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MINI-FOCUS ISSUE: INTERVENTIONAL CARDIOLOGY

ADVANCED

CASE REPORT: TCT CONNECT CASE

Intracoronary Lithotripsy

A New Solution for Undilatable In-Stent Chronic Total Occlusions

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ABSTRACT

Percutaneous coronary intervention was performed in a flush in-stent right coronary artery chronic total occlusion. Successful retrograde recanalization was performed but the lesion was balloon undilatable as confirmed by intravascular ultrasound. High-pressure post-dilation with noncompliant and plaque modification balloons failed, but intravascular lithotripsy successfully expanded the lesion. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2021;3:780–5)

HISTORY OF PRESENTATION

A 63-year-old woman with medically refractory Canadian Cardiovascular Society class III angina and worsening lower extremity edema was referred for percutaneous coronary intervention (PCI) of a right coronary artery (RCA) chronic total occlusion (CTO).

PAST MEDICAL HISTORY

The patient had multiple comorbidities: hypertension, dyslipidemia, chronic obstructive pulmonary disease, obesity, chronic kidney disease, smoking, and had undergone multiple previous PCIs. Four months prior, she had a retrograde attempt for RCA CTO crossing that failed due to inability to cross the septal collaterals. She was receiving isosorbide mononitrate 60 mg daily and amlodipine 10 mg daily.

LEARNING OBJECTIVES

- To understand the importance of meticulous coronary lesion preparation before stent implantation to reduce the risk of in-stent restenosis and stent thrombosis.
- To appreciate the potential role of intravascular lithotripsy in expanding balloon undilatable in-stent coronary lesions.

DIFFERENTIAL DIAGNOSIS

Other causes of chest pain were ruled out. Chest radiography did not demonstrate any pulmonary or bone abnormalities. She did not have any gastrointestinal disease, and her chest pain was similar to the symptoms she had before the previous PCIs.

INVESTIGATIONS

Coronary angiography revealed an ostial in-stent RCA CTO with a 40-mm estimated occlusion length. The distal vessel filled via septal collaterals from the left anterior descending coronary (**Figure 1,**

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Videos 1A and 1B). On echocardiography, the left ventricular ejection fraction was 55% with akinesis in the basal inferoseptal, basal inferior, basal inferolateral, mid-inferior and mid-inferolateral segments. Positron emission tomography revealed ischemia and viability of the myocardium supplied by the RCA.

MANAGEMENT

Due to flush RCA occlusion, a primary retrograde crossing strategy was pursued. Attempts to cross various septal collaterals using a Suoh 03 and a Sion black guidewire (Asahi Intecc, Nagoya, Japan) failed despite using both surfing and contrast-guided attempts. Eventually, a Fielder XTR guidewire (Asahi Intecc) crossed to the distal RCA and was advanced to the distal cap of the occlusion (**Figure 2,** Videos 2A and 2B), followed by a Turnpike LP microcatheter (Teleflex, Wayne, Pennsylvania). The RCA occlusion was crossed from the distal to the proximal true lumen using a Gladius Mongo guidewire (Asahi Intecc) that was advanced to the ascending aorta and snared with a 27- to 45-mm EN Snare (Merit Medical, South Jordan, Utah) (**Figure 3,** Videos 3A and 3B), followed by externalization of a R350 wire (Teleflex). The proximal RCA was pre-dilated with 2.5- and 3.0-mm balloons that appeared to expand. A 3.0- × 38-mm drug-eluting stent was deployed, followed by high-pressure post-dilation with noncompliant balloons and a cutting balloon (**Figure 4,** Videos 4A to 4D). However, the lesion was balloon undilatable, as confirmed by intravascular ultrasound. A 3.5- × 40-mm peripheral Shockwave balloon (Shockwave Medical Inc., Santa Clara, California) was delivered to the proximal RCA. After 140 pulses, the lesion expanded (**Figure 5,** Videos 5A and 5B). An additional 3.0- × 33-mm drug-eluting stent was deployed in the mid-RCA with a nice final angiographic result (**Figure 6,** Videos 6A and 6B). The patient was discharged home the following day and had complete angina resolution.

