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CASE REPORT

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Overcoming very late severe calcific stenosis due to two layers of under-expanded stents with intravascular lithotripsy treatment: A case report

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Abstract

Intravascular lithotripsy (IVL) shockwave treatment is effective in treatment of severe calcific coronary stenosis within two layers of old under-expanded stents. Intravascular imaging is essential to analyze the mechanism of in-stent failure and optimize treatment.

KEYWORDS

angioplasty, coronary calcification, lithotripsy, under-expanded stent

1 | INTRODUCTION

Under-expanded stent in heavily calcific coronary stenosis has become a common challenge for interventional cardiologists as we undertake more complex coronary interventions for older population cohorts. It results in short-term and long-term stent failure and adverse patient outcomes. These complex lesions can be treated after many years with intravascular lithotripsy (IVL-Shockwave Medical Inc®). We report a case of a patient with severe stenosis at the site of two-layer under-expanded coronary stents implanted 17 years prior. Intravascular ultrasound scan depicted the presence of calcium deposits under the old stent struts as the likely mechanism of stent under-expansion. Intravascular lithotripsy fractures the thick calcium ring under the stent struts leading to a complete stent expansion of the old stents. Severe calcific coronary lesions can result in stent under-expansion which persists over decades. Intravascular lithotripsy could be a valuable treatment modality to overcome this unfavorable common issue.

Percutaneous coronary intervention on heavily calcified lesions remains challenging and has significant procedure-related and patient-related adverse outcomes. It is associated with stent under-expansion, stent thrombosis, restenosis, and subsequently major adverse cardiac events.[1,2] Multiple treatment strategies have been developed over the last three decades to overcome this hurdle including cutting/scoring balloons, high-pressure balloons, and rotational or orbital atherectomy.[3] Intravascular lithotripsy (IVL-Shockwave Medical Inc®) is a new modality for calcium modification and preparation of calcified lesions, but its use after the stent implantation remains uncertain.[4,5] We report a case of a patient admitted at our department after acute myocardial infarction. Coronary angiography showed severe in-stent restenosis in mid left anterior descending (LAD). Intracoronary imaging highlighted struts under-expansion in the middle of two-layered old stents surrounded by thick circumferential calcification. Intravascular lithotripsy created calcium microfractures beyond the stent struts with final good stent expansion.

2 | CASE PRESENTATION

A 73-year-old man with past medical history of ischemic heart disease, acute myocardial infarction (2003) with percutaneous intervention (PCI) and stent implantation in proximal-to-mid left anterior descending artery (LAD), type 2 diabetes mellitus, hypertension, dyslipidemia, obesity, and smoker was admitted at our institution with an acute coronary syndrome. He underwent stent implantations at another institution in the proximal-to-mid LAD for non-ST segment myocardial infarction 17 years ago and also 7 years later.

The cardiovascular and respiratory examinations on admission were normal. Blood pressure was 100/75 mmHg and heart rate was 50 bpm, electrocardiogram showed sinus bradycardia with first-degree heart block and T-wave inversion in leads V2-V6. Initial blood test showed elevated troponin I level at 1261 ng/L (normal level <26 ng/L). His medical therapy on admission was aspirin 100 mg/day, ramipril 10 mg/day, bisoprolol 10 mg/day, and Rosuvastatin 40 mg/day, Frusemide 40 mg/day, prazosin 1 mg/day, and Metformin 2 g/day.

Coronary angiography showed severe in-stent stenosis and under-expanded stent struts in mid-LAD (Figure 1A, Video S1). Optical coherence tomography (OCT - Abbott®) was attempted, but images were suboptimal as the OCT catheter was obstructing the flow and contrast opacification at the site of severe stenosis (Figure 2A, Video S2). Therefore, intravascular ultrasound (IVUS—Boston Scientific®) was performed confirming the severely under-expanded two-layer stents with heavy and diffuse calcification burden (Figure 2D, Video S3).

Multiple prolonged and high-pressure inflations in under-expanded site with noncompliant balloon were performed (2.0/15 + 2.5/12 mm at 20 atm for 30 s; Figure 2D). Hourglass images persisted during all inflations (Figure 1B). Therefore, two cycles of 10 impulses of IVL were performed (3.0/12 mm balloon inflated at 6 atm) which resulted in better expansion stents struts (Figure 1C). A repeat IVUS pullback image was obtained which highlighted the crushed calcium under the old stent struts and good stent expansion (Figure 2E, Video S4).

