Controlled Balloon Explosion: Report of a Rarely Used Technique to Dilate Highly Calcified Coronary Lesions

Zoltan Varga, MD, PhD; Chirag Desai, MD; Jacob Haiar; Adam Stys, MD; Tom Stys, MD

Abstract
Despite advanced methods for modification of resistant coronary lesions, dilatation of highly calcified coronary artery segments remains a challenge. Traditional methods used in these situations include inflation with noncompliant balloons, cutting balloons, laser atherectomy, rotational atherectomy, orbital atherectomy, and intravascular lithotripsy. Our case report describes the successful application of a less commonly used method for lesion optimization, the intentional rupture of an undersized coronary balloon partially inserted into the stenotic segment.

Background

The field of interventional cardiology has seen major advances in the last decade. Despite these advances, the dilatation of highly calcified, resistant coronary artery lesions remains a challenge. Traditional methods used in such situations include high pressure inflation with noncompliant balloons, the use of cutting balloons, laser atherectomy, rotational atherectomy, orbital atherectomy, and intravascular lithotripsy.[1] With suboptimal predilatation, the patient is at increased risk of stent underexpansion and subsequent long-term complications.[2] To decrease the risk of underexpansion when the aforementioned methods fail, multiple alternative methods have been developed. One of the less commonly used methods is the intentional rupture of an undersized coronary balloon after partial insertion into the stenotic segment[3], as illustrated in our case report.

Case Presentation

A 65-year-old male presented with a few days of productive cough, progressive fatigue, worsening scrotal edema, and high-grade fever. His past medical history included essential hypertension, tobacco abuse, ischemic cardiomyopathy with a left ventricular ejection fraction (LVEF) of 20%, and severe multivessel coronary artery disease (CAD) involving the left main (LM) (80%), mid left anterior descending artery (LAD) (100%), and distal right coronary artery (RCA) (90%). Vital signs at presentation were notable for hypotension and sinus tachycardia. Physical exam showed 2+ pitting edema of the lower extremities, significant scrotal edema, and inspiratory and expiratory wheezes on auscultation. Laboratory test results were notable for troponin elevation of 0.12 ng/mL and BNP of 7722 pg/mL. Creatinine was elevated at 1.74 mg/dL, which was above the patient's baseline. An electrocardiogram (EKG) showed inferior Q waves, widespread T wave abnormalities, a right bundle branch block, and a left posterior fascicular block (Figure 1). The chest x-ray showed cardiomegaly without pulmonary infiltrates/consolidation. An echocardiogram showed a severely enlarged left ventricle with a left ventricular ejection fraction of 15%-20%. During his hospital stay, the patient developed cardiogenic shock requiring short-term inotropic support with dobutamine. After stabilization, the patient underwent a coronary angiogram, which showed progression of his CAD with a 90% distal LM stenosis, mid-LAD chronic total occlusion (CTO), and a 99% distal RCA lesion. In the past, the patient had elected not to pursue invasive management and was treated only medically. This time, the patient was willing to consider any treatment option, so cardiothoracic surgery was consulted. The patient was not found to be a good candidate for surgical revascularization. Before discharge, the patient underwent successful percutaneous coronary intervention (PCI) of the RCA with drug-eluting stent (DES) placement. Two weeks later, he presented for staged PCI of the LAD CTO. For the procedure, right radial access was utilized.

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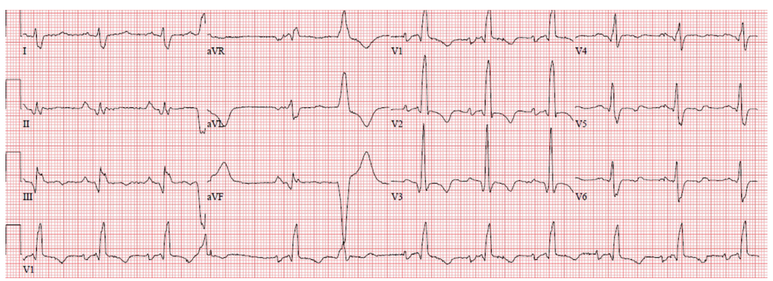

Figure 1. EKG at presentation.

