Successful Hemostasis With Prolonged Balloon Inflation at the Proximal Site of the Coronary Perforation

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ABSTRACT: Coronary perforation (CP) is a rare complication of percutaneous coronary intervention (PCI) and can lead to pericardial tamponade. Prolonged balloon inflation is a reasonable treatment for CP, but there is no standard recommendation on the preferable choice between the balloon site for prolonged balloon inflation (ie, proximal and in situ of the perforation). We present a rare case of successful prolonged balloon inflation at the proximal site of the CP after the failure of balloon inflation at the site of perforation. The patient developed CP during balloon inflation post-stent, rapidly progressing to cardiac tamponade. In situ prolonged balloon inflation (3 times) failed to close the CP, but proximal inflation could manage the CP. The take-home message from this case is that balloon expansion at the proximal site could be better than in situ of perforation in patients with CP after PCI.

KEYWORDS: Coronary perforation, prolonged balloon inflation, case report

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Introduction

Coronary perforation (CP) is a rare complication of percutaneous coronary intervention (PCI), and its frequency is increasing with intervention complexity.[1] CP can lead to pericardial effusion and tamponade.[1] The incidence of CP is estimated to be 0.1%-0.7% and is associated with increased morbidity and mortality.[2] CP is often lethal when undiagnosed or untreated. When CP occurs, techniques such as covered stents and prolonged balloon inflation can be used to seal the perforation. The risk factors for CP include old age, female sex, history of coronary artery bypass graft, use of clopidogrel, hypertension, peripheral artery disease, congestive heart failure, low body mass index, low creatinine clearance, complex coronary lesions, chronic total occlusion, heavy calcifications, angulated/tortuous/narrow coronary artery, aggressive use of oversized balloons and stents, use of atheroablative devices, and use of hydrophilic guidewires.[3] Covered stents to block feeding branches, coils, fat embolization, microspheres, absorbable suture, or watchful observation after prolonged balloon inflation are reasonable options for small vessel perforations.[4,5] All these techniques aim to control the source of extravasation, reduce morbidity and mortality, and avoid the need for urgent cardiac surgery. Still, for prolonged balloon inflation, there is no proven recommendation on the optimal location (ie, proximal site or in situ of the perforation). We described a case of CP that occurred during stent implantation in the middle of the left anterior descending artery. The CP could not be stopped in situ but was successfully managed by prolonged balloon inflation at the proximal site of the perforation.

Case Report

A 75-year-old woman presented with chest pain. She had a history of diabetes, dyslipidemia, and hypertension and was admitted for PCI of the left anterior descending artery (LAD). Figure 1 presents the case timeline. Chest pain was present for 7 years but was aggravated for 1 month after activity and was accompanied by dyspnea. No radiating pain occurred. There was no fever, dyspnea, palpitation, upright breathing, or syncope. Coronary angiography (CAG) 1 month before admission revealed insignificant atherosclerotic plaques in the right coronary artery but severe stenosis in both the left circumflex artery (LCX) and LAD. She underwent elective stent deployment in the left LCX at that time. Physical examination was unremarkable, except for hypertension (145/80 mmHg). The patient's complete blood count, biochemical analyses (including the myocardial enzymes), and coagulation tests were normal. An electrocardiogram showed sinus rhythm and nonspecific ST-T segment changes. Transthoracic echocardiography images revealed decreased left ventricular diastolic function.

Elective PCI was performed with a 6 Fr guiding catheter and an Asahi Sion guidewire via a trans-radial sheath. After wiring, pre-dilatation was performed with a 2.0 × 20 mm compliant balloon at 10 atm and a 2.5 × 10 mm cutting balloon. Two drug-eluting stents of 2.75 × 33 mm and 3.0 × 18 mm were deployed from the mid to proximal segment of LAD. The overlapping stents were post-dilated at 18 atm with a 2.75 × 10 mm non-compliant balloon catheter. CAG showed a CP at the stent of the mid-LAD (Figure 2a). The patient complained of severe chest pain, and a drop in blood pressure and heart rate was noted a few minutes later, followed by Adams-Stokes syndrome. External cardiac massage was started, and the patient was intubated and ventilated. Large pericardial effusion restricting heartbeat was visualized by fluoroscopy during cardiopulmonary resuscitation (CPR). Repeat angiography confirmed an Ellis type III CP at the stent implantation site (Figure 2b).