ABBREVIATIONS AND ACRONYMS

CTO = chronic total occlusion

IVL = intravascular lithotripsy

PCI = percutaneous coronary intervention

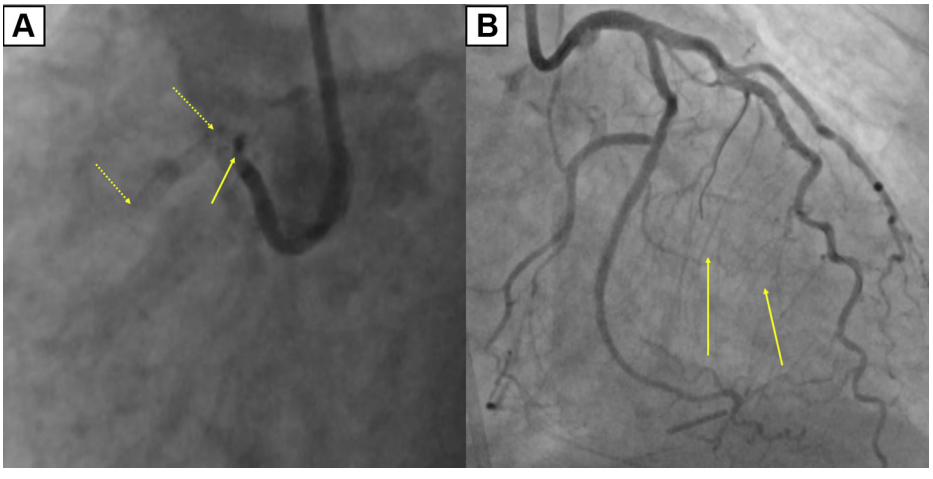
RCA = right coronary artery

DISCUSSION

Severe coronary calcification is associated with poor acute and long-term outcomes after PCI (1–3) because it carries increased risk of complications, such as stent loss (4), failure to expand the lesion (5), balloon rupture (6), and high rates of repeat target vessel revascularization (7). Several treatment modalities can be used in heavily calcified lesions, such as high-pressure balloon inflations; plaque modification balloons; very high-pressure balloons (35 atm; currently only available in Europe); rotational, orbital, and laser atherectomy; and recently, intravascular lithotripsy (IVL). Laser with simultaneous contrast injection is often effective in expanding balloon undilatable in-stent lesions but should be avoided in de novo lesions due to high risk of causing dissection (8).

IVL is performed using a specialized balloon catheter that contains multiple emitters of sonic pressure

FIGURE 1 Baseline Coronary Angiography



(A) Ostial right coronary artery chronic total occlusion **(arrow)**. The occlusion is approximately 40 mm long in-stent restenotic lesion **(dashed arrows)**. **(B) Arrows** show appropriate septal collaterals from the left anterior descending coronary.

