Successful surgical resection of giant arteriovenous malformation in supraclavicular fossa

Kohei Horikawa, MD, Hiroyuki Nishi, MD, Naosumi Sekiya, MD, Mitsutomo Yamada, MD, *and* Toshiki Takahashi, MD, *Osaka, Japan*

ABSTRACT

A 42-year-old woman with a large congenital giant arteriovenous malformation in the left supraclavicular fossa underwent surgical resection. Although endovascular treatment was initially planned, it was impossible to occlude the multiple feeding arteries (transverse cervical, clavicular branch of left internal mammary, thoracoacromial, anterior/posterior circumflex humeral), and the anatomy was difficult. After removal of the left clavicle, the arteriovenous malformation was exposed. Care was taken to not injure the brachial plexus, and each feeding artery was ligated, followed by division of the drainage veins. The postoperative course was uneventful, and no sign of recurrence has been seen. (J Vasc Surg Cases and Innovative Techniques 2018;4:91-4.)

An arteriovenous malformation (AVM) is a vascular anomaly that shows a wide range of clinical presentations. AVMs are rarely seen around the subclavian artery, and most are traumatic or iatrogenic.[1] In addition, congenital AVMs around the subclavian artery are extremely rare; their treatment can be challenging, with a high risk associated with management, because of the presence of important structures, including the subclavian artery, veins, and nerve plexus. Although endovascular treatment is generally the first choice,[2] some patients require surgical resection when endovascular therapy is difficult to perform because of technical or anatomic reasons. Here, we report a case of a giant AVM in the supraclavicular fossa region that was successfully treated with surgical resection. Publication consent was obtained from the patient.

CASE REPORT

A 42-year-old woman was referred to our hospital because of an expanding pulsatile mass in the left supraclavicular fossa. The patient stated that the mass had gradually enlarged during several years. She had no history of trauma or other medical disorders, and there were no neurologic or ischemic symptoms. A physical examination revealed a mass measuring approximately 7 × 5 cm above the left clavicle with a palpable thrill and audible continuous bruit. Duplex ultrasound scanning confirmed an AVM in the left supraclavicular fossa; enhanced computed tomography (CT) revealed a huge vascular mass 5 cm in diameter (Fig 1, *a*). Arterial sources were the transverse cervical artery and subclavian branch of the left internal mammary artery, and three major drainage veins were seen on the distal side of the mass (Fig 1, *b*), although no direct communication between the mass and left subclavian artery was shown. Magnetic resonance imaging and angiography demonstrated a vascular mass compressing the brachial plexus (Fig 1, *c*).

We decided on selective occlusion of the feeding arteries with coils. Angiography showed four major feeding arteries: transverse cervical artery, clavicular branch of the left internal mammary artery, thoracoacromial artery, and anterior/posterior circumflex humeral artery (Fig 1, *d*). Although a coil was successfully placed to occlude the transverse cervical artery and clavicular branch of the left internal mammary artery, it was impossible to occlude the thoracoacromial and anterior/posterior circumflex humeral arteries because of difficult access. Therefore, the diameter of the mass could not be reduced. A final angiography examination demonstrated the remaining AVM, and its excision was planned 18 days after unsuccessful embolization.

Under general anesthesia, the patient was placed in a beach chair position to obtain an adequate view of the mass. The left clavicle was removed by an orthopedic surgeon to expose the AVM (Fig 2, *a*). We dissected around the AVM carefully so as not to damage the mass or surrounding tissues. We worked from distal on the subclavian artery segment toward the proximal exposure. The feeding arteries were detected and divided with ligation (Fig 2, *b*), which resulted in a decrease of pressure in the mass. An ultrasonic scalpel (Harmonic scalpel; Ethicon, Johnson & Johnson, Somerville, NJ) was used near the brachial plexus (Fig 2, *c*). Finally, the drainage veins were clamped, and we completely excised the AVM (Fig 2, *d* and *e*), after which the left clavicle was reconstructed with a plate by the orthopedic surgeon. The operation time was 249 minutes, and estimated blood loss was 180 mL.

The postoperative course was uneventful, and the patient did not complain of ischemic or neurologic symptoms. Histologic findings revealed dilation of venous tissue as well as of the

From the Department of Cardiovascular Surgery, Osaka Police Hospital.

Author conflict of interest: none.

