Packing of a Splenic Artery Aneurysm Using a Novel Hydrogel-Coated Coil

1) Division of Endovascular Treatment, Department of Radiology, Japanese Red Cross Medical Center, Japan

Akinori Harada¹⁾, Yosuke Nozawa¹⁾, Tetsuhisa Yamada¹⁾, Jun-ichi Nishimura¹⁾

Abstract

We report our initial experience with embolization of a splenic artery aneurysm in a woman in her 50s using the combination of large-diameter, hydrogel-coated detachable coils and a large-bore, high-flow microcatheter. The 20-mm diameter splenic artery aneurysm was packed densely with 10 hydrogel-coated coils, and the volume embolization ratio after full hydrogel expansion was 50.7%, a strikingly high value. Excellent occlusion was achieved with a small number of hydrogel-coated coils, which yield high volumes. This procedure can reduce the need for retreatment.

Key words: Hydrogel-coated coil, Splenic artery aneurysm, Coil embolization, Azur35

(Interventional Radiology ; 4: 43-47)

Introduction

Endovascular treatment of visceral artery aneurysms is associated with good outcomes and has increasingly become a first-line treatment option [1-6]. Coil packing is an efficient approach for treatment of saccular aneurysms, although a high number of coils are needed for large aneurysms, which can lead to medical issues and increased cost. Hydrogel-coated coils increase in volume as the hydrogel expands after coil placement; therefore, fewer hydrogel-coated coils can be used for packing large aneurysms.

The Azur[®] and Azur CX[®] are hydrogel-coated coils in the Azur[®] series (Terumo, Tokyo, Japan), with each available in diameters of 0.018 and 0.035 inches. In the Azur series, the Azur35 has the largest diameter, and has been available in Japan since 2018. Both the Azur[®] and Azur CX[®] fill gaps between the platinum core coils through expansion of the hydrogel. The Azur[®] is coated with a hydrogel on the outside of the platinum core coil, and the coil diameter increases with expansion of the hydrogel. In contrast, the Azur CX[®] has a hydrogel coating inside the platinum core coil. Since the hydrogel in the Azur CX[®] fills gaps in the pri-

mary coil, the coil diameter does not change after hydrogel expansion. Another distinction between the 2 hydrogel-coated coils is the shape of the secondary coil: the Azur[®] has a helical shape, while the Azur CX[®] has a complex 3-dimensional shape. These characteristics are shown in **Table 1**.

This report describes our initial experience with successful packing of a splenic artery aneurysm (SAA) using Azur series coils. We mainly used the 0.035-inch Azur CX35[®] and Azur35[®] coils. The choice of large-volume coils enabled use of fewer coils in this case.

Case Report

Ultrasonography as part of a routine medical checkup revealed a round pulsatile lesion with a diameter of 20 mm just above the pancreatic tail in a woman in her 50s with no relevant symptoms or medical history. Enhanced computed tomography (CT) revealed an SAA with a diameter of 20 mm (**Fig. 1**). Transcatheter therapy was chosen to treat the SAA. We planned intra-aneurysmal coil packing using hydrogel-coated detachable coils to achieve embolization with a smaller number of coils.

Received: September 12, 2018. Accepted: April 14, 2019.

doi: 10.22575/interventionalradiology.2018-0016

Correspondence Author: Akinori Harada, E-mail: harada_akinori@med.jrc.or.jp

Table 1. Characteristics of Azur® series hydrogel-coated coils

The lineup of Azur series

Coil lineup	hydrogel expansion	primary diameter(inch)		secondary diameter(mm)	length(cm)	loop shape
		bare platinum coil	after expansion			
AzurCX18	inside of coil	0.0145~0.0150	0.0145~0.0150	4~20	13~40	complex
AzurCX35	inside of coil	0.0290	0.0290	4~20	7~39	complex
Azur18	outside of coil	0.0145	0.0320	2~20	5~30	helical
Azur35	outside of coil	0.0310	0.0480	3~20	2~30	helical