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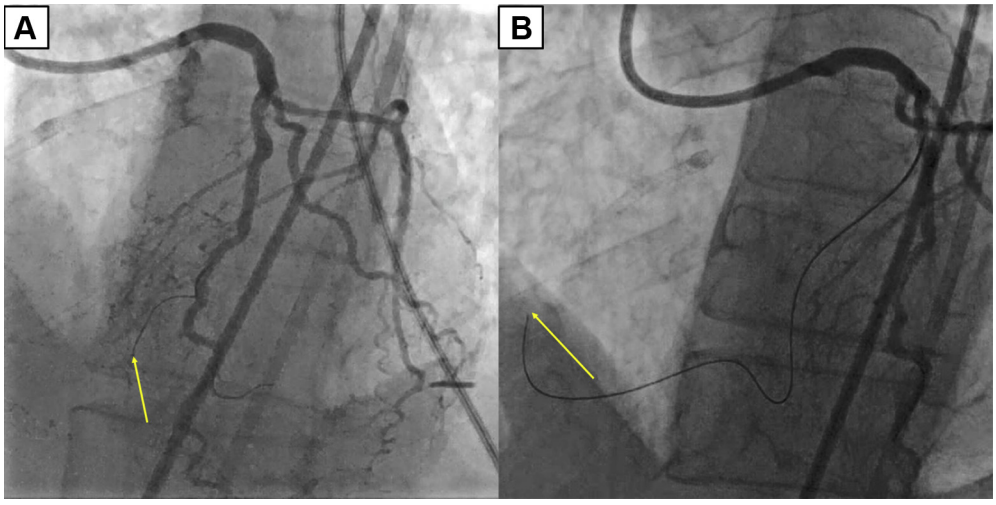
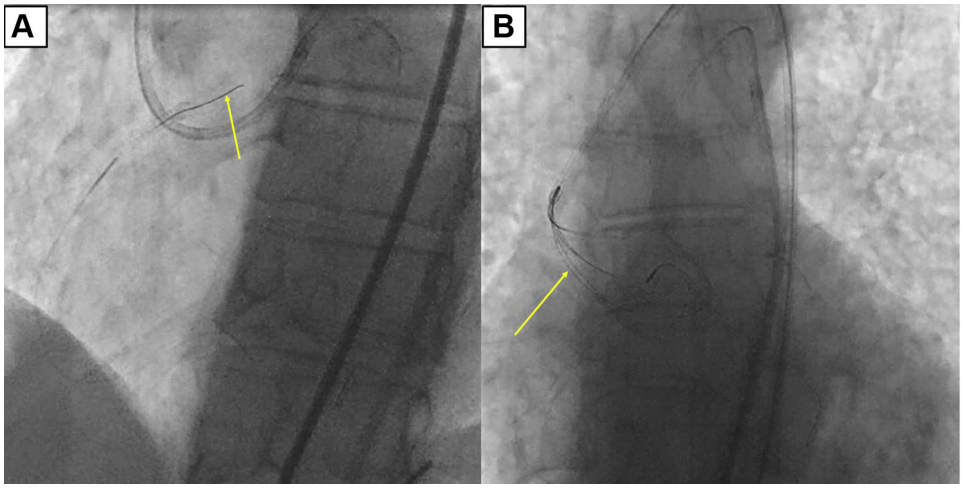
FIGURE 2 Crossing of a Septal Collateral



(A) Multiple septal collaterals could not be crossed with a Sion black guidewire (Asahi) **(arrow)** using both surfing and contrast guidance. **(B)** A Fiedler XTR guidewire (Asahi Intecc) **(arrow)** eventually crossed to the distal and mid right coronary artery and was advanced to the distal cap of the occlusion.

