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CASE REPORT

ADVANCED

CLINICAL CASE

Lithoplasty-Facilitated Proximal Cap Penetration of a Calcified Chronic Total Occlusion Coronary Lesion

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ABSTRACT

We present a case of calcified chronic total occlusion of the left anterior descending coronary artery with ambiguous cap at the bifurcation with a large diagonal branch, in which intravascular lithoplasty balloon was used to modify the calcified proximal cap and facilitate wire crossing. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2022;4:44–48) © 2022 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

HISTORY OF PRESENTATION

An 84-year-old male known to be hypertensive and hyperlipidemic presented with dyspnea New York Heart Association functional class III with intermittent typical chest pain. He had sick sinus syndrome and paroxysmal atrial fibrillation managed by implantation of dual-chamber permanent pacemaker and oral anticoagulation.

On admission, the patient was alert with no fever, his blood pressure was 160/95 mm Hg, and his heart rhythm was regular at a rate of 75 beats/min. Heart/chest auscultation revealed grade III/VI systolic murmur on the aortic area (A1).

LEARNING OBJECTIVES

- To adopt a new concept of modifying a calcified proximal CTO cap using intravascular lithoplasty to facilitate wire crossing.
- To recall the role of intravascular ultrasound in CTO in order to understand the lesion and to guide the wire manipulation.

PAST MEDICAL HISTORY

The patient had pulmonary embolism in 1998 and hypothyroidism treated with L-thyroxin.

INVESTIGATIONS

The laboratory values were within normal range apart from elevated N-terminal pro-B-type natriuretic peptide (3,128 pg/mL). Electrocardiogram showed pacemaker rhythm with nonspecific ST-T wave changes. Transthoracic echocardiography showed preserved left ventricular systolic function with no segmental wall motion abnormalities and scleroses of aortic valve. Coronary angiography was subsequently performed and showed a relevant proximal lesion in the left anterior descending (LAD) artery followed by chronic total occlusion (CTO) of mid-segment at the bifurcation with a large diagonal branch (**Figure 1**).

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MANAGEMENT

Because the distal LAD was filling from ipsilateral collaterals (from large diagonal and left circumflex arteries) (**Figure 1**), a single right femoral access with 7-F extra back up guiding catheter was used. We started with antegrade wire escalation strategy. A workhorse wire was placed in the diagonal branch. Using a microcatheter wire escalation was performed starting with a polymer-jacketed soft tapered wire, polymer-jacketed harder and non-tapered wire, then an upgrade to intermediate hydrophilic tapered wire, and finally with stiffer hydrophilic wire; however, none could cross the lesion and instead they prolapsed in the diagonal branch (Video 1).

We performed intravascular ultrasound (IVUS) through the diagonal branch (Volcano Eagle Eye Platinum, Volcano Corporation) with manual pullback to visualize the CTO cap (**Figure 2A**) and to guide wire crossing. IVUS-guided wire crossing failed and revealed a calcified CTO cap. Therefore, we intended to modify this cap using intravascular lithoplasty (IVL) balloon. We advanced a 2.5-mm lithoplasty balloon (Shockwave IVL, Shockwave Medical) over the wire in the diagonal branch (the balloon was approximately 0.25 mm smaller than the diagonal) until it reached the bifurcation just at the CTO cap (**Figure 3A**). The balloon was inflated up to 4 atm and delivered 10 shocks; after that the pressure was elevated to 6 atm then deflated. After IVL, IVUS showed fractures in the calcified CTO cap as well as in the circumferential calcified plaque of mid-LAD (**Figure 2B**, Video 2). Another trial for antegrade crossing, a hydrophilic intermediate-tapered wire was able penetrate the proximal cap, but it pierced the extra plaque (**Figure 3B**); then a stiffer hydrophilic-tapered wire was advanced via the parallel wire technique which succeeded to cross into the true lumen (**Figure 3C**). The procedure continued with wire exchange with a workhorse wire, predilatation with noncompliant balloon and stenting mid- to proximal-LAD with a total of 3 stents (**Figure 3D**). IVUS after stent inflation showed good results (Video 3). Because of extension of dissection distally secondary to wire manipulation in extra plaque, the stented segment was prolonged distally.

