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Surgical Management for a Broken Delivery Shaft *in Vivo* during PCI Following Acute Myocardial Infarction in a Complex LAD Artery Lesion: A Case Report and Literature Review

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Abstract

Stuck up and fracture of coronary angioplasty hardware are unwonted complications of percutaneous coronary interventions (PCI) for which surgical retrieval and management is once in a while required. We present one case of a 59-year-old diabetic, a hypertensive gentleman who attended the emergency room (ER) with central chest pain for 2 hours. After evaluation of the patient by physical and noninvasive diagnostic tests, he was diagnosed as a case of acute myocardial infarction (AMI) with stable hemodynamic. For the aforementioned findings, the patient was treated first with a thrombolytic agent in ER and then shifted to Cardiology Department for monitoring and further coronary evaluation by coronary angiography (CAG). CAG revealed essentially single vessel disease (SVD) with complex left anterior descending (LAD) artery lesion, so PCI was attempted but failed with an unfortunate incidence of the broken delivery shaft and left *in vivo*. Immediate decision making and surgical management for retrieval of lost angioplasty device and correction coronary lesion with revascularization save the patient from grave complication. All the series of events and management approaches of this very complex coronary artery lesion are discussed in this article.

Keywords

Percutaneous Coronary Intervention (PCI), Acute Myocardial Infarction (AMI), Angioplasty Hardware, Broken Delivery Shaft, Complex Coronary Lesion, Surgical Revascularization

1. Introduction

In vivo entrapment of angioplasty hardware (catheters, guide wires, angioplasty balloons, and stents), fracture and retention during the percutaneous coronary intervention (PCI) are rare but may lead to a grave sequel, like intracoronary or systemic embolization, thrombus formation, emergent coronary artery bypass graft surgery, or death. In recent years, the incidence of loss of angioplasty hardware during PCI has significantly lessened, from 8.3% to 0.21%, probably due to improvements in technology as well as device designing with the universal use of pre-mounted stents (1 - 3). Although various non-surgical retrieval approaches of unexpanded stents have been carried out with a success rate as high as 86%, however, surgical removal can still be required in a few cases [1] [2] [3] [4]. Making a prompt decision and planning for managing this type of complication is always important. We report a case of stuck-up stent and braking of the delivery shaft *in vivo* during PCI on a complex coronary lesion in the left anterior descending (LAD) artery with the diagnosis of acute myocardial infarction (AMI) that required surgical removal, correction, and revascularization.

2. Case Summary

A 59-year-old diabetic-hypertensive gentleman was attended the emergency room (ER) with central chest pain for 2 hours. The characteristics of the pain were typical to angina pectoris. On physical examination, the patient was: conscious, oriented, blood pressure-110/70 mm Hg, pulse 85/min with sinus rhythm, oxygen saturation 97% in room air, afebrile, audible first and second heart sound without any other abnormal heart sound, air entry to the lungs were equal with bilateral basal crackles. Then the patient was assessed with 12 lead electrocardiograms (ECG) and blood for high sensitive troponin-I cardiac bio-markers. ECG revealed anterior ST-segment elevation (**Figure 1**), and high sensitive troponin-I level was raised (14,048 nanograms per liter of blood). From the aforementioned clinical and noninvasive diagnostic investigation, the patient was diagnosed as a case of acute ST-segment elevation myocardial infarction (STEMI) or acute myocardial infarction (AMI). So that we initially managed the patient with a thrombolytic agent (Tenectiplase) in ER. After that, the patient was shifted to the cardiology department for monitoring and further coronary evaluation by coronary angiography (CAG). The following day he underwent CAG to review his coronary artery status, which revealed that the patient had coronary artery disease (CAD): essentially single vessels disease (SVD) (**Figure 2**). On account of this, the patient was recommended urgent PCI. Our interventional cardiology team approached for PCI in the same setting through the right radial artery. The left coronary artery (LCA) was engaged with the guiding catheter extra back-up (EBU)-3.5 (6 French) followed by Sion blue wire crossed the lesion of the LAD artery; another wire crossed the lesion of the diagonal branch. Pre-dilatation was done with a 2.0 × 15 mm percutaneous transluminal coronary angioplasty (PTCA) balloon at 08 - 10 standard atmosphere pressure (ATM). The proximal

