Coronary Intravascular Lithotripsy in a Tight Circumferential Calcified Lesion in the Presence of Haematoma Extending into Left Main Coronary Artery After Rotational Atherectomy

Jonathan Xinguo Fang, Arthur Sze-Yue Yung, Simon Cheung-Chi Lam and Frankie Chor-Cheung Tam

Division of Cardiology, Department of Medicine, Queen Mary Hospital, Li Ka Shing Faculty of Medicine, University of Hong Kong, Hong Kong, China

Abstract

Calcified disease increases procedural challenges and is associated with worse outcomes in percutaneous coronary intervention. Coronary intravascular lithotripsy is a new balloon-based modality for treating calcified disease with deep circumferential calcification. Its main benefit is simplicity and safety compared to atherectomy. However, atherectomy remains the modality of choice in balloon-uncrossable lesions. More than one modality is often needed for treatment of calcified disease. The authors present a case of a balloon-uncrossable calcified ostial left circumflex lesion which was first treated with rotational atherectomy. However, there was haematoma formation in the ostial circumflex extending into left main coronary artery, together with suboptimal preparation of calcified disease. Intravascular coronary lithotripsy was then used to successfully prepare the calcified lesion for stenting without causing extension of the haematoma.

Keywords

Coronary intravascular lithotripsy, rotational atherectomy

Disclosure: The authors have no conflicts of interest to declare.
Consent: The patient gave written informed consent for publication of this case report and videos.
Received: 6 June 2021 **Accepted:** 16 January 2022 **Citation:** *Interventional Cardiology* 2022;17:e12. **DOI:** https://doi.org/10.15420/icr.2021.18
Correspondence: Jonathan Xinguo Fang, Division of Cardiology, Department of Medicine, Queen Mary Hospital, Li Ka Shing Faculty of Medicine, University of Hong Kong, K1930, Block K, Queen Mary Hospital, 102 Pokfulam Rd, Pokfulam, Hong Kong, China. E: fangjonathan@gmail.com

Coronary intravascular lithotripsy (IVL) is a new modality for treatment of long, deep and circumferential coronary calcification. We present a case of IVL for treatment calcified lesion in the presence of haematoma formation after rotational atherectomy.

Case Report

A 67-year-old woman was admitted for unstable angina. She had a 20 pack-year history of smoking, and was receiving amlodipine and losartan for hypertension and atorvastatin for hyperlipidaemia. She had presented with atypical chest pain in the past 2 years and had recent acute worsening, with Canadian Cardiovascular Society class IV symptoms for 3 days.

On examination her chest was clear. Her blood pressure was 132/73 mmHg and her heart rate was 63 BPM and regular. Auscultation of the precordium revealed no murmur. The ECG showed biphasic T waves in lead V2, T wave inversion in V1, V3–V6 and III, and nonspecific ST-T changes in II and avF. Troponin was normal and an echocardiogram showed normal ejection fraction and valves. A coronary angiogram showed minor disease in the right coronary artery, 80% disease in the mid left-anterior descending artery (LAD), and 99% critical disease in the proximal left circumflex artery starting from the ostium (*Supplementary Material Video 1*). Percutaneous coronary intervention was performed via right-femoral artery access with a 7 Fr Launcher Extra-Backup 3.5 (Medtronic) guiding catheter and Runthrough Hypercoat (Terumo) guidewire.

Optical coherence tomography (OCT) showed concentric calcium in the mid LAD, with a mean luminal diameter of 1.95 mm^2 in the narrowest segment. The OCT catheter failed to cross the ostial left circumflex artery disease. Percutaneous coronary intervention of the circumflex artery and the LAD was performed. A Finecross (Terumo) microcatheter was used to exchange wire to a rotafloppy wire.

Rotational atherectomy with a 1.5 mm burr was used on the ostial-proximal circumflex artery. The burr was advanced with six passes at 185,000 rotations per minute. Buckling of the burr was noted during one of the passes, and the rotational atherectomy was stopped after six passes (*Supplementary Material Video 2*).

OCT showed haematoma formation from the left circumflex artery extending into the left main coronary artery, along with suboptimal expansion of calcification with circumferential calcium with a mean luminal area of 1.71 mm^2 still present (*Supplementary Material Video 3*). Coronary IVL was used to further prepare the calcification in the presence of the haematoma. A 3.0 mm Shockwave balloon was used, with 30 shocks delivered in three cycles. Angiography showed good expansion of the Shockwave balloon in the proximal circumflex calcified lesion during delivery of the shocks (*Supplementary Material Video 4*).

OCT showed good cracking of calcification without any extension of the haematoma (*Supplementary Material Video 5*).

Intervention was conducted on the LAD before returning to the left main and circumflex artery. A Sion blue wire was advanced to the distal LAD, and the mid LAD lesion was similarly prepared with a 3.0 mm Shockwave balloon for three cycles. The mid LAD was stented with a 3.0/29.0 mm drug-eluting stent, and postdilated with non-compliant 3.0 mm and 3.5 mm balloons up to 20 atm. OCT showed good stent apposition and expansion.

A 3.5/38.0 mm drug-eluting stent was then deployed in the left main into the proximal left circumflex artery covering the lesion and the haematoma. Postdilation at the left circumflex was done with a non-compliant 3.5 mm balloon at 20 atm. Proximal optimisation technique was conducted using a 4.5 mm non-compliant balloon at 12 atm and a 5.0 mm at 6 atm. OCT showed good stent expansion and apposition and mild proximal stent edge under-expansion. There was no haematoma proximal or distal to the stent (*Supplementary Material Video 6*). The proximal stent edge was further optimised using the 5.0 mm noncompliant balloon. Angiography showed a good result (*Supplementary Material Video 7*).

