Anchoring Balloon Retrieval as a Strategic Approach to a Partially Deployed, Deformed Stent Attached to the Coronary Intima and a Ruptured Stent Balloon During Percutaneous Coronary Intervention: A Case Report

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Abstract

Stent deformation and stent balloon rupture during percutaneous coronary intervention (PCI) are both rare occurrences. The simultaneous combination of these is even rarer and can lead to catastrophic outcomes without appropriate management. We report a case of a deformed stent attached to the coronary intima and simultaneously a ruptured, uninflatable stent balloon during PCI. The deformed stent and the ruptured stent balloon were retrieved successfully by anchoring balloon retrieval.

Keywords: percutaneous coronary intervention, complication, stent deformation, ruptured stent balloon, anchoring balloon retrieval

Introduction

Coronary stent deformation is a rare but potentially serious complication that can occur during percutaneous coronary intervention (PCI). This case report focuses on a particularly challenging instance of stent deformation and outlines the management strategies employed to address this issue. Effective management of this situation is critical to ensure patient safety and optimal clinical outcomes, as the potentially catastrophic outcomes include arrhythmia, vessel rupture, the need for emergency surgical intervention, and death. Various nonsurgical methods have been adopted for the retrieval of a deformed stent. One innovative salvage technique that has shown promise is anchoring balloon retrieval.

Case Report

A 66-year-old man had a 20-pack-year history of cigarette smoking along with hypertension, type-2 diabetes mellitus and

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dyslipidemia. He presented to the outpatient department with exertional chest tightness lasting for three months. The electrocardiogram showed normal sinus rhythm. The treadmill exercise test showed upsloping ST depression in V4-5 and horizontal ST depression in V6, which implied myocardial ischemia. Coronary angiography (CAG) was indicated for the patient.

The CAG revealed 85% stenosis of the middle left anterior descending artery (LAD), 80% stenosis of the distal left circumflex artery (LCX) (Figure 1), and 60% stenosis of the posterior left ventricular artery (PLV). We placed a 6 Fr BL3.5 guiding catheter with Runthrough EF wire (Terumo Corporation, Tokyo, Japan) crossing to the distal LAD and a Sion blue wire (Asahi Intecc, Aichi, Japan) crossing to the distal LCX. Pre-dilatation of the lesion was performed using a 3.0*15 mm semi-compliant balloon at 12 atm. The residual angiographic stenosis was suboptimal at more than 40% after 1:1 balloon angioplasty (Figure 2A). We therefore proceeded to stent deployment. Using a 6 F Expressman guiding extension catheter (GEC) (APT Medical), a 3.0*33 mm drug-eluting stent (DES) (Biomatrix, Biosensors International, Morges, Switzerland) was deployed to the proximal to middle LAD at 12 atm. However, we were unable to fully inflate the stent balloon. Under cine angiography, we were unable to clarify whether the stent was still mounted on the stent balloon or not. On the next inflation, the patient presented with non-sustained ventricular tachycardia and there was contrast enhancement in the distal LAD, which indicated ruptured stent balloon with contrast leakage (Figure 2B). We considered the stent deployment a failure, but as we withdrew the stent and stent balloon catheter, we encountered strong resistance. We failed to retrieve the stent and the stent balloon catheter by deep seated guiding catheter and GEC. We found that the DES was partially deployed and partially mounted on the stent balloon. The attempt at pullback had resulted in stent deformation which could have been stent elongation and/or stent intussusception (Figure 3). We were unable to detach the stent and stent balloon catheter, neither by snare nor by twirl guidewires. The deformed stent with the ruptured stent balloon at the left main (LM) coronary artery to proximal LAD was not retrievable and not crushable. We therefore introduced another Sion blue wire through the deformed stent, crossing to