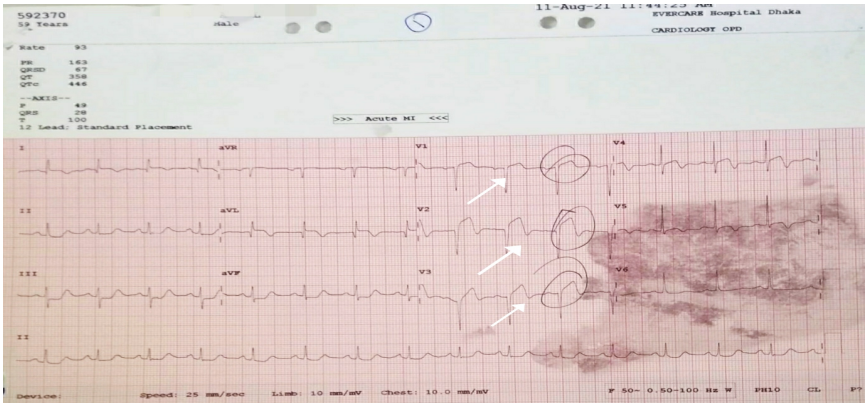


Figure 1. A 12-lead electrocardiogram (ECG), showing: anterior ST-segment elevation myocardial infarction (STEMI). Arrow marked area showing ST-elevation in V1 - V3 lead. This ECG was performed at the time of presentation.

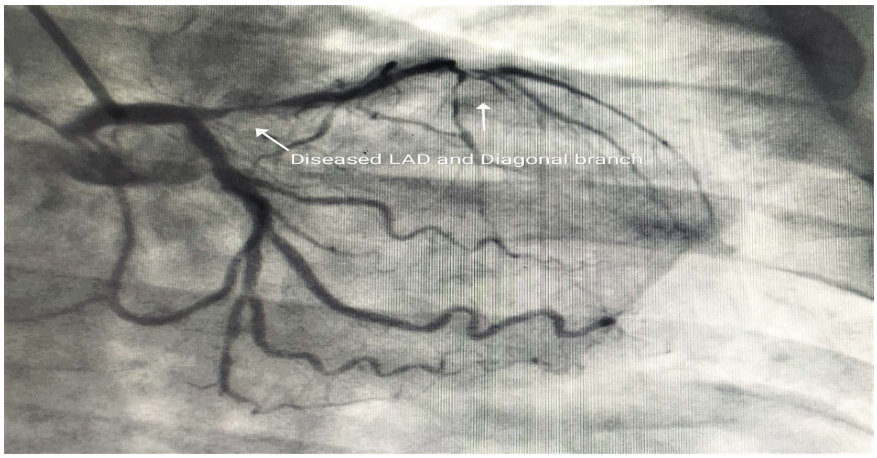
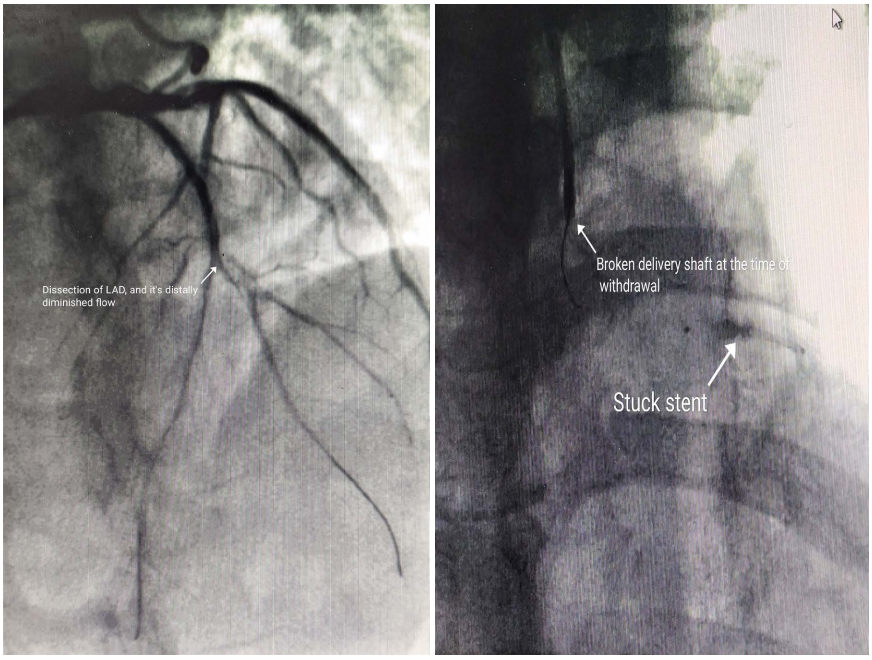


