Iatrogenic Pulmonary Artery Perforation

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Research Article

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Abstract

Background: Vascular plugs have been increasingly used for lower recanalization compared with coil embolization in pulmonary arteriovenous malformation (PAVM) embolization. To deliver the vascular plug close to the PAVM, a large-diameter delivery catheter should be advanced into the feeding pulmonary artery. However, the pulmonary artery has a complex branching pattern and the risk of injury increases when a larger catheter is used in negotiating the PAVM feeder.

Case Presentation: We describe a patient who developed pulmonary artery perforation during the selection of the distal feeding artery with a 5-Fr catheter in PAVM embolization. We immediately treated the PAVM and life-threatening complication by using a type IV vascular plug and coil embolization in a single session.

Conclusion: To prevent catheter-related complications during PAVM embolization, a smaller diameter delivery system should be used for small, tortuous feeding arteries, and use of a soft, tip-angled catheter for vascular plug delivery should be considered.

Background

Pulmonary arteriovenous malformations (PAVMs) are direct connections between the pulmonary artery and vein, and transcatheter embolization is the treatment of choice with high technical success (White et al., 1996). Pulmonary artery perforation associated with catheter manipulation during the procedure is rare but life-threatening (Chamarthy et al., 2018). With the use of new instruments reported to have lower recanalization rates, the incidence of cases where a large-diameter catheter is required to approach the feeding artery has been increasing compared with conventional microcoil embolization cases (Ratnani et al., 2019, Tau et al., 2016). Herein, we report the case of a patient who developed a hemothorax due to pulmonary artery perforation associated with 5-Fr catheter manipulation during PAVM embolization. In the same session, we effectively treated PAVM and its complications simultaneously.

Case Presentation

A 53-year-old female patient was referred to our hospital to undergo endovascular embolization for a single PAVM. On contrast-enhanced computed tomography (CT), a simple-type PAVM with a single 3-mm-diameter feeding artery was found in the right middle lobe (Fig. 1). Feeding artery embolization was planned using a type IV vascular plug (Amplatzer Vascular Plug [AVP] IV; AGA Medical, Plymouth, Minnesota). Angiography was performed by selecting the right lobar pulmonary artery using an 80-cm 6-Fr guiding catheter (Flexor Shuttle Guiding Sheath; Cook Medical, Bloomington, Indiana) and a 125-cm 5-Fr hydrophilic catheter (Impress Headhunter 1; Merit Medical, South Jordan, Utah). Similar to the CT finding, a simple PAVM arose at the medial segmental branch of the right middle lobar artery with a tortuous course (Fig. 2A). The juxta-sac-distal feeding artery was successfully selected using a 5-Fr hydrophilic catheter and 0.035-inch guide wire. However, after the guide wire was gently withdrawn, the tip of the 5-Fr catheter was restored to its original shape and the angled catheter tip perforated the adjacent pulmonary artery. Contrast extravasation was observed on the subsequent angiography (Fig. 2B). First, the prepared 7-mm AVP was deployed proximal to the perforation site; however, the residual shunt flow and extravasation persisted (Fig. 2C). Additional embolization was performed using 7- and 6-mm detachable coils (Concerto; Medtronic, Minneapolis, Minnesota). The completion angiography confirmed that the shunt flow and contrast leakage had disappeared (Fig. 2D). Three days later, CT revealed a right hemothorax with basal lung atelectasis (Fig. 3A). After 4 days, the right pleural effusion was slightly increased, and a 10.2-Fr percutaneous drainage catheter was inserted. On the 6-month follow-up CT, the PAVM was well occluded, and the venous sac and draining vein were markedly reduced, the right hemothorax was completely resolved, and no sequelae remained except for a mild subsegmental atelectasis (Fig. 3B, 3C).

Discussion

PAVM rupture during embolization is a rare and devastating complication, reported only in a few studies (Chamarthy et al., 2018, Prasad et al., 2004). Recently, new embolic materials, including AVPs and microvascular plugs (MVPs), have been increasingly used for PAVM embolization, showing lower recanalization rates than that in coil embolization alone (Ratnani et al., 2019, Tau et al., 2016). In addition, the embolization procedure is simple and enables single-device occlusion. However, the devices required larger delivery systems than those in microcoil embolization. For example, all type IV AVPs or ≥7-mm-sized MVPs require a 4- to 5-Fr diagnostic catheter for delivery. For a higher success rate in terms of recanalization, the embolic material-to-sac distance should be minimized (Milic et al., 2005). To achieve these conditions, the delivery catheter should be placed juxta-proximal to the venous sac. Vascular rupture risk increases during catheterization of small and tortuous feeding artery.