Since there were already two layers of stents, it was decided to proceed with a drug-coated balloon angioplasty (3.5/17 mm SeQuent® Paclitaxel Coated Balloon—B/BRAUN). Final OCT scan showed the crushed calcium under the old struts with appropriate expansion of stent struts with mean diameter of 3.01 mm and luminal area of 7.19 mm^2 (Figure 2B,C, Video S5) and confirming the very good angiographic result (Figure 2D). No major complications during the procedure or hospitalization occurred. Dual antiplatelet therapy with ticagrelor and aspirin was prescribed for 12 months. At 6-month follow-up, the patient was free of angina and on good clinical status.

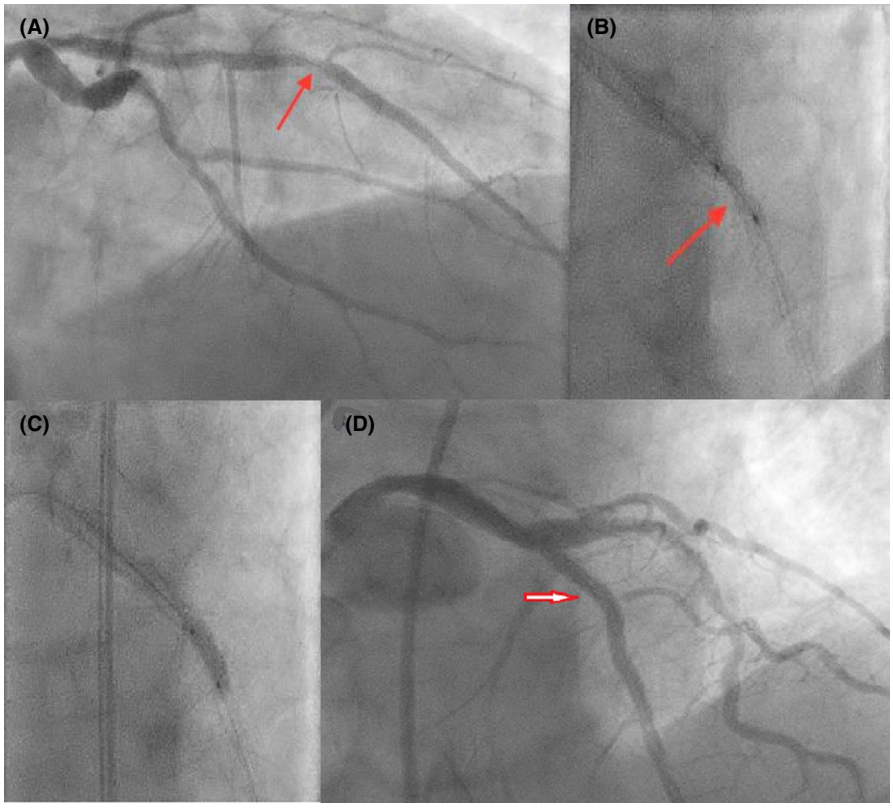

FIGURE 1 (A) Diagnostic angiogram. Severe in-stent stenosis in the mid part of left anterior descending artery (arrow). (B) Balloon angioplasty with a noncompliant balloon (2.5/15 mm inflation at 20 atmospheres showing undilatable segment [arrow]). (C) Coronary angiography illustrated resolution of severe focal stenosis post-IVL therapy. (D) Full expansion of IVL shockwave balloon inflated at 6 atm and two cycles of treatment provided (arrow)

