

Internal coil packing method for the Amplatzer vascular plug 4

Masamichi Koganemaru 

Shuichi Tanoue 

Asako Kuhara 

Tomoko Kugiyama 

Toshi Abe 

ABSTRACT

The Amplatzer vascular plugs (AVPs), including AVP 4, have excellent occlusion; however, insufficient embolization or recanalization may occasionally occur. This study aimed to evaluate the feasibility and effectiveness of internal coil packing method to insert microcoils into the AVP 4 using an experimental vascular model. The insertion of a 1.7 F microcatheter through the nitinol mesh of the AVP 4 was not possible. Only 0.010-inch electrolytic detachable microcoils could be inserted through catheter tips in contact with nitinol mesh. The internal coil packing of the AVP 4 may be accomplished by inserting 0.010-inch microcoils into the AVP 4 in cases of continued perfusion or recanalization with required short-segment embolization.

The Amplatzer vascular plug (AVP) 4 (St. Jude Medical) can be easily delivered to the target site of embolization through a 0.038-inch diagnostic catheter, even when the target vessel is relatively small and/or access to the site is challenging (1, 2). The AVP 4 has a flexible nitinol mesh structure with a multilayered, double-lobed design. Lopera (2) reported persistent patency 2 weeks after gastroduodenal artery embolization with AVP 4 before radioembolization. Residual perfusion reportedly occurs when another artery is branched on the proximal side of the placed AVP 4 (3). Although AVP is reported to have excellent rapid occlusion, internal coil packing can be performed as an optional procedure when persistent patency or recanalization occurs (4–6). However, these reports used the AVP 1, and the optimal coil packing method for AVP 4 is not clear. The aim of this report is to experimentally clarify whether the internal coil packing method is possible for the AVP 4.

Technique

For the experimental procedure, an 8 mm diameter AVP 4 was placed within a vascular model measuring 6 mm in diameter (Fig.). The vascular model was constructed from glass component. A simulated internal coil packing method for the AVP 4 was performed under direct fluoroscopic visualization of the vascular model using enough saline to detach the electrolytic detachable microcoils. Subsequent to detaching the AVP 4, unilateral coil packing of the double-lobed nitinol mesh was performed. The coil delivery systems included a 4 F diagnostic catheter (Medikit Co., Ltd.), a 1.7 F microcatheter tip (Excelsior SL-10, Stryker Neurovascular), and a 0.014-inch guidewire (Transend EX, Stryker Neurovascular). The electrolytically detachable coils had a primary diameter of 0.010 or 0.014 inches (2 mm or 3 mm diameter, Target Helical Ultra or Target XL, Stryker Neurovascular). Three different methods of internal coil packing were tested. These procedures were performed 3 times each by 2 interventional radiologists (M.K., T.K.) with >20 and 9 years of experience, respectively. The same results were obtained in each trial as follows:

1. The 4 F catheter tip was placed in contact with the nitinol mesh of the AVP 4, and the 1.7 F microcatheter was coaxially inserted into the AVP 4 with the guidewire. If the microcatheter could be inserted into the AVP 4, coil packing with microcoils was performed.

Guidewire insertion into the AVP 4 was relatively easy, but microcatheter insertion exhibited strong resistance at the nitinol mesh structure. Coil packing after inserting the microcatheter into the AVP 4 was deemed impossible.

From the Department of Radiology (M.K. ✉), mkoganemaru@med.kurume-u.ac.jp, Kurume University School of Medicine, Kurume, Japan.

Received 04 January 2019; revision requested 28 January 2019; last revision received 30 January 2019; accepted 05 February 2019.

Published online 4 July 2019.

DOI 10.5152/dir.2019.19009

You may cite this article as: Koganemaru M, Tanoue S, Kuhara A, Kugiyama T, Abe T. Internal coil packing method for the Amplatzer vascular plug 4. *Diagn Interv Radiol* 2019; 25:410–412.

2. The 4 F catheter and 1.7 F microcatheter tips were put in contact with the nitinol mesh of the AVP 4 and only the microcoils were inserted into the AVP 4 (Fig.).

Using these methods, inserting the 0.010-inch microcoils into the nitinol mesh of the AVP 4 was possible (Fig.) with electrolytic detachment inside the AVP 4 (Fig. b–d). The catheters were stable, and they could be easily inserted at the same position (Fig. b, c) during microcoil insertion. Internal packing was performed by inserting 6 microcoils in the 3-step procedure (Fig. d, average length of coils for each of the 3 trials, 44 cm; range of coil length, 6–10 cm). The 0.014-inch microcoils could not be inserted through the nitinol mesh of the AVP 4.