In this case, two possible causes of the PAVM perforation can be postulated. One was the angioarchitecture of the PAVM, where the feeding artery was small in diameter (3-mm) and had a tortuous course. As the feeding artery originated from the right middle lobe medial segmental pulmonary artery, it had a U-shaped proximal course and the distal feeding artery was tortuous. Another cause was the attempt to approach the distal feeding artery using an inappropriate angled 5-Fr catheter (headhunter type). After advancing the catheter to the right before the venous sac, the guide wire was gently removed. At that moment, the proximal angle of the headhunter catheter was restored to its original shape, and the angled catheter tip perforated the adjacent pulmonary artery.

To prevent significant complications during PAVM embolization, as in our case, several factors should be considered. First, a smaller diameter delivery system should be used especially for small and tortuous feeding arteries. Small-sized MVPs can be delivered using a microcatheter system. However, at that time, MVPs were not available in our country. Second, if a 4- or 5-Fr catheter is required in specific cases, use of a soft and tip-angled catheter, which is less stiff than multiangled catheters, should be considered. Finally, careful manipulation of the guide wire is important. Owing to the stiffness of a 0.035-in hydrophilic wire, it can cause perforations. We recommend using a triaxial system to access small and tortuous distal feeding arteries. For example, after distal feeding artery selection with a microcatheter system, a 5-Fr catheter can be inserted over the microcatheter and wire.

In the case of life-threatening hemothorax caused by spontaneous PAVM rupture, emergent embolotherapy is generally performed, with a high success rate (Ference et al., 1994). Similarly, when pulmonary artery perforation occurs, vascular plug and/or coil embolization should be performed proximal to the rupture site to preserve the branches to the adjacent normal parenchyma as much as possible. As the pulmonary artery perforation occurred just before the targeted distal feeding artery in our case, both the PAVM and its complications could be treated in the same session. A percutaneous drainage catheter, which was additionally inserted in the hemothorax, was also effective. All drainage should be performed after embolization, as evacuation of tamponaded blood before embolization may worsen bleeding (Khan et al., 2007). Thoracotomy may be performed to prevent fibrothorax or empyema depending on the response to the initial drainage (Khera et al., 2020).

Conclusion

We report a rare case of pulmonary artery perforation that caused a hemothorax associated with 5-Fr catheter manipulation during PAVM embolization. We treated both the PAVM and its complications appropriately with immediate embolization using AVP and coils. To avoid catheter-related complications during PAVM embolization, a smaller diameter delivery system should be used for small, tortuous feeding arteries, and use of a soft, tip-angled catheter for vascular plug delivery should be considered.

List Of Abbreviations

PAVM: Pulmonary arteriovenous malformation

CT: Computed tomography

AVP: Amplatzer vascular plug

MVP: Microvascular plug

Declarations

Ethics approval and consent to participate

For this type of study formal consent is not required. This study was approved by the Institutional Review Board of Kyungpook National University Hospital (IRB No. 2021-03-016).

Consent for publication

Written informed consent was obtained from the patient for publication of this case report and any accompanying images.

Availability of data and material

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

JH performed the chart review and was major contributors in writing the manuscript. SYL and JGC were main performers of the procedure. SYL and DK were major contributors in revision of the manuscript. SYL and JL were major contributor in mentoring the creation of this manuscript. All authors read and approved the final version of the manuscript.

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References

1. White RI, Jr., Pollak JS, Wirth JA (1996) Pulmonary arteriovenous malformations: diagnosis and transcatheter embolotherapy. J Vasc Interv Radiol 7(6):787-804. http://doi.org/10.1016/s1051-0443(96)70851-5.

2. Chamarthy MR, Park H, Sutphin P, Kumar G, Lamus D, Saboo S, Anderson M, Kalva SP (2018) Pulmonary arteriovenous malformations: endovascular therapy. Cardiovasc Diagn Ther 8(3):338-49. http://doi.org/10.21037/cdt.2017.12.08.

