

Shockwave Intravascular Lithoplasty as the Last Option to Restore Flow in a Nonagenarian With an Acute Coronary Syndrome

Qais Radaideh, MD, MS¹; Nagarjuna Gujjula, MD¹; Ann E. Narmi, MD¹; Nicolas W. Shammam, MD, MS²; Toufik Mahfood Haddad, MD¹

¹Division of Cardiovascular Diseases, Creighton University School of Medicine, Omaha, Nebraska; ²Midwest Cardiovascular Research

Abstract: A 93-year-old woman was referred for non–ST-elevation myocardial infarction (NSTEMI). Coronary angiography revealed subacute occlusion of the left circumflex artery, which was treated with percutaneous coronary intervention without complications. She had severe 90% stenosis of the left anterior descending artery. This lesion was not dilatable. During balloon angioplasty, plaque rupture occurred. The patient developed STEMI. The presence of coronary dissection prevented the use of rotational or orbital atherectomy. Intravascular lithotripsy (Shockwave Medical) was successful in dilating this severely calcified lesion and facilitated stent delivery and expansion and the restoration of TIMI 3 flow. This case illustrates the effectiveness of coronary lithotripsy as a bailout approach to tackle severely calcified lesions when other modalities of treatment are contraindicated or not available.

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Introduction

Severe calcified coronary artery lesions remain a challenge for interventional cardiologists. Frequently, coronary angiography underestimates the presence of severe calcium within a plaque, which renders it non-dilatable with balloon angioplasty.^{1,2} Plaque modification becomes necessary to allow a wider lumen gain and minimize dissections, and to deliver and expand a stent successfully. Intravascular lithotripsy (IVL) has emerged as an effective technique to modify severely calcified plaque. However, most clinical trials of IVL, including the recently published DISRUPT CAD III, did not include ST-elevation myocardial infarction (STEMI), acute thrombotic lesions, or coronary dissections. We present a case of coronary lithotripsy as a bailout strategy in the setting of acute dissection in a patient with STEMI and a non-dilatable severely calcified lesion.³

Case Report

A 93-year-old female with hypertension and chronic kidney disease presented with dyspnea, elevated high-sensitivity troponin at 210 ng/L, and nonspecific electrocardiogram changes consistent with non-STEMI (NSTEMI). Echocardiogram showed an ejection fraction (EF) of 45% with anterolateral and inferior wall motion abnormalities. After detailed discussion of the risks and benefits of heart catheterization, an early invasive strategy was planned. Aspirin (324 mg) was administered and intravenous heparin started. Right radial

access was obtained, and a coronary angiogram was performed using 6 Fr catheters.

Coronary angiography showed a culprit proximal left circumflex 99% stenosis successfully treated with a 2.25-mm x 24-mm Synergy drug-eluting stent (DES) (Boston Scientific). The mid left anterior descending (LAD) artery had a 90% lesion (**Figure 1a**) that did not appear to be severely calcified. We initially used a 3.5-mm x 15-mm NC Emerge balloon (Boston Scientific) that crossed and inflated up to 12 ATM and then to high pressure at 20 ATM without successful dilation. Due to heavy calcification, there was a residual waist despite multiple balloon inflations (**Figure 1b**). Next, we escalated to scoring balloons, including a 3.0-mm Wolverine (Boston Scientific) and 2.5-mm AngioSculpt (Philips), neither of which crossed the lesion.

We terminated the procedure with plans to bring the patient back to the lab for plaque modification with atherectomy of the LAD artery lesion. The patient was preloaded with 600 mg clopidogrel. The activated clotting time at that point was greater than 300 seconds. The radial sheath was removed without complication. Post procedure, while on the procedure table, the patient developed jaw pain and severe chest pain. EKG showed ST-segment elevation anteriorly. Emergently, access was obtained through the right common femoral artery, and coronary angiography demonstrated a total occlusion of the mid LAD and TIMI 0 (**Figure 1c**), likely secondary to plaque rupture and thrombotic occlusion.