Figure 2. RAO (right anterior oblique) caudal view showing LAD (left anterior descending)artery calcified and has got 90% - 99% narrowing in its proximal segment followed by 90% - 99% diffuse diseased and first diagonal was small and diseased, and second diagonal has got sub-total occlusion at its origin.

lesion was stented with a 2.75 mm × 18 mm stent at 12 - 14 ATM. A check angiogram was carried out after the withdrawing of wire, where proximal LAD was well dilated, but unfortunately, mid LAD had a long dissection with interruption to the distal flow. To overcome the situation, our team decided to put a stent in Mid LAD. Then, again ballooning was performed in mid LAD, and a 2.25 mm × 28 mm stent was approached to Mid LAD, but not crossed the Mid LAD lesion. At the time of withdrawal of the stent, it was stuck in the proximal stent and proximal calcified segment. That stent was tried to pull back, but the delivery shaft was broken, immediately attempts were made to get it back with a snare, but it could not be retrieved and unfortunately left *in vivo* (**Figure 3**).

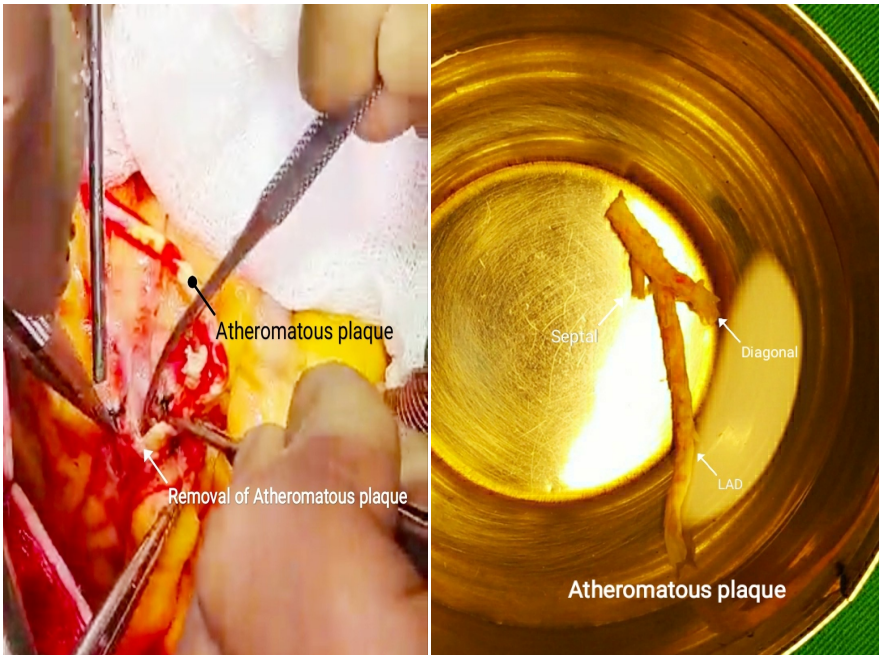
Immediately the decision was made to retrieve the lost angioplasty device surgically and for that, the patient was shifted to cardiac operation theater with stable hemodynamic. Without delay, our cardiac surgical team decided to go for surgical management. Surgery began after all aseptic preparation and general



(a) (b)

Figure 3. (a) Left anterior oblique cranial view showing; check angiogram following proximal LAD stenting, where proximal LAD was well dilated but unfortunately mid LAD having a long dissection which interrupted the distal flow; (b) right anterior oblique caudal view showing; an undeployed mid LAD stent stuck in the proximal calcified segment of LAD with previously deployed stent on it and at the time of withdrawal of undeployed stent delivery shaft was broken and left along with stent *in vivo*.

