Case Report

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Giant High-Flow Type Pulmonary Arteriovenous Malformation: Coil Embolization with Flow Control by Balloon Occlusion and an Anchored Detachable Coil

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Pulmonary arteriovenous malformations (PAVMs) are often treated by pushable fibered or non-fibered microcoils, using an anchor or scaffold technique or with an Amplatzer plug through a guiding sheath. When performing percutaneous transcatheter microcoil embolization, there is a risk of coil migration, particularly with high-flow type PAVMs. The authors report on a unique treatment in a patient with a giant high-flow PAVM whose nidus had a maximum diameter of 6 cm. A detachable coil, not detached from a delivery wire (an anchored detachable coil), was first placed in the feeding artery under flow control by balloon occlusion, and then multiple microcoils were packed proximally to the anchored detachable coil. After confirming the stability of the microcoils during a gradual deflation of the balloon, we finally released the first detachable coil. The nidus was reduced in size to 15 mm at one year postoperatively.

Index terms: *Pulmonary arteriovenous malformation; High-flow type; Embolization; Balloon occlusion; Detachable coil*

INTRODUCTION

A pulmonary arteriovenous malformation (PAVM) is a congenital abnormality, whereby pulmonary arteries and veins directly communicate with each other, resulting in right-to-left shunting and reduced arterial oxygen saturation. PAVMs cause symptoms such as general fatigue, dyspnea, or cyanosis. If left untreated, a PAVM often manifests as hemoptysis, a transient ischemic attack, cerebral infarction, or brain abscess and life-threatening conditions (1-3). Although PAVMs used to be surgically treated, they are now often treated by pushable fibered or non-fibered microcoils, using an anchor or scaffold technique or with an Amplatzer plug through a guiding sheath, even though the availability of these devices may vary among countries (4-6). When platinum microcoils are used as emboli, there is a risk of coil migration, particularly for high-flow type PAVMs. The authors report a patient with a giant high-flow type PAVM with a nidus measuring 6 cm (maximum diameter), and who was treated by transcatheter microcoil embolization using an anchored detachable coil under balloon-occluded flow control.

CASE REPORT

A 50-year-old man with a right-side homonymous hemianopsia and finger clubbing was referred to our

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hospital. He underwent gadolinium-enhanced MR imaging of the head and was suspected of having a brain abscess in the left optic radiation of the cerebrum. Furthermore, a mass shadow measuring 6 cm in size was noted in the right cardiophrenic angle by routine chest radiograph.

Contrast-enhanced CT of the thorax revealed a giant, complex-type PAVM with two feeding arteries and one draining vein, the nidus of which had a maximum diameter

