In the article “Predictors of cerebral aneurysm persistence and occlusion after flow diversion: a single-institution series of 445 cases with angiographic follow-up,” Bender et al. present their concept of Pipeline embolization device (PED) flow diversion treatment of anterior cerebral circulation aneurysms and their analysis of predictors of aneurysm persistence and occlusion. Over a 5-year period, 491 PED procedures were performed at a single institution, and in 445 cases, a follow-up catheter angiogram obtained at least 6 months after the procedure was available, and all were included for analysis. Most of the aneurysms treated arose from the internal carotid artery, but also 17% of the treated aneurysms were treated off-label with PEDs, including aneurysms of the middle cerebral artery and anterior cerebral artery locations. In 92% of the cases a single PED device was used, and in 5% of the cases adjunctive coils were placed. Overall, complete aneurysm occlusion was achieved in 72%, 78%, and 87% at 6, 12, and 24 months, respectively. On multivariate analysis the authors found that at 12 months adjunctive coiling predicted occlusion (OR 0.260, p = 0.036), while male sex (OR 2.923, p = 0.032), aneurysm size (OR 3.584, p = 0.011), and incorporation of a branch vessel (OR 2.206, p = 0.035) predicted persistence.

We congratulate the authors on their results with the PED in this publication as well as in their recently published paper on declining complication rates in PED procedures. We agree with the authors that PED treatment continues to expand its role in treating intracranial aneurysms because of the excellent aneurysm occlusion rates and favorable patient outcomes. Achieving such insights into the proper indications for PED treatment and into the technique itself is critical. Compared to the current study from Bender et al., we employ a partly different treatment strategy using the PED, notably in multiple-device use. Specifically, we believe that for FDA “on-label” patients with large and giant wide-necked aneurysms, a single PED device rarely provides enough coverage of the aneurysm neck, and that such cases, ultimately failing single-PED treatment, can be occluded more reliably through application of multiple overlapping devices during the initial treatment. Moreover, in the special case of aneurysms with branching vessels (arising immediately next to the aneurysm or originating from the aneurysm itself) staged multi-device strategies can be used effectively to treat the aneurysm with a low risk of morbidity despite covering the index branch with multiple PED constructs—even in situations where the branch vessel is ultimately occluded after development of a collateral supply to the affected vascular territory. Therefore, the finding in this article that incorporated branch vessels predict aneurysm persistence should not necessarily be understood to suggest such aneurysms reflect an absolute contraindication to PED treatment.

Since the first report of PED use in the PITA trial, PED-supported coiling has been understood to be a very effective treatment for cerebral aneurysms. However, it should be recognized that for cases in which significant relief of mass effect is essential to therapy (visual deficits related to optic nerve compression, etc.), the alternate use of multiple overlapping PEDs, eliminating the need for adjunctive coiling, may provide a better clinical outcome with equivalent aneurysm occlusion rates.

With such a small rate of multiple PED treatment (8%),
it remains unclear whether the authors have a unique strategy for multi-device use in unusual cases, or if the use of multiple devices represented a salvage strategy in cases in which the intended single-PED procedure became complicated or failed. This is an important question, since unintended multiple-device use during a salvage maneuver may bias the outcome data with multiple devices—thus implying higher complications than would be observed with strategies employing prospective intentional multiple-device use. Notably, occlusion rates as well as possible differences in aneurysm size, location, and shape between single- and multiple-PED groups are not presented and discussed in this article.

Another missing discussion point is the length (besides the diameter) of the PED device. For us, this is an important feature to plan the ideal treatment construct by landing the device precisely over the aneurysm and to intentional load (pack) the device. In multiple-device use, we intend to overlap PEDs with different diameters and lengths to achieve high coverage over the aneurysm neck while covering the nonaffected segments of the parent vessel, proximal and distal to the aneurysm, ideally with only one device.

In summary, this study provides support for the expanding use of PED in treating intracranial aneurysms, due to favorable aneurysm occlusion rates and patient outcome. From our experience overlapping PEDs of different diameter and lengths tailored to specific aneurysms can be used to further refine treatments, further increasing occlusion rates with acceptably low morbidity/mortality rates.

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References

Response
Matthew T. Bender, MD,1 Geoffrey P. Colby, MD, PhD,2 and Alexander L. Coon, MD1
1Department of Neurosurgery, Johns Hopkins University School of Medicine, Baltimore, Maryland; and 2Department of Neurosurgery, University of California, Los Angeles, California

We appreciate Dr. Burkhardt and colleagues’ thoughtful reflections on our series involving angiographic outcomes of 445 anterior-circulation PED procedures for cerebral aneurysm. We believe our techniques are complementary and there is a role for multiple-device constructs, which constituted the majority of the Pipeline for Uncoilable or Failed Aneurysms (PUFS) trial.

There are numerous reasons why a multiple-PED construct might be used. Revisiting the 36 such cases in this series, we found that in 24 cases (67%), the multiple-device construct was planned: to extend the construct in cases of large/giant or fusiform aneurysms (n = 15), to double cover some branch vessel aneurysms (n = 6), to cover multiple aneurysms along a single vessel (n = 2), or to double cover blister-type aneurysms (n = 1). In 12 cases (33%), we did not plan to use multiple devices at procedure outset. Two of these were salvage maneuvers when the first device prolapsed into the aneurysm. The other 10 were to extend a construct in which the first device ended close to the aneurysm neck, risking prolapse with additional foreshortening.

Whether intended at procedure outset or not, the result in nearly all multiple-PED cases was the same as what Burkhardt et al. described: devices were overlapped to increase metal density across the aneurysm neck. Occlusion outcomes would be expected to reflect any benefit, but they were similar: 72% and 74% for single-PED and 72% and 77% for multiple-PED procedures at 6 and 12 months, respectively. The largest prior series comparing single- (n = 126) and multiple-device (n = 52) constructs also showed no difference in occlusion rates, which were 68% versus 70% complete at last follow-up, respectively.1 In that series—with a mean lesion size of 12 mm for multiple-PED cases and 9 mm for single-PED cases—and in the present series—in which the mean lesion size in multiple-PED cases was 13 mm, 33% had a fusiform or dissecting morphology, and a greater majority (89%) were located along the internal carotid artery—the population of aneurysms treated with multiple devices mirrored that of aneurysms in the PUFS cohort, although the average size was not as large. Given the heterogeneous indications included in retrospective series, it may still be that for large proximal carotid artery aneurysms, there is an occlusion benefit to multiple-device constructs.

We agree with Burkhardt et al. that lower occlusion rates do not represent a contraindication to flow diversion for branch vessel aneurysms, but we generally favor adjunctive coiling over additional PEDs as an ameliorator. In our experience (forthcoming elsewhere), a “light” coil pack suffices, which allows for a reduction in mass effect with healing and may offer cost savings over a second flow-diverting stent. For branch vessel aneurysms, we have used multiple-device constructs for true ophthalmic artery aneurysms for which both devices can be landed proximal
to the posterior communicating artery. In more distal regions, the benefits of flow diversion with adjunctive coiling include the following: flow diversion can be accomplished in a single stage, it avoids high-density overlapping metal in perforator-rich regions, and it allows more progressive collateralization of covered branch vessels. Both adjunctive coiling and multiple-device techniques add procedural complexity, but similar safety profiles can be achieved with vigilance concerning platelet aggregation and stent thrombosis. Whereas the PUFS trial was designed to gain FDA approval for flow diversion as a single modality in the treatment of large proximal carotid artery aneurysms, our series reflects flow diversion’s contemporary use in which adjunctive coiling is possible and many treatments are in more distal locations.

References