Cardiovasc Intervent Radiol
DOI 10.1007/s00270-013-0755-3

TECHNICAL NOTE

Transcardiac Retrograde Transvenous Embolization of Proximally Occluded Pulmonary Arteriovenous Malformation

Masaki Komiyama · Tomoya Ishiguro · Ryoko Umaba · Tsugutoshi Suzuki

Received: 9 August 2013 / Accepted: 31 August 2013

Abstract

Purpose To report a novel transcardiac retrograde transvenous coil embolization of inadequately proximally occluded pulmonary arteriovenous malformation (AVM).

Methods Pulmonary AVM in the right A4 segment in an 8-year-old boy with hereditary hemorrhagic telangiectasia was initially treated by proximal occlusion of the feeding artery with coils. 6 years later, recurrent AVM caused dyspnea on exertion. The A4 AVM was reperfused by many collaterals from local pulmonary arteries. Via the Brockenbrough procedure, an 8F-long sheath was introduced from right atrium to left atrium. A 7F balloon catheter was then coaxially introduced into right middle pulmonary vein. Then a microcatheter was introduced retrogradely from pulmonary vein to pulmonary artery through the recurrent AVM.

Results The venous sac and the distal arterial segment of the A4 AVM were successfully embolized with detachable coils. The A4 AVM was completely occluded. No adverse effects were observed, and dyspnea on exertion disappeared.

Conclusion This novel transcardiac retrograde transvenous embolization is useful for inadequately treated pulmonary AVM with proximal feeding artery occlusion.

Keywords Brockenbrough method · Coil embolization · Pulmonary arteriovenous malformation · Pulmonary vein · Transseptal approach

M. Komiyama (✉) · T. Ishiguro · R. Umaba
Department of Neuro-Intervention, Osaka City General Hospital, 2-13-22, Miyakojima-Hondori, Miyakojima, Osaka City, Osaka 534-0021, Japan
e-mail: komiyama@japan-mail.com

T. Ishiguro
e-mail: t-guro@tcct.zaq.ne.jp

R. Umaba
e-mail: so_osv@yahoo.co.jp

T. Suzuki
Department of Pediatric Electrophysiology, Osaka City General Hospital, Osaka, Japan
e-mail: tsugutoshi@me.com

Introduction

Pulmonary arteriovenous malformations (AVMs) with feeding artery diameter of 3 mm or greater are currently treated by transarterial coil embolization [1–4]. Occlusion of the feeding artery too proximally may result in recurrence of the AVM.

We report a novel interventional procedure using a classic Brockenbrough and Braunwald [5] procedure to occlude recurrent pulmonary AVM after inadequate treatment of proximal feeding artery occlusion.

Patient and Methods

Patient

This 8-year-old boy was a member of a known hereditary hemorrhagic telangiectasia family. Lung computed tomography (CT) revealed bilateral multiple pulmonary AVMs. Because the right A4 lesion was the largest, the A3 and A4 lesions were first embolized at the local university hospital (Fig. 1A). Coils (0.035-in.) were deployed about 15 mm proximally in the feeding arteries of both AVMs. At the end of the procedure, both AVMs were not