3. Ratnani R, Sutphin PD, Koshti V, Park H, Chamarthy M, Battaile J, Kalva SP (2019) Retrospective Comparison of Pulmonary Arteriovenous Malformation Embolization with the Polytetrafluoroethylene-Covered Nitinol Microvascular Plug, AMPLATZER Plug, and Coils in Patients with Hereditary Hemorrhagic Telangiectasia. J Vasc Interv Radiol 30(7):1089-97. http://doi.org/10.1016/j.jvir.2019.02.025.

4. Tau N, Atar E, Mei-Zahav M, Bachar GN, Dagan T, Birk E, Bruckheimer E (2016) Amplatzer Vascular Plugs Versus Coils for Embolization of Pulmonary Arteriovenous Malformations in Patients with Hereditary Hemorrhagic Telangiectasia. Cardiovasc Intervent Radiol 39(8):1110-4. http://doi.org/10.1007/s00270-016-1357-7.

5. Prasad V, Chan RP, Faughnan ME (2004) Embolotherapy of pulmonary arteriovenous malformations: efficacy of platinum versus stainless steel coils. J Vasc Interv Radiol 15(2 Pt 1):153-

60. http://doi.org/10.1097/01.rvi.0000106390.63463.05.

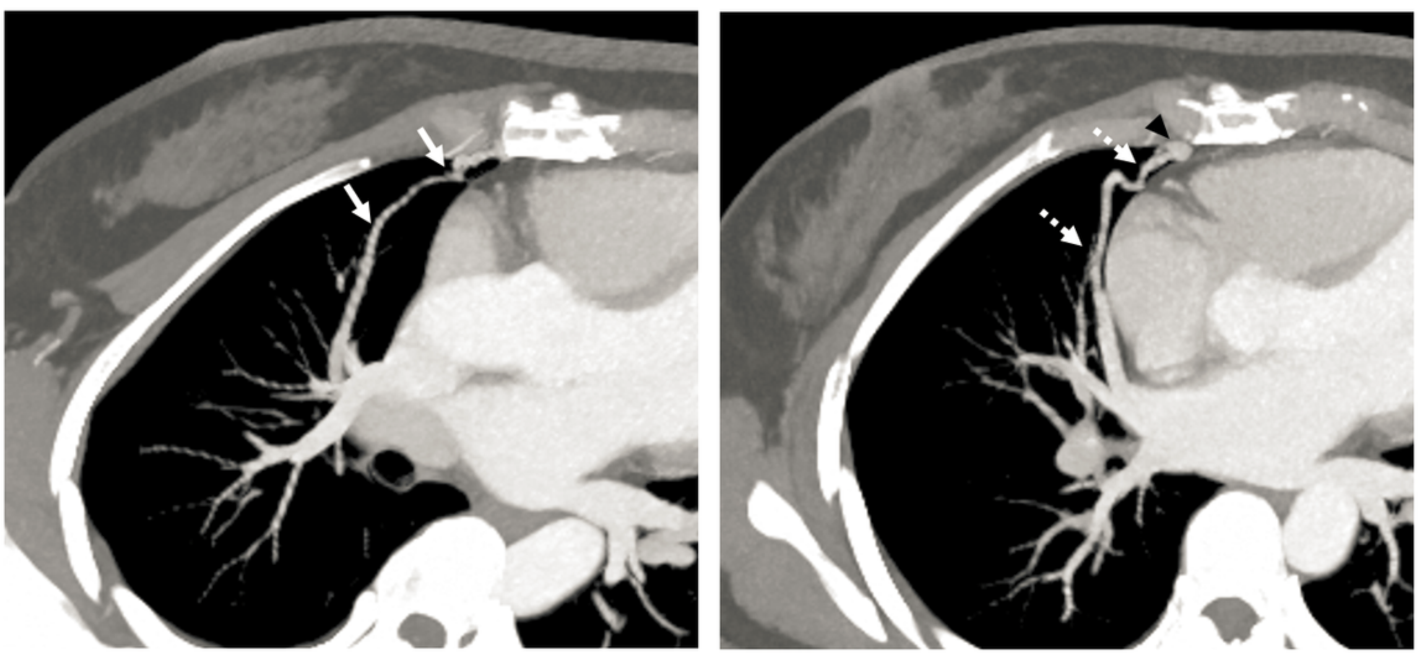
6. Milic A, Chan RP, Cohen JH, Faughnan ME (2005) Reperfusion of pulmonary arteriovenous malformations after embolotherapy. J Vasc Interv Radiol 16(12):1675-83. http://doi.org/10.1097/01.RVI.0000182163.25493.BB.