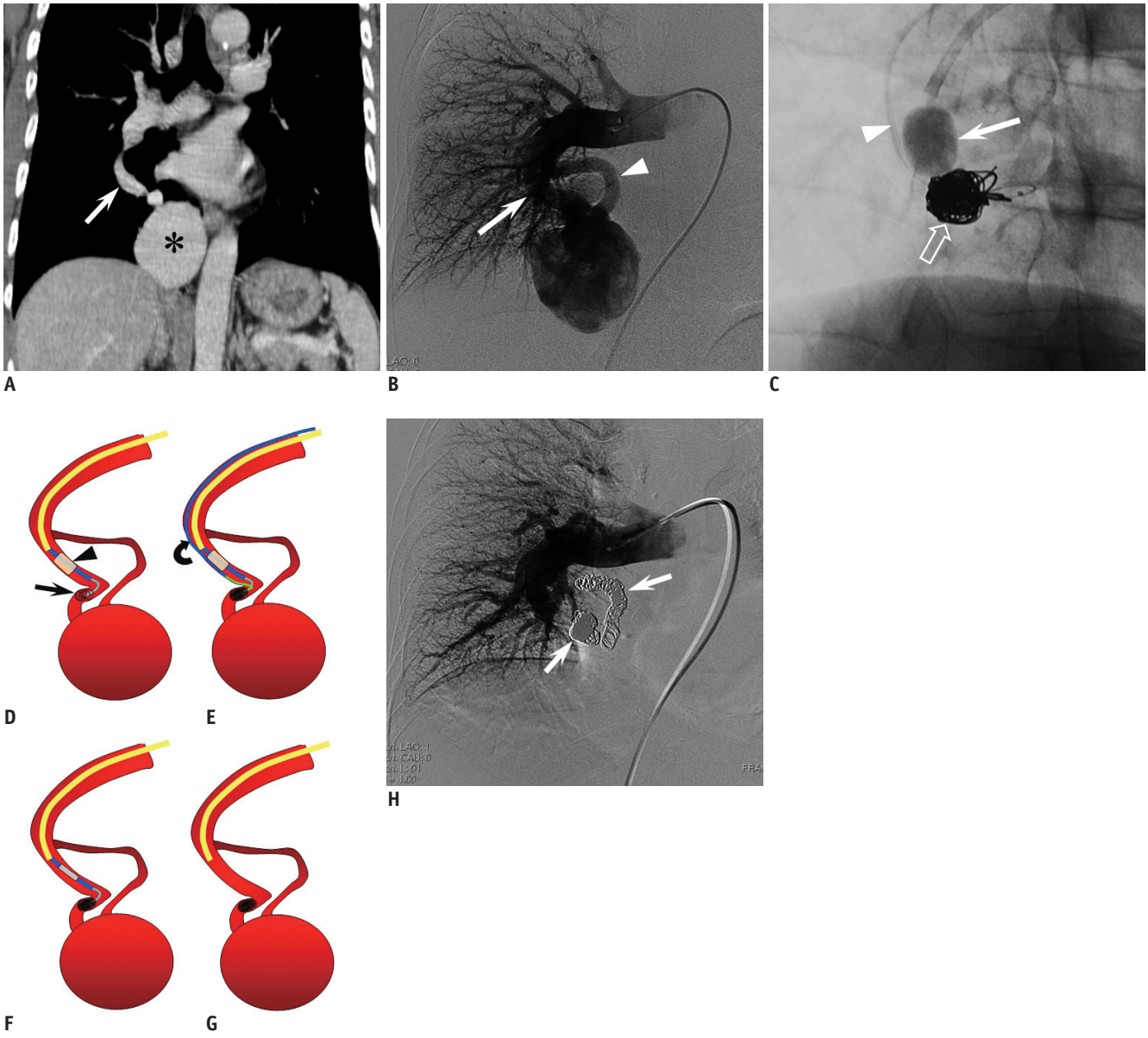

Fig. 1. 50-year-old man with giant, complex-type pulmonary arteriovenous malformation in right thorax.
A. Multiplanar reformatted coronal CT image showing high-flow type giant pulmonary arteriovenous malformation with two feeding arteries. One measured 10.5 mm in maximum diameter (arrow) and originated from lateral basal segment branch of right pulmonary artery (A9), while other measured 9.5 mm and originated from posterior basal segment branch (A10). Note giant nidus (asterisk), which measured 6 cm in maximum diameter in right cardiophrenic angle. **B.** Right pulmonary arteriogram shows entire structure of giant pulmonary arteriovenous malformation. One feeding artery originated from lateral basal segment branch of right pulmonary artery (A9) (arrow) and another from posterior basal segment branch (A10) (arrowhead). **C.** Fluoroscopic image of inflated balloon (arrow), second microcatheter (arrowhead) advanced beyond balloon, and multiple platinum microcoils (open arrow) to embolize feeding artery from lateral basal segment branch of right pulmonary artery (A9). **D-G.** Schemes showing microcoil embolization procedure. First anchored detachable coil (arrow in **D**) was placed under flow control achieved using balloon (arrowhead in **D**) without detaching it from delivery wire; multiple microcoils were packed proximally adjacent to first anchored detachable coil using other types of multi-purpose and coaxial catheters (curved arrow in **E**) by passing balloon. Balloon was then carefully deflated, confirming that no coil migration occurred (**F**), and finally first anchored detachable coil was detached from delivery wire (**G**). **H.** Right pulmonary arteriogram obtained after coil embolization. Note multiple platinum microcoils (arrows) in A9 and A10 feeders. Feeding arteries, nidus, and drainage vein are not visualized. At one year postoperatively, diameter of nidus was reduced to 15 mm.

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measuring 6 cm. One feeding artery originated from the lateral basal segment branch of the right pulmonary artery (A9), while the other originated from the posterior basal segment branch (A10). Axial and multiplanar reformatted CT images revealed maximum diameters of the A9 and A10 feeding arteries to be 10.5 and 9.2 mm, respectively (Fig. 1A). A thick drainage vein, with a maximum diameter measuring 18 mm, was found to originate from the lateral portion of the nidus, run posteriorly and superiorly, and to drain into the left atrium.

The patient provided informed consent, and the treatment was performed in accordance with the principles of the Declaration of Helsinki (7). We confirmed the giant PAVM by right pulmonary arteriography (Fig. 1B) performed through a 6-Fr guiding catheter (Mach1 Peripheral Guide Catheter; Boston Scientific, Natick, MA) placed in the right pulmonary artery using the right femoral venous approach. Configurations of the PAVM and the diameters of feeding arteries, the nidus, and the draining vein corresponded to those previously evaluated on CT images.