3. The 4F catheter was slightly separated from the AVP 4 to where the 1.7 F microcatheter (45° angled tip) was in contact with the AVP 4. Next, only the microcoils were inserted into the AVP 4.

It was impossible to insert the microcoils into the AVP 4 during this procedure, resulting in microcatheter kickback. A similar procedure was performed at another site of the nitinol mesh with the same results.

Discussion

The AVP 4 can be delivered using a diagnostic catheter with an inner lumen of 0.038 inches. Compared with other types of AVPs, it is possible to embolize more distal sites and tortuous vessels with the AVP 4, and acceptable target vessel diameter is approximately 3–6 mm (2). Although AVP 4 has excellent occlusion, insufficient embolization or recanalization may occasionally be seen (1, 2, 5, 7). If occlusion is not observed, gel-foam-assisted embolization and a method to embolize around the AVP with microcoils have been reported (3, 8). However, an additional embolization procedure around

the AVP may lead to adverse effects in some cases. For example, AVP 4 may be embolized at the origin of the gastroduodenal artery (3). Therefore, if additional embolizations are needed, the available distance for short-segment embolization is very short in some cases. Use of AVP 4 is efficacious due to its remarkably low frequency of migration and excellent occlusion even when there is a short distance between the embolized vessel and the non-target vessel (3).

Reports showed that in cases of continued perfusion or recanalization, AVP 1 could be supported by additional microcoil embolization inside the AVP, and that it is possible to insert the microcatheter into the AVP (4–6). This technique allows for embolization at the site of the already placed AVP, resulting in embolization with a short landing zone. Based on a similar concept, this experiment tests whether AVP 4 could be embolized by inserting microcoils into the AVP 4 during continuous perfusion or recanalization.

Consequently, both the 4 F catheter and 1.7 F microcatheter tips were in contact with the AVP 4, and only the 0.010-inch microcoils could be inserted into the AVP 4. Unlike AVP 1, the microcatheter did not enter the AVP 4, possibly because the nitinol mesh is tight. The superficial tip measurements of the 0.010 and 0.014-inch microcoils were 0.0506 mm² (radius, 0.254/2 mm) and 0.0995 mm² (radius, 0.356/2 mm), respectively. The superficial measurements of the 0.014-inch microcoil tip may be one reason why the 0.014-inch microcoil could not be inserted into the AVP 4, being 1.96 times the superficial measurement of the 0.010-inch microcoil. In addition, the 0.014-inch guidewire could be inserted into the AVP, but the 0.014-inch microcoil could not, which may be because the guidewire has a hydrophilic surface coating. The pushing force of the guidewire is transmitted straight to the tip. The microcoil is highly flexible; hence it easily bounces back when

