Thrombosis related to true axillo-brachial arterial aneurysm following ligation of longstanding arteriovenous fistula for hemodialysis

Tsutomu Doita, MD, Taro Yamasumi, MD, *and* Takashi Nakamura, MD, PhD, *Sakai, Osaka, Japan*

ABSTRACT

A 52-year-old man who had received hemodialysis via a left radial–cephalic arteriovenous fistula (AVF) for 18 years presented with severe ischemic symptoms in the left upper arm 12 years after occlusion of the AVF. Diagnostic imaging revealed thrombotic occlusion from a left axillary–brachial artery aneurysm, which required distal bypass surgery. The inflow artery of an AVF can develop aneurysmal degeneration, resulting in upper limb ischemia by embolization or decreased flow, especially with a ligated or occluded AVF or immunosuppressive therapy after renal transplantation. In such cases, the AVF should be monitored, even if ligated or occluded. (J Vasc Surg Cases Innov Tech 2023;9:101334.)

Keywords: Arteriovenous fistula; Brachial artery aneurysm; Upper limb ischemia

Axillary artery (AXA) and brachial artery (BA) aneurysms are usually pseudoaneurysms, secondary to an infectious, post-traumatic, or iatrogenic etiology, while true AXA and BA aneurysms are rare.[1] Arterial aneurysmal degeneration of the inflow artery after arteriovenous fistula (AVF) ligation can lead to upper limb ischemia by embolization or decreased blood flow, sometimes requiring surgical revascularization.[2-4] We report a case of upper limb ischemia caused by thrombosis of an axillo-brachial aneurysm that developed after ligation of a longstanding AVF. The patient provided written informed consent for the report of his case details and imaging studies.

CASE REPORT

A 52-year-old man noted pain at rest, coldness, and left hand numbness. His medical history included renal failure secondary to chronic glomerulonephritis, hypertension, paroxysmal atrial fibrillation, cerebral aneurysm, pheochromocytoma, and spontaneous splenic rupture. He was receiving antithrombotic therapy but not immunosuppressive therapy. At age 22 years, a left radial–cephalic AVF was created and used for hemodialysis. The AVF was finally placed at the elbow level, and percutaneous transluminal angioplasty procedures were often performed to maintain functional patency. At 40 years of age, an ~12-cm thrombus occlusion formed in the dilated cephalic vein from the mid- to proximal upper arm. Vascular access was created through a right radial–cephalic AVF, and the left AVF was ligated by resecting the dilated pulsatile outflow cephalic vein. Thereafter, hemodialysis was given through the right AVF, with no additional left arm AVF placement.

At 45 years of age, ischemic symptoms appeared, with left forearm pain on exertion and left finger coldness and/or numbness. The ulnar artery (UA) alone was audible by Doppler. Angiography and ultrasound revealed aneurysmal dilation of the patent left AXA-BA, total left radial artery occlusion, and severe stenosis of the ostium of the left UA; thus, BA-UA bypass surgery using the ipsilateral basilic vein was performed. Six months later, bypass graft occlusion was found, although he remained asymptomatic due to the development of collateral arteries. At age 49 years, splenectomy to treat a splenic rupture was performed, and repeated blood pressure measurements in the upper left arm were conducted. Thereafter, he experienced hand numbness, but his symptoms remained stable. After 2 years, his left hand pain at rest and coldness and numbness without sensory deficits had deteriorated, and 2 months later, the patient was referred to our department. The radial artery and UA were not palpable, only a monophasic waveform was detected by Doppler in the UA and palmar arch.

Computed tomography angiography, angiography, and ultrasound showed thrombotic occlusion of the AXA aneurysm and a diffuse aneurysmal BA, with a maximum diameter of 33 mm and 22 mm and a length of 72 mm and 215 mm, respectively (Fig 1). Deep BA and radial artery occlusion was also confirmed, although the UA and interosseous artery (IA) were patent (Fig 2). A redo bypass and left AXA–anterior IA bypass surgery procedure using a great saphenous vein graft were planned, because the mid to distal UA showed circumferential calcification.

Under general and regional anesthesia, following an infraclavicular transverse skin incision, the AXA was gently dissected after harvesting the great saphenous vein. Doppler signaling identified the IA after a longitudinal incision above the proximal UA was marked based on the preoperative ultrasound findings. A bypass route was created by tunneling under the pectoralis major muscle through the axilla fossa to the upper arm. The proximal AXA and reversed great saphenous vein graft were anastomosed with continuous 6-0 polypropylene suture, with

From the Department of Vascular Surgery, Japan Organization of Occupational Health and Safety, Osaka Rosai Hospital.

