

Review began 04/17/2022
Review ended 04/21/2022
Published 04/26/2022

© Copyright 2022

Sharma. This is an open access article distributed under the terms of the Creative Commons Attribution License CC-BY 4.0., which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Shock Wave Intravascular Lithotripsy (IVL)-Assisted Staged Percutaneous Coronary Intervention (PCI) for a Calcified Right Coronary Artery in a Patient With Unstable Angina: Shock the Rock

Sanjay Kumar Sharma ¹

1. Department of Cardiology, Neo Hospital, Noida, IND

Corresponding author: Sanjay Kumar Sharma, drsanjukgautam@hotmail.com

Abstract

Coronary artery calcification represents one of the challenging and demanding subsets of percutaneous coronary intervention (PCI). Accumulated evidence has aptly outlined that shockwave intravascular lithotripsy (IVL) is a reliable tool to overcome calcified stenosis in coronary arteries. However, there is a lack of published case reports in the Indian context. Herein, we describe a case of right coronary artery (RCA) calcifications successfully managed with shock wave IVL-assisted staged PCI. Initially, a 74-year-old male patient presented with ST-segment elevation myocardial infarction (STEMI). At that time, coronary angiography demonstrated calcific thrombotic occlusion in the left anterior descending artery (LAD) and stenosis in proximal and mid tubular RCA. It was decided to proceed with immediate PCI of LAD followed by staged PCI of RCA. The patient presented with unstable angina at the time of the second repeat PCI of RCA and was managed with shock wave IVL-assisted staged PCI. Ultimately, the patient's condition was improved with good thrombolysis in myocardial infarction (TIMI) flow.

Categories: Cardiac/Thoracic/Vascular Surgery, Cardiology, Medical Education

Keywords: single-vessel disease, right coronary artery, percutaneous coronary intervention, lithotripsy, calcifications

Introduction

Coronary artery calcification (CAC) hinders percutaneous coronary intervention (PCI) by impeding stent crossing, disrupting drug-polymer from the stent surface, altering drug delivery and elution kinetics, and reducing stent expansion and apposition [1]. Thankful to the novel shockwave intravascular lithotripsy (IVL) system that emits circumferential mechanical energy and thus disrupts the calcium, minimizes soft-tissue injury while aiding stent deployment has greatly enriched therapeutic armamentarium of calcified lesions [2]. Despite the overwhelming clinical evidence with encouraging outcomes available for shock wave IVL-assisted PCI [3-5], there is a paucity of the data in the Indian context. Toward this end, we hereby report a case of a male patient with right coronary artery (RCA) calcifications presented with unstable angina. He was treated with shockwave IVL-assisted staged PCI.

Case Presentation

A 74-year-old male with a past history of hypertension, uncontrolled diabetes mellitus, and pancreatitis admitted to a tertiary care facility for staged PCI of RCA. He had developed ST-segment elevation myocardial infarction (STEMI) nearly one month ago, which was managed with the implantation of a drug-eluting stent (DES) (Figure 1).

How to cite this article

Sharma S (April 26, 2022) Shock Wave Intravascular Lithotripsy (IVL)-Assisted Staged Percutaneous Coronary Intervention (PCI) for a Calcified Right Coronary Artery in a Patient With Unstable Angina: Shock the Rock. Cureus 14(4): e24489. DOI 10.7759/cureus.24489