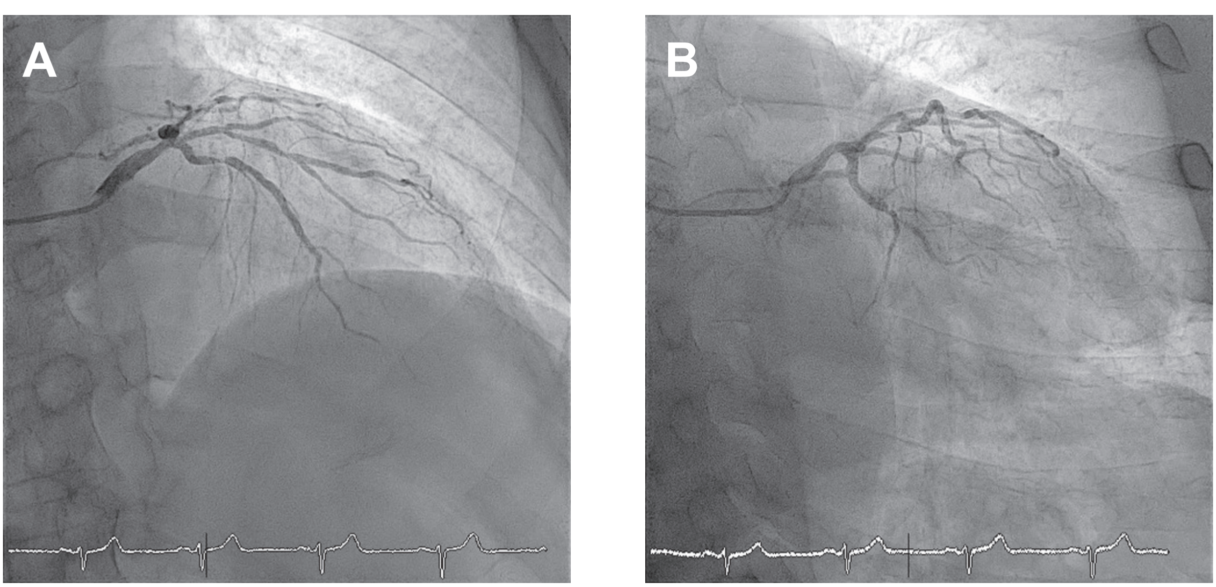

Figure 1. Coronary angiography of the left coronary arteries. **A.** Middle left anterior descending artery (LAD) with 85% stenosis. **B.** Distal left circumflex artery (LCX) with 80% stenosis.

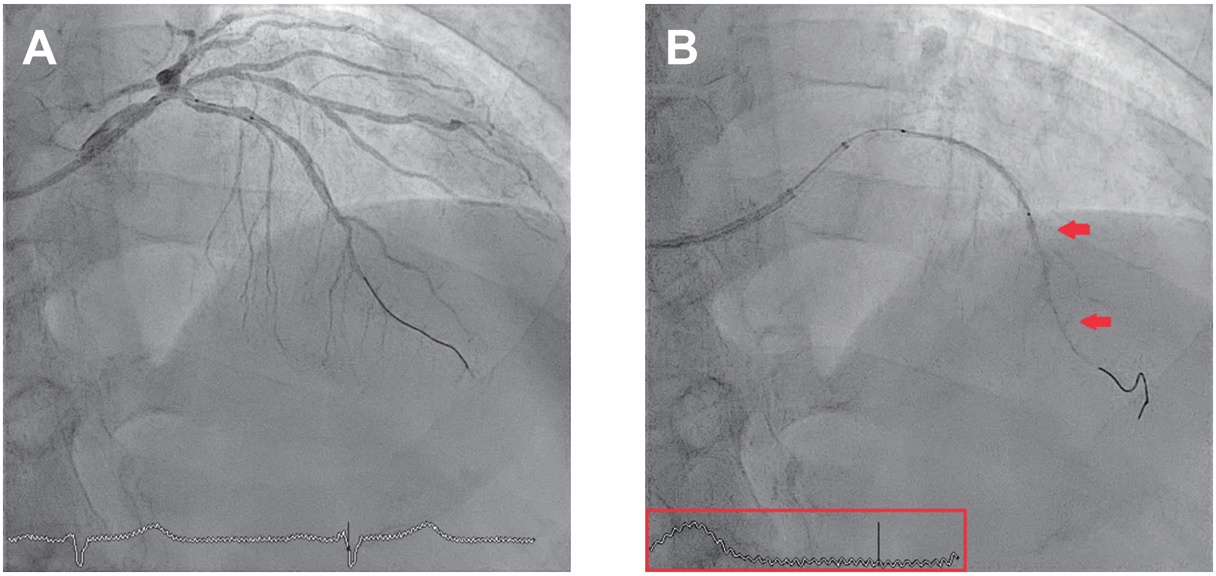

Figure 2. A. Suboptimal angiographic residual stenosis after 1:1 balloon angioplasty pre-dilatation by 3.0x15 mm semi-compliant balloon. **B.** Non-sustained ventricular tachycardia (red blank) during stent deployment with contrast enhancement distal to the middle LAD lesion (red arrow), indicating ruptured stent balloon with contrast leakage.

