Using Coils to Treat a Coronary Perforation

How the block and deliver technique can be used successfully.

BY ROBERTO GARBO, MD, AND MARIO IANNACCONE, MD

Coronary perforations have traditionally been classified into five types (Ellis classification).1

- Type I: focal extraluminal crater without extravasation
- Type II: pericardial or myocardial blushing without jet extravasation
- Type III: active jet extravasation
- Type IV: cavity spilling
- Type V: distal perforation

Type V coronary perforations can be sealed with coils and are frequently related to the use of hydrophilic or stiff guidewires. Any distal vessel can be involved in complex percutaneous coronary intervention (PCI), whereas in chronic total occlusion (CTO) PCI with retrograde approach, the main site of perforations are collaterals, both epicardial and septal. In the case of collateral rupture during CTO PCI, one must take into account that flow to the rupture point can be provided by both the donor and the receiving artery, therefore sealing with coils may be necessary from both sides. In such a case, the operator has to release the coil distally to the collateral rupture and then proximally.2 The tip injection from the microcatheter is useful for checking the right position, the correct release, and the sealing of the perforation.

HOW I DO IT

In a coronary perforation, the first step of treatment is to inflate a balloon proximal to the perforation site to reduce the risk of cardiac tamponade. In some (rare) cases, simple balloon inflation together with observation and heparin reversal (after removal of equipment from the coronary artery) may be sufficient to seal the perforation. However, in most cases, definitive treatment with coil embolization is preferred, and if the procedure is done correctly, the risk for late reopening and late tamponade is eliminated.3

Embolization is the most common form of treatment for distal perforation and can be performed using fat microspheres or coils. In the coronary artery, the most efficient and secure technique is without a doubt coil embolization. Microspheres should be avoided in coronary perforation because they can migrate and cause occlusion in other vessels with catastrophic consequences. Fat embolization should only be used in emergency situations when coils are not available due to the lack of accuracy during the maneuver of embolization.4

There are two possible coil release strategies. The easiest technique is to put a microcatheter at the level of the distal perforation (with the trapping technique if the guidewire that caused the perforation is still in place), check the perforation site with contrast injection through the microcatheter, and then release the initial detachable coil. It is then possible to inject again through the microcatheter and place other coils if necessary.

The second strategy is the “block and deliver (BAD)” technique,5 which consists of the delivery of a balloon to avoid extravasation and then using a buddy wire to advance a microcatheter through a single ≥ 6-F guiding catheter, without requiring exchange for a larger guiding catheter or the use of a dual (ping-pong) catheter technique. The microcatheter must be delivered near the perforation, and the balloon needs to be deflated just as the guidewire and microcatheter cross the vessel, avoiding extravasation. When the microcatheter is in the correct position with the proximal balloon inflated (to avoid extravasation), it is possible to do a tip injection of contrast material to check the position and release the coils. This is a safe and effective technique for the management of distal vessel or collateral channel perforations in everyday PCI and CTO PCI.4

To release the coils, it is necessary to insert the coil’s delivery wire and introducer sheath into the microcatheter; the introducer sheath is removed when the delivery wire is 2 inches away from the proximal end of its introducer sheath. It is beneficial to perform this with two operators to advance the coils correctly.
When the delivery wire is held in place, the introducer sheath has to be removed; therefore, the coils are advanced under fluoroscopic guidance into the target vessel. Prior to coil detachment it is necessary to verify that the coils are not protruding into the vessel and that the radiopaque part is totally outside of the microcatheter. If the position is correct, the coils are connected to the deployment system and released.

The BAD technique allows for the verification of perforation sealing before and after the release of the material by tip injections directly from the microcatheter. Pericardiocentesis may be required if the patient develops hemodynamic instability.

A recent published study retrospectively evaluated the BAD technique at five high-volume centers in Italy, showing that the technique is safe and effective, with a high rate of successful sealing and no difference between patients with coronary perforation during CTO revascularization or during non-CTO PCI.

**MATERIALS**

Two types of coils are currently available: pushable and detachable. With pushable coils, the release is less controlled and precise. In the 1980s, Guido Guglielmi, MD, invented the detachable coil for the endovascular treatment of cerebral aneurysms. Coils are permanent metallic agents with a wired structure of synthetic wool or Dacron fibers and thrombogenic properties. The coils are attached to a stainless steel delivery wire covered with an introducer sheath.

Coils can be standard or soft, and they can have a 360° (frame/fill method), “J”, or helicoidal shape. For coronary embolization, the standard 360°-shaped coils are commonly used (main sizes: 1.5 X 20 mm to 2.5 X 40 mm).

The detachable coils are a controlled release, and there are two types: (1) electromechanical-controlled detachment and (2) mechanical-controlled detachment.

Coils can be delivered through microcatheters, but they must be compatible with the inner lumen diameter of the microcatheter. When using a low-profile microcatheter with a 0.016-inch inner lumen such as the Asahi Caravel (Asahi Intecc USA, Inc.), a 0.010-inch coil can be used. Larger microcatheters such as the Asahi Corsair (Asahi Intecc USA, Inc.) or the FineCross (Terumo Interventional Systems), which both have an 0.018-inch inner lumen, are compatible with 0.018-inch coils. Generally, 0.018-inch coils are more stable during release when compared with the 0.010-inch coils. However, in coronary perforations, 0.010-inch coils are enough.

Frequently used coils are listed in Table 1. The Target detachable coils (Stryker) are the most commonly used; the 360° shape allows for accurate positioning of the spirals.

**COMPLICATIONS**

The BAD technique is generally very safe. However, there are some possible complications. The chosen coil size has to be correctly evaluated. Typically, the coil size must be larger than the target vessel to ensure complete vessel adherence and embolization. Coils that are too large may inadvertently be deployed too proximally, and coils that are too small may migrate too distally. Electromechanical detachment devices, especially when used in septal collaterals, can determine an electric stimulation into the myocardium, which can be followed by ventricular arrhythmias in some cases.

**CONCLUSION**

Coronary perforation is a rare complication that can have a fatal outcome if not correctly managed. Coronary perforation is a rare complication that can have a fatal outcome if not correctly managed. Coronary perforation is a rare complication that can have a fatal outcome if not correctly managed. (Continued on page 53)

<table>
<thead>
<tr>
<th>Coil Name</th>
<th>Manufacturer</th>
<th>Diameter (inch)</th>
<th>Description</th>
<th>Detachment System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axium detachable coil</td>
<td>Medtronic</td>
<td>0.018-0.010</td>
<td>Bare platinum coil with or without PGLA or nylon microfilaments enlaced through the coil</td>
<td>Mechanical</td>
</tr>
<tr>
<td>HydroCoil embolic system (HES)</td>
<td>MicroVention Terumo</td>
<td>0.018-0.010</td>
<td>Bare platinum coil combined with an expanding hydrogel polymer</td>
<td>Thermomechanical</td>
</tr>
<tr>
<td>MicroPlex coil system (MCS)</td>
<td>Terumo</td>
<td></td>
<td>Bare platinum coil with various shapes and softness profiles</td>
<td>Thermomechanical</td>
</tr>
<tr>
<td>Target detachable coil</td>
<td>Stryker</td>
<td>0.010</td>
<td>Bare platinum coil with various shapes and softness profiles</td>
<td>Electromechanical</td>
</tr>
</tbody>
</table>
embolization with microcoils, in particular with the BAD technique, is safe and effective to deal with distal coronary perforation and avoid significant pericardial effusion.


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