ABBREVIATIONS AND ACRONYMS

CTO = chronic total occlusion

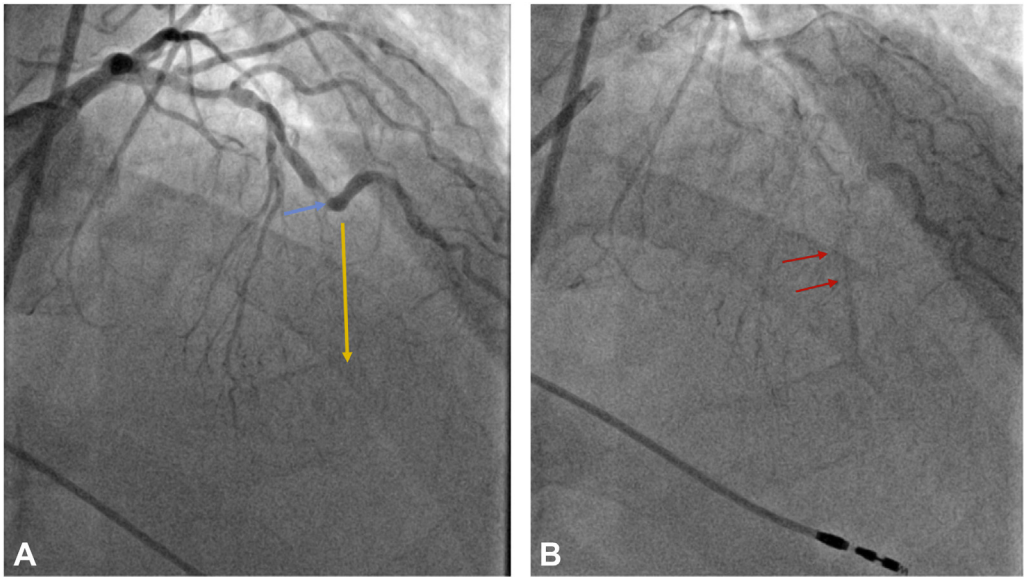
IVL = intravascular lithoplasty

LAD = left anterior descending artery

DISCUSSION

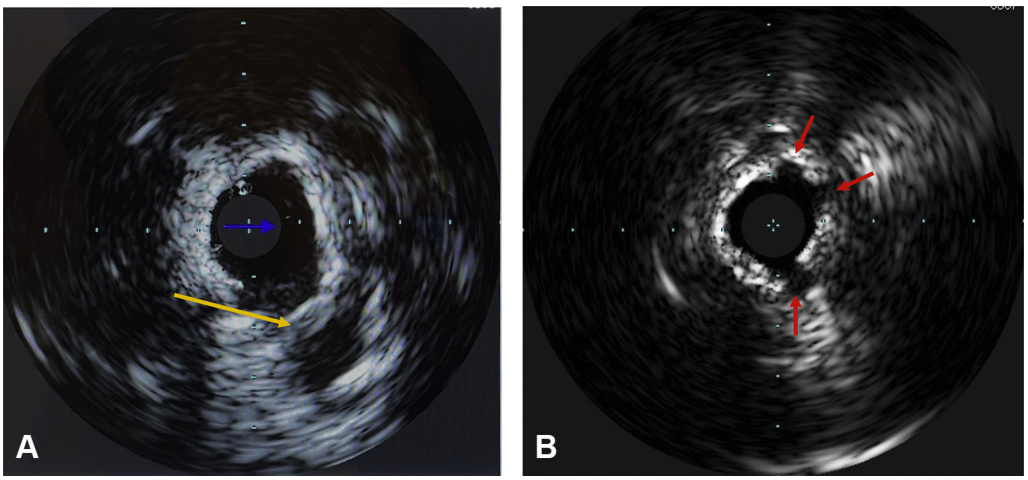
Several scores and algorithms were described to predict the feasibility and to guide the CTO recanalization. All of these scores included blunt and/or ambiguous cap and presence of calcification as