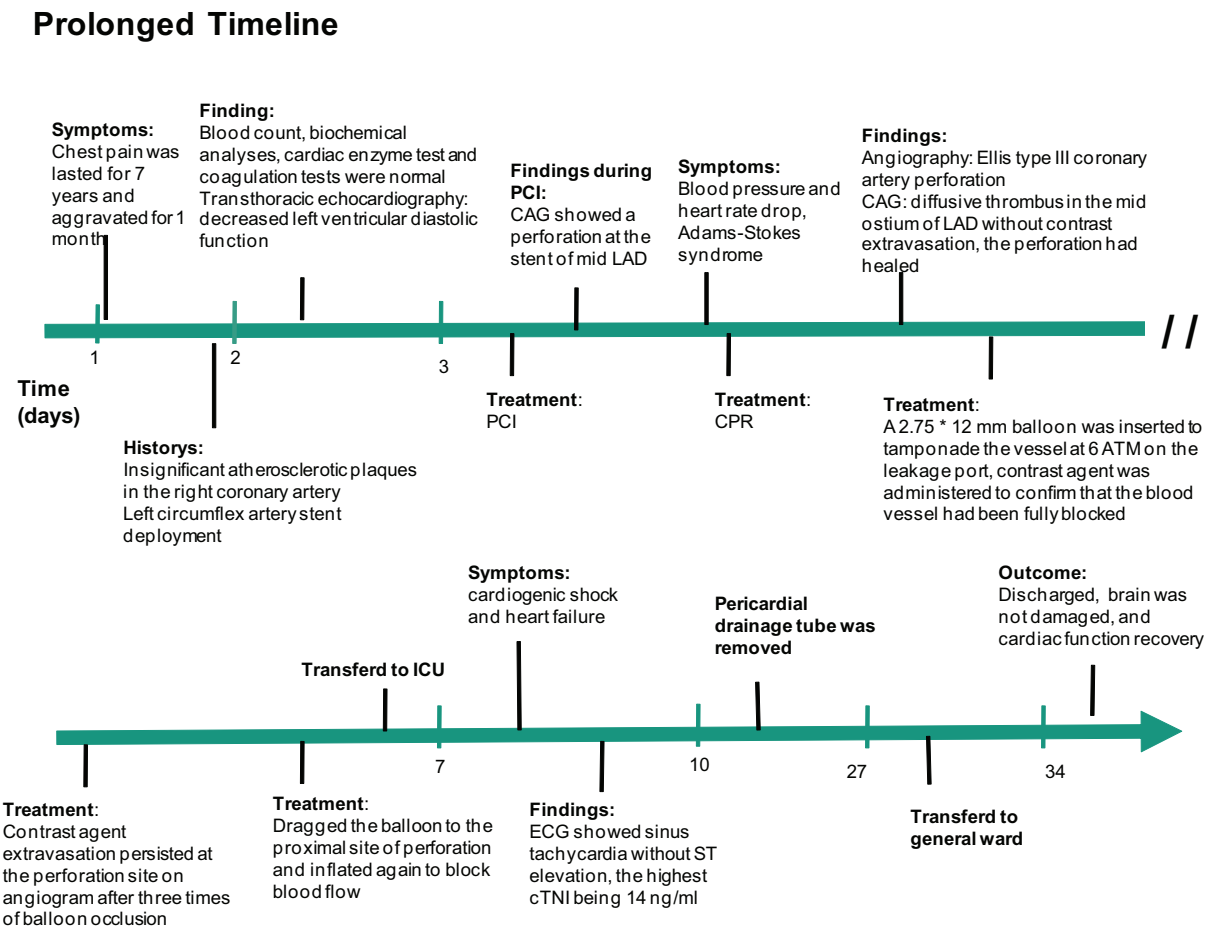

Figure 1. Case timeline.

Pericardiocentesis was performed successfully, and about 400 ml of blood was suctioned and re-injected through a femoral vein. The patient's hemodynamics were stably restored, and the whole CRP lasted 15 minutes. The guidewire system dislocated during the rescue process, caused by the patient's unconscious agitation. It took some time to reset the guiding catheter and advance the guidewire. Repeat CAG showed a diffusive thrombus in the mid ostium of the LAD without contrast extravasation, indicating that the perforation had healed (Figure 2c). Considering the benefit of the anterior descending branch, we aspirated the thrombus to avoid further occlusion. After aspiration, the anterior descending artery recovered patency, but contrast agent extravasation occurred (Figure 2d). Prolonged balloon inflation was performed. A 2.75 × 12 mm balloon was inserted to tamponade the vessel at 6 atm on the leakage port. A contrast agent was administered to confirm that the blood vessel had been fully blocked (Figure 2e). The balloon was dilated for 15 minutes, with a 2-minute break for blood perfusion. Contrast agent extravasation persisted at the perforation site on the angiogram after 3 balloon occlusions (Figure 2f). We dragged the balloon to the proximal site of the CP and inflated it again to block the blood flow (Figure 2g). Simultaneously, we prepared a membrane-covered stent to standby. The balloon was dilated for about 10 minutes and subsequently deflated. Repeat angiography showed no contrast agent extravasation and no obvious thrombosis reformed in the stent (Figure 2h). The operation was completed, and the patient was sent to the intensive care unit (ICU) for monitoring and treatment.

