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CASE REPORT

INTERMEDIATE

CLINICAL CASE

Prolonged Balloon Inflation to Effect Full Stent Expansion in Critical CAD During Left Ventricular Support

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ABSTRACT

The extent to which a stent is expanded is a primary factor in determining both short- and long-term outcomes during percutaneous coronary intervention (PCI). This paper presents the first case of prolonged balloon inflation using the pressure optimization protocol allowing full stent expansion during PCI of critical coronary artery disease with severely reduced ejection fraction using the Impella. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2019;1:844–7) 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/).

CASE

PRESENTATION. A 71-year-old male patient with severe interstitial lung disease (diffusing capacity of lung for carbon monoxide) of <55%, hypertension, and type 2 diabetes presented to the hospital with sudden onset of chest pain. Physical examination was unremarkable, and vital signs were normal.

INVESTIGATIONS. Electrocardiography did not show ischemic changes. Blood laboratory results showed the patient had an elevated troponin level of 2.15 (normal is <0.01 ng/ml) compatible with acute coronary syndrome and non-ST-segment elevation myocardial infarction.

LEARNING OBJECTIVES

- To demonstrate the safety of the POP during coronary intervention in an unstable patient requiring hemodynamic support;
- To expand the utility of POP beyond intervention of stable coronary artery disease to unstable patients;
- To demonstrate the application of POP as an alternative to atherectomy in treating calcified lesions in hemodynamically unstable patients.

MANAGEMENT. The patient was started on therapy consisting of aspirin, clopidogrel, and heparin infusion. Coronary angiography showed 60% left main (LM) stenosis, 60% moderately calcified left anterior descending artery (LAD) (**Figure 1A**), and 100% right coronary artery lesions with left-to-right collaterals suggestive of chronic total occlusion (**Figure 1B**). Intravascular ultrasonography of the LM showed a minimal lumen area of 5.2 mm^2 with a 90° arc of calcium (**Figure 1C**). On the transthoracic echocardiogram, the patient had left ventricular systolic dysfunction (ejection fraction of 20% to 25%) with diffuse hypokinesis. Due to the patient's severe interstitial lung disease, he was turned down for coronary artery bypass surgery.

By multidisciplinary heart team decision, elective percutaneous coronary intervention (PCI) with an Impella (Abiomed, Danvers, Massachusetts) for left ventricular support was to be performed. Prior to the

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Informed consent was obtained for this case.

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intervention, the patient became hemodynamically unstable, with hypotension (blood pressure of 86/50 mm Hg) and sinus tachycardia (110 to 120 beats/min). He was started on 10 μg/min of norepinephrine and was taken urgently to the catheter laboratory. An Impella CP was placed by using left femoral access. After the LAD was wired using 0.014-inch Runthroughwire, a 3.0- × 15-mm semicompliant balloon was incrementally inflated for 74 s (highest pressure was 16 atm). A 2.5- × 38-mm Resolute Onyx stent (Medtronic, Fridley, Minnesota) was deployed (16 atm for 87 s) with persistent mid-stent waist (Figure 2A) (minimal diameter of 2.49 mm). A 3- × 15-mm noncompliant balloon was inflated (12 atm for 45 s, then 16 atm for 90 s) with persistent waist (minimal diameter of 2.49 mm) (Figure 2B) and then increased to 18 atm for 30 s at which time inflation pressure suddenly decreased to 17.3 atm, and the balloon became fully expanded (minimal diameter of 2.84 mm) (Figure 2C). During each inflation, blood pressure decreased with loss of pressure phasicity but with maintenance of cardiac output (Figure 3).

LM was stented with a 4.0- × 12-mm Xience Sierra (Edwards Lifescience, Irvine, California) drug-eluting stent (inflation 13 s). Next a 4.5- × 12-mm noncompliant balloon was inflated for 20 s. An intravascular ultrasonography catheter was unable to cross, and post-PCI imaging was not performed. During inflation, there was hypotension and loss of pressure phasicity, but cardiac output was maintained (3.2 l/min), the patient was conversing with the catheter laboratory staff (Figure 4). Right coronary artery PCI was performed successfully. The patient was gradually weaned from the Impella, which was removed at the end of the case.