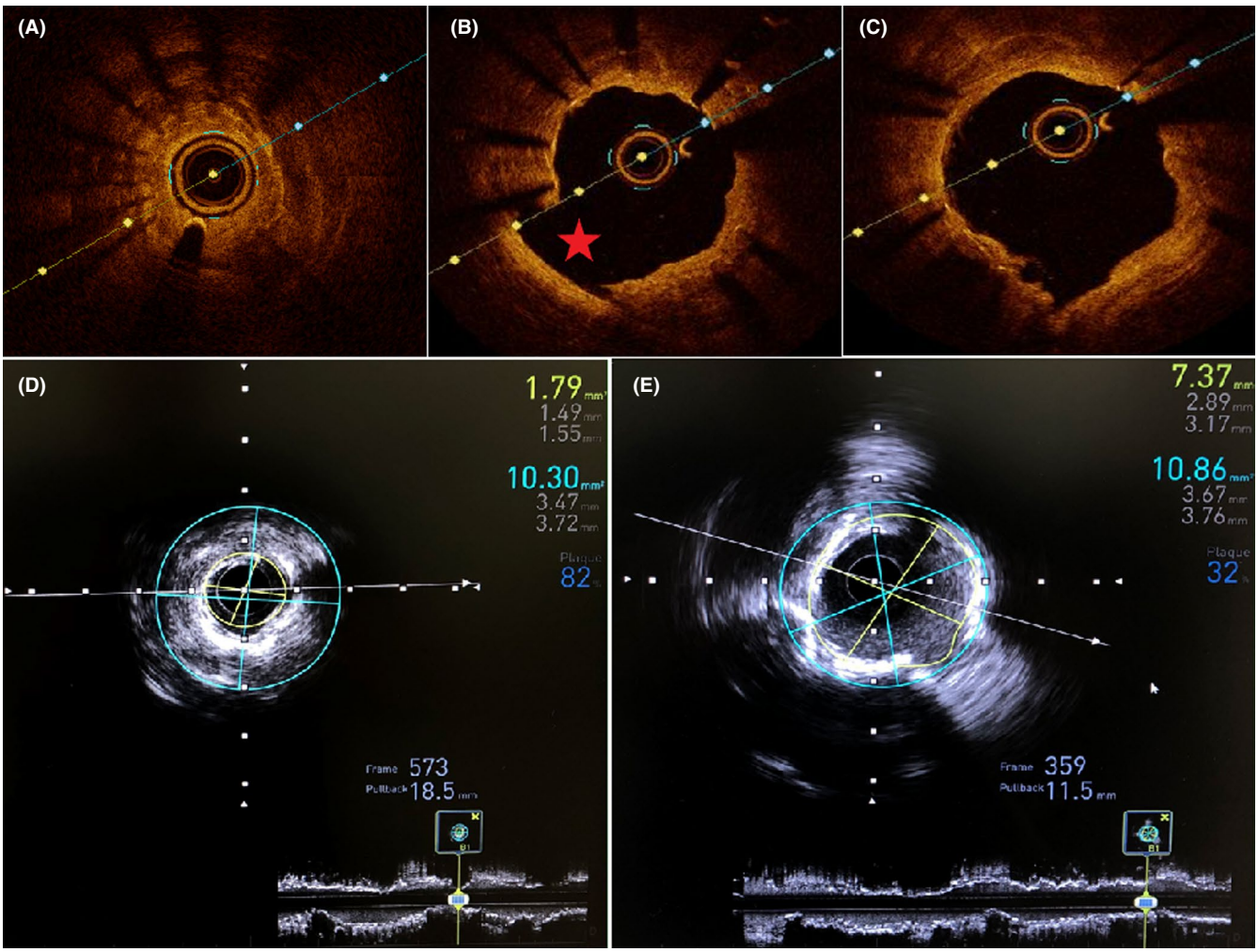

FIGURE 2 (A) Pre- and postlithotripsy OCT scan of under-expanded stents with mean diameter 0.92 mm and luminal area 0.66 mm^2 (B) Postlithotripsy OCT showing fractured calcium (asterisk; C) Final OCT imaging following drug-coated balloon angioplasty showing mean diameter 3.01 mm and luminal area 7.19 mm^2 (D) Prelithotripsy IVUS scan of under-expanded stents with luminal area 1.79 mm^2 (E) Postlithotripsy IVUS scan showing luminal area 7.37 mm^2

3 | DISCUSSION

Percutaneous coronary intervention in calcific lesions is challenging, and evidence suggests stent implantation following an optimal lesion preparation. This has been attempted for decades with cutting or scoring balloons and atherectomy (rotational, orbital, or laser).[3] Underutilization of these modalities has provided the current evidence of under-expanded stents.[1] Traditionally, it has been proposed to use stent ablation in treatment of these situations.[6]

Intravascular lithotripsy is a new technique based on calcium fracture by ultrasound waves. Recent reports support the off-label use of IVL as a bail-out therapy for under-expanded stents.[7,8] However, little is known about its utilization on layers of stents implanted many years earlier.