Correspondence: Takashi Nakamura, MD, PhD, Department of Vascular Surgery, Japan Organization of Occupational Health and Safety, Osaka Rosai Hospital, 1179-3 Nagasone-cho, Kita-ku, Sakai, Osaka 591-8025, Japan (e-mail: takashin@mvd.biglobe.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

https://doi.org/10.1016/j.jvscit.2023.101334

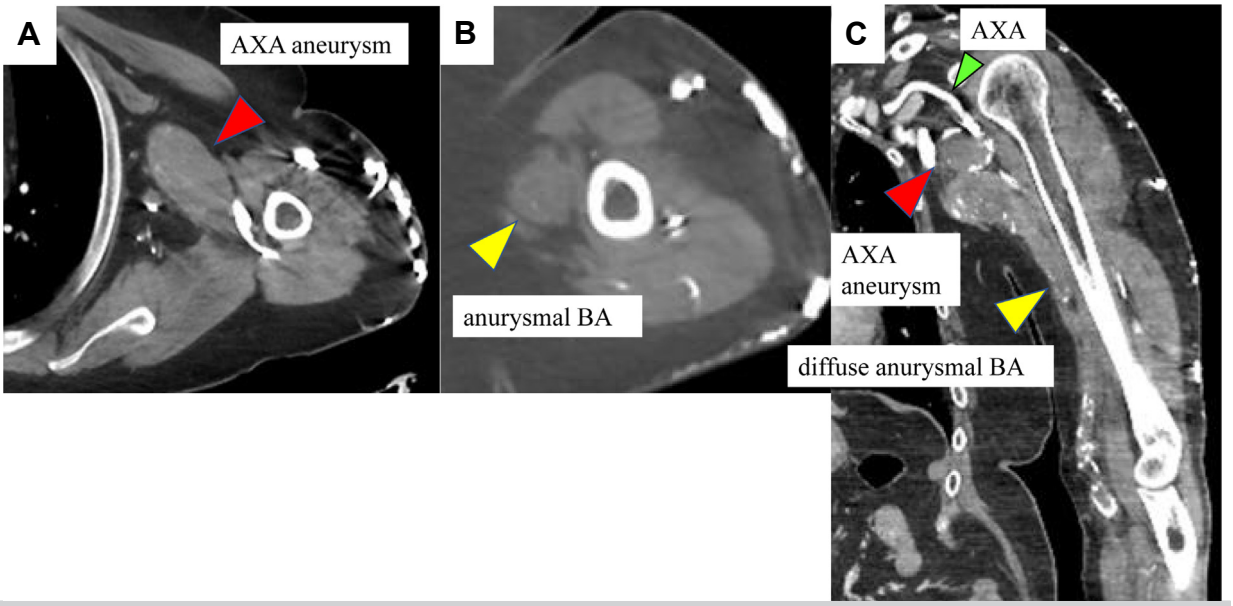

Fig 1. Preoperative computed tomography angiography. **A,** Axial view showing the left aneurysmal axillary artery (AXA; *red arrow*), which was thrombosed and occluded. **B,** Axial view showing the left aneurysmal brachial artery (BA; *yellow arrow*), which was thrombosed and occluded. **C,** Coronal view showing the thrombosed occlusion of the left AXA aneurysm (*red arrow*) and the diffuse aneurysmal BA (*yellow arrow*), measuring 33 mm and 22 mm in maximum diameter, respectively.

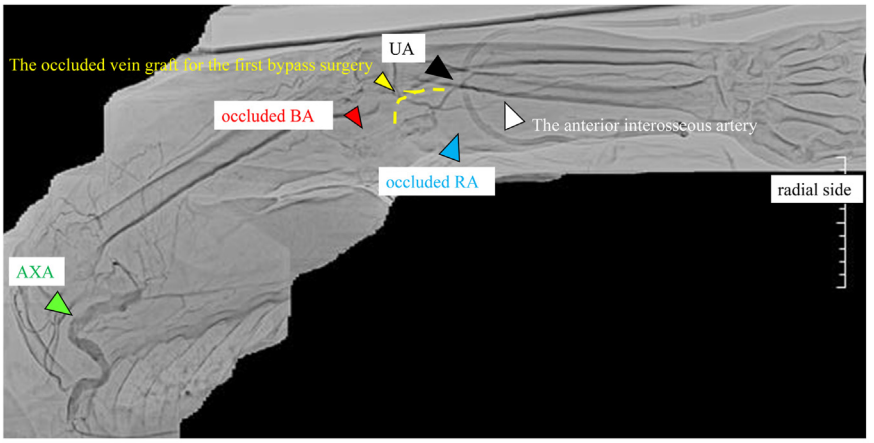

Fig 2. Preoperative angiogram showing thrombosed occlusion of the axillary artery (AXA), occlusion of the deep brachial artery (BA) and radial artery (*blue arrow*), and occluded vein graft from the first bypass surgery (*yellow dotted line*). The ulnar artery (UA; *black arrow*) and anterior interosseous artery (*white arrow*) were confirmed to be patent.