FOLLOW-UP. The patient was seen in the clinic. He had no angina and NYHA functional class was I/II, which was his baseline prior to the event.

ABBREVIATIONS AND ACRONYMS

LAD = left anterior descending

LM = left main

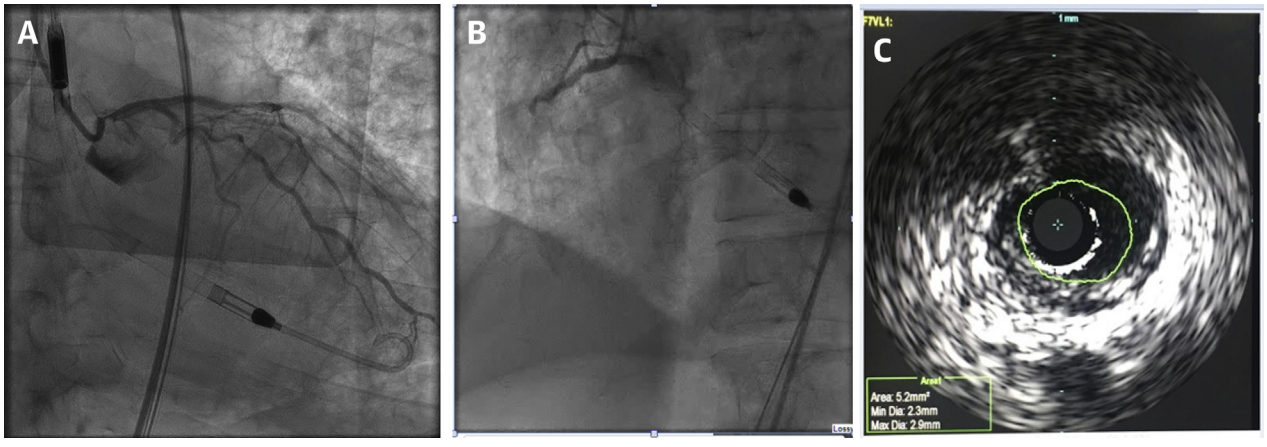
PCI = percutaneous coronary intervention

POP = pressure optimization protocol

DISCUSSION

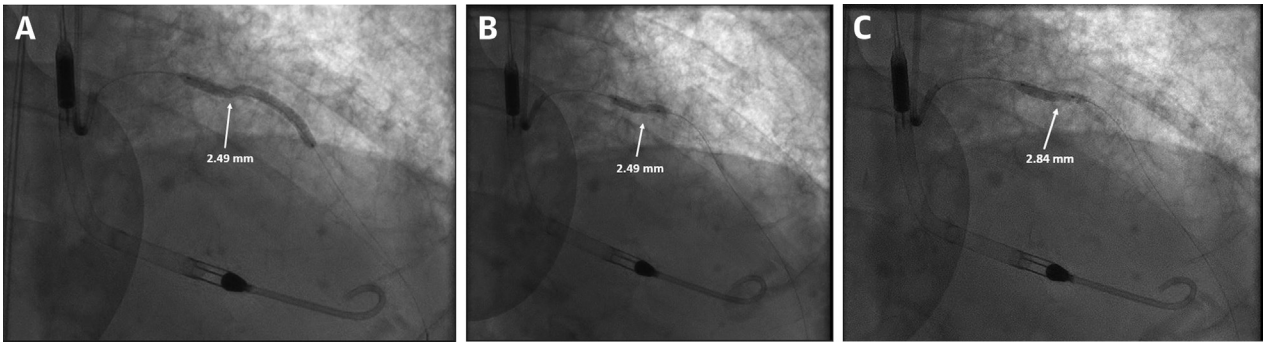
The degree of stent expansion is critical in optimizing short- and long-term outcomes. Several studies have demonstrated that stent expansion can be optimized by high pressure and prolonged inflation (1, 2). The "pressure optimization protocol," or POP, describes the method of prolonged inflation with stability of 30 s without pressure decay implying full stent expansion, allowable at the inflation pressure provided (3). The POP has been demonstrated by imaging using optical coherence tomography to fully expand stents relative to shorter inflation time (15 to 30 s) and to improve long-term outcomes, especially target vessel revascularization (2,3). Furthermore, in hemodynamically stable patients, POP has been shown to be safe despite an average inflation time of 100 to 110 s (2,3). To date, POP has not been deployed in critical