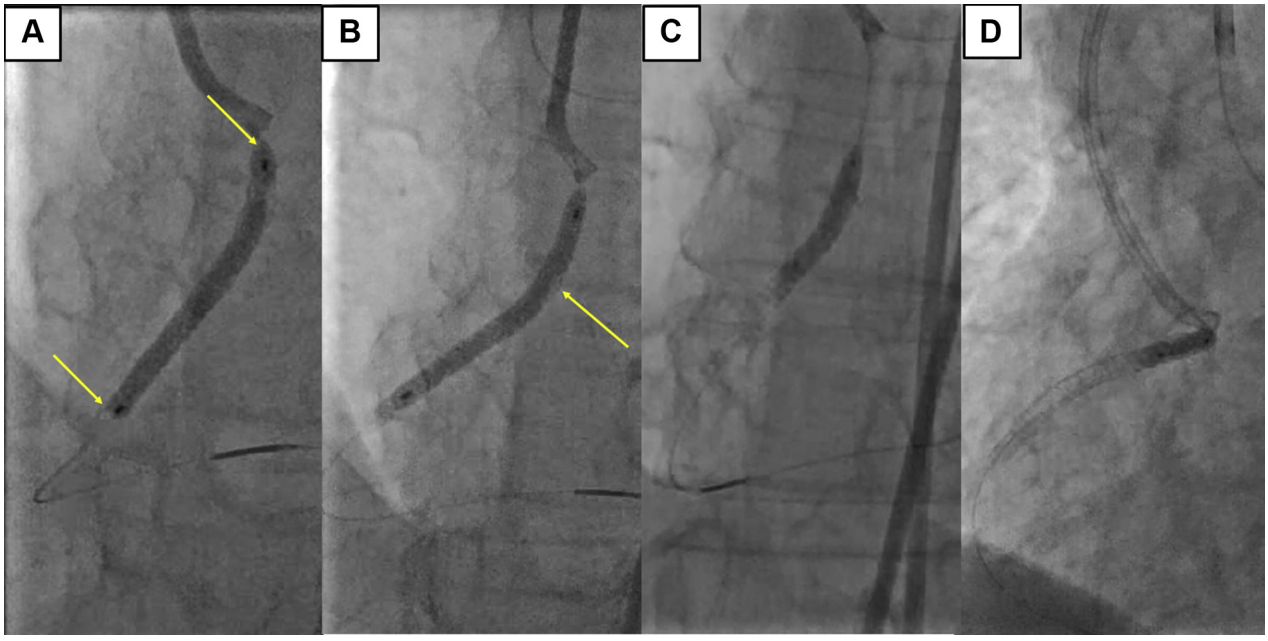
waves that selectively fracture calcium and alter vessel compliance. Barotrauma risk is low because of low balloon inflation pressure (4 atm). Until recently, IVL was only approved for peripheral use in the United States, but the peripheral catheter was sometimes be used off-label in coronary lesions (9), as was done in our case. All pivotal trials of IVL have excluded in-stent lesions (10), yet early case reports have been encouraging (11). Delivery of the peripheral IVL balloon can be challenging; it requires strong guide catheter support, but deliverability will likely significantly improve once the coronary IVL catheters become available. The potential impact of IVL on stent and polymer integrity and whether it potentially increases the risk of restenosis requires further study.

FIGURE 3 Crossing of the Ostial Right Coronary Artery Chronic Total Occlusion



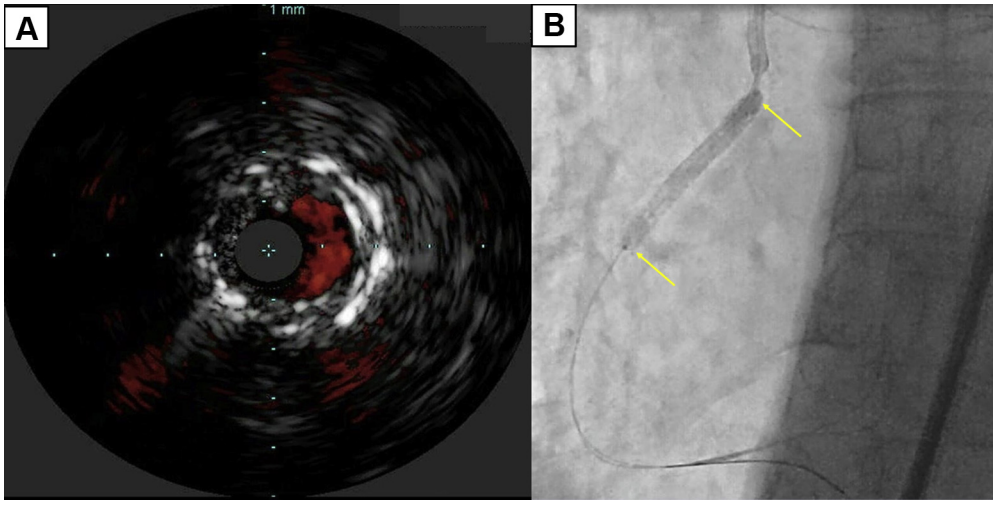
(A) The occlusion was crossed from the distal to the proximal true lumen with a Gladius Mongo guidewire (Asahi Intecc) to the aorta **(arrow)**. **(B)** The guidewire was snared with a 27-45 mm EN Snare (Merit Medical) in the aorta **(arrow)** and a R350 guidewire was externalized.