a corner stitch on the anastomosis heel. A distal anastomosis was created with continuous 7-0 polypropylene suture with three corner stitches at each heel and toe. Intraoperative angiography revealed that the distal anastomosis was not created with the anterior IA but rather the collateral portion, although blood flow to the palmar arch was satisfactory (Fig 3). The postoperative course was uneventful, and his left hand pain at rest and coldness and numbness resolved shortly thereafter. Two years later, the patient remained asymptomatic with a patent bypass graft confirmed by ultrasound.

DISCUSSION

AXA and BA aneurysms are usually pseudoaneurysms occurring secondary to infection or trauma, and true AXA and BA aneurysms are rare, with some reports noting aneurysm of the inflow artery after AVF creation.[2-7] Increased blood flow after AVF creation causes upregulated local production of vasodilators (nitric oxide) and matrix metalloproteinases 2 and 9, resulting in loss of vessel wall vasoconstriction.[6] That report also noted that a longstanding AVF leads to

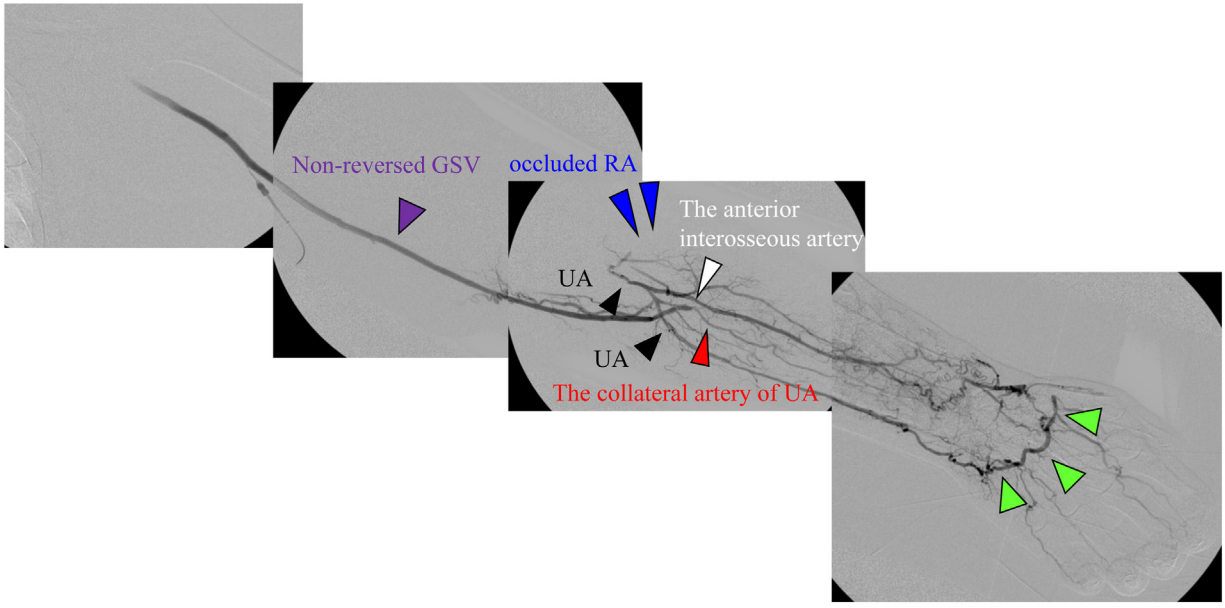

Fig 3. Intraoperative angiogram showing the distal anastomosis was created not to the ulnar artery (UA; *black arrowheads*) but to its collateral artery (*red arrowhead*) and occlusion of the radial artery (*RA*; *blue arrowheads*). The palmar arch blood circulation was satisfactory (*green arrowheads*), *GSV,* Great saphenous vein.

elastic fiber degeneration and increased calcium and phosphate deposition.[6] These are related to aneurysmal remodeling of the AVF inflow artery, including the AXA, which is accelerated by increased vessel wall resistance after AVF ligation or immunosuppressive therapy after renal transplantation. In our patient, the longstanding AVF led to aneurysmal dilation of the AXA–BA, which was accelerated by AVF ligation. This aneurysmal AXA–BA caused embolization and decreased flow, leading to upper extremity ischemia. It is speculated that the repeated blood pressure measurements in the left upper arm at the splenectomy for the splenic rupture caused thrombotic occlusion and distal embolization of the AXA–BA aneurysm and collateral vessels, including the deep BA, resulting in severe upper limb ischemia.