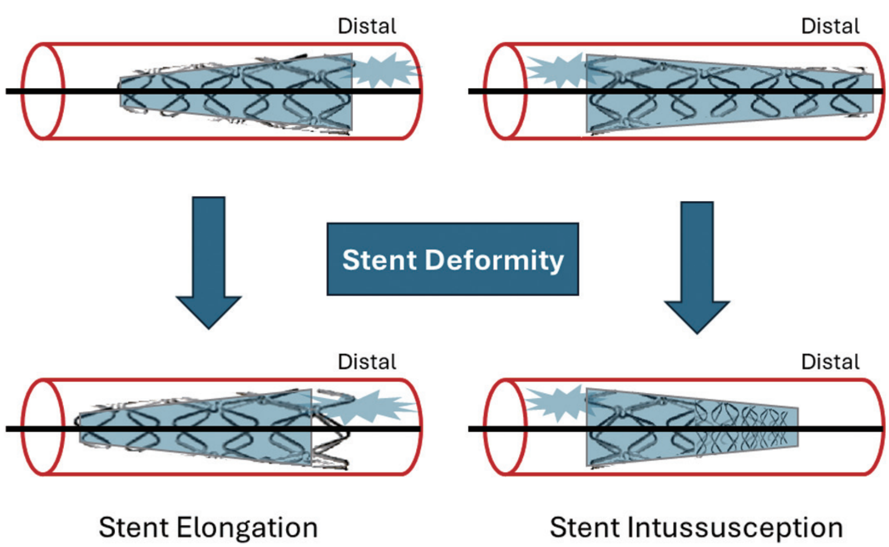

Figure 3. Possible mechanisms of stent deformation, including stent elongation and/or stent intussusception.

the distal LCX. Using a 2.0*10 mm noncompliant balloon anchoring in the guiding catheter we were able to pinch the deformed stent onto the stent balloon (Figure 4A-C). We then successfully retrieved the deformed stent and the ruptured stent balloon by gently disengaging the guiding catheter and workhorse guidewire from the left radial artery access (Figure 4D-F).

We subsequently repeated PCI, establishing fresh vascular access through the right radial artery using a 6 Fr sheath. The CAG showed TIMI 3 flow without thrombus formation. We placed a 6 Fr BL3.5 guiding catheter with Runthrough EF wire crossing to the distal LAD and Sion blue