anesthetic induction. However, after induction blood pressure and heart rate suddenly had fallen, the patient developed cardiac arrest. The patient was managed promptly by giving cardiopulmonary resuscitation (1 cycle) with inotropic drugs. Later on, the patient's heart was quickly approached with a full median sternotomy and pericardiotomy (a significant amount of pericardial fluid was noted). Cardio-Pulmonary Bypass (CPB) was established by aortic and two-stage single venous cannula with prior systemic heparinization. After reducing the temperature, the aorta was cross clamped, and the heart was arrested at diastole by cold blood cardioplegia. For conduit, the left great saphenous vein was harvested. However, internal mammary artery harvesting was not approached, considering patients' hemodynamic status. The epicardium of the heart over LAD territory was found ecchymotic, atheromatous plaques on the LAD were observed through the adventitia, which was found diffusely hard on palpation. A longitudinal arteriotomy (2 - 3 cm) was created on proximal LAD, extension into Mid LAD, and 2nd diagonal. The lumen occluded almost totally with large calcified atheromatous plaques about 3 - 4 cm in length extended up to mid LAD, second diagonal, and septal branch. Open endarterectomy was meticulously done from proximal LAD, second diagonal, and septal branch, with left most proximal major stenotic lesion (**Figure 4**). After dissecting out atheromatous plaque, a longitudinal incision was made on it and found a stuck-up stent along with the

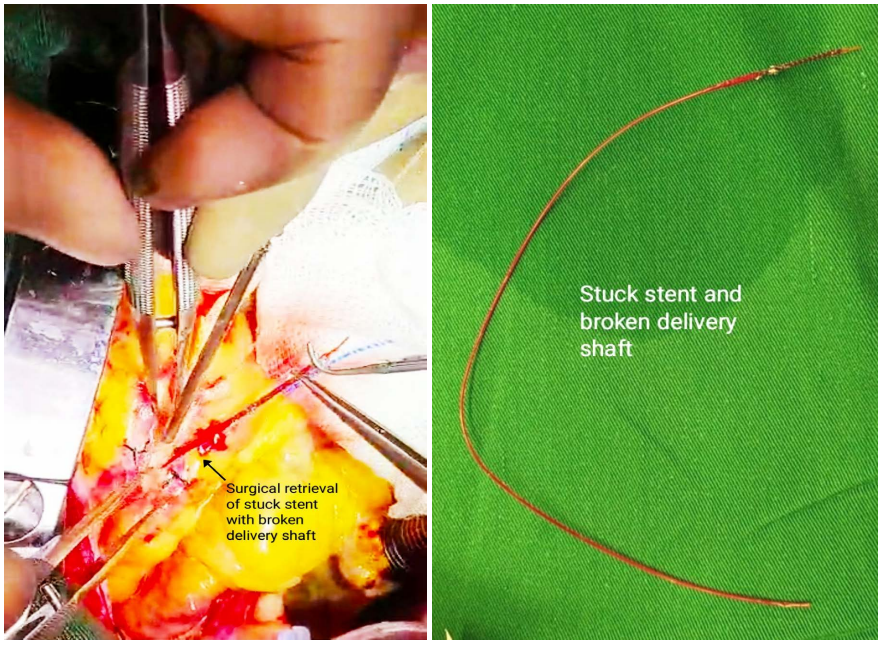


(a) (b)

Figure 4. Removal of atheromatous plaque from LAD, Diagonal and Septal branch through arteriotomy opening in LAD and first diagonal; (a) removal of atheromatous plaque using on-pump arrest heart technique (b) showing removed atheromatous plaque with branching.

broken delivery shaft, which was then totally removed (about 15 cm long) with gentle pulling (**Figure 5**). After heparin saline flushing and preparing venous conduit (with a long longitudinal incision to match the length of arteriotomy on LAD and diagonal), the distal anastomosis was carried out in an onlay fashion using a running 8-0 polypropylene suture (**Figure 6**). Then reverse saphenous vein conduit anastomosed proximally to the ascending aorta using 4 mm aortic punch for the aortic hole and 6-0 polypropylene for suturing. No leakage was seen at the anastomotic sites, and flow through the graft flow was good. The patient was then slowly weaned from CPB with total extracorporeal circulation and cross-clamp times were 110 minutes and 96 minutes, respectively. Reversal of systemic heparinization and hemostasis was ensured. In the pericardial cavity, 2 chest drain tubes were kept. The sternum was re-approximated using steel wires, subcutaneous tissues, and the skin was closed with absorbable sutures. With a stable hemodynamic condition, the patient was shifted to the intensive care unit (ICU) and he was kept there for 2 days. The patient was treated with antiplatelet and anticoagulant (e.g., Intravenous heparin followed by oral warfarin).

There were no signs of postoperative myocardial infarction or any other postoperative complications. On the 5th postoperative day, an echocardiographic examination was done and found: mid to distal inter-ventricular septum and part of apex were grossly hypokinetic with preserved muscle mass, rest of the walls were found normal in motion. However, mild left ventricular systolic dysfunction (ejection fraction: 38%), but there was good right ventricular function observed.