The patient suffered from cardiogenic shock and heart failure for several days. ECG showed sinus tachycardia without ST elevation. The highest cTNI was 14 ng/ml. Liver and kidney functions were not injured. The pericardial drainage tube was removed 1 week after no drainage within 48 hours. The patient gradually recovered 3 weeks later. Her brain was not damaged, and she was transferred to the general ward after cardiac function recovery. Protamine was not administered to neutralize heparin. The patient had no late bleeding post-PCI. The drainage of pericardial fluid gradually decreased from 20 ml per day to nil, and the indwelling tube was removed 1 week later. The patient recovered in good condition. The patient is being followed up once a month without symptoms.

Discussion and Conclusion

CP is rare but one of the most serious and life-threatening complications of PCI. The severity of CAP has traditionally been classified into 3 types (Ellis classification) based on the angiographic appearance of the perforation: type I, extraluminal crater without extravasation; type II, pericardial or myocardial

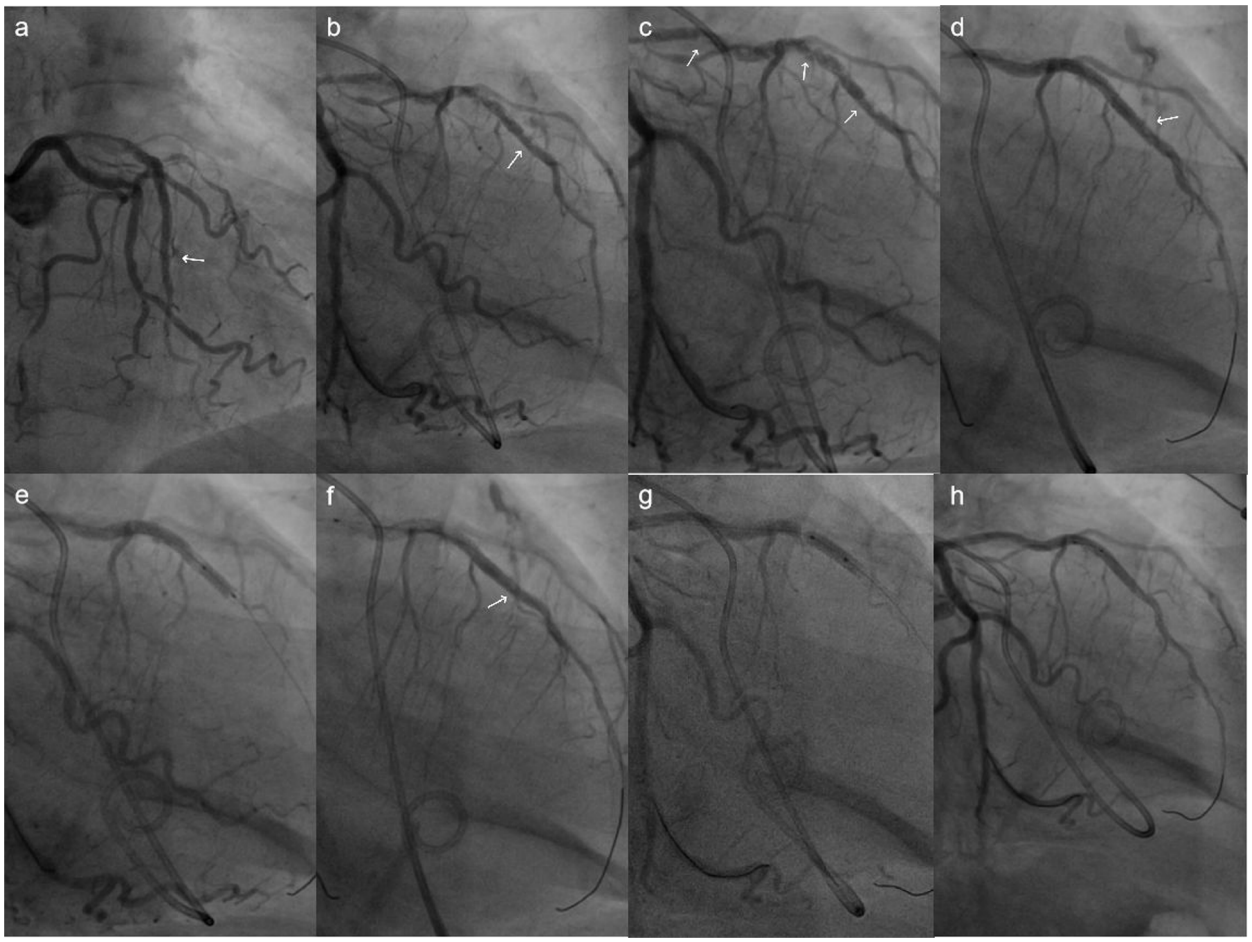

Figure 2. (a) CAG showed a perforation at the stent of mid-LAD. (b) CAG confirmed an Ellis type III CP at the stent. (c) CAG showed diffusive thrombus in the mid ostium of LAD without contrast extravasation. (d) After aspiration, LAD recovered patency, but the contrast agent extravasation reoccurred. (e) Prolonged balloon inflation was performed in situ of perforation. (f) Contrast agent extravasation persisted after 3 times of balloon inflation in situ. (g) Prolonged balloon inflation was performed at the proximal site of the perforation. (h) CAG showed no contrast agent extravasation.