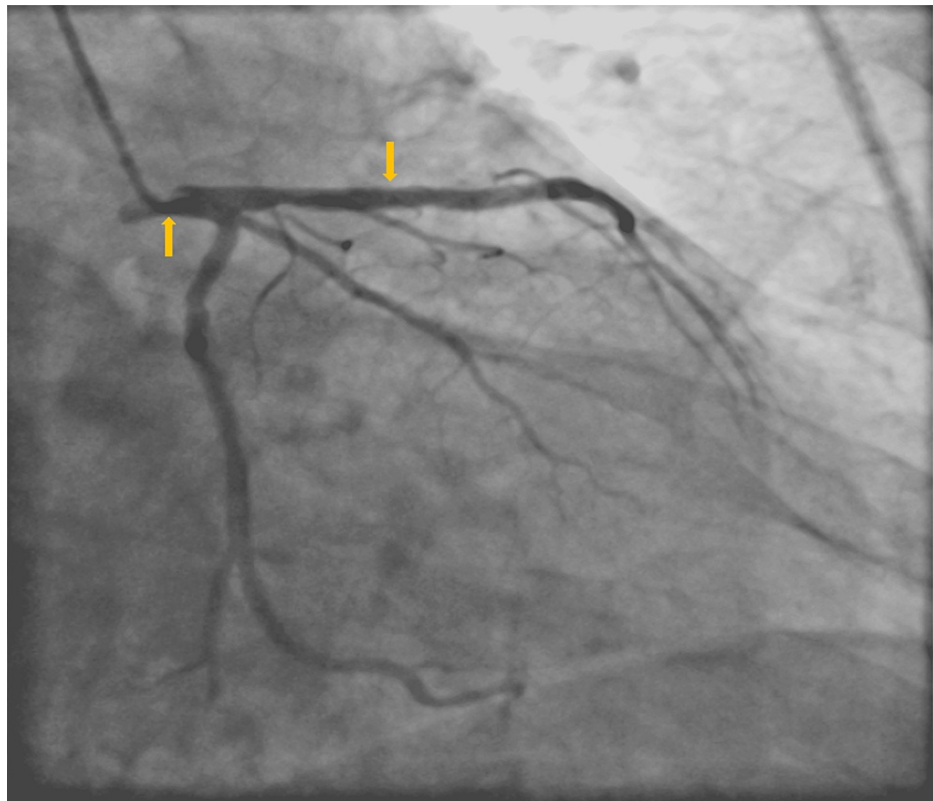


FIGURE 1: Normal left main, previously patent LAD stent

LAD: left anterior descending artery

At that time, transthoracic echocardiography revealed akinetic mid anterior septum, apex, mid anterior wall, dilated left ventricle, severe left ventricular systolic dysfunction with an ejection fraction of 30%, grade 1 diastolic dysfunction, and mild aortic regurgitation. All laboratory parameters were normal, except for troponin-I (619.9 ng/dl). Further, coronary angiography revealed normal left main (LM), 100% calcific thrombotic stenosis in left anterior descending artery (LAD), 50% stenosis in proximal left circumflex artery (LCX), and normal obtuse marginal artery-OM1 and OM2, 70% stenosis in proximal RCA and 80-90% stenosis in mid tubular RCA, normal posterior descending artery (PDA)/posterior left ventricular (PLV) artery. We planned to proceed with the immediate PCI of LAD followed by staged PCI of RCA. Nearly one month later, the patient was admitted to an intensive care unit (ICU) for the second PCI using shockwave IVL system. At this time, he was presented with unstable angina. On admission, the patient had a blood pressure of 143/86 mmHg, a pulse rate of 69 beats per minute, and oxygen saturation of 99% on room air. Moreover, chest and neurological examinations were normal. Coronary angiography was performed at arrival demonstrated normal LM, type-II vessel proximal to mild patent stent in LAD, normal diagonal arteries-D1 and D2, 40-50% stenosis in proximal LCX, normal OM1 and OM2 arteries, 60-70% stenosis in RCA-mild 95% calcific stenosis followed by 70% diffuse stenosis, normal PDA/PLV (Figure 2).