(a) (b)

Figure 5. Surgical retrieval of stuck stent along with broken delivery shaft from LAD (left anterior descending) artery lumen; (a) retrieval technique (b) long delivery shaft (about 15 cm length) with stuck stent.

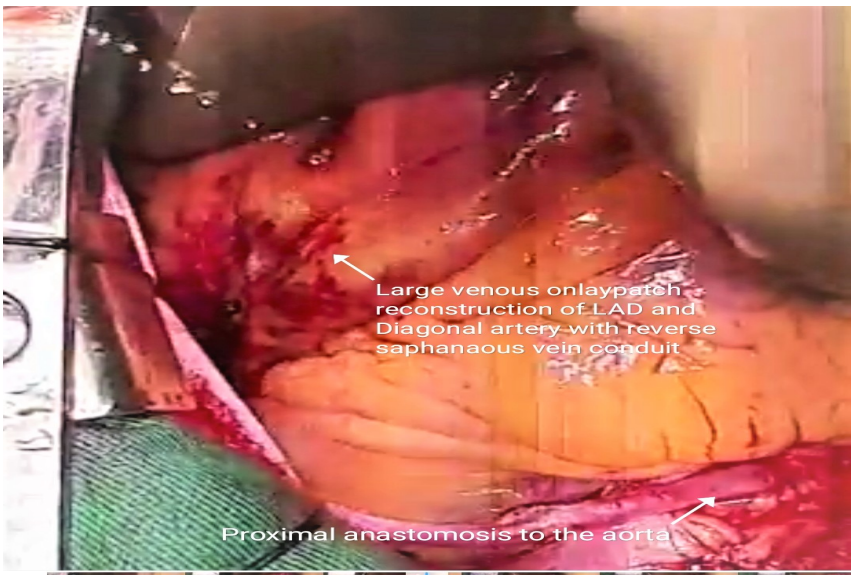


Figure 6. LAD and diagonal branch reconstructed with large onlay venous patch using reverse great saphanous vein conduit and revascularization was completed with creating proximal anastomosis to ascending aorta.

The patient was discharged from the hospital on the 8th postoperative day with uneventful recovery and with New York Heart Association (NYHA) functional class II. The patient came for a routine follow-up to our outpatient department after the 6th week of surgery, where we demonstrated the improvement in NYHA functional class from II to I, in ECG resolving ST-segment changes (**Figure 7**),

and in left ventricular ejection fraction (LVEF) from 38% (on the 5th day of surgery) to 47% (on 6th weeks after surgery) (Figure 8).

3. Discussion

In previous literature, the incidence of broken retained coronary angioplasty hardware is around 0.2% [3] [5]. However, these incidences have significantly downtrend in recent years, which might be due to improvements in technology and device designing with the universal use of pre-mounted stents [5] [6] [7]. Among the angioplasty device losses, stent loss was most frequent, and the common cause of that event was during the attempt of delivering a stent through a previously deployed stent [3]-[8] or during stent-balloon assembly was pulled back into the guiding catheter before reaching the target lesion [1] [2]. Weak support of the guiding wire or catheter, long stent, and complex coronary arterial pathology viz extensive calcification, tortuousness of artery proximal to the pathological segment, lesion involving bifurcation sites are more prone to stent entrapment [1] [2] [3] [8]. In this reported case, the patient underwent PCI for

