Embolization: What's on Your Coil Technology Wish List?

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Coil technology has come a long way in just the past 5 to 10 years. We have learned to be comfortable with pushable, fibered coils, and they are a good option, but it is clear that more challenging anatomy requires a better option. The advent of lower-profile, softer, detachable coils has allowed us to tackle more complex anatomy that would not have been previously possible. Additionally, the use of liquid embolics has grown significantly, albeit off-label in peripheral applications.

For vessel sacrifice applications, I would ask for an embolic that completes the task with a single device, can be delivered in the most tortuous anatomies, is fully detachable, and retrievable after delivery. Because we are asking for anything, I would like a single, long coil that can be delivered by the operator to the targeted vessel and then detached to the desired length—in other words, a single coil that can be dialed into a desired diameter and detached at any length.

For aneurysm exclusion, a soft, large-volume framing coil that packs well within the aneurysm sac would be ideal. A nice addition would be the ability to deliver a liquid embolic through the coil delivery system—an embolic that would adhere to the coil and complete the aneurysm exclusion with a single coil combined with a liquid embolic.

Multiple advances have been made in coil technology, including controlled deployment with detachable coils, a wide range of diameters and lengths to treat a variety of vascular pathology, improved trackability, and increased thrombogenicity. Despite these advancements, there are still certain limitations that can be problematic.

Although there are various techniques to decrease time to occlusion, including incorporating thrombogenic fibers or expandable hydrogel polymers onto the coil, we lack a coil capable of producing immediate and reliable occlusion with a single device. Such a coil would be invaluable, because it could decrease procedure time and hopefully result in cost savings. The MVP microvascular plug (Medtronic) effectively serves this purpose for vessels up to 5 mm, but we are limited when treating larger vessels. Patients with severe coagulopathy (eg, disseminated intravascular coagulation in patients with trauma) often do not successfully occlude despite multiple coils. An effective coil capable of producing rapid occlusion in such a circumstance would also be valuable.

Metallic artifact on CT and MR imaging is another significant drawback of existing coil technology. Following patients after coil embolization with cross-sectional imaging can be extremely difficult or impossible secondary to artifact. After coiling intracranial aneurysms, for example,

follow-up generally requires subsequent invasive diagnostic cerebral angiography. Embolization coils that produce no artifact could provide tremendous benefit to patients, because these patients may then potentially be followed with noninvasive imaging. The Medusa MultiCoil (EndoShape) is innovative in that it is nonmetallic and produces minimal artifact; however, this device requires a large catheter for deployment, limiting its utilization. The development of such an embolization coil compatible with standard microcatheters would ameliorate patient care and would certainly be on my wish list.

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The widespread use of cross-sectional imaging allows interventional radiologists to deal with increasingly challenging cases of embolization in elective and emergent situations. In the last few years, coils have been developed specifically for peripheral applications, and we now have very long coils with more packing density capacity and softness, enabling controlled placement via microcatheters once the site for coil release has been reached. Furthermore, reliable systems developed for the neurovasculature applications focused on the controlled release of coils, ensuring more safety in avoiding nontarget embolization. Generally, coils are easily visible on fluoroscopy, but they cause artifacts on CT scans. A large metal cast of coils can impede judgment of CT scans about the proper fill of an aneurysm or target vessels, resulting in clinical consequences in the patient's management.

Among the ideal features of next-generation coils would be good radiopacity during the coils' release to eliminate or greatly reduce artifacts on CT and MR imaging.

Another idea would be a drug-eluting detachable coil. The central portion (eg, 30 cm in the middle of a 60-cm-long coil), would elute procoagulant drug (thrombin, for example). The eluting portion, which would accelerate the coagulation process, should only be on the central section of the coil to allow repositioning of the drug-free tip of the device until the correct placement is reached, and the coil should have a drug-free distal portion for finishing. This technology could be useful for vessel sacrifice in bleeding or for aneurysm exclusion.

A second brainchild, even if technically harder to realize, may be an electrolyte detachable coil with the feature of magnetic charging with energy during the release phase to create the best high-density packaging possible, achieved with the coil clinging to itself. When an aneurysm is completely embolized, only 30% to 40% of its volume is filled by coils. This cast can be compressed on the bottom of the sac by the blood flow, and the patient could need a second treatment to prevent aneurysm growth. Magnetic coils could potentially avoid this problem, with complete filling of the aneurysm sac in one embolization procedure. ■