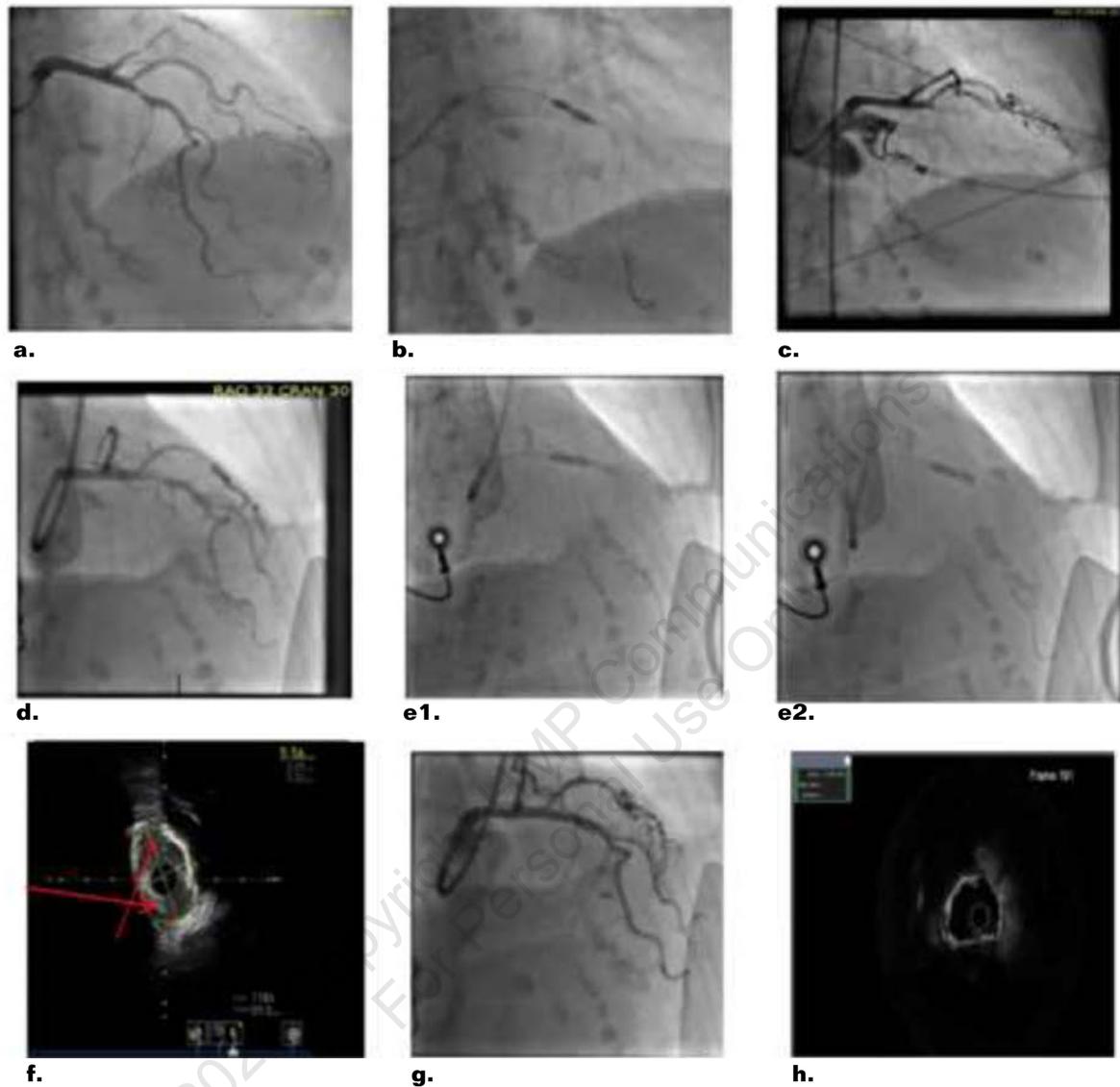


Figure 1. Coronary angiography.

- (a) 99% left circumflex artery, 90% left anterior descending artery (LAD).
- (b) Waist of predilation balloon at mid-LAD lesion.
- (c) 100% mid-LAD.
- (d) Edge dissection proximal to mid-LAD.
- (e1) Shockwave intravascular lithotripsy (IVL) balloon.
- (e2) Shockwave IVL balloon.
- (f) Intravascular ultrasound (IVUS) post Shockwave IVL shows fractured subendothelial calcium.
- (g) Final angiogram.
- (h) IVUS post stent, minimum stent area 9 mm².

A workhorse wire was advanced and crossed the lesion, and TIMI 3 flow was restored immediately consistent with transient thrombus. A compliant balloon (2.5 mm) was used with continued residual waist. There was evidence of edge dissection just proximal to the lesion (**Figure 1d**). The patient was started on a glycoprotein IIb/IIIa inhibitor (tirofiban). Atherectomy was contraindicated because of the risk of extending the dissection and the high chance for distal embolization with

the presence of thrombus. A 3.5-mm x 12-mm Shockwave balloon was advanced as a last resort and was wedged into the proximal portion of the plaque. Three sets of 10 pulses were delivered with inflation to 4 ATM, and each time the balloon was advanced gradually into the lesion until total crossing of the lesion (**Figure 1e1** and **Figure 1e2**).