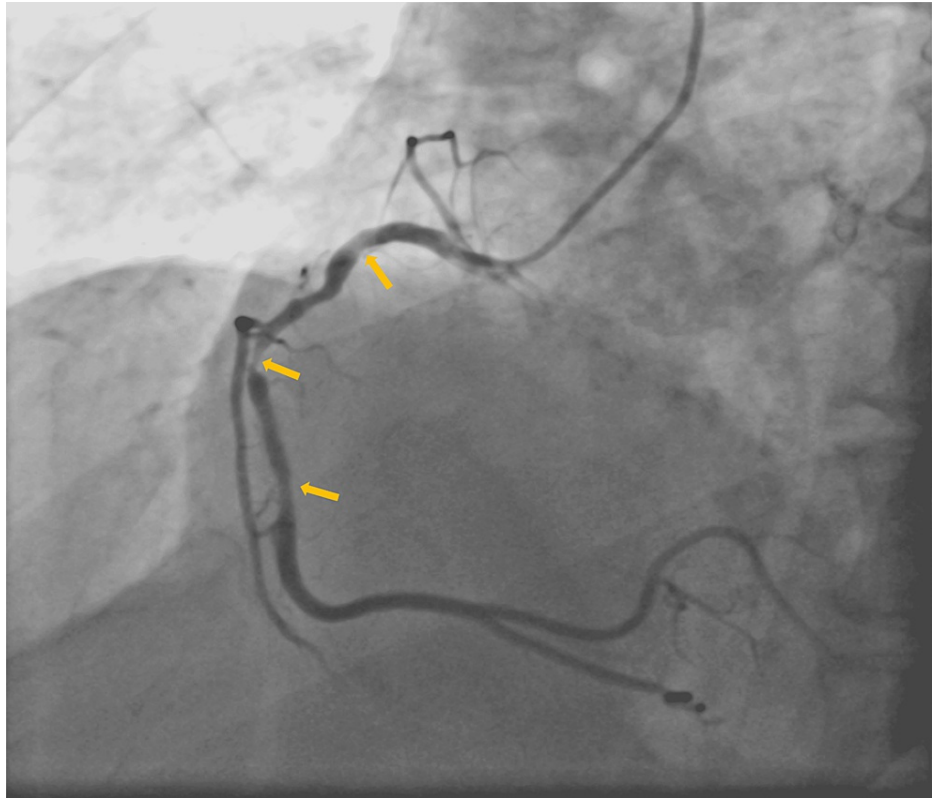


FIGURE 2: Coronary angiography of RCA revealed 60–70% stenosis—mild 95% calcific stenosis followed by 70% diffuse stenosis, normal PDA/PLV

PDA: posterior descending artery; PLV: posterior left ventricular; RCA: right coronary artery

The patient was diagnosed as having a single-vessel disease. A 3.5 JR guiding catheter (Medtronic, Minneapolis, MN, USA) was engaged in ostial RCA and then the guidewire was crossed to distal RCA. Thereafter, sequentially shockwave IVL was performed using a 2.0×10 mm balloon, which was inflated to 12 atmospheres, and 10 pulses of ultrasound energy of 10 seconds were successively delivered (Figure 3). This cycle was repeated four times.



FIGURE 3: A 3.5 JR guiding catheter was engaged in RCA ostium and was crossed wire to distal RCA and sequentially IVL done

RCA: right coronary artery; IVL: intravascular lithotripsy

After shock wave IVL, two overlapped DESs of a 3.0×40 mm (Figure 4) and a 3.5×18 mm (Figure 5) sizes

were implanted followed by post-dilatation with a 3.5 × 10 mm non-compliant balloon (Figure 6).