FIGURE 1 Coronary Angiogram Showing 60% LM and 60% Mid LAD Lesion



(A) Coronary angiogram showing 60% LM and 60% mid LAD lesion. **(B)** Coronary angiogram showing 100% occluded RCA. **(C)** Intravascular US of LM with minimal area of 5.2 mm^2. LAD = left anterior descending artery; LM = left main; RCA = right coronary artery; US = ultrasonography.

FIGURE 2 Waist in Mid-Stent After Deployment: Minimal Diameter 2.49 mm After 87 s Inflation



(A) Waist in mid-stent after deployment: minimal diameter 2.49 mm after 87 s inflation. **(B)** Waist post-dilation of 3 mm noncompliant balloon at 16 atm for 90 s: minimal diameter of 2.49 mm. **(C)** Resolution of waist with an inflation of 18 atm after 30 s: minimal diameter 2.84 mm.

coronary disease in a patient with hemodynamic instability due to the fear of worsening of hemodynamic status, as was shown by the loss of phasicity in the present case. Left ventricular support with an Impella theoretically should allow for maintenance of hemodynamic stability during POP. It should also be mentioned that the LAD could have been treated initially with atherectomy. In this case, if high-pressure inflation using POP not been successful and not produced an angiographic dissection, rotational atherectomy would have been the next step. The present case demonstrated that prolonged balloon inflation with POP can, in fact, be performed safely and allow for improved stent

FIGURE 3 Decrease in and Loss of Phasicity of Systemic Pressure During LAD Inflation With Maintenance of Cardiac Output