Discussion

Treatment of calcified disease is a major challenge in percutaneous coronary intervention. Calcified lesions in acute coronary syndrome are associated with increased risks of stent thrombosis and ischaemic target-vessel revascularisation at 1 year.[1]

Treatment modalities include balloon-based methods as well as ablative methods. Ablative methods include atherectomy with either rotational or orbital atherectomy and excimer laser.[2] Balloon-based methods, such as scoring and cutting balloons along with super high-pressure balloons, have the advantage of ease of use and are useful in luminal calcification. Nevertheless, all balloon-based methods are limited by crossability of the balloon.

Atherectomy has the advantage of debulking of calcification. In general, atherectomy is used in balloon-uncrossable lesions and in lesions with heavy calcification with long segment (length >5 mm) or thick (>0.5 mm) calcification and large arc calcification (>180°).[2] However, atherectomy is associated with increased risks of dissection, perforation and haematoma formation, and its use has a steeper learning curve. The excimer laser is another modality for uncrossable lesions, which debulks lesions by vaporisation. This modality is often limited by low availability.

In the case described here, the initial lesion was uncrossable so rotational atherectomy was chosen as the initial option. There was haematoma formation after rotational atherectomy with a 1.5 mm burr into the angulated ostial circumflex. We hypothesise that the mechanism of haematoma formation was eccentric cutting during atherectomy because of angulation or wire bias. A sudden jump during one of the atherectomy runs could have induced eccentric ablation. In retrospect, the initial burr size of 1.5 mm might also have been too large for the initial run.

In recent years, coronary IVL has been shown to be a safe alternative treatment of calcified disease, especially deep circumferential calcified disease. It has a high success rate of up to 95% as shown in the DISRUPT I, II and III trials.[3–5] The main action of IVL is fragmentation of calcium to increase vessel compliance.[3] Of note, only a low pressure of 4–6 atm is required during the use of the lithotripsy balloon, thus potentially minimising further extension of haematoma or dissection during use. Indeed, one of the advantages of lithotripsy is the relatively low risk of perforation, dissection or no-reflow phenomenon compared with atherectomy. Other advantages of IVL include a relatively shallow learning curve, a low chance of atheroma embolisation, and the avoidance of eccentric calcium ablation due to unfavourable guidewire bias, which can occur during rotational atherecomty.[2,3]

However, the main disadvantage of IVL is the low crossability of the balloon.[2] In balloon-uncrossable lesions, atherectomy or excimer laser remains the initial option. Calcified disease often has both superficial calcium, which is more suitable for atherectomy, as well as deep calcification, which is favourable for IVL. Therefore, it is not uncommon to treat calcified disease with more than one modality.

The successful combination of an atherectomy method together with IVL can potentially treat calcified disease more thoroughly than with either modality alone. To the best of our knowledge, this is the first reported case of the use of coronary IVL to further prepare a calcified lesion after rotational atherectomy has caused extensive haematoma formation.

An alternative strategy in this situation may include the use of a cutting balloon to release the haematoma. However, the higher pressure needed for preparation of cutting balloon compared to a Shockwave balloon could potentially lead to progression of dissection into the left main. On the other hand, stenting directly after haematoma formation with under-prepared calcification could lead to stent under expansion and poor long-term results. Therefore, IVL might be the most appropriate option in this scenario.

Currently, there are no consensus guidelines on the use of IVL in the treatment of calcified disease in the presence of a haematoma, dissection or suboptimal lesion preparation after rotational or orbital atherectomy. However, in our opinion, IVL has a potential role in these situations as demonstrated by the relative safety of IVL in the presence of haematoma in this case.

Conclusion

In this case, coronary IVL was used to safely treat the calcified lesion without significant extension or disturbance of intracoronary haematoma. Its adjunct use after rotational atherectomy in balloon-uncrossable lesions may improve preparation of difficult-to-treat calcified lesions. ❑

Clinical Perspective

- Interventional treatment of calcified coronary artery disease may require more than one modality to achieve an optimal result.
- Haematoma formation or dissection after atherectomy, together with suboptimal preparation of calcified disease in an ostial lesion extending into the left main coronary artery, is a challenging scenario.
- Coronary intravascular lithotripsy was safe and easy to use in this patient and may offer potential benefits in this situation for further lesion preparation before stenting.

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;63:1845–54. https://doi.org/10.1016/j.jacc.2014.01.034; PMID: 24561145.
2. 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. https://doi.org/10.1016/j.jcin.2019.03.038; PMID: 31395217.
3. Brinton TJ, Ali ZA, Hill JM, et al. Feasibility of Shockwave coronary intravascular lithotripsy for the treatment of calcified coronary stenoses. *Circulation* 2019;139:834–6. https://doi.org/10.1161/CIRCULATIONAHA.118.036531; PMID: 30715944.
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. https://doi.org/10.1161/CIRCINTERVENTIONS.119.008434; PMID: 31553205.
5. Hill JM, Kereiakes DJ, Shlofmitz RA, et al. Intravascular lithotripsy for treatment of severely calcified coronary artery disease. *J Am Coll Cardiol* 2020;76:2635–46. https://doi.org/10.1016/j.jacc.2020.09.603; PMID: 33069849.