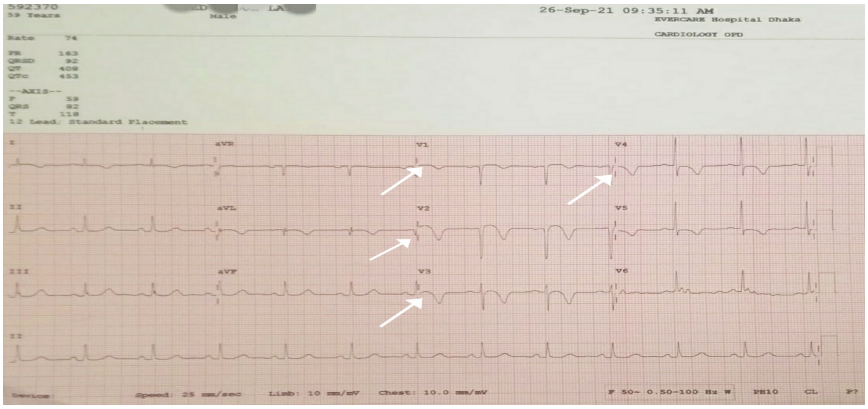
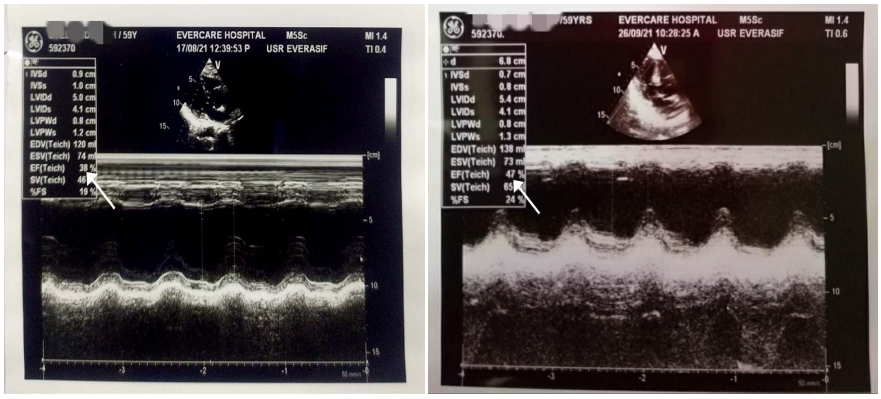


Figure 7. 12 lead electrocardiogram (ECG) on 6th weeks after surgery, showing resolving ST-segment elevation with T-inversion in V1 - V4 lead (arrow marked area).



(a) (b)

Figure 8. Post operative echocardiographic image showing improvement of left ventricular ejection fraction (LVEF) %; (a) LVEF on 5th Postoperative day (b) LVEF on 6th weeks after surgery.

essentially SVD with a tight calcified lesion in LAD and involving branch vessels with AMI. It was unfortunate that after deploying a proximal LAD stent, an angiography revealed long segment dissection in mid LAD, resulting in flow interrupted distally. To manage that event a stent was attempted to be deployed with prior ballooning [9]. But the stent was not crossed that tight stenotic lesion and at the time of withdrawal of guidewire stuck in the proximal stent and proximal calcified segment. When it was trying to pull back delivery shaft was broken, which was tried to get it back with a snare, but failed and unfortunately left *in vivo*. In this reported case, contributing factors for fracture of angioplasty hardware and failed deployment of the stent were most likely due to calcified tight coronary lesion involving branched vessels, hardware reuse, and polymer aging [6] [9]. However, navigation of the catheter through the narrow calcified coronary might cause trauma [9]. And it was observed in this reported case. The damaged fragment within the lumen of the coronary artery may create a nidus for thrombus formation and that might be complicated as AMI, dysrhythmias, perforation, and embolic phenomena [10]. So, the removal of the broken fragment left in the lumen is mandatory. Although various techniques percutaneous retrieval of coronary angioplasty hardwires are available and it has become a preferred procedure, being more appealing and minimal invasive [1] [2] [3] [4], in this reported case, it was attempted but unfortunately failed. So, we consider surgical retrieval and coronary revascularization. The reason behind that decision was, vigorous efforts at percutaneous retrieval present more risk to the endothelium of an already diseased vessel, and long length hardware retained in the lumen of a coronary vessel and aorta might endanger with acute thrombosis and its sequel [11]. In this presenting case, LAD arterial lesion was complex diffusely calcified atheromatous, for that, we conducted an open coronary endarterectomy with onlay bypass grafting. In literature, this technique was found to be safe and effective even in the case of in-stent restenosis [12]. In this reported case, we follow-up the patient and demonstrated improvement in ECG changes (resolving ST-segment change), in LVEF (%), and NYHA functional class after coronary revascularization, which corresponded with previous literature [13] [14]. When coronary angioplasty hardware is stuck up or fractured and remains *in vivo*, in such cases, we advocate the removal of that angioplasty hardware and downstream grafting of the coronary artery unless it can be ascertained that the vessel is otherwise unharmed.

4. Conclusion

Coronary angioplasty hardware should be handled gently, carefully, and strictly according to the manufacturers' instructions for use. And it should be checked for its integrity once taken out of the body of the patient. However, *in vivo* entrapment of angioplasty hardware, fracture, and retention during the PCI are rare and percutaneous retrieval of particularly complex bifurcation lesions still presents limits and risks. In those cases, it will be critical to fully inform the pa-

tient regarding the risk of the procedure and consider surgical revascularization.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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