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Embolization of covered stent during bailout of a coronary perforation — a double jeopardy

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Abstract
Coronary perforation is rare, but dreaded complication of percutaneous coronary intervention (PCI), which may be type-I (extra luminal crater), II (myocardial or pericardial staining), and III (contrast streaming). Type-III perforations, most dreaded one, are managed with reversal of anticoagulation and prolonged balloon tamponade, covered stents, and rarely emergent surgical repair. Here, we report case of 74-year-old diabetic and hypertensive female who had suffered type-III perforation during PCI by predilatation with semicompliant balloon of mid left anterior descending artery (LAD) lesion as it was calcified. During deployment of covered stent, it got embolized into guiding catheter as we tried to forcefully push the stent, but could not do so as the bed was not fully prepared. It was successfully retrieved with semicompliant monorail balloon, and deployed to seal the perforation. LAD was finally stented with another drug eluting stent distally overlapping with covered stent proximally achieving optimal result.

Key words: Coronary perforation; Percutaneous coronary intervention; Covered stent; Stent embolization

Introduction
Coronary perforation is an exceedingly rare, but the most dreaded complication of percutaneous coronary intervention (PCI). Its incidence varies from 0.1–0.5%, with mortality reaching up to 19% depending on the complexity of procedure and severity of perforation. It may be just limited to extra luminal crater or complicate into pericardial effusion with or without tamponade which may require either deployment of covered stent, or rarely emergency surgery [1]. Advance age, female sex, chronic total occlusion, type- C lesions, tortuous vessels, high-pressure balloon dilatation, and plaque modification using rotablation, cutting or scoring balloon are few of the risk factors [2].

Case report
A 74-year-old diabetic and hypertensive female presented with exertional angina Canadian Cardiovascular Society (CCS) — class II for past 2 years with recent worsening for past 6 weeks despite guideline directed medical therapy. Her blood pressure was fairly controlled by medications. Her treadmill test was strongly positive for exercise induced myocardial ischemia. Her haemorrhage and routine biochemistry were normal. An electrocardiogram showed ST-T changes suggestive of left ventricular hypertrophy. Echocardiography revealed mild concentric left ventricular hypertrophy, grade-II diastolic dysfunction, and normal systolic function with an ejection fraction of 60%. Her coronary angiogram which was performed outside our institute suggested diffuse and calcified lesion with 90% stenosis in mid left anterior descending artery (LAD) (Fig.1). She visited our institute for percutaneous coronary intervention (PCI) of involved segment, which was planned through transfemoral route after her consent. After accessing right femoral artery with 6F sheath and administering unfractionated heparin (100 U/Kg), left main artery was hooked with 6F Extra Backup guide catheter (EBU- Medtronic, USA). Lesion was crossed with 0.014” runthrough wire (Terumo, Japan) and was gradually predilated using 1.5x10, and 2x10 mm sapphire semicompliant balloons (Orbus Neisch, Netherland) at 18 atm pressure as lesion was not properly giving up. During dilatation by 2.5x10 mm sapphire noncompliant balloon, patient complained of severe chest pain (Fig.2A). Her blood pressure fell down to 100/76 mmHg. The balloon was withdrawn into guide catheter and check angiogram revealed grade-III coronary perforation as contrast was streaming from vessel (Fig.2B). Intravenous infusion of normal saline was started. The same 2.5x10 balloon was parked proximal to site of perforation and inflated for 5 minute at 4 atm pressures with a constant watch over his hemodynamics as well as ECG. This was repeated four times but leak was persistent (Fig. 3A). 2.75x18 mm Graftmaster (JOSTENT coronary stent graft; Abbott, USA) was tried to be deployed across lesion but as bed was not fully dilated, it could not be delivered despite forceful push. Graftmaster was withdrawn, but only balloon came out of haemostatic valve suggesting stent dislodgement. On careful fluoroscopic review, Graftmaster seemed to be visible at tip of guiding catheter (Fig. 4A). As situation was precarious, it was decided to recapture embolized stent instead of pulling entire system (stent, guide catheter and wire). Therefore, another 2x10 mm sapphire balloon was carefully pushed inside the dislodged covered stent, and then stent-balloon assembly was gradually pushed across perforated segment (Fig. 4B), deployed at 18 atm pressure (Fig. 5A, B), and post dilated using 2.5x10 and 2.75 mm sapphire noncompliant balloon at 16 atm pressure. Once, perforation was sealed and covered stent appeared adequately dilated, another 2.5x18 mm Endeavour Resolute (zotarolimus eluting stent;
Medtronic, USA) was deployed distally overlapping with Graftmaster proximally at 12 atm pressure achieving TIMI III flow (Fig. 6A, B). After sealing with covered stent, blood pressure shoot to 118/86 mg, pain subsided, and ECG got normalized. Echocardiography was repeated during next 72 hours to rule out late tamponade. She was discharged in stable condition with ticagrelor- 180 mg, aspirin-75 mg, rosuvastatin- 40 mg, metoprolol-100 mg, ramipril-10 mg, hydrochlorothiazide- 12.5 mg, and gilbenclamide- 2 mg once daily. She is in regular follow up since last 18 months and is asymptomatic with same drugs.