FIGURE 4: A 3.0 × 40 mm DES was negotiated and deployed

DES: drug-eluting stent

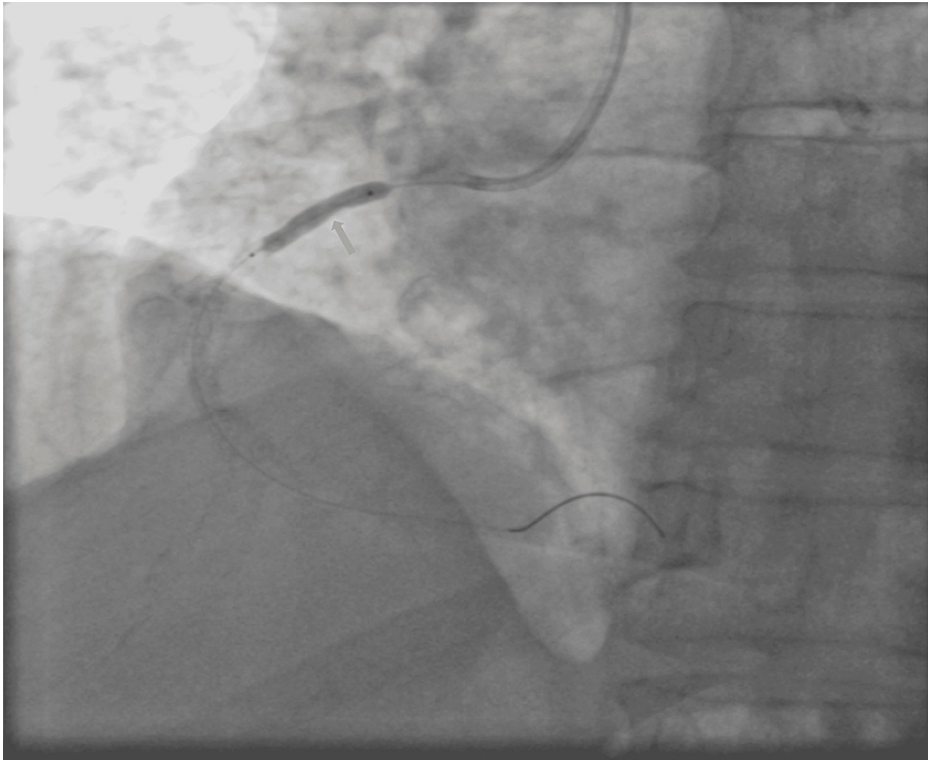


FIGURE 5: A 3.5 × 18 mm DES was deployed by overlapping with proximal of stent 3.0 × 40 mm
DES: drug-eluting stent

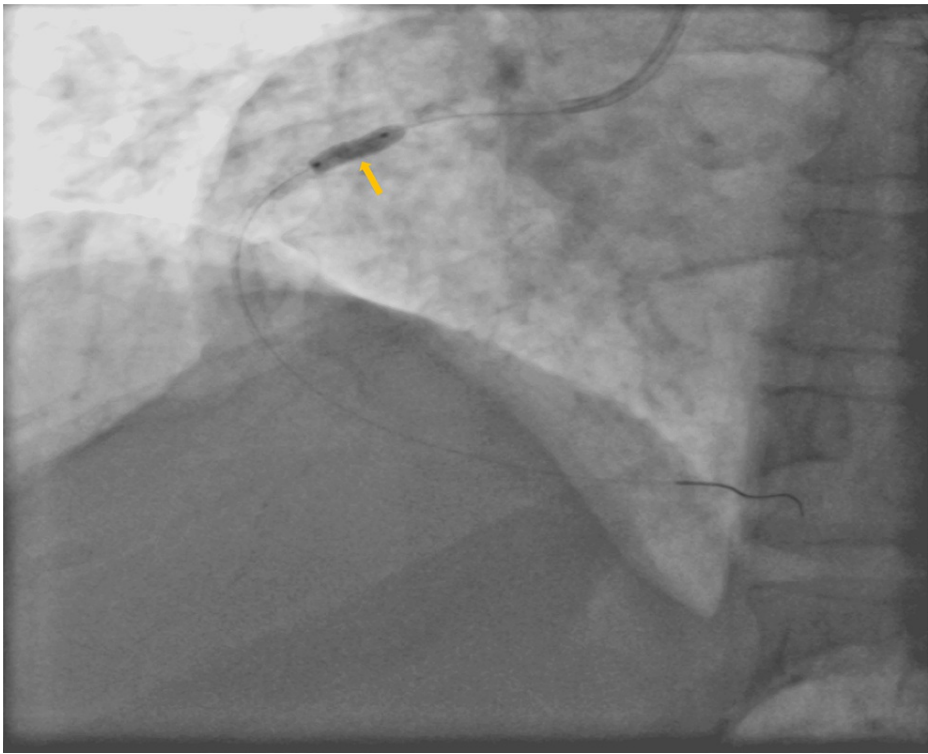


FIGURE 6: Sequentially post-dilated with a 3.5 × 10 mm non-compliant balloon

No complications occurred during hospitalization. After shockwave IVL-assisted staged PCI, excellent angiography outcomes have been achieved with the establishment of thrombolysis in myocardial infarction (TIMI) 3 flow (Figure 7).

