CASE REPORTS:
Filters to Prevent Distal Embolization during Coronary Artery Stenting: The Risk of Mousetrap
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We describe a case of acute coronary syndrome treated with percutaneous intervention using a distal protection system that was complicated by filter entrapment into the stent struts. We discuss the advantages and concerns of distal protection and suggest some technical aspects to take into account when dealing with filter protection systems.

Recently, a number of clinical studies demonstrated that distal embolization occurs routinely during percutaneous coronary interventions (PCI) — not only on saphenous vein grafts, but also on native coronary arteries.\(^1\)\(^-\)\(^9\) During primary PCI, embolizations large enough to be visible on angiography have been reported to occur in 9–15% of cases.\(^1\),\(^2\) Distal protection with filters can prevent, at least in part, plaque embolization during PCI in stable angina or acute coronary syndromes.\(^3\)\(^,\)\(^4\)\(^,\)\(^6\)\(^,\)\(^7\)\(^,\)\(^10\)\(^-\)\(^13\) In these small studies on native coronary arteries, as well as on larger trials on saphenous vein grafts,\(^8\) filter-based distal protection devices have shown a very satisfactory safety profile.

We report here on a case of filter-based distal protection device entrapment during coronary artery stenting requiring urgent surgical intervention.

**Case Report.** A 63-year-old male was referred to our catheterization laboratory because of ST depression acute coronary syndrome. Upon arrival, the patient was still complaining of mild chest pain for the past hour despite having received nitrates, aspirin, unfractionated heparin and tirofiban. Clopidogrel 300 mg had already been administered in the referring cardiac care unit. The patient’s blood pressure was 95/60 mmHg and his heart rate was 90 beats per minute. An ECG showed ST down-sloping from V2 to V6, and his troponin I was elevated. Echocardiography demonstrated ipo-akinesia of the inferior-lateral wall of the left ventricle.

Coronary angiography was performed via the right radial approach (6 Fr sheath), as is routinely done at our center. It showed critical lesions on the mid-right coronary and proximal circumflex arteries (Figure 1), and a borderline lesion on the mid-left anterior descending artery. The angiographic features of the circumflex lesion were consistent with the presence of a large intracoronary thrombus.

Taking into account the patient’s acute clinical presentation and his posterior-lateral wall motion abnormalities, we decided to treat the lesion in the right coronary artery by direct stenting. Despite the lack of evidence of benefit with the use of embolic protection in acute coronary syndromes involving small vessels, we decide to treat the lesion on the circumflex artery by stenting with the adjunctive use of distal protection due to the presence of angiographic signs of a large intracoronary thrombus. Due to the tortuosity of the vessel, as well as the relatively small size of the circumflex artery (reference luminal diameter 2.52 mm on quantitative coronary angiography), a 3.0 Spider™ filter-based distal protection device (eV3, Inc., Plymouth, Minnesota) was chosen due to its technical characteristics: low
profile (3.2 Fr), availability in a wide range of sizes fitting vessels from 2.5 mm, and the possibility to use a guidewire of choice to cross the lesion.

Intervention was then performed through a 6 Fr radial shape guiding catheter (Boston Scientific Corp., Natick, Massachusetts) for both lesions. After successful stent implantation in the right coronary lesion, the circumflex artery was engaged with a floppy guidewire. The guidewire was then exchanged for the Spider, which was positioned about 3 cm distal to the target lesion (Figure 2). After predilation with a 2.5 balloon, a 2.5 x 20 Amazonia stent (Invasys, Inc.) was successfully implanted with a good angiographic result and a residual luminal stenosis < 10%. However, at the time of filter recovery, the retrieval catheter could not cross the stent (Figure 3). Each attempt to cross the stent with the retrieval sheath was associated with a backward movement of the filter that precluded applying greater strength to the crossing maneuver. Several attempts to cross the stent with the retrieval sheath were performed after overdilatation of the stent with a 3.0 mm balloon at 18 atmospheres, and after positioning of an extra-support buddy wire into the vessel. An additional, unsuccessful attempt was made to partially close the filter with a balloon catheter tip advanced through the stent over the filter loop. However, at this point, even the balloon catheter could not cross the stent, probably due to the protrusion of deformed stent struts into the lumen and to backward movement of the filter device at any attempt to apply strength to the crossing maneuver. At the end of procedure, residual TIMI 2 flow persisted through the filter (still located about 2 cm distal to the end of the stent), together with evidence of ST-segment elevation on ECG in the lateral leads, as well as moderate hypotension. An intra-aortic balloon counterpulsation catheter was then positioned and the patient was referred to the nearest heart surgery facility (about 12 miles away). The patient reached the operating room 55 minutes after the transfer decision. In the operating room, the surgeon extracted, through a distal artery excision, the filter which appeared tightly wrapped in the distal part of the stent (Figure 4). Revascularization of the obtuse marginal and left anterior descending arteries with a saphenous vein graft and the left internal mammary artery, respectively, was also performed. The patient was discharged on day 7 after intervention, with a peak CK-MB release of 245 U/L and without ECG evidence of Q-waves. The echocardiogram performed on day 60 postintervention showed normal left ventricular dimensions and an ejection fraction with no regional wall motion abnormalities.