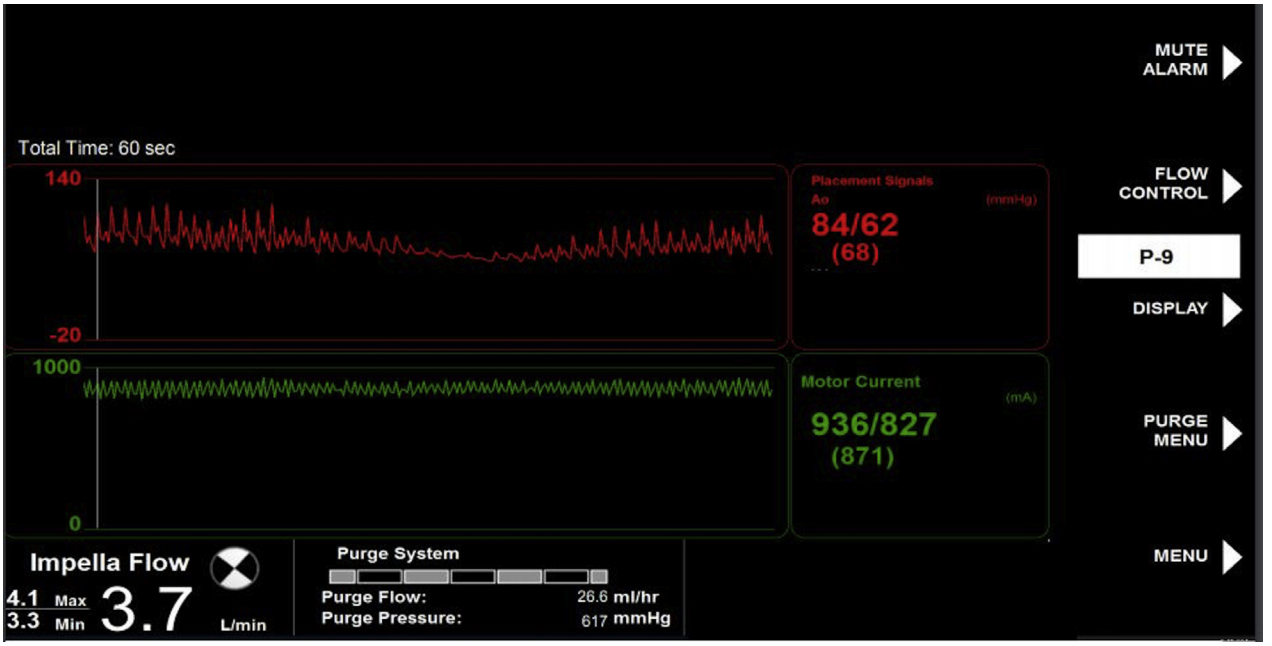
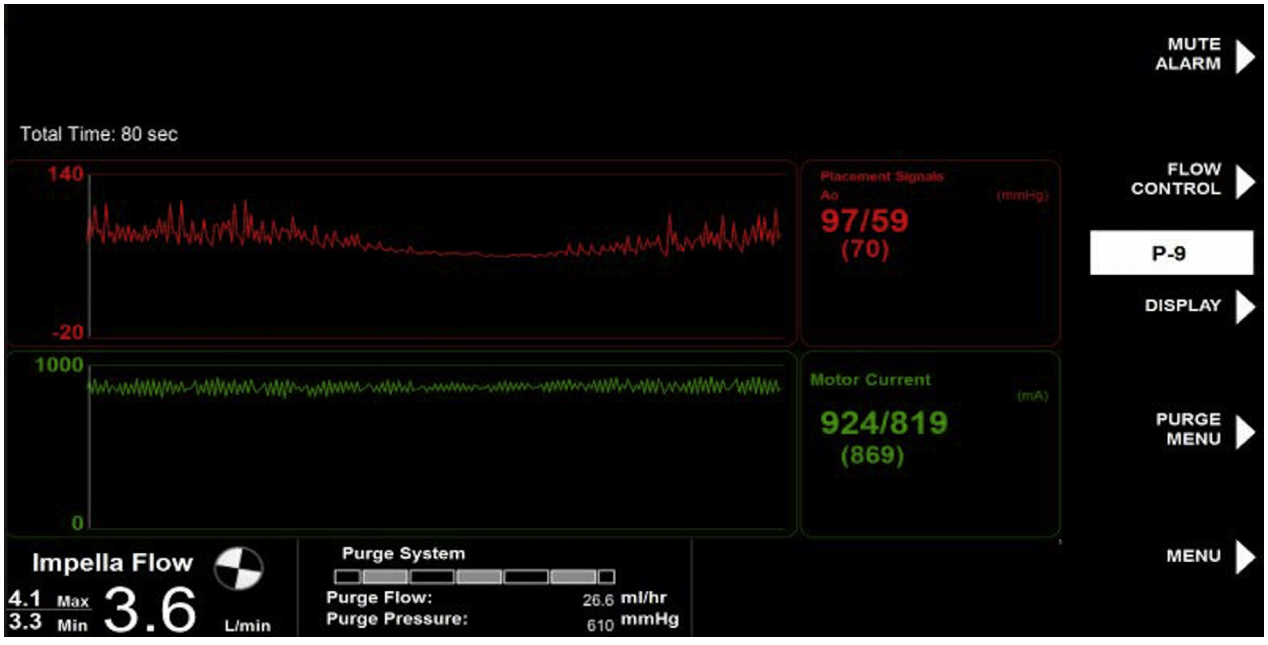


FIGURE 4 Decrease in and Loss of Phasicity of Systemic Pressure With Maintenance of Cardiac Output During Left Main Stenting



expansion, a key to improve short- and long-term outcomes.

CONCLUSIONS

Although POP has been shown to be a useful (albeit underused) technique, it has not been used in hemodynamically unstable patients with critical coronary disease. This case demonstrates its value in fully expanding the stent without resorting to atherectomy techniques (which have their own attendant risks) in this high-risk patient subset (4).

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KEY WORDS acute coronary syndrome, intravascular ultrasonography, percutaneous coronary intervention, reduced ejection fraction, stent