Figure 1. Enhanced computed tomography showing a 20-mm diameter, splenic artery aneurysm (arrowhead). **Figure 2. Celiac arteriography showing a large, saccular splenic artery aneurysm (arrowhead).**

Embolization

Two shepherd's hook-type 4.5-F guiding sheaths (Parent Plus 45, SHC; Medikit, Tokyo, Japan) were inserted sequentially into the bilateral femoral arteries and placed in the celiac artery. One guiding sheath was used for coiling, and the other sheath was used to advance a balloon catheter to preserve the splenic artery trunk. The presence of the SAA with a diameter of 20 mm was confirmed with celiac arteriography (**Fig. 2**). A 2.0-F microcatheter (Sniper2-μ7; Terumo Clinical Supply, Gifu, Japan) was advanced to the peripheral side of the splenic artery using a 0.014-inch guidewire (Cruise; Asahi Intecc, Aichi, Japan). The microcatheter was exchanged for a 4 mm × 40 mm percutaneous transluminal angioplasty balloon catheter (Sterling; Boston Scientific Japan, Tokyo, Japan). Through another sheath, a 3.4-F high-flow microcatheter (Tactics; Technocrat Corporation, Aichi, Japan) was indwelled in the aneurysm using a 0.025-inch guidewire (Radifocus; Terumo) (**Fig. 3**), and coil packing was performed. The balloon catheter was inflated during coil embolization to prevent coil protrusion. The SAA was packed with a total of 10 hydrogel-coated detachable coils. Two 20 mm × 39 cm Azur CX35® coils were initially placed for framing. Then, 4 Azur35® coils (12 mm × 30 cm and 6 mm × 20 cm, 2 each) were placed into the

aneurysm for filling. Finally, 4 Azur18® coils (6 mm × 20 cm, all) were used for filling and finishing. Postembolization arteriography confirmed successful occlusion of the SAA as well as patency of the splenic artery (**Fig. 4, 5**). No complications such as organ ischemia or pancreatitis occurred after the procedure. The patient has been followed as an outpatient, and ultrasound examination at 4 months after the procedure showed no blood flow into the aneurysm.

Volume embolization ratio

Aneurysm volume was calculated as a prolate spheroid: ($V = 4/3\pi \times a \times b \times c$), where a, b, and c were half the greatest diameter of the aneurysm in 3 perpendicular directions measured with contrast-enhanced CT. Coil volume was calculated as a cylinder: ($V = 2r \times \pi \times l$), where r was half the outer diameter of the coil and l was the length of the coil. The total volume of all coils was also calculated. The volume embolization ratio (VER) was calculated as follows:

$$\text{VER (\%)} = (\text{volume of coils} / \text{volume of aneurysm}) \times 100.$$

In the current patient, the SAA measured 20.0 × 19.0 × 19.0 mm, with a volume of 3,780.4 mm³. Therefore, the

Figure 3. Angiography with a high-flow microcatheter (Tactics®) placed inside the aneurysm (arrowhead).

VER was 23.9% for the platinum core coils alone and increased to 50.7% when the hydrogel polymer was fully expanded. In addition, the estimated VER was 27.3% if the hydrogel of only the first 4 coils (Azur CX35® and 2 Azur 35® coils) was fully expanded.

Discussion

To our knowledge, this is the first report of SAA embolization using packing with Azur35® coils in Japan. Placement of coils as densely as possible inside the aneurysm is essential to prevent recanalization and coil compaction in the embolized aneurysm and further increases in aneurysm size. Previous studies suggested that the rates of aneurysm re-rupture and recanalization might be lower with high-VER coil embolization [7]. A VER of $\geq 24\%$ should be the goal of endovascular embolization [6, 8]. However, it is difficult

Figure 4. A: Lateral view of splenic artery aneurysm during coil packing demonstrates the relationship between the aneurysmal neck and parent artery, with temporary occlusion using a percutaneous transluminal angioplasty balloon (arrowhead). B: Lateral view of celiac arteriography during coil packing shows patency of the splenic artery trunk (arrowhead).