7. Ference BA, Shannon TM, White RI, Jr., Zawin M, Burdge CM (1994) Life-threatening pulmonary hemorrhage with pulmonary arteriovenous malformations and hereditary hemorrhagic telangiectasia. Chest 106(5):1387-90. http://doi.org/10.1378/chest.106.5.1387.

8. Khan AA, Hunt I, Hamdane K, Tambiah J, Deshpande RP, Reidy JF (2007) Massive pulmonary arteriovenous malformation presenting with tamponading haemothorax. Thorax 62(9):836. http://doi.org/10.1136/thx.2006.071852.

9. Khera PS, Chauhan N, Garg PK, Choudhary R, Deokar K, Niwas R (2020) Hemothorax secondary to ruptured pulmonary arteriovenous malformation: A combined stitch in time saves nine. Lung India 37(3):272-4. http://doi.org/10.4103/lungindia.lungindia_321_19.

Figures



(a) (b)

Figure 1

Preprocedural computed tomography images with maximum-intensity projection reconstruction (A, B), showing the angioarchitecture of the simple-type PAVM. The small-diameter feeding artery (arrows) with a tortuous course, venous sac (asterisk), and single draining vein (dashed arrows) are shown

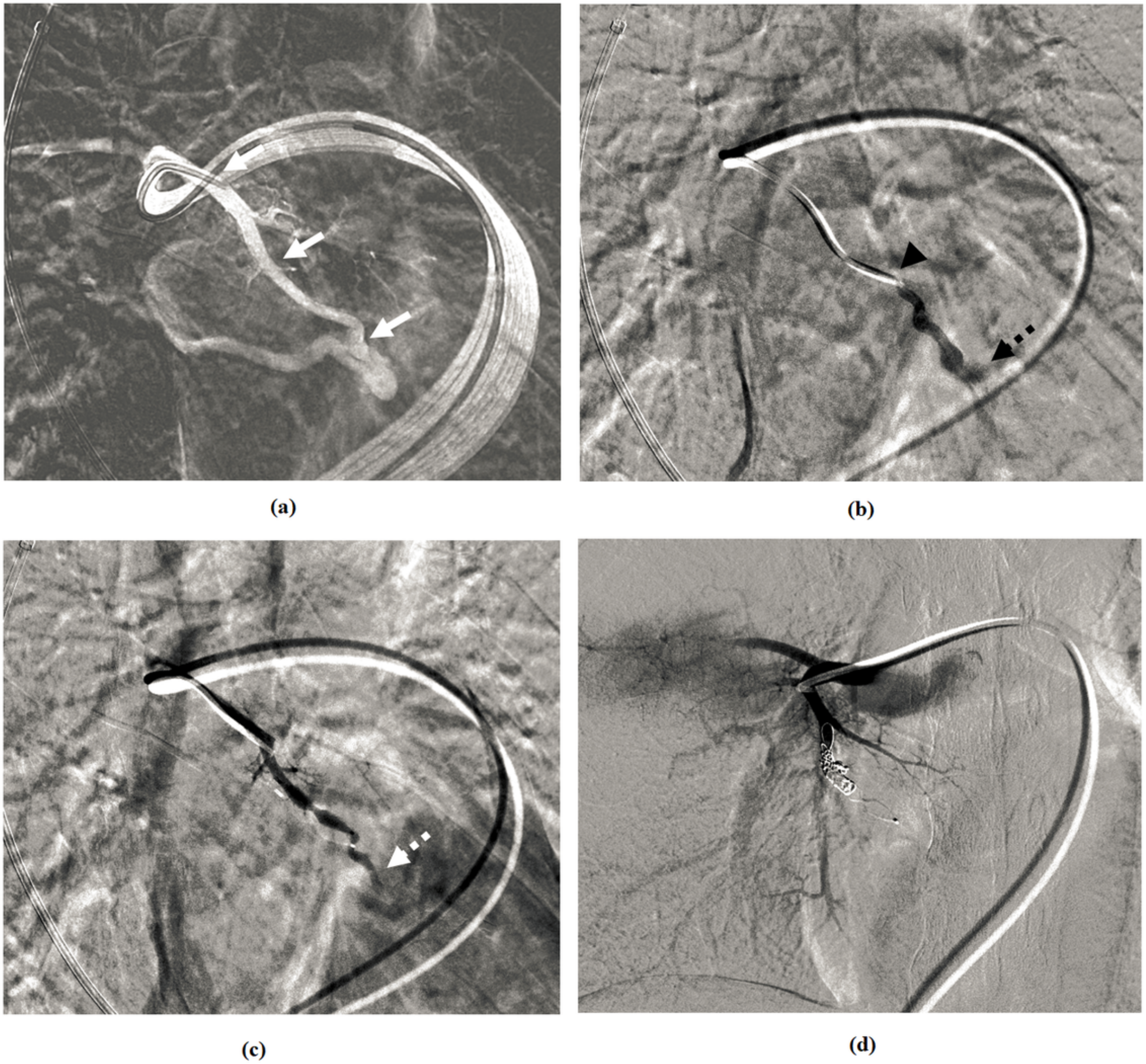


Figure 2