Correspondence: Hiroyuki Nishi, MD, Department of Cardiovascular Surgery, Osaka Police Hospital, 10-31, Kitayama-cho, Tennoji-ku, Osaka 543-0035, Japan (e-mail: nishi24@jc4.so-net.ne.jp).

The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2468-4287

© 2018 The Author(s). Published by Elsevier Inc. on behalf of Society for Vascular Surgery. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

https://doi.org/10.1016/j.jvscit.2017.12.010

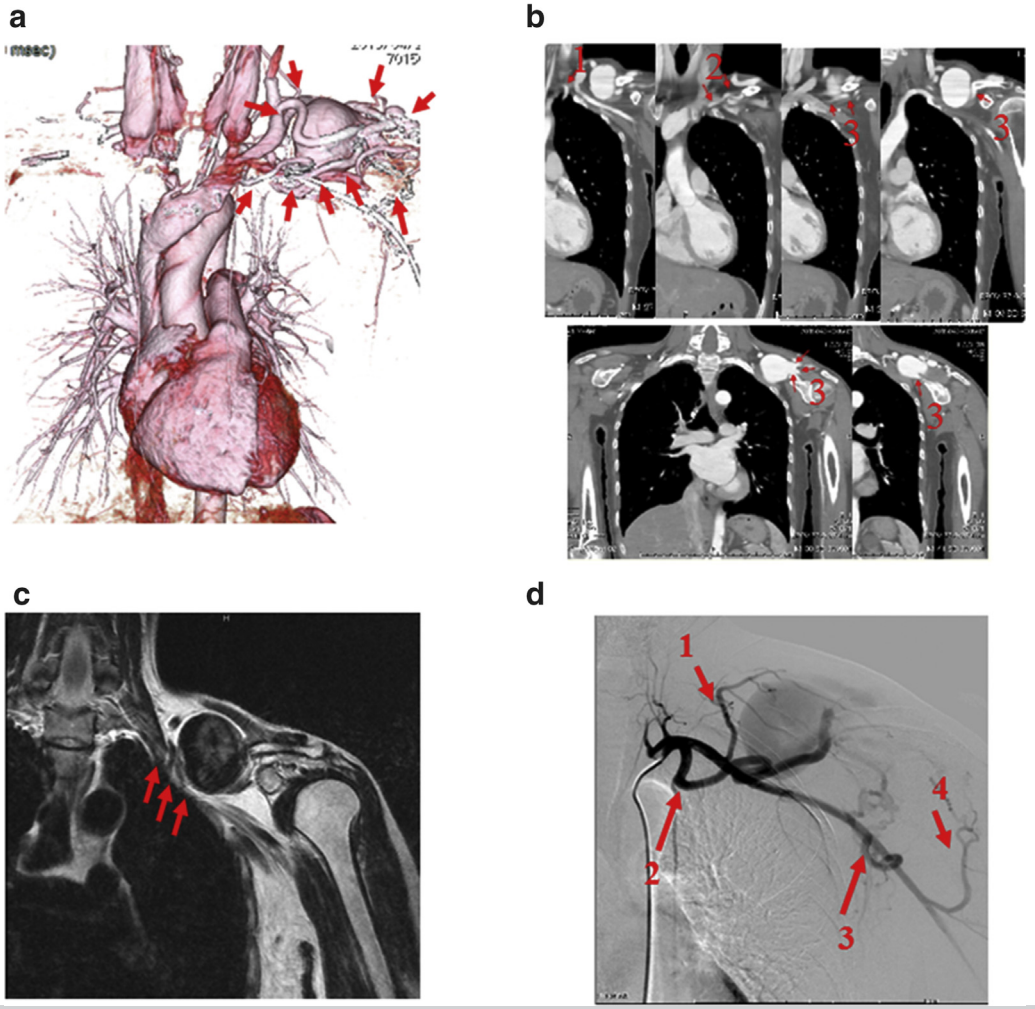

Fig 1. Preoperative computed tomography (CT) findings. **a,** Findings obtained with three-dimensional CT revealed feeding arteries and drainage veins around the mass. **b1,** Clavicular branch of left internal mammary artery. **b2,** Transverse cervical artery feeding the arteriovenous malformation (AVM). **b3,** At least three drainage veins were shown (*arrows*). **c,** Preoperative magnetic resonance imaging and angiography findings. An AVM is seen compressing the brachial plexus (*arrows*). **d,** Four major feeding arteries were shown: *1*, transverse cervical artery; *2*, clavicular branch of left internal mammary artery; *3*, thoracoacromial artery; and *4*, anterior/posterior circumflex humeral artery.

surrounding arterial tissue, which was indicative of an AVM. Postoperative enhanced CT showed complete resection of the mass (Fig 3). The patient was discharged on postoperative day 10 without any complications, and follow-up CT results 1 year after surgery demonstrated no sign of recurrence.