Figure 5. A: A total of 10 coils are densely packed in the splenic artery aneurysm (arrowhead). B: Celiac arteriography after coil packing shows disappearance of contrast medium flow into the aneurysm (arrowhead) and patency of the splenic artery trunk.

to obtain a high VER in large-diameter or wide-necked aneurysms.

The Azur35[®] is considered especially useful for large aneurysms. This is a detachable, 0.031-inch, platinum core coil covered with hydrogel, that can expand to 0.048 inches within approximately 20 min after contact of the hydrogel polymer with blood, providing approximately 4 times more filling volume compared with conventional, bare platinum, 0.035-inch coils [9, 10]. Therefore, vessel occlusion with the Azur[®] series occurs through a volume- and space-occupying effect, not a thrombotic effect, which is more often observed with fibered coils [11, 12]. In the Azur[®] series, the Azur35[®] achieves the largest volume, and the high embolic effect reduces the number of coils used. In the current patient, about 40 20-cm-long, 0.018-inch coils would be required to achieve a VER of 24%; this could not only lead to medical issues and increased cost but also increased procedure time and radiation exposure.

In the current case, we used Azur CX35[®] coils with the same diameter as that of the aneurysm for initial framing for several reasons. First, the Azur CX35[®] loop has a complex 3-dimensional shape that is suitable for framing. Second, since the outer diameter does not change after hydrogel expansion, contact with the vessel wall does not increase the pressure in the aneurysm. Following framing with the Azur CX35[®], we used the Azur35[®] to further increase coil volume. Since the hydrogel of the Azur35[®] expands on the outside of the coil, the smallest secondary coil diameter of 12 mm was selected among the longest length of 30 cm, to avoid overpressure in the aneurysm through hydrogel expansion. Next, the smallest secondary coil diameter of 6 mm was also chosen among the second longest 20 cm long coils. As the last coil, we selected the Azur18[®] with a length of 20 cm; this coil is much softer than a 0.035-inch coil, enabling easy placement in the aneurysm. Among the soft, 0.018-inch coils, we aimed at using a more voluminous coil. An approximate VER of 24% using platinum core coils alone was set as the goal of embolization. Toward the end, the catheter tip nearly slipped out from the aneurysm due to kickback, so we finished the procedure at that time.

Delivery of 0.035-inch coils for aneurysm packing requires a large-bore, 4.0-F diagnostic or comparable catheter.

In the current case, the delivery catheter was easily and atraumatically introduced into the aneurysm using a Tactics[®] flexible high-flow microcatheter, with a 0.035-inch inner lumen. An inner catheter as large as 2.5 F can be inserted into the lumen of the Tactics[®] microcatheter.

However, careful attention is required during coil packing, even with the combination of 0.035-inch coils and a Tactics[®] microcatheter, because the use of large and stiff coils can cause early catheter kick-back and may increase the risk of aneurysm rupture during the procedure. In addition, the 0.035-inch coil has no alignment marker, making identification of the detachment point challenging. Since the Tactics[®] is a one-marker microcatheter, inserting an inner catheter with 2 markers into a Tactics[®] microcatheter when using a

0.018-inch coil might be considered as a safer coil packing approach.

There are several disadvantages associated with hydrogel-coated coils, especially the Azur35[®] and Azur18[®], in which the hydrogel expands outward. First, the repositioning time during coil indwelling is limited to 3 min [10]. Otherwise, the expansion of the hydrogel may cause the coil to stick in the catheter or become unremovable. In cases where a Tactics[®] microcatheter is used in combination with the Azur35[®], the repositioning time may be further shortened, because the Tactics[®] microcatheter has a little smaller inner lumen than the common 4.0-F diagnostic catheter. Second, the hydrogel may not fully expand at the point where the coils overlap or where they come in contact with the vessel wall. Therefore, the volume of the coil after expansion of the hydrogel is only an estimate. Finally, if the coil unravels, the hydrogel might be damaged and become fragmented, and the pieces of the fragmented hydrogel pose a risk of distal migration.