blush without contrast jet extravasation; type III extravasation through frank (⩾1 mm diameter) perforation with contrast streaming and cavity spilling.[6]

Once CP Ellis types II-III CAP is identified, prompt management is crucial to avoid emergency surgery and devastating sequelae. A possible cause of CP, in this case, could be the 18-atm balloon pressure of the overlapping stents using a 2.75 × 10 mm noncompliant balloon catheter, but it will remain uncertain. The urgency of surgery should be determined in refractory cases with failure of percutaneous methods.[7] CP is a rare event and is always managed urgently. CP is found by identifying contrast leakage during the procedure or detecting pericardial tamponade.[3] There is no literature on the prevention of CP, but non-modifiable (old age, female sex, history of coronary artery bypass graft, use of clopidogrel, hypertension, peripheral artery disease, congestive heart failure, low body mass index, low creatinine clearance, complex coronary lesions, chronic total occlusion, heavy calcifications, angulated/tortuous/narrow coronary artery) and modifiable (aggressive use of oversized balloons and stents, use of atheroablative devices, and use of hydrophilic guidewires) risk factors are known.[3] Hence, the operator should remain aware of the possibility of CP, especially when using oversized balloons and stents, atheroablative devices, or hydrophilic guidewires in patients with risk factors.

Covered stents can quickly and effectively seal the perforation, but there are disadvantages, such as the increased risk of stent thrombosis,[8] exclusion of side-branch vessels adjacent to the perforation site,[9] and lack of flexibility. Moreover, covered stents are not routinely available in every catheterization lab, especially in developing countries.[10]

Prolonged balloon inflation with low pressure for 10 to 20 minutes should be attempted if tolerated and without significant myocardial injury.[11] It is the earliest and most available protocol for CP, maintaining vascular patency and providing preparation time for emergency cardiac surgery. However, there is no proven recommendation on the optimal location, the proximal site, or in situ of the perforation for prolonged balloon inflation.[12]

In this case, the patient developed CP during balloon inflation post-stent, rapidly progressing to cardiac tamponade. Initially, we dilated the balloon in situ for 15 min three times, but the procedure failed. Moreover, inflation dislodged the fresh thrombus, leading to rebleeding. Therefore, we pulled the

balloon to the proximal site of the leakage and continued inflation, which was successful. Al-Lamee et al [13] reported that prolonged balloon inflation was attempted in 33 patients but failed in 15 (45.5%). Meguro et al[14] reported prolonged balloon inflation in 11 patients with CP, with failure in 3 (27.3%). We presume that balloon dilation in situ stops the leak but can open the lips of the tear, preventing effective self-resolution in many cases. Proximal balloon inflation will decrease blood pressure to the tear, allowing the lips to be in contact and seal, but multiple runs can be required.[12] Still, proximal balloon inflation can also fail, as previously reported,[15] which could be related to the extent or direction of the tear. The take-home message from this case is that balloon expansion at the proximal site could be better than in situ of perforation in patients with CP after PCI.

Since the patient had 2 stents implanted, reversal of heparin may predispose to stent thrombosis and thrombus formation within the auto-transfusion circuit.[4] In the case reported here, protamine was not administered, but the patient had no late bleeding post-PCI.

There is no proven recommendation on the optimal location for managing CP using balloon inflation (ie, proximal site or in situ of the perforation). We present a rare case of successful prolonged balloon inflation at the proximal site of the CP after the failure of in situ prolonged balloon inflation. This case is important since proximal inflation could be tried first, requiring shorter inflation time than in situ inflation.

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Author Contributions

Yunxiang wang wrote the manuscript. Xiaolong Zheng provided the pictures of this article. Yaosheng Mei, Changchun Lai, and Yiqun Wang participated in the whole treatment and provided guidance. All authors read and approved the final manuscript.

Author's Note

We confirm that all listed authors have made a significant scientific contribution to the research in the manuscript and agreed to be an author. And the authorship will not be changed after this point.

Ethics Statements

This research was conducted in compliance with the Declaration of Helsinki. Written informed consent for publication of this case, the de-identified patient details, and accompanying images were obtained. This project was exempted from review by the institutional review board at Yongkang First People's Hospital.

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