Published online: 23 October 2013

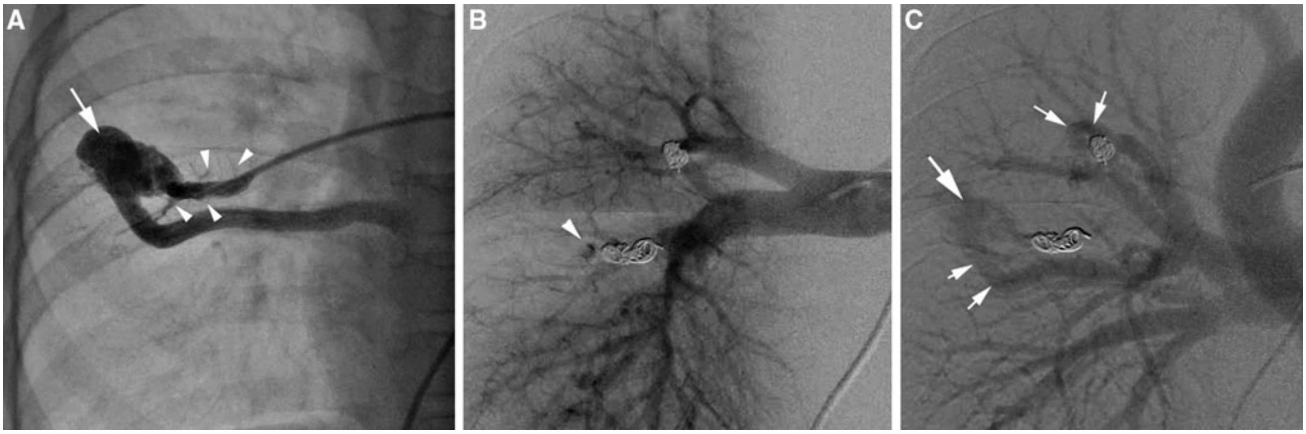

Fig. 1 **A** Selective angiography of right A4 AVM reveals the venous sac (*large arrow*) just distal to the fistulous point. Normal small arteries (*arrowheads*) are visualized at the distal segment of the feeding artery. These small arteries can be collaterals when the feeding artery is occluded proximally. **B**, **C** Control angiography (early arterial and late venous images, respectively) immediately after the first embolization reveals residual shunt flows (*small arrows*) from adjacent pulmonary arteries and through the deposited coils (*arrowhead*) in both A3 and A4 lesions. The venous sac (*large arrow*) is also shown

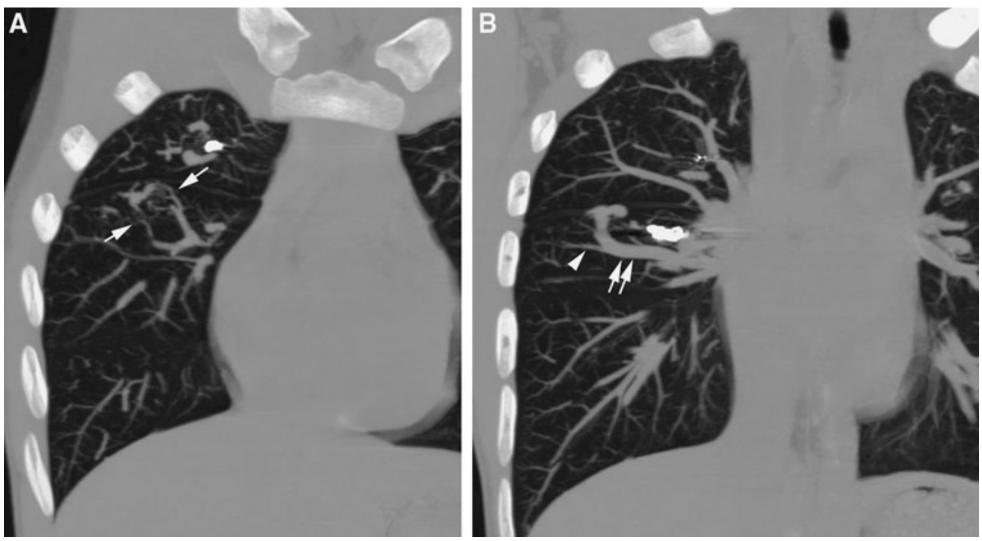

Fig. 2 **A**, **B** Reconstructed contrast-enhanced CT images 6 years later show occlusion of the feeding arteries at the deposited coils. Small collaterals (*arrows*) from surrounding pulmonary arteries perfuse the distal arterial segment and AVM. Draining vein (*double arrows*) receives shunted flow as well as flow from small normal pulmonary vein (*arrowhead*)

completely occluded (Fig. 1B, C). The remaining AVMs were occluded in our hospital. During the procedure, the largest right A4 lesion was probed with a microcatheter and a micro-guide wire to pierce coil mass distally, but this attempt failed as a result of the hardness of the coils. At the age of 14 years, the patient began to feel dyspnea on exertion. Lung CT revealed recurrence of right A3 and A4 lesions (Fig. 2). We planned to occlude A4 AVM from pulmonary venous route retrogradely. Because A3 AVM had a complex anatomical structure, it was impossible to use the retrograde catheter navigation safely. We concluded that this A3 lesion was not retreatable.