Following lithotripsy, the lesion was dilated with a 3.5-mm x 12-mm NC balloon at 12 ATM with full balloon expansion.

Intravascular ultrasound (IVUS) post Shockwave lithotripsy showed fractured calcium in 2 different areas (**Figure 1f**). A 3.5-mm x 24-mm Synergy stent was deployed and inflated up to 16 mm ATM, then post dilated with a 4.0 x 8 NC Emerge balloon at 16 ATM with no residual narrowing (**Figure 1g**). Post stent IVUS showed a minimal stent area of 9 mm² (**Figure 1h**) with good opposition and expansion of the stent.

Discussion

Balloon angioplasty may unmask a severe calcified lesion that might be underappreciated angiographically. Plaque modification techniques can be accomplished with mechanical techniques such as rotational or orbital atherectomy, laser atherectomy, and specialty balloons with the ability to modify a plaque such as scoring balloons, cutting balloons, or recently, Shockwave lithotripsy. The mechanical techniques are effective in improving the acute procedural results but carry significant risk of perforations and distal embolization. In addition, these devices may be contraindicated in certain instances such as the presence of dissections or thrombus, and in the case of orbital atherectomy within a stent.⁴⁻⁵ Shockwave IVL has been recently introduced to modify severe calcified coronary and peripheral arterial disease with the use of high-energy pulses, and its technique is comparable with balloon angioplasty.⁶

Percutaneous coronary intervention (PCI) of severely calcified lesions is known to result in lower procedural success rates, higher complication rates, and worse long-term clinical outcomes compared with noncalcified lesions.⁷ Calcium modification through adequate pre-dilation is crucial in ensuring procedural success and reducing adverse cardiovascular outcomes. Our case demonstrates the difficulty in dilating coronary calcium with balloon angioplasty alone and the difficulty when tackling these lesions in the setting of acute thrombotic lesions and dissections. IVL was utilized in this case with excellent success, allowing us to cross a severely calcified lesion and achieve optimal stent results. IVL is a novel balloon-based technology that relies on acoustic mechanical energy to fracture severe vascular calcium in both the superficial and deep layers of the vessel.⁸ Early data appear to support this technology in treating severe coronary and peripheral calcified arteries effectively and safely. In the DISRUPT III coronary artery disease (CAD) study, 431 patients with stable CAD or unstable angina (excluding patients with positive troponin) were treated for severely calcified coronary lesions. The primary safety endpoint was 92.2% and the primary effectiveness endpoint of procedural success was 92.4%, with a low level of complications of all-cause death rate (0.5%), target lesion failure (7.8%), and definite stent thrombosis (0.8%).³

The use of Shockwave IVL in the setting of STEMI has been validated as a safe and reliable method in a retrospective registry by Cosgrave et al. In this registry, it was reported that in 76% of cases, plain balloon angioplasty was unsuccessful in crossing the lesion.⁹ In our case, IVL not only treated the lesion successfully but also played an important role in crossing it. At this time, it is unclear how coronary lithotripsy compares with

mechanical atherectomy in the coronary arteries and whether it improves hard outcomes when used as an adjunct to DES. It is, however, clear that its advantage at this time is to improve acute procedural success and facilitate crossing of the lesion with balloons or stents. The long-term outcomes of plaque modification are currently being tested by the ECLIPSE trial (Evaluation of Treatment Strategies for Severe Calcific Coronary Arteries: Orbital Atherectomy vs Conventional Angioplasty Technique Prior to Implantation of Drug-Eluting Stents) comparing orbital atherectomy and DES with angioplasty and DES (ClinicalTrials.gov Identifier: NCT03108456).¹⁰

Conclusion

The use of IVL is beneficial and safe in modifying severely calcified coronary lesions and may be the last option available for a successful outcome in the setting of nondilatable thrombotic lesions with dissections. In addition, IVL appears to be effective in facilitating crossing lesions, which are otherwise very difficult to cross with conventional balloons. ■

Disclosure: The authors have completed and returned the ICMJE Form for Disclosure of Potential Conflicts of Interest. The authors report no conflicts of interest regarding the content herein.

The authors report that patient consent was provided for publication of the images used herein.

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Address for correspondence: Qais Radaideh, MD, MS, Creighton University School of Medicine, 7710 Mercy Road, Suite 401, Omaha, NE 68124. Email: qaisrad89@gmail.com

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