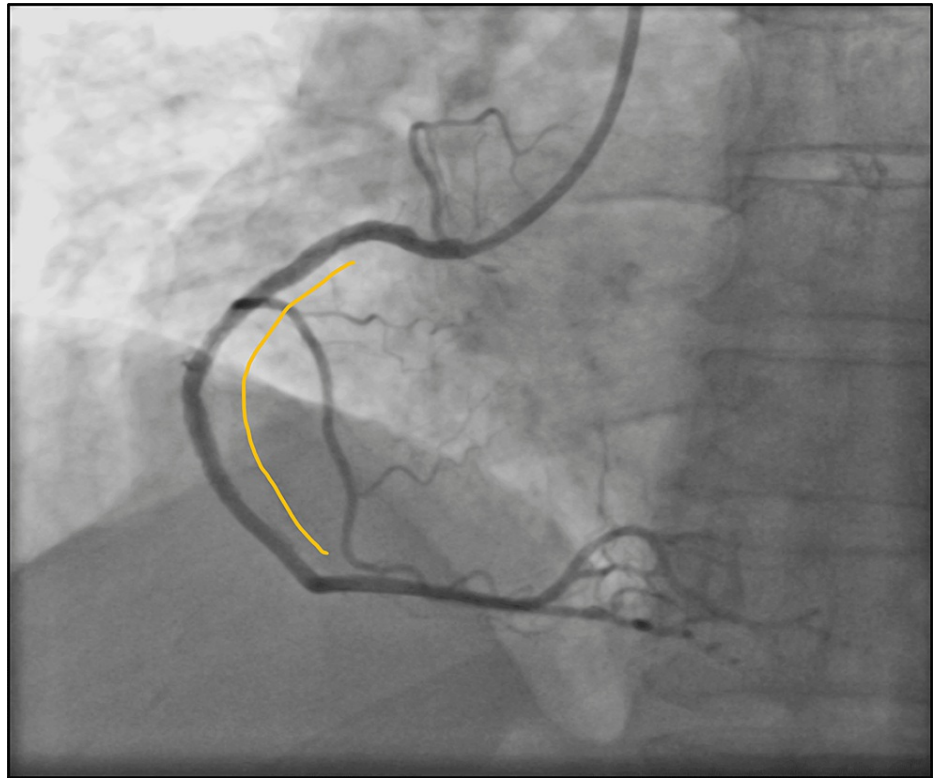


FIGURE 7: Final TIMI flow

TIMI: thrombolysis in myocardial infarction

Discussion

The prevalence of CAC in PCI cases is estimated to be within the range of 18-26%; however, this number is expected to rise. Extremely calcified coronary lesions remain a hurdle for PCI as their dilatation and precise implantation of stents are quite challenging. Very tight calcified lesions may resist dilatation at low balloon inflation pressures or rupture at high pressures. This causes high rates of procedural complications and, consequently, poor clinical outcomes [6]. Recent therapeutic calcium debulking techniques used to overcome CAC can be categorized into two groups: non-balloon (rotational, orbital, and laser coronary atherectomy) and balloon-based technologies (high-pressure/ultra-high-pressure non-compliant balloon, scoring/cutting balloons, shockwave IVL balloon). Sadly, these techniques are encumbered by a significant number of procedural complications, such as distal embolization, vascular wall injury, and coronary artery dissection or perforation [7]. Derived from lithotripsy technology employed to treat nephrolithiasis [8], the shockwave IVL system has also proved to be beneficial in treating CAC. Compared to the aforementioned conventional approaches, the shockwave IVL system requires minimal training and provides excellent outcomes of luminal widening, successful stent implantation, and reduced risk of major adverse cardiovascular events [6]. These observations are noted in our case, too.