After inserting a 4.2-Fr multi-purpose catheter (Selecon PA Catheter, Terumo Clinical Supply Co., Ltd., Gifu, Japan) through the guiding catheter, we first attempted to place a detachable coil (0.018 inch, 14-mm diameter, 30-cm length) (Standard Detach-18; Cook Medical Inc., Bloomington, IN) in the A9 feeder as a coil anchor, using a 2.5-Fr coaxial microcatheter (Renegade-18 Microcatheter; Boston Scientific, Natick, MA) advanced through the 4.2-Fr multi-purpose catheter. However, the coil swam vigorously in the stream of the high-flow A9 feeder, and could not be secured. Consequently, we replaced the 4.2-Fr multi-purpose catheter with a 5.2-Fr catheter and a 9-mm balloon (Selecon MP Catheter II; Terumo Clinical Supply Co., Ltd., Gifu, Japan) into the A9 feeder through the guiding catheter, occluded the proximal portion of the A9 feeder, and then the 2.5-Fr coaxial microcatheter was advanced through the balloon catheter. The first detachable coil was then successfully placed in the A9 feeder under the flow control. Because we were apprehensive that the first coil might migrate into the nidus due to the high flow, which was reestablished after balloon deflation, we did not detach the first coil from the delivery wire at that time. Rather, we further introduced another 2.5-Fr coaxial microcatheter through another 4.2-Fr multi-purpose catheter (also using the right femoral venous approach) 1 cm distally to the first puncture site. We then carefully advanced the second microcatheter just proximally to the first anchored coil by carefully passing by the slightly deflated balloon. After re-inflating the balloon to prevent flow, we packed three more detachable coils (0.018 inch, 12-mm diameter, 30-cm length) (Standard Detach-18) in the A9 feeder just proximally to the first anchored coil, which had not been detached at this time. To ensure tight impaction of embolization coils in the A9 feeder, we placed a total of 6 platinum microcoils (0.018 inch, 4- to 8-mm diameter, 14-cm length) (Nester; Cook Medical Inc., Bloomington, IN) via the second microcatheter (Fig. 1C).

After confirming that the coils were stable enough in the A9 feeder during a trial gradual deflation of the balloon, we finally released the first detachable coil from its delivery wire. This first anchored coil was readily detached by rotating the delivery wire counterclockwise for 15 full turns. The delivery wire was then withdrawn without feeling any resistance or tangling with the other coils under fluoroscopic observation. Schemes showing microcoil embolization procedure are shown in Figures (Fig. 1D-G).

Similarly, by using a balloon catheter and an anchored detachable coil, the A10 feeder was also embolized with six detachable coils (0.018 inch, 5- to 12-mm diameter, 12- to 30-cm length) (Standard Detach-18) and 5 platinum coils (0.018 inch, 5- to 6-mm diameter, 5- to 14-cm length) (Nester; Cook Medical Inc.). Right pulmonary arteriography after embolization did not visualize the feeding arteries, nidus, or the drainage vein (Fig. 1H).

The circulatory shunt rate by lung perfusion scintigraphy improved from 33% to 17% immediately after embolization therapy. Arterial oxygen saturation tests improved from 86% before treatment to 98% immediately after treatment and in one year after embolization therapy. The diameter of the nidus was found to have decreased to 15 mm by a follow-up CT conducted at one year postoperatively.

DISCUSSION

Treatments such as surgical resection and transcatheter embolization are often performed for PAVMs when thoracic symptoms like hypoxemia, hemoptysis, or neurological complications such as an infarction, abscess, or transient ischemic attack are present. PAVMs with feeding arteries measuring > 3 mm in diameter are often treated to prevent neurological complications (8). Our patient presented with hypoxemia and a cerebral abscess and as a result, treatment was considered to be necessary. As the PAVM was a high-flow type with multiple thick feeders and a fairly large

nidus, we considered that flow control with a balloon catheter was indispensable when performing microcoil embolization.

Mori et al. (9) reported PAVMs in five patients that were successfully embolized using metallic coils under flow control using a balloon catheter. They first deployed metallic coil anchors in feeding arteries and tangled platinum microcoils among them. We did not use coil anchors in our case because we were unsure of their safety in feeding arteries branching from pulmonary arteries at the time of treatment planning.

The most unique aspects of the procedures adopted in the described case were: the placement of the first detachable coil under flow control without releasing it from the delivery wire, the packing of multiple microcoils just proximally to the first coil as an anchor using another catheter, and the subsequent detachment of the first detachable coil from the delivery wire. We believe that these multi-step processes with the aid of balloon occlusion and an anchored detachable coil, prevented coil migration and ensured patient safety.

The first detachable coil was eventually detached and the delivery wire was withdrawn readily and safely. However, had we used an interlocking detachable coil as the anchor, the delivery wire might have become entangled in the microcoils, and placed proximally to the anchored coil when retrieving the delivery wire because of the hook-like configuration of the interlocking portion. Thus, the use of an interlocking detachable coil would be contraindicated when using as an anchored coil. Furthermore, although PAVMs are now often treated with an Amplatzer plug through a guiding sheath, this device has not been available in our country.

In summary, we propose that platinum microcoil embolization with an anchored detachable coil and balloon-occluded flow control is a reasonable treatment option in patients with a giant high-flow type PAVM with multiple, thick feeding arteries.

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