DISCUSSION

An AVM around the subclavian artery is rare, and most cases are iatrogenic or traumatic.[1] Congenital AVMs are extremely rare, with only 17 cases reported, all occurring around the subclavian artery, of which nine were in newborn or infant patients.[3-17] This is a rare case of a giant AVM not directly associated with the subclavian artery.

Although some patients with AVMs are asymptomatic, all should be treated in a manner to prevent further complications related to high-output congestive heart failure or spontaneous hemorrhage. Furthermore, indications for treating AVMs not associated with heart failure or bleeding include pain, mass effect, and, rarely, concern for possible malignant disease. Basically, complete surgical resection of an AVM without causing nerve or vascular injury is challenging, and should rupture occur, management becomes more difficult. Several treatment options for an AVM have been presented, such as transcatheter coil embolization[11] and surgical resection.[6,7,9,12,14] Endovascular intervention, including the use of embolic coils and stent graft therapy, is safe and less invasive[2]; it is also associated with low morbidity and excellent clinical outcomes, with an endovascular prosthesis currently one of the first choices for treatment of a subclavian AVM.[15,17] However, care should be taken in using such a prosthesis

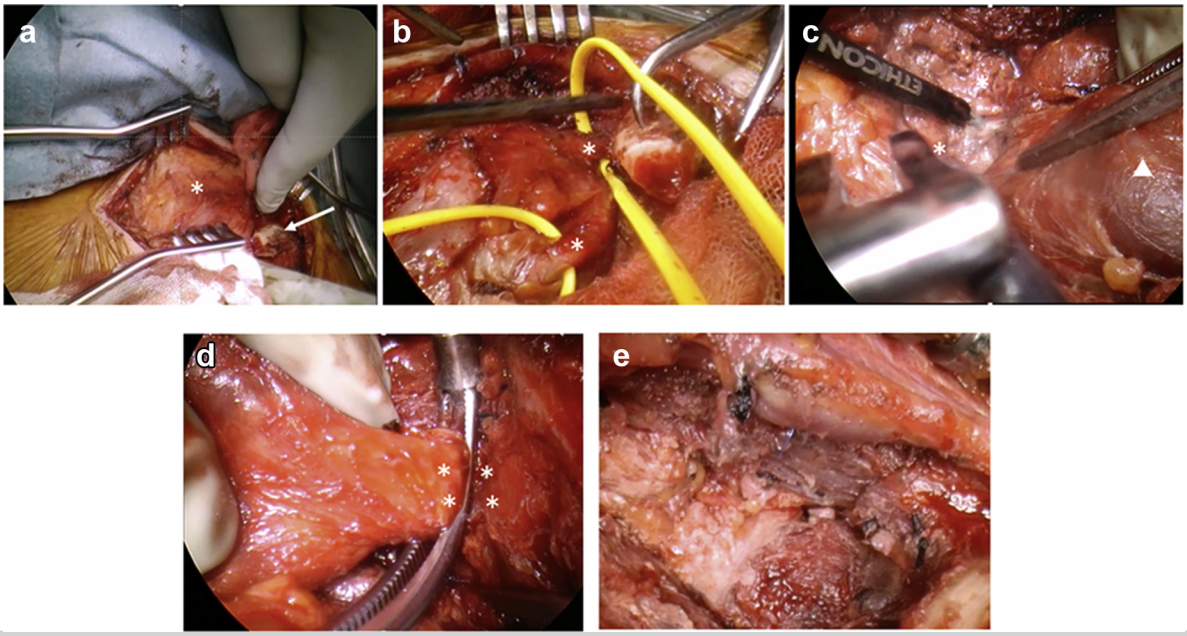

Fig 2. Surgical procedures. **a,** The left clavicle was removed to expose the arteriovenous malformation (AVM; *asterisk*). The edge of the clavicle was visualized (*arrow*). **b,** Feeding arteries (*asterisks*) were detected and divided, marked with silicone tapes, and were then divided with ligation. **c,** An ultrasonic scalpel was used near the brachial plexus (*asterisk*). The AVM (▲) was retracted with forceps. **d,** Drainage veins (*asterisks*) were clamped. **e,** The AVM was completely excised.