**Discussion**

Coronary artery perforation may result into minimal contrast staining to frank rupture causing cardiac tamponade which can be lethal [3]. It is outcome of dissection or intimal flap which may completely penetrate the arterial wall. During PCI, guide wire manipulation from sub-intimal passage to false lumen, predilatation with oversized balloon, advancement and inflation of balloon or stent, calcified and tortuous vessel are few of the causes. In a study by Shimony et al among 57 perforations out of 9,568 interventions, wires, balloons, and stents were responsible for 52%, 26%, and 21% of the cases respectively [4]. It varies from Type I-extra luminal crater without extravasations, Type II- pericardial or myocardial blushing, and Type III- perforation ≥ 1 mm diameter with contrast streaming and cavity spilling as defined by Ellis et al [5]. Only close monitoring is required for Type I and II perforations which are predominately guidewire induced and tends to seal spontaneously [1]. Sometimes, prolonged and repeated balloon inflation proximal to site of perforation and reversal of anticoagulation with protamine to keep an activated clotting time (ACT) < 150 second may be required. In cases of distal perforations, micro coils, gel foam, thrombin, fibrin-glue, collagen, autologus subcutaneous fat, and polyvinyl alcohol (PVA) particles are the options. Proximal perforations causing hemopericardium or hemodynamic instability require either implantation of covered stent, bare metal stents with narrow struts, or immediate surgical exploration [6].

Covered stents are bulkier, less flexible, high profile and less deliverable as their trackibility across the tortuous and calcified vessels is difficult. Target vessel must be of appropriate size as current generation of covered stents are available in limited size and diameter. If covered stents fail, emergency surgery is the only option in precarious situation, which itself is associated with significant morbidity and mortality [1]. However, only 3–5% of cases require surgery as percutaneous approach is successful in majority of cases [3, 8]. Graftmaster Jostent (covered stent; Abbott Vascular, USA) consists of ultrathin, biocompatible, and expandable polytetrafluoroethylene (PTFE) layer which is sandwiched
between two coaxially aligned stainless steel stents. PTFE layer acts as a mechanical barrier which seals perforation. Autologus veins or equine pericardium are being utilized in newer generation of covered stent which improves its flexibility and also decrease thrombogenicity [7]. Lansky et al have described deployment of 52 Graftmaster to seal 41 perforations with overall procedure success rate of 96% with no in-hospital myocardial infarction, death or requirement emergency surgery, thereby making its use reliable and highly effective [9].

When a major side branch is likely to be occluded, cardiac surgery may be exercised as an alternative treatment option as all covered stents carry inherent risk of side branch occlusion. These stents are associated with increased incidence of sub-acute stent thrombosis, restenosis, and target lesion revascularization because of increased thrombogenicity and delayed endothelialisation. Therefore, dual-antiplatelet therapy must be prolonged for at least 1 year or even more [10].

As current generation of stents come with premounted systems, risk of stent embolization has drastically come down [11]. Extreme angulation, unfavourable anatomy, coronary calcification, underestimation of stent size, inadequate predilatation, and direct stenting are some of risk factors of stent embolization. Stent dislodgement from delivery system most often occurs when stent balloon assembly is pulled back into guiding catheter [12]. In our case, underlying calcium was hurdle which led the bed inadequately prepared despite graduated predilatation with multiple balloons. Secondly, stent was forcefully pushed across angulated branch which didn’t allow it. Therefore, plaque modification should be done with rota ablation, scoring balloon, cutting balloon, or high pressure balloon before attempting to deliver the stent in such situation.

Low-profile angioplasty balloon catheters, gooseneck snares, myocardial biopsy forceps, and multipurpose baskets are few of percutaneous techniques to retrieve embolized stents from coronary and peripheral circulation. In our case, as embolized stent was within guiding catheter and wire was placed in distal artery, small balloon assisted not only in its retrieval but also its delivery across perforated segment. In this case, it might have been more suitable and useful to pull the entire assembly and rewiring the vessel, had there been no perforation. Therefore, in cases of perforation or dissection, utmost care should be taken to keep wire as distal as possible because it will act as rail road for all devices including balloon, coil, and stent to bail out.

**Conflict of interest**

None
References


Figure legend

**Figure 1.** Coronary angiogram of left system showing diffuse disease with critical stenosis in mid left anterior descending (LAD) artery. LAD and left circumflex artery have separate ostia. (A — antero-posterior caudal view; B — antero-posterior cranial view)

**Figure 2.** Predilatation being performed with semicompliant balloon (A); Contrast streaming from mid LAD indicating perforation (white arrow showing spilling of contrast; B)

**Figure 3.** Contrast still streaming from site of perforation after balloon tamponade (white arrow showing spilling of contrast; A); Covered stent being tried to position across the site of perforation (B)

**Figure 4.** Embolized stent (white arrowhead) seen at the tip of the guiding catheter (A); Embolized stent positioned across the site of perforation with the help of small semicompliant balloon (B)

**Figure 5.** Covered stent was inflated with 2x10 semicompliant balloon all across its length (A; B)

**Figure 6.** 2.5x18 mm Endeavour Resolute being deployed distally overlapping with the Graftmaster proximally (A); Final angiogram revealed well opposed stents with TIMI III flow in LAD and complete sealing of perforation (B)