Discussion. Filter-based and total occlusion distal protection devices have been demonstrated to be safe and useful tools in the setting of saphenous vein graft interventions.8,14 Recent single-center studies suggest that the prevention of distal embolization might also be helpful in interventions on native coronary arteries, although7,10–13,15 more recently, two randomized trials failed to demonstrate the efficacy of distal embolic protection in the setting of primary PCI.16,17 The FLAME trial, a multicenter randomized trial testing the efficacy of a filter-based distal protection device, the FilterWire Ez (Boston Scientific) during primary PCI, is ongoing. With regard to the safety of filter-based distal protection devices, reports are unanimously reassuring, with no evidence of significant device-related complications in both saphenous vein grafts and native coronary arteries.3,6–13,16,17 However, it should be emphasized that the above-mentioned studies were characterized by stringent inclusion and exclusion angiographic criteria for patient enrollment, and no “all comers” studies are available yet.

To our knowledge, this is the first report on a severe complication related to the use of a filter-based distal protection device: the entrapment of a Spider device distal to the stent, requiring urgent surgical intervention for removal. It should be emphasized that the above-mentioned was the first and only device-related complication that occurred in the overall experience (> 190 cases) with coronary filter-based distal protection devices by the seasoned operator at our institution.
In the present case report, several factors might have contributed to the inability to cross the stent with the retrieval sheath, thus leading to failure in filter retrieval: excessive tortuosity of the vessel at the level of stent implantation, coupled with poor back-up support from the guiding catheter; and the relatively small stent diameter; mechanical properties of the Amazonia stent (high strut flexibility) which may have favored distortion/protrusion of the stent struts during the crossing attempts. In our opinion, this case draws attention to the necessity to carefully evaluate some aspects of selecting patients and materials when dealing with filter-based distal protection:

1) Proximal vessel tortuosity should be carefully considered, particularly when vessel diameter is less than 3.0 mm and a tight bend is located within the stent length. In fact, the recovery catheter usually has a large profile, and the large-tip guidewire discrepancy may easily interact with the stent struts. The relatively low support of the filter guidewire, together with the rigidity of the recovery sheath, may further add to the risk of an inability to advance it across the stent.

2) High strut flexibility and deformability, as is the case with the Amazonia stent, may favor the protrusion of stent struts into the lumen during the crossing attempts with the retrieval sheath, thus precluding further successful attempts to cross the stent.

3) Optimal support from the guiding catheter is crucial to allow sufficient strength application during the crossing maneuvers.

4) At surgery, the distal extraction of the filter also led to the removal of the stent since, the two devices were found to be tightly wrapped together (Figure 4). Backward movement of the filter device up to the distal end of the stent may have occurred during patient transportation maneuvers. Indeed, the nitinol mesh of the Spider filter may be particularly prone to interact with stent struts, especially if protruding, in instances of unintentional backward shift of the filter near the stent.

5) When selecting the landing zone for filter delivery, an appropriate trade-off should be achieved between the effort to protect side branches and the necessity to ensure a safe distance between the filter and the stent.

6) A word of caution should be heeded when planning the use of a distal protection device in clinical settings different from degenerated saphenous vein grafts. In fact, routine use of embolic protection devices in acute coronary syndromes has been demonstrated to be ineffective, while their selective use in patients with a heavy embolic burden is still under investigation. On the other hand, the risk of device-related complications in this clinical setting, as the one reported here, is low, but still not negligible. In these cases, the use of a platelet glycoprotein IIb-IIIa inhibitor should be considered.


18. Mizote I, Ueda Y, Ohtani T, et al. Distal protection improved reperfusion and reduced left ventricular dysfunction in patients with