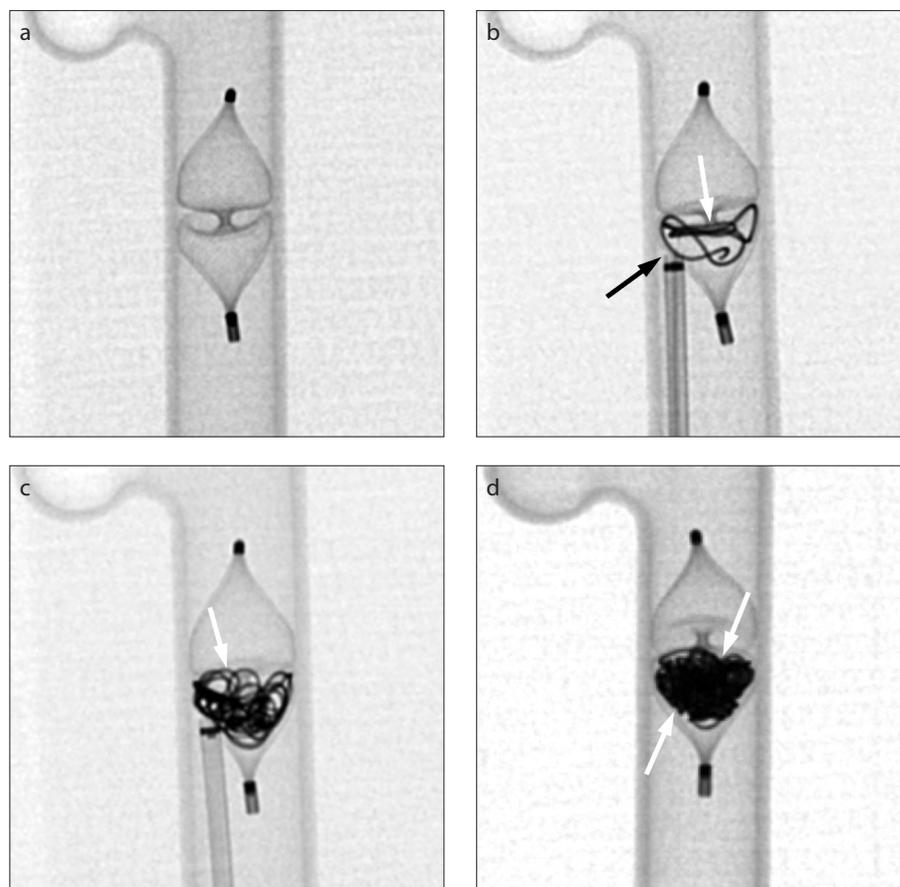


Figure. a–d. Internal coil packing method of AVP 4. Using a vascular model, placement is performed after detaching the AVP 4 (a). The tips of both the 4 F catheter and 1.7 F microcatheter are in contact (black arrow) to the AVP 4, and only the microcoil (white arrow) is inserted unilaterally into the double-lobed nitinol mesh (b). Additional microcoil packing (white arrow) while continuing the procedure (c). Internal packing of the AVP 4 was achieved after inserting 6 microcoils (d, white arrows).

Main points

- AVP 4 has excellent occlusion; however, insufficient embolization or recanalization may occasionally occur.
- Only 0.010-inch electrolytic detachable microcoils could be inserted under catheter tips in contact with nitinol mesh of the AVP 4 as an internal coil packing method.
- Internal coil packing method of the AVP 4 for continued perfusion or recanalization with required short-segment embolization may be accomplished by inserting 0.010-inch microcoils into the AVP 4.

in contact with the nitinol mesh structure of the AVP. Moreover, the microcoil does not have a hydrophilic coating.

In an attempt to use the angled microcatheter tip, we found that the microcoil was not stable enough to be inserted into the AVP. Using an angled microcatheter tip does not adequately support microcoil insertion.

Limitations of this method includes its feasibility, particularly *in vivo*; also, the feasibility of using other types of catheters, coils, or other embolic materials such as liquid materials is unclear. Internal coil packing was performed unilaterally on one lobe of the double-lobed nitinol mesh structure of AVP 4. Therefore, the clinical impact of this method is unknown. In addition, detachable coils are more expensive compared with other embolic materials.

In conclusion, the internal coil packing method of the AVP 4 for continued

perfusion or recanalization with required short-segment embolization may be accomplished by inserting 0.010-inch microcoils into the AVP 4.

Conflict of interest disclosure

The authors declared no conflicts of interest.

References

1. Wang W, Li H, Tam MD, Zhou D, Wang DX, Spain J. The Amplatzer vascular plug: a review of the device and its clinical applications. *Cardiovasc Intervent Radiol* 2012; 35:725–740. [\[CrossRef\]](#)
2. Lopera JE. The Amplatzer vascular plug: review of evolution and current applications. *Semin Intervent Radiol* 2015; 32:356–369. [\[CrossRef\]](#)
3. Bulla K, Hubich S, Pech M, Löwenthal D, Ricke J, Dudeck O. Superiority of proximal embolization of the gastroduodenal artery with the Amplatzer vascular plug 4 before yttrium-90 radioembolization: a retrospective comparison with coils in 134 patients. *Cardiovasc Intervent Radiol* 2014; 37:396–404. [\[CrossRef\]](#)
4. Koganemaru M, Tanaka N, Nagata S, Abe T. Internal coil packing for mesh occlusion device. *J Vasc Interv Radiol* 2017; 28:1199–1201. [\[CrossRef\]](#)
5. Koganemaru M, Tanoue S, Kuhara A, et al. Internal coil packing of an Amplatzer vascular plug after incomplete occlusion of the afferent vessel of a splenic artery aneurysm. *J Vasc Interv Radiol* 2018; 29:1310–1313. [\[CrossRef\]](#)
6. Katada Y, Onozawa S, Takahashi S, Suzuki S. Ultrashort-segment embolization of high-flow vessels using a coil packing technique in an Amplatzer vascular plug. *J Endovasc Ther* 2018; 25:757–759. [\[CrossRef\]](#)
7. Güneşli S, Çınar C, Bozkaya H, Parıldar M, Oran İ. Applications of the Amplatzer vascular plug to various vascular lesions. *Diagn Interv Radiol* 2014; 20:155–159. [\[CrossRef\]](#)
8. Wang W, Tam MD, Spain J, Quintini C. Gel-foam-assisted amplatzer vascular plug technique for rapid occlusion in proximal splenic artery embolization. *AJR Am J Roentgenol* 2013; 200:677–681. [\[CrossRef\]](#)