Dual access was not obtained due to the absence of significant right-to-left collaterals. The LM ostium was engaged with a 6 French Launcher Extra Backup (EBU) 3.5 guide catheter (Medtronic). Initially, the procedure proceeded according to the plan. We were able to cross the LAD CTO without significant difficulties using a Prowater .014-inch, 180 cm coronary guide wire (Abbott Vascular) (Figure 2A). Unfortunately, we were unable to advance further interventional equipment into the lesion. Eventually, we managed to partially insert a semi-compliant balloon into the proximal end of the stenotic area. At this point, with two-thirds of the Sprinter Legend Rx 1.5 mm x 6 mm balloon (Medtronic) still proximal to the lesion, we elected to go forward with the technique of controlled balloon explosion (Figure 2B). Eventually, balloon rupture (Figure 2C) occurred at a pressure of 20 atmospheres. The following angiogram showed a dissection in the LAD, an expected finding with this technique (Figure 3A). After the successful lesion modification, we advanced a 2.0 mm x 20 mm Euphora Rx balloon (Medtronic) for the purpose of post dilatation. Subsequently, a 2.5 mm x 34 mm Resolute Onyx (Medtronic) drug-eluting stent was successfully placed (Figure 3B). The remainder of the procedure was uneventful. For his LM disease, the patient successfully underwent staged high-risk PCI. A repeat echocardiogram after 3 months showed an improved EF at 25%-30%.

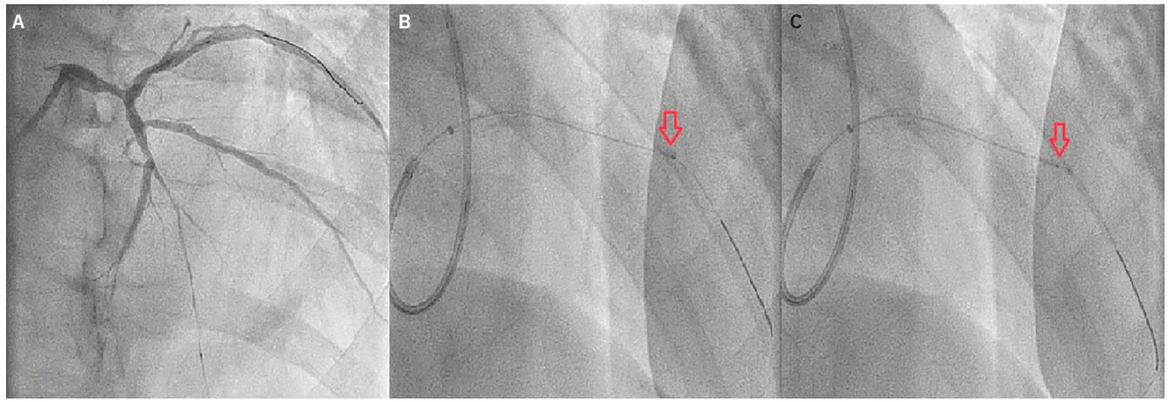

Figure 2. Controlled balloon explosion technique.

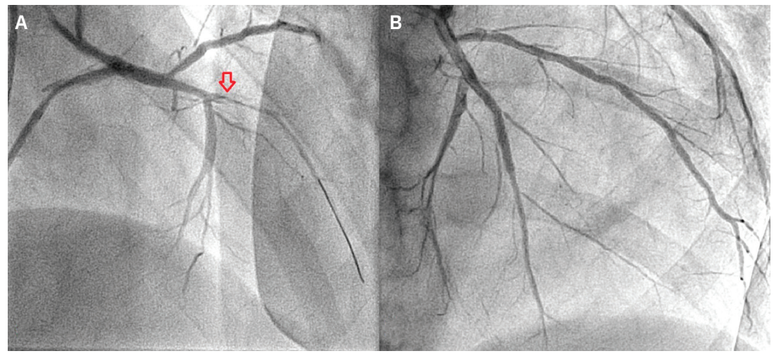

Figure 3. Post-balloon explosion stent placement.

Discussion and Conclusions

As discussed above, stent underexpansion and the subsequent complications represent a significant challenge in contemporary interventional cardiology. Effective pre-dilatation before stent deployment significantly decreases the risk of stent underexpansion.[4] In cases where a lesion can be crossed with a balloon, pre-dilatation with a noncompliant balloon is the typical first choice, potentially followed by the use of a cutting balloon. Highly calcified lesions might require the use of more advanced techniques, including rotational atherectomy, orbital atherectomy, laser, or the new technique of intravascular lithotripsy. If conventional methods of lesion modification fail to deliver an acceptable result, or are not available at the moment, intentional rupture of a balloon partially inserted into the proximal end of the lesion might be considered. Although the results of this technique are somewhat unpredictable, as illustrated by our case report, it can be effective in facilitating successful passage through an otherwise uncrossable lesion. For this purpose, small balloon size (1.2 mm-1.5 mm) is advisable[1,3], although highly resistant lesions might require the use of larger balloons.[1] The shockwave caused by the explosion of the balloon leads to the formation of a 'controlled dissection', which may permit crossing the lesion with a noncompliant balloon or a stent, similar to the case presented above.[1] The dissection created by the explosion is expected and is treated by the subsequent stent, so usually doesn't represent a significant problem. The most severe complication of this approach is a potential for coronary artery rupture with life-threatening bleeding to the pericardial space with tamponade. Management options of this potential complication include prolonged balloon inflation, covered coronary stent and emergent surgery. ■

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