FIGURE 1 Coronary Angiography of Left Coronary Artery



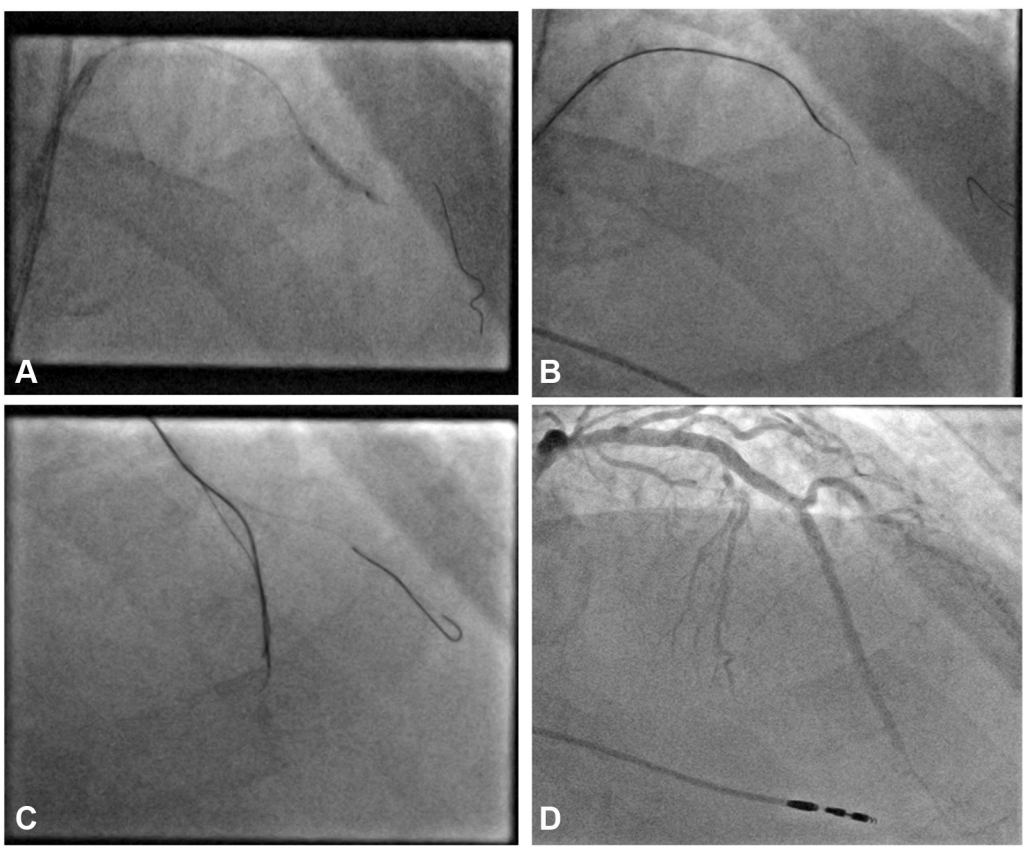
(A) Calcified significant stenosis of proximal left anterior descending artery (LAD) mid-LAD occlusion is shown **(blue arrow)** as well as the bend of the distal segment **(orange arrow). (B)** Retrograde filling of distal LAD **(red arrows).**

FIGURE 2 Intravenous Ultrasound of the LAD Before and After Lithoplasty



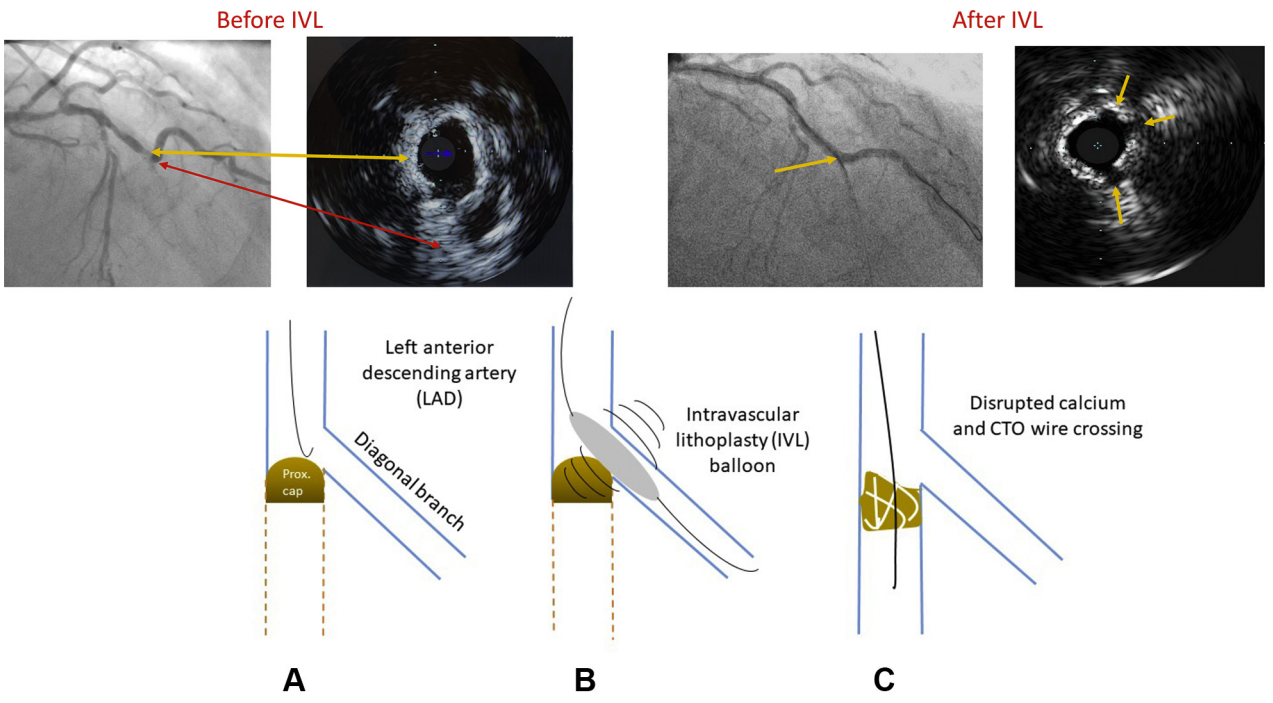
(A) Intravascular ultrasound showed a calcified mid-LAD just at the origin of chronic total occlusion cap **(blue arrow)** and the calcified chronic total occlusion cap **(yellow arrow). (B)** Fractures in the calcium after intravascular lithoplasty **(red arrows)**. Abbreviations as in Figure 1.