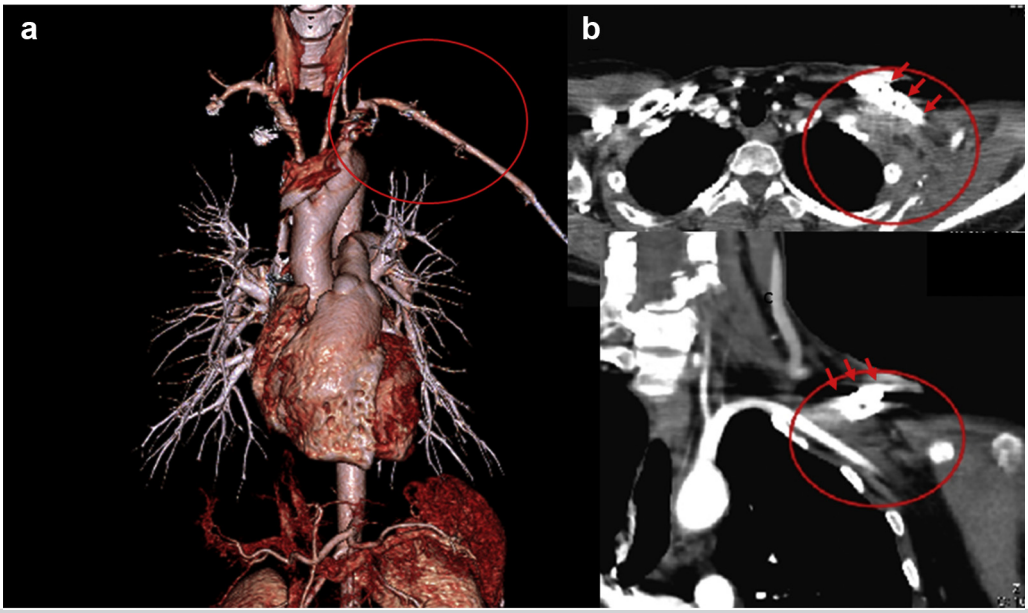

Fig 3. Postoperative computed tomography (CT) findings. **a,** No mass enhancement was seen near the left subclavian artery (*circle*). **b,** Complete resection of the mass is shown (*circles*). The *arrows* note the titanium plate used to fix the clavicle.

because occlusion of the inflow vessels to the AVM eliminates the possibility of future access for embolization. In this case, we attempted to perform coil embolization, although that was unsuccessful because of multiple feeding arteries with high flow rates and the difficult anatomy. Stent graft therapy was also impossible because all of the feeding arteries were branches of major arteries with small diameters. Therefore, surgical resection was considered to be the best choice for treatment.

Surgical resection in the area of the subclavian artery requires a supraclavicular incision with clavicular resection or a thoracotomy. The resection should be as complete as possible because the rate of recurrence is high.[18] Also, neurologic complications should be avoided; thus, an excellent surgical field is mandatory. For our patient, a beach chair position and removal of the clavicle were useful to obtain an excellent view of the large drainage vein as well as of the feeding arteries. Cooperation with an orthopedic surgeon was also important. The main risk of the operation was considered to be bleeding because of the large mass size and the complexity of the AVM. There were several feeding arteries in this case that were ligated and individually divided in a careful manner. Preoperative imaging also contributed to identification of the inflow vessels. The drainage veins were huge and located deep within the surgical field and were clamped and sutured. Another risk of this operation was injury to the brachial plexus, and we used an ultrasonic scalpel to avoid the nerve and bleeding. While detecting vessels and nerves, an ultrasonic scalpel is useful for dissection of fat tissue. By clearing away fat tissue, structures around an AVM can be visualized. Also, the device does not stimulate or damage nerves as seen with electrocautery. Finally, bleeding from soft tissues can be avoided by its coagulating effect. We considered that such a comprehensive approach is important and mandatory for safe resection of a giant AVM.