Intracoronary imaging is very beneficial in detecting the site and mechanism of stent failure and reference coronary diameters to plan for appropriate intervention. In our case, the OCT and IVUS image analysis permitted to describe the mechanism of stent under-expansion due to the presence of severe calcification under the old struts. It is recommended to maintain 1:1 ratio between IVL balloon and vessel diameter.[9] Thus, we chose a 3.0/12 mm IVL balloon.

In this case, intracoronary lithotripsy acted by creating calcium fractures and consequently better expansion of stent struts and transmission of the radial force of stents implanted 17 years prior. The circumferential stent expansion significantly improved after IVL (pre-IVL IVUS mean lumen diameter of 1.52 mm with luminal area at 1.79 mm^2 vs. post-IVL mean lumen diameter of 3.03 with luminal area at 7.37 mm^2).

4 | CONCLUSION

Percutaneous treatment of heavily calcified coronary lesions remains challenging. Acute and late procedural failure due to stent under-expansion is common. Intracoronary imaging is essential to evaluate the mechanisms of the stent failure. Intravascular lithotripsy in under-expanded stents implanted many years before was performed safely and effectively in this patient. Intracoronary lithotripsy creates calcium fractures under the stent struts allowing better stent expansion.

ETHICAL APPROVAL AND CONSENT TO PARTICIPATE

Ethics approval was not required for this publication, and patient consent was obtained to report this case report.

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CONFLICT OF INTEREST

None declared.

AUTHOR CONTRIBUTIONS

Each named author has substantially contributed to conducting the investigation and drafting this manuscript.

CONSENT FOR PUBLICATION

The authors confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient and is available in the patient's hospital medical record.

DATA AVAILABILITY STATEMENT

Clinical and procedural data are available in Fiona Stanley Hospital Medical Records.

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REFERENCES

1. Généreux P, Madhavan MV, Mintz GS, et al. Ischemic outcomes after coronary intervention of calcified vessels in acute coronary syndromes. Pooled analysis from the HORIZONS-AMI (harmonizing outcomes with revascularization and stents in acute myocardial infarction) and ACUITY (acute catheterization and urgent intervention triage strategy) TRIALS. *J Am Coll Cardiol*. 2014;63:1845-1854.
2. Bourantas CV, Zhang Y-J, Garg S, et al. Prognostic implications of coronary calcification in patients with obstructive coronary artery disease treated by percutaneous coronary intervention: a patient-level pooled analysis of 7 contemporary stent trials. *Heart*. 2014;100:1158-1164.
3. Barbato E, Shlofmitz E, Milkas A, Shlofmitz R, Azzalini L, Colombo A. State of the art: evolving concepts in the treatment of heavily calcified and undilatable coronary stenoses - from debulking to plaque modification, a 40-year-long journey. *EuroIntervention*. 2017;13:696-705.
4. Ali ZA, Nef H, Escaned J, et al. Safety and effectiveness of coronary intravascular lithotripsy for treatment of severely calcified coronary stenoses: the disrupt CAD II study. *Circ Cardiovasc Interv*. 2019;12:e008434.
5. Wong B, El-Jack S, Newcombe R, Glenie T, Armstrong G, Khan A. Shockwave intravascular lithotripsy for calcified coronary lesions: first real-world experience. *J Invasive Cardiol*. 2019;31:46-48.
6. Ferri LA, Jabbour RJ, Giannini F, et al. Safety and efficacy of rotational atherectomy for the treatment of undilatable underexpanded stents implanted in calcific lesions. *Catheter Cardiovasc Interv*. 2017;90:E19-E24.
7. Demarchi A, Ugo F, Cavallino C, Rametta F. Very late stent expansion with intracoronary lithotripsy: a case report. *Eur Hear J - Case Reports*. 2020;4:1-4.
8. Ali ZA, McEntegart M, Hill JM, Spratt JC. Intravascular lithotripsy for treatment of stent underexpansion secondary to severe coronary calcification. *Eur Heart J*. 2020;41:485-486.
9. Forero MNT, Daemen J. The coronary intravascular lithotripsy system. *Interv Cardiol*. 2019;14:174-181.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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