FIGURE 3 Intravascular Lithoplasty and Wire Crossing



(A) Inflation of the intravascular lithoplasty balloon at the site of occlusion. **(B)** Penetrating the proximal cap using intermediate hydrophilic-tapered wire. **(C)** The wire has penetrated extra plaque, and a stiffer wire succeeded to cross in true lumen (parallel wire technique). **(D)** Final angiographic result.

FIGURE 4 **The Mechanism of Lithoplasty-Assisted Proximal Cap Modification**



Images show the angiography and intravascular ultrasound before and after intravascular lithoplasty (IVL). **(A)** Calcified proximal cap of mid-left anterior descending artery (LAD) at the bifurcation with diagonal branch (**yellow and red arrows** before IVL). **(B)** Advancement and inflation of lithoplasty balloon just at the chronic total occlusion cap through diagonal branch with shock impulses delivery at the calcified cap. **(C)** Fractured and disrupted calcium after lithoplasty with facilitated wire crossing (**yellow arrow** after IVL).

predictors for a difficult CTO (1). Proximal cap ambiguity is present in approximately one-third of CTO lesions. Moderate to severe calcified lesions represent approximately 50% of all CTOs. Both calcification and proximal cap ambiguity are predictors of complexity and procedural failure (2).

Lithoplasty is a transcatheter technique based on ultrasound shock waves in which multiple emitters mounted on a balloon catheter platform create diffusive, circumferential pulsatile pressure waves aiming to disrupt calcified plaque. Compared with other calcific-plaque modifying techniques such as atherectomy, IVL provides many potential advantages. The lithoplasty technique depends mainly on creating cracks and fractures in calcified atheroma; therefore, the risk of distal embolization with consequent disturbance of the microcirculation is reduced. Moreover, the IVL balloon delivers circumferential ultrashort pulses of high-intensity acoustic energy unlike traditional balloon technology, which depends mainly on static barometric pressure. Therefore, this mechanism results in calcium modification with low risk of vessel dissection and perforation as reported in the Shockwave Coronary Lithoplasty (Disrupt CAD II) study (3). Additionally, because IVL is typically performed at low atmospheric pressure (4 to 6 atm), it minimizes mechanical vascular trauma. In this case report, we relied on these advantages to get the benefit of calcium modification of the LAD cap with minimum risk on diagonal branch.

The concept of modifying the proximal CTO cap was described by Yokoi et al (4), but a scoring balloon was used to facilitate wire entry. In our case, we described a new approach to modify a calcified ambiguous proximal CTO cap by inflation of an IVL balloon in a side branch (0.25 mm smaller than the side branch) just at the CTO-cap. We assumed that IVL would disrupt the calcium and reduce the convexity of the proximal cap, which would facilitate wire crossing as shown in **Figure 4**. This assumption was supported by an optical coherence tomography-based analysis that showed an occurrence of circumferential calcium fractures (by intimal and medial calcification disruption) following IVL (5).

FOLLOW-UP

A follow-up coronary angiography was performed 3 months later showing good results after LAD recanalization (Video 4).

CONCLUSIONS

A calcified ambiguous CTO proximal cap is challenging, particularly in the presence of a side branch. This case describes a promising new approach using the side branch to modify the proximal cap using IVL to facilitate CTO crossing.

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Dr Elbasha has received a scholarship from the Egyptian government. Dr Richardt has received institutional research grants from St Jude Medical, Biotronik, and Medtronic. Dr Hemetsberger has received honoraria from Boston Scientific. Dr Allali has consulted for Boston Scientific and Shockwave Medical.

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KEY WORDS coronary calcium, intravascular lithoplasty, intravascular ultrasound, percutaneous coronary intervention

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