenous vein graft lithotripsy has been described with positive results, particularly in yielding more optimal stent expansion.[4,5] To our knowledge, employment of IVL in an arterial bypass graft has not been demonstrated. De novo, significantly calcified obstructive internal mammary arterial conduit coronary artery disease is not commonly seen.

In our case, a repeat CABG surgery would be of prohibitive risk given the patient's prior sternotomy, current clinical condition, and extensive comorbidities. Rotational or orbital atherectomy in the LIMA graft, especially given the acute take-off and the ostial disease location, would be relatively contraindicated in our case, as in most arterial graft cases.

As previously described, arterialization of a venous graft[6] with calcium deposition in the vessel wall rather than a plaque may be a case where IVL is preferable over atherectomy. Our case represented an arterial conduit with severe calcification in the vessel wall mixed with soft plaque within the vessel (Figure 1B), in a location where rotational and orbital atherectomy would be ill-advised and potentially compromise the safety of the patient. Intravascular lithotripsy provided effective and safe yielding of the lesion in a LIMA segment with ultimate, optimal DES deployment and expansion.

Follow-up

Over eight months after the procedure, the patient does not report any new angina, while her dyspnea remains much improved. She has not been readmitted to the hospital.

Conclusion

In less common instances where severe, obstructive, calcified lesions occur in coronary artery bypass conduits, intravascular lithotripsy may be feasible, effective, and safe.

Learning Objectives

- Severe, obstructive, calcified LIMA disease is not commonly observed.
- Rotational or orbital atherectomy are contraindicated and risk-prohibitive in arterial bypass conduits.
- Intravascular lithotripsy can be considered for lesion preparation in patients with calcified LIMA stenoses. ■

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