Conclusion

We have reported our initial experience with the Azur35[®] coil, which can achieve maximum volume and improvement in the filling rate with no dependence on thrombus formation. Use of the Azur35[®] enables embolization with fewer coils, shortens the procedure time, reduces radiation exposure, and reduces medical expenses. Development of a Tactics[®] microcatheter with 2 markers and a 0.035-inch coil with an alignment marker should lead to technically easier procedures.

Conflict of interest: The authors have no conflicts of interest to report.

References

1. Etezadi V, Gandhi RT, Benenati JF, Rochon P, Gordon M, Benenati MJ, et al. Endovascular treatment of visceral and renal artery aneurysms. *J Vasc Interv Radiol* 2011; 22: 1246-1253.
2. Sessa C, Tinelli G, Porcu P, Aubert A, Thony F, Magne JL. Treatment of visceral artery aneurysms: description of a retrospective series of 42 aneurysms in 34 patients. *Ann Vasc Surg* 2004; 18: 695-703.
3. Ikeda O, Tamura Y, Nakasone Y, Iryou Y, Yamashita Y. Nonoperative management of unruptured visceral artery aneurysms: Treatment by transcatheter coil embolization. *J Vasc Surg* 2008; 47: 1212-1219.
4. Patel A, Weintraub JL, Nowakowski FS, Kim E, Fischman AM, Ellozy SH, et al. Single-center experience with elective transcatheter coil embolization of splenic artery aneurysms: technique and midterm follow-up. *J Vasc Interv Radiol* 2012; 23: 893-899.
5. Yamamoto S, Hirota S, Maeda H, Achiwa S, Arai K, Kobayashi K, et al. Transcatheter coil embolization of splenic artery aneurysm. *Cardiovasc Intervent Radiol* 2008; 31: 527-534.
6. Yasumoto T, Osuga K, Yamamoto H, Ono Y, Masada M, Mikami K, et al. Long-term outcomes of coil packing for visceral aneurysms: correlation between packing density and incidence of coil compaction or recanalization. *J Vasc Interv Radiol* 2013; 24:

- 1798-1807.
7. Uchiyama N, Kida S, Nomura M, Hasegawa M, Yamashita T, Yamashita J, et al. Significance of volume embolization ratio as a predictor of recanalization on endovascular treatment of cerebral aneurysms treated with Guglielmi detachable coils. *Intervent Neuroradiol* 2000; 6 Suppl 1: 59-63.
 8. Tamatani S, Ito Y, Abe H, Koike T, Takeuchi S, Tanaka R. Evaluation of the stability of aneurysms after embolization using detachable coils: Correlation between stability of aneurysms and embolized volume of aneurysms. *Am J Neuroradiol* 2002; 23: 762-767.
 9. Ginat DT, Saad W, Kitanono T. Balloon-occluded retrograde transvenous obliteration of a gastroduodenal shunt using hydrogel-coated coil embolization. *Radiology Case Rep* 2009; 4: 1-4.
 10. Osuga K, Kishimoto K, Tanaka K, Nakamura M, Ono Y, Maeda N, et al. Initial experience with use of hydrogel microcoils in embolization of pulmonary arteriovenous malformations. *Springer Plus* 2014; 3: 609.
 11. Ferral H. Hydrogel-coated coils: product description and clinical applications. *Semin Intervent Radiol* 2015; 32: 343-348.
 12. Fohlen A, Namur J, Ghegediban H, Laurent A, Wassef M, Pelage JP. Peripheral embolization using hydrogel-coated coils versus fibered coils: short-term results in an animal model. *Cardiovasc Intervent Radiol* 2018; 41: 305-312.

Interventional Radiology is an Open Access journal distributed under the Creative Commons Attribution-NonCommercial 4.0 International License. To view the details of this license, please visit (<https://creativecommons.org/licenses/by-nc/4.0/>).