Pulmonary arteriovenous malformation (PAVM) embolization. A The roadmap image shows the angioarchitecture of the PAVM, with a small-diameter feeding artery (arrows) with a tortuous course, similar to the computed tomography finding. B The digital subtraction angiography (DSA) image shows the headhunter type 5-Fr catheter (arrowhead) that had access to the juxta-sac-feeding artery (not presented) was restored to its original shape after the 0.035-in guide wire was withdrawn, causing pulmonary artery perforation and contrast extravasation (dashed arrow). C The DSA image obtained after deployment of a 7-mm-sized type IV vascular plug shows residual shunt flow (dashed arrow) and contrast leakage. D The completion angiography image after the additional coil embolization confirms no residual bleeding or shunt flow

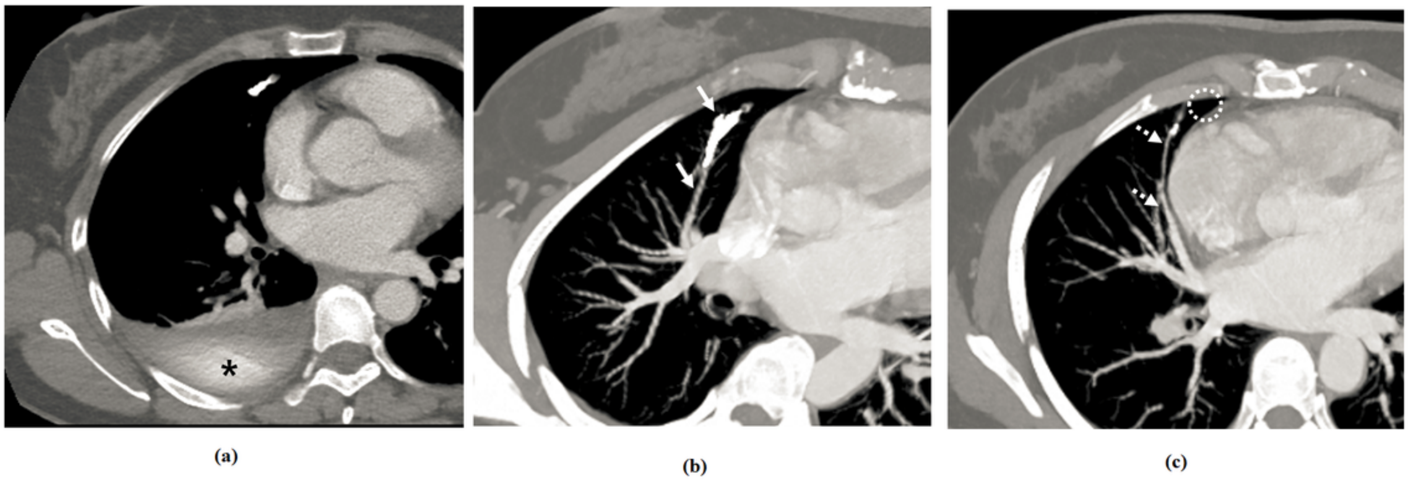


Figure 3

A Computed tomography (CT) image 3 days after embolization, showing right hemothorax and extravasated contrast medium (asterisk). B, C Four-month follow-up CT images with maximum-intensity projection reconstruction, showing resolution of all pleural effusions, occlusion of the feeding artery by the embolic devices (arrows), significant reduction of the draining vein diameter (dashed arrows), and almost complete disappearance of the venous sac (dashed circle)