FIGURE 4 **Failure to Expand the Ostial Right Coronary Artery Stent**



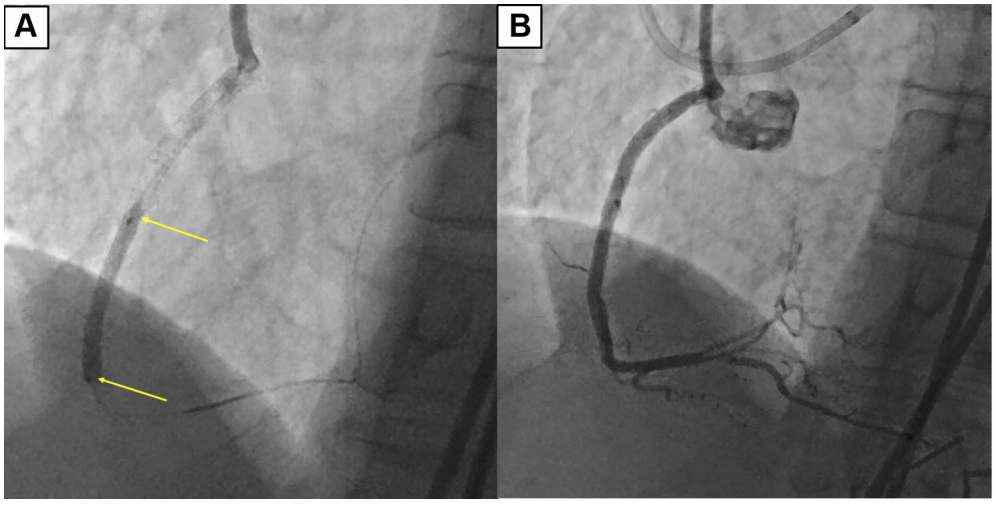
(A) A 3.0 × 38 mm drug-eluting stent was deployed **(arrows)** with an area of underexpansion. **(B)** The lesion was post-dilated with the stent balloon, but the underexpanded area did not improve **(arrow)**. **(C)** Post-dilation was repeated with 3.0 × 20 mm noncompliant balloon at high pressure. **(D)** Post-dilation with 3.0 × 10 mm cutting balloon.

FIGURE 5 **Intravascular Lithotripsy of the Balloon Undilatable Ostial Right Coronary Artery Lesion**



(A) Intravascular ultrasound of the balloon undilatable lesion. **(B)** Intravascular lithotripsy with 140 pulses with a 3.5 × 40 mm intravascular lithotripsy balloon (Shockwave Medical Inc.) expanded the lesion.

FIGURE 6 Final Result



(A) An additional 3.0 × 33 mm drug-eluting stent was deployed in the mid-right coronary artery. **(B)** Final result with Thrombolysis In Myocardial Infarction flow grade 3 and well-expanded stents.

FOLLOW-UP

Dual antiplatelet therapy with aspirin and clopidogrel was recommended indefinitely at discharge. Unfortunately, the patient stopped taking antiplatelet therapy and was hospitalized with a non–ST-segment elevation myocardial infarction and RCA stent reocclusion, followed by coronary artery bypass graft surgery.

CONCLUSIONS

Meticulous lesion preparation is critical before stent implantation, because stent underexpansion is associated with increased risk of in-stent restenosis and stent thrombosis. IVL may help expand balloon undilatable in-stent lesions.

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KEY WORDS chronic total occlusion, lithotripsy, percutaneous coronary intervention

APPENDIX For supplemental videos, please see the online version of this paper.