CONCLUSIONS

Surgical removal of a rare giant AVM around the subclavian artery is challenging. The mass was linked to multiple arteries and veins and was close to the brachial plexus. A comprehensive approach, including preoperative accurate determination of the feeding arteries and drainage veins, creation of an excellent surgical view, and use of appropriate modalities, is important for successful resection.

REFERENCES

1. Lee BB, Do YS, Yakes W, Kim DI, Mattassi R, Hyon WS. Management of arteriovenous malformations: a multidisciplinary approach. J Vasc Surg 2004;39:590-600.
2. Hilfiker PR, Razavi MK, Kee ST, Sze DY, Semba CP, Dake MD. Stent-graft therapy for subclavian artery aneurysms and fistulas: single-center mid-term results. J Vasc Interv Radiol 2000;11:578-84.
3. Chloroyiannis Y, Reul GJ. Iatrogenic left subclavian artery-to-left brachiocephalic vein fistula. Tex Heart Inst J 2004;31:172-4.
4. Renger RJ, de Bruijn AJ, Aarts HC, van der Hem LG. Endovascular treatment of a pseudoaneurysm of the subclavian artery. J Trauma 2003;55:969-71.
5. Walker WJ, Mullins CE, Knovick GC. Cyanosis, cardiomegaly, and weak pulses. A manifestation of massive congenital systemic arteriovenous fistula. Circulation 1964;29:777-81.
6. Sapire DW, Lobe TE, Swischuk LE, Casta A, Schwartz MZ, Droge M. Subclavian-artery-to-innominate-vein fistula presenting with congestive failure in a newborn infant. Pediatr Cardiol 1983;4:155-7.
7. Gutierrez FR, Monaco MP, Hartmann AF Jr, McKnight RC. Congenital arteriovenous malformations between brachiocephalic arteries and systemic veins. Chest 1987;92:897-9.
8. Wong CK, Lau CP, Leung WH. An arteriovenous fistula from an aberrant right subclavian artery to the superior caval vein in a congenitally myxoedematous adult. Int J Cardiol 1989;25:126-9.
9. Rossi G, Miotto D, Bongioví S, Grego F, Nicolosi GL, Pessina AC. Spontaneous idiopathic subclavian arteriovenous fistula: a case report. Angiology 1992;43:672-7.
10. Evans AJ, Whitaker SC, Gregson RH. Case report: congenital mediastinal arteriovenous fistula in an adult—diagnosis with digital subtraction angiography. Clin Radiol 1992;46:209-10.
11. Hughes JP, Ruttley MS, Newell RL. Congenital arteriovenous malformations arising from the subclavian artery. Clin Radiol 1999;54:73-6.
12. Dogan R, Yilmaz M, Ozkutlu S, Elsharshari H. Congenital subclavian artery to subclavian vein fistula presenting with congestive heart failure in an infant. Pediatr Cardiol 2000;21:269-70.
13. Brountzos EN, Kelekis NL, Danassi-Afentaki D, Nikolaou V, Apostolopoulou S, Kelekis DA. Congenital subclavian artery-to-subclavian vein fistula in an adult: treatment with transcatheter embolization. Cardiovasc Intervent Radiol 2004;27:675-7.
14. Tatum GH, Newman B, Ralphe JC. Neonatal congestive heart failure due to a subclavian artery to subclavian vein fistula diagnosed by noninvasive procedures. Congenit Heart Dis 2006;1:120-3.
15. Awasthy N, Tomar M, Radhakrishnan S, Kumar P. Nonsurgical management of a congenital aortocaval fistula from right subclavian artery to superior vena cava along with SVC obstruction. Pediatr Cardiol 2011;32:227-9.
16. Balakrishnan PL, Guleserian KJ, Schuster J, Blalock SE. Congenital arteriovenous malformation between the subclavian artery and superior vena cava presenting in neonatal heart failure. Pediatr Cardiol 2011;32:1204-6.
17. Guan L, Zhou D, Liang L, Chang X, Li M, Ge J. Transcatheter closure of a congenital subclavian arteriovenous fistula using a duct occluder. Int J Cardiol 2014;177:e135-6.
18. Kim JY, Kim DI, Do YS, Lee BB, Kim YW, Shin SW, et al. Surgical treatment for congenital arteriovenous malformation: 10 years' experience. Eur J Vasc Endovasc Surg 2006;32:101-6.

Submitted Sep 7, 2017; accepted Dec 20, 2017.