Novel Transcardiac Retrograde Procedure

Under general anesthesia, the patent foramen ovale was probed initially with a 7F balloon catheter (CI Catheter; Cathex, Tokyo, Japan). Because the foramen ovale was occluded, we decided to proceed to a transseptal procedure. The 7F catheter was navigated to right pulmonary artery for control angiography. Then an 8F Schwarz sheath system (St. Jude Medical, St. Paul, MN, USA) was brought to the right atrium, and the atrial septum was punctured with a sharp Brockenbrough needle (St. Jude Medical). Two septal punctures were required to navigate another 7F balloon catheter (CI Catheter) to the right middle

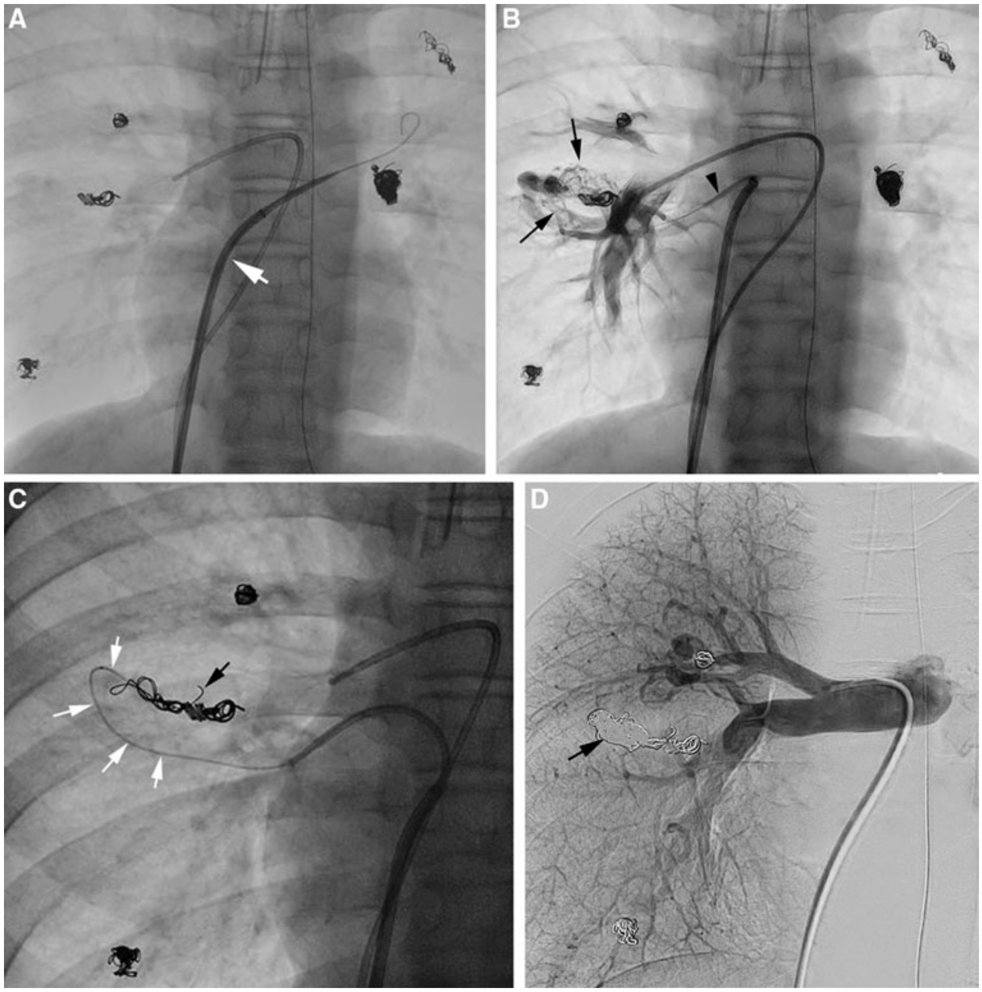

Fig. 3 **A** By Brockenbrough procedure, an 8F sheath (*arrow*) and inner catheter crosses the atrial septum to the left atrium. The looped tip of the guide wire is in the left upper pulmonary vein. **B** A 7F balloon catheter (*arrowhead,* balloon deflated) is introduced into the right middle pulmonary vein. Selective A4 angiography reveals fine collaterals (*arrows*) to the distal arterial segment. **C** An 18-type platinum coil is deployed at the distal arterial segment as well as proximal part of a venous sac through a microcatheter (*white arrows*), which is introduced from venous side to arterial side through the AVM. The tip of the first coil (*black arrow*) is embedded in the small collateral arterial anastomosis. **D** Postembolization angiography reveals complete disappearance of the A4 AVM. Most coils are deposited in the venous sac (*arrow*). The A3 AVM with complex angioarchitecture is left untreated