Disrupt coronary artery disease (CAD) II study, a prospective multicenter, single-arm post-approval study, concluded the safety and effectiveness of shock wave IVL-assisted PCI in severe CAC [9], this is in agreement with findings reported by Aksoy et al. [10]. Wong and coworkers [3] reported the usefulness of the shockwave IVL system in coronary calcium modification to optimize stent expansion in cases of acute coronary syndromes (ACS) (29% of ACS patients were staged PCIs for severe non-culprit lesions), stable angina, and PCI before transcatheter aortic valve implantation. According to Tsiafoutis et al. [11], the shock wave IVL-assisted PCI appears to be a safe and useful alternative to achieve procedural success in CAC in STEMI cases. Further, many authors have reported promising outcomes of shock wave IVL system in percutaneous revascularization of severely calcified LM disease [12], severely calcified and undilatable LAD lesions in a patient with recurrent myocardial infarction [4], chronic total occlusion (CTO) PCI [13].

All previously mentioned studies hold the view that shock wave IVL-assisted PCI remains the default strategy for severely calcified coronary stenoses. In the present case, calcified stenosis of RCA has been

successfully treated with shockwave IVL-assisted staged PCI in patients presented with unstable angina. Considering the following facts, we have used shockwave IVL in our case: a) IVL has preferential effect on deep calcium than other ablation techniques, b) being a balloon-based technique, it is user-friendly with a short learning curve [14]. Patel and co-investigator [15] proposed the use of shockwave IVL in staged PCI during which thrombus burden and myocardial electrical instability may be significantly less. This notion is backed by the DEFER-STEMI (Deferred Stent Trial in STEMI), wherein deferring stent implantation in STEMI culminated in reduced no-reflow and increased myocardial salvage, with nearly 4% requiring urgent PCI prior to the staged procedure [16]. However, there is room for research on shockwave IVL-assisted staged PCI in treating CAC.

Conclusions

CAC still represents one of the most challenging subsets in PCI because of worse clinical outcomes. Slowly but surely, the proportion of patients with severely calcified lesions has been projected to grow worldwide, including in India. The optimal treatment for the condition still remains demanding. IVL is a relatively novel technique designed to overcome calcified stenosis in coronary arteries, with promising outcomes from several clinical trials. In this case, our experience demonstrates that conjugation of shockwave IVL system with staged PCI is safe in treating CAC and associated with a low rate of complication and high procedural success.

Additional Information

Disclosures

Human subjects: Consent was obtained or waived by all participants in this study. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