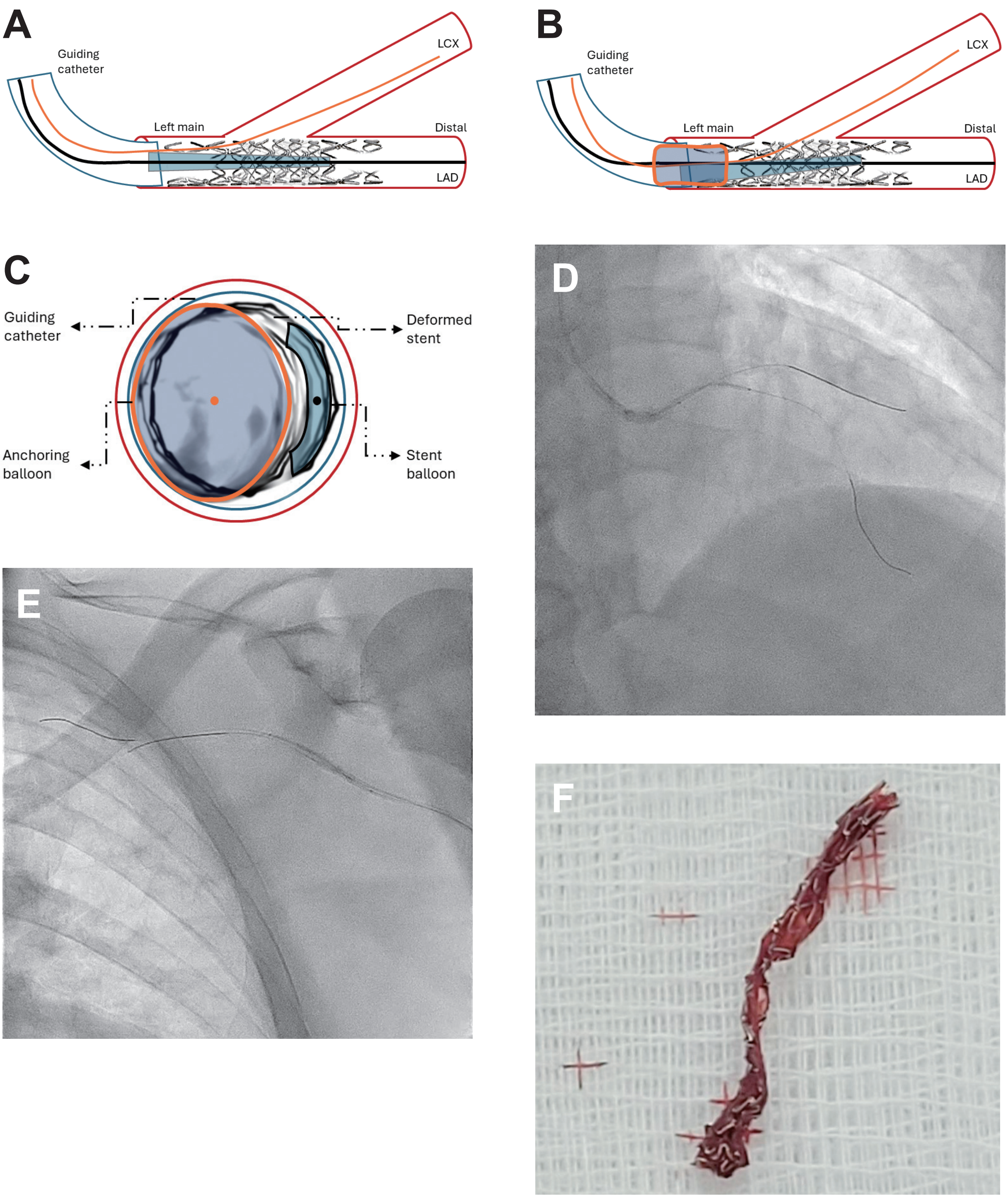

Figure 4. Anchoring balloon retrieval. **A.** Workhorse wire introduced into the distal LCX. **B.** Small noncompliant balloon anchoring in the guiding catheter to pinch the deformed stent onto the stent balloon. **C.** Cross-section of anchoring balloon retrieval. **D.** Coronary angiography of the left coronary arteries during anchoring balloon retrieval. **E.** Retrieval process of whole system in the left subclavian artery. **F.** The retrieved deformed stent.

wire crossing to the distal LCX. We then deployed a 2.75*33 mm DES (Biomatrix) to the proximal to middle LAD at 16 atm, and post-dilated with a non-compliant balloon. We pre-dilated the lesion in the distal LCX with a 2.5*15 mm semi-compliant balloon at 12 atm, and deployed a 2.5*19 mm DES (Biomatrix) to the distal LCX at 14 atm, post-dilated with a non-compliant balloon. The final coronary angiography showed minimal residual stenosis and TIMI 3 flow (Figure 5). The patient had an uneventful course during the one-year follow-up period.

Discussion

Stent balloon rupture poses significant risks, though advancements in technology have reduced its frequency in recent years. Simpfendorfer et al. reported that balloon rupture occurs in 55 out of 1500 PCIs, accounting for 3.6% of cases. The ruptures happen at an average pressure of 10.7 atm, with 7 out of the 55 ruptured lesions (12.7%) exhibiting calcification.[1] Alfonso et al. documented balloon rupture in 66 out of 1139 attempted coronary lesion stentings, representing 5.8% of cases. In 50 patients, the procedure was completed successfully without complications. However, in 16 patients, balloon rupture led to coronary dissection, and 3 patients died due to cardiac tamponade, acute myocardial infarction, and distal embolization of balloon material, respectively.[2]

Recent improvements in stent and balloon materials, as well as enhanced procedural techniques, have contributed to a decrease in stent balloon rupture. However, despite these advancements, it remains a serious concern due to the potential for severe complications. These complications can include vascular damage, embolization, and hemodynamic instability, potentially leading to arrhythmias or myocardial infarction. The management depends on whether the stent is mounted on the stent balloon or not. If the stent is still mounted on the balloon, retrieval of the whole system (balloon and stent) might be feasible. If the stent is not mounted on the balloon, the stent could be considered deployed, whereupon we could retrieve the balloon, and switch to another balloon for post-dilatation. Retrieving a stent by force runs the risk of further deformation, potentially leading to catastrophic complications. In this reported case, a deformed