pulmonary vein. Intermittent inflation of the balloon (maximum dilatation diameter of 11 mm) facilitated navigation of the 7F balloon catheter from the left atrium to the right pulmonary veins (Fig. 3A, B).

A RapidTransit catheter (Codman Neurovascular, Raynham, MA, USA) and a 0.014-in. Transend floppy guide wire (Boston Scientific, Nitick, MA, USA) were introduced into the pulmonary vein (S4 segment), easily brought to the venous sac, and reached to the arterial side of the AVM. Because many small collaterals entered the distal segment of the A4 pulmonary artery, this arterial segment as well as a large venous sac were occluded with detachable platinum coils (0.018-inch type GDC coils; Boston Scientific) (Fig. 3C). The balloon of the 7F catheter was not inflated during coil embolization. The total number of deposited coils was 12. This resulted in complete disappearance of the A4 AVM (Fig. 3D). There were no adverse effects related to the procedure. Oxygen saturation improved from 93–94 % (before embolization) to 98–99 % (after embolization). The patient was free of dyspnea on exertion for a short follow-up period of 1 month.

Discussion

Proximal deposition of coils to the AVMs may result in collateral perfusion of the AVM, either from the surrounding pulmonary arteries or from the bronchial arteries [3, 4, 6]. When AVM recurs as a result of proximal occlusion of feeding artery, it is usually impossible to navigate the catheter beyond or through the deposited coil mass to the distal arterial segment and to add coils. In such situations, an alternative to occlude the AVM is coil embolization through the pulmonary vein in a retrograde fashion. This approach is probably only possible for pulmonary AVM with simple angioarchitecture. About 80 % of pulmonary AVMs have this simple structure [1].

To establish this novel approach, transseptal catheterization (Brockenbrough method) is required. By perforating the atrial septum with a standard transseptal needle, the catheter crosses the septum to the left atrium [5]. After the procedure, the perforated septum eventually closes without any adverse effects. Possible complications of this approach include arrhythmias and cardiac injury during the catheter manipulation. When cardiac procedures are performed by experienced cardiologists, these complications are minimal. To our knowledge, this transseptal approach has not been reported in the treatment of pulmonary AVMs.

In conclusion, in the treatment of pulmonary AVM, the appropriate deposition of coils to occlude the AVM is mandatory. When the feeding artery is occluded by proximally deployed coils and the AVM recurs by collateral perfusion, this novel transcardiac retrograde transvenous embolization enables occlusion of the AVM.

Conflict of interest The authors declare that they have no conflict of interest.

References

1. White RI, Mitchell SE, Barth KH et al (1983) Angioarchitecture of pulmonary arteriovenous malformations: an important consideration before embolotherapy. Am J Roentgenol 140:681–686
2. Dutton JAE, Jackson JE, Hughes JMB et al (1995) Pulmonary arteriovenous malformations: results of treatment with coil embolization in 53 patients. Am J Roentgenol 165:1119–1125
3. Mager JJ, Overtoom TTC, Blauw H et al (2004) Embolotherapy of pulmonary arteriovenous malformations: long-term results in 112 patients. J Vasc Interv Radiol 15:451–456
4. Pollak JS, Sanjay S, Thabet A et al (2006) Clinical and anatomic outcomes after embolotherapy of pulmonary arteriovenous malformations. J Vasc Interv Radiol 17:35–45
5. Brockenbrough EC, Braunwald E (1960) A new technique for left ventricular angiocardiography and transseptal left heart catheterization. Am J Cardiol 6:1062–1064
6. Sagara K, Miyazono N, Inoue H et al (1998) Recanalization after coil embolotherapy of pulmonary arteriovenous malformations: study of long-term outcome and mechanism for recanalization. Am J Roentgenol 170:727–730