References

1. Ali ZA, Brinton TJ, Hill JM, et al.: Optical coherence tomography characterization of coronary lithoplasty for treatment of calcified lesions: first description. *JACC Cardiovasc Imaging*. 2017, 10:897-906. [10.1016/j.jcmg.2017.05.012](https://doi.org/10.1016/j.jcmg.2017.05.012)
2. Powers CJ, Tinterow MM, Burpee JF: Extracorporeal shock wave lithotripsy: a study of renal stone differences. *Kans Med*. 1989, 90:19-22.
3. Wong B, El-Jack S, Newcombe R, Glenie T, Armstrong G, Khan A: Shockwave intravascular lithotripsy for calcified coronary lesions: first real-world experience. *Heart Lung Circ*. 2019, 28:S7-8. [10.1016/j.hlc.2019.05.022](https://doi.org/10.1016/j.hlc.2019.05.022)
4. Legutko J, Niewiara Ł, Tomala M, et al.: Successful shockwave intravascular lithotripsy for a severely calcified and undilatable left anterior descending coronary artery lesion in a patient with recurrent myocardial infarction. *Kardiologia Pol*. 2019, 77:723-5. [10.33963/KP.14859](https://doi.org/10.33963/KP.14859)
5. Tomasiewicz B, Kosowski M, Zimoch W, Telichowski A, Kübler P, Reczuch K: Heavily calcified coronary lesion treated by shockwave intravascular lithotripsy. *Kardiologia Pol*. 2019, 77:890-1. [10.33963/KP.14917](https://doi.org/10.33963/KP.14917)
6. Kaul A, Dhalla PS, Bapatla A, Khalid R, Garcia J, Armenta-Quiroga AS, Khan S: Current treatment modalities for calcified coronary artery disease: a review article comparing novel intravascular lithotripsy and traditional rotational atherectomy. *Cureus*. 2020, 12:e10922. [10.7759/cureus.10922](https://doi.org/10.7759/cureus.10922)
7. Tripolino C, Grillo P, Tassone EJ, Morabito G, Maselli D, Missiroli B: A case of critical calcified innominate artery stenosis successfully treated with the shockwave lithoplasty. *Clin Med Insights Case Rep*. 2019, 12:1-3. [10.1177/1179547619828707](https://doi.org/10.1177/1179547619828707)
8. Chaussy CH, Brendel W, Schmiedt E: Extracorporeally induced destruction of kidney stones by shock waves. *Lancet*. 1980, 2:1265-8. [10.1016/S0140-6736\(80\)92335-1](https://doi.org/10.1016/S0140-6736(80)92335-1)
9. 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. [10.1161/CIRCINTERVENTIONS.119.008434](https://doi.org/10.1161/CIRCINTERVENTIONS.119.008434)
10. Aksoy A, Salazar C, Becher MU, et al.: Intravascular lithotripsy in calcified coronary lesions: a prospective, observational, multicenter registry. *Circ Cardiovasc Interv*. 2019, 12:e008154. [10.1161/CIRCINTERVENTIONS.119.008154](https://doi.org/10.1161/CIRCINTERVENTIONS.119.008154)
11. Tsiafoutsis I, Katsanou K, Koutouzis M, Katsivas A: Shockwave intravascular lithotripsy of Undilatable STEMI lesion in primary PCI. *J Invasive Cardiol*. 2021, 33:E67-8.
12. Ocaranza-Sánchez R, Abellás-Sequeiros RA, Santás-Álvarez M, Bayón-Lorenzo J, Gonzalez-Juanatey C: First-in-man reported 12-months follow-up after intravascular lithotripsy in left main percutaneous revascularization. *Coron Artery Dis*. 2021, 32:586-7. [10.1097/MCA.0000000000001003](https://doi.org/10.1097/MCA.0000000000001003)
13. Øksnes A, Cosgrove C, Walsh S, et al.: Intravascular lithotripsy for calcium modification in chronic total occlusion percutaneous coronary intervention. *J Interv Cardiol*. 2021, 2021:1-6. [10.1155/2021/9958035](https://doi.org/10.1155/2021/9958035)
14. De Maria GL, Scarsini R, Banning AP: Management of calcific coronary artery lesions: is it time to change our interventional therapeutic approach?. *JACC Cardiovasc Interv*. 2019, 12:1465-78. [10.1016/j.jcin.2019.03.038](https://doi.org/10.1016/j.jcin.2019.03.038)
15. Patel S, Madhavan MV, Spina R, Figtree GA, Karimi Galougahi K: Deferred intravascular lithotripsy-facilitated stenting in ACS: novel approach to improve PCI outcomes in severe calcification?. *JACC Case*

- Rep. 2020, 2:1700-1. [10.1016/j.jaccas.2020.07.043](https://doi.org/10.1016/j.jaccas.2020.07.043)
16. Carrick D, Oldroyd KG, McEntegart M, et al.: A randomized trial of deferred stenting versus immediate stenting to prevent no- or slow-reflow in acute ST-segment elevation myocardial infarction (DEFER-STEMI). *J Am Coll Cardiol*. 2014, 63:2088-98. [10.1016/j.jacc.2014.02.530](https://doi.org/10.1016/j.jacc.2014.02.530)