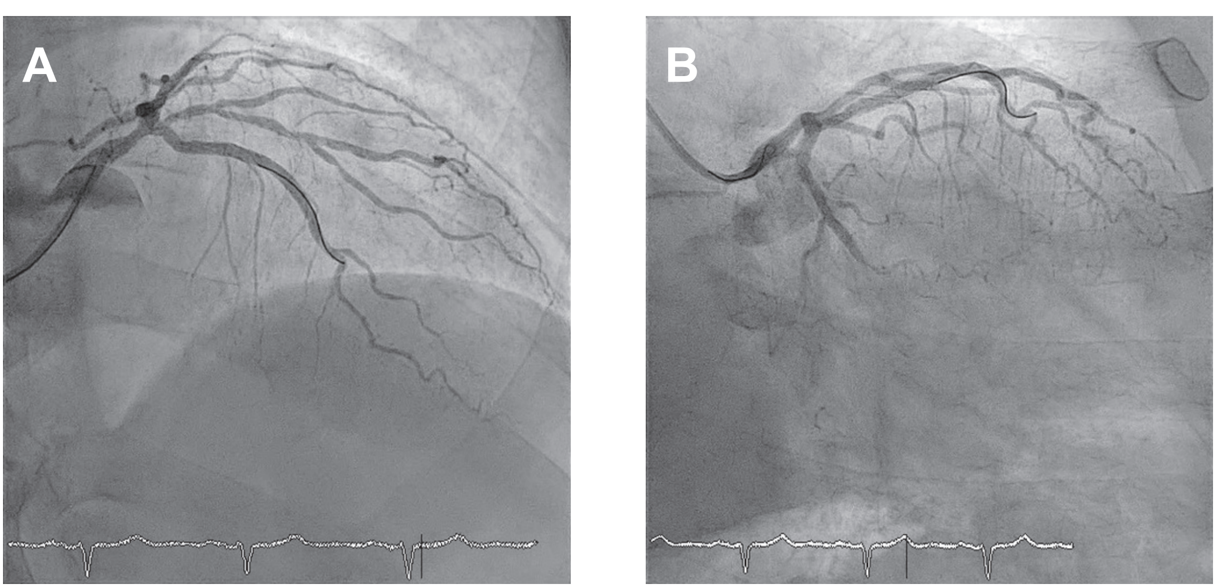

Figure 5. The final coronary angiography of the left coronary arteries showing residual stenosis of less than 15% with TIMI 3 flow.

stent was mounted on a ruptured balloon, complicating the retrieval process.

Coronary stent deformation and dislodgment are relatively rare complications, but are associated with major adverse cardiovascular events, including myocardial infarction, stroke, and death.[3] They can be caused by several factors, including anatomical and procedural factors. Anatomical factors include severely calcified or tortuous arteries that hinder proper stent expansion. Calcification impedes expansion, increasing the risk of stent deformation, while tortuosity complicates proper positioning and expansion. In our presented case, our limitation lay in not employing intravascular imaging, like intravascular ultrasound (IVUS) or optical coherence tomography (OCT) to assess target lesion characteristics before stenting. Procedural factors, like ruptured stent balloons, can lead to incomplete stent expansion or stent deformation. The deformed stent may adhere to the coronary intima or become entangled with the ruptured balloon. It is therefore crucial to approach stent retrieval with caution and to consider alternative strategies to minimize the risk of adverse outcomes. If the remaining balloon system is in the guiding catheter, retrieval could be achieved by guide extension catheter trapping technique[4] or retrieval catcher with head-end scalable gauze basket structure (APT Medical).[5] Anchoring balloon retrieval involves the use of a small balloon catheter to engage and secure the deformed stent. With the wire crossing the deformed stent into a side branch, the small balloon is advanced near the deformed stent, then inflated to anchor it in the guiding catheter. This helps stabilize the deformed stent and allows for controlled retrieval with minimal risk of further deformation or embolization. The anchoring balloon retrieval technique offers advantages over alternatives like twisting wire or loop snare methods, particularly after initial stent retrieval failures. It provides stable anchorage within the guiding catheter, ensuring better control and reducing further balloon and stent migration to the distal coronary artery. Its drawbacks include the complexity and time involved in achieving proper balloon sizing and positioning, along with the increased risk of balloon rupture or dislodgement, which can further complicate device retrieval. In the reported case, anchoring balloon retrieval resulted in the successful extraction of the deformed stent without causing additional vessel injury or complications. Post-procedural angiography confirmed good vessel patency, and the patient had an uneventful recovery. Anchoring balloon retrieval is a feasible and effective salvage technique for managing deformed stents during PCI.

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All authors declare no conflict of interest.

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