A literature search found three series and 24 case reports, including 33 patients with donor artery aneurysm formation after AVF creation, excluding traumatic and infective cases.[1-5,7-28] These were analyzed and compared with a review of three series reported by Chemla et al,[2] Marzelle et al,[3] and Mesters et al[3] (Table). Male patients comprised 81.8% of the 33 cases, and the median age at AVF creation was 30.7 years (range, 14-51 years). The median AVF duration was 12.1 years (range, 2-25 years), with a median time from ligation or occlusion of the AVF to arterial aneurysm diagnosis of 10.1 years (range, 0-21 years). The findings from the three series indicated trends similar those found in our review. Most patients underwent AVF creation in their 30s with a long duration. Also, the AVF was ligated or occluded in most patients, with immunosuppressive therapy used after renal transplantation.

The clinical presentations of AVF donor artery aneurysms are most commonly pain, swelling, and a pulsatile mass in the arm. Nerve compression or paresthesia has occasionally been described, with rupture reported in only one case. Distal embolization can occur due to mobilization of the mural thrombus within the aneurysm, which can sometimes lead to acute or subacute upper limb ischemia.[6] In most cases, surgical intervention is aneurysmectomy, with interposition bypass or bypass surgery performed less often. If the AVF is ligated or occluded and no longer used, its condition will likely not be followed up in many cases. In particular, when the AVF has been reestablished in the arm contralateral to the original AVF, the blood pressure is usually measured on the original AVF side. However, in such cases, donor arteries could have undetected aneurysmal degeneration. Measuring the blood pressure on the donor artery aneurysm side can lead to thrombus formation in the aneurysm and distal embolization. Therefore, the original AVF should be followed up, and blood pressure measurements on the donor artery aneurysm side should be avoided in such cases. To prevent donor artery aneurysmal degeneration in high-flow AVF cases, surgery to reduce the blood flow might be effective, although additional studies are needed to determine which patients will benefit from a surgical procedure and the appropriate methods and timing to use.

Table. Review of donor artery aneurysm formation after arteriovenous fistula (AVF) creation

Investigator	Journal	Patients, No.	Male sex, %	Median age at AVF creation, years	Median duration of AVF use, years	Ligation/ occlusion, %	Median interval from AVF ligation/ occlusion to arterial aneurysm diagnosis, years	Median age at donor artery aneurysm intervention, years	Renal transplantation, %	Rupture, No.
Chemla et al,[2] 2010	Semin Dial	13	92.3	34.6 ± 18.5 (10-72)	13.4 ± 9.6 (3-29.5)	38.5	3.6 ± 1.5 (2-6)	51.2 ± 13.8 (26-77)	76.9	0
Marzelle et al,[3] 2012	JVS	10	70	38.1 ± 5.3 (27-44)	6.9 ± 4.1 (1.4-12.2)	100	2.8 ± 3.3 (0-8.8)	47.6 ± 8.2 (34-57)	80	1
Mesters et al,[4] 2014	Eur J Vasc Endovasc Surg	12	75	NA	NA	91.7	NA	63 (31-83)	100	0
Our review[a]	NA	33	81.8	30.7 ± 8.9 (14-51)	12.1 ± 7.5 (2-25)	78.8	10.1 ± 5.9 (0-21)	54.7 ± 11.9 (35-86)	81.2	0
Our case, 2021	NA	1	Male	22	18	Both present	12	52	0	0

NA, Not applicable or not available.
[a]We found three series and 24 case reports, including 33 cases of donor artery aneurysm formation after AVF construction, excluding any traumatic or infective cases[1,5-28]; we analyzed these 33 cases and compared our review with the data from the three series.

CONCLUSIONS

With a longstanding AVF, donor arteries can develop dilation or aneurysmal degeneration, especially with a ligated or occluded AVF or because of immunosuppressive therapy after renal transplantation. Embolization by a mural thrombus within the aneurysm and decreased flow can lead to upper limb ischemia. In such cases, AVF monitoring is important, even if ligated or occluded.

DISCLOSURES

None.

REFERENCES

1. Clarke MT, Waterland PW, Bahia SS, Asquith JR, Pherwani AD, Wong JCL. True brachial artery aneurysm: a rarity. Eur J Vasc Endovasc Surg 2012;43:617.
2. Chemla E, Nortley M, Morsy M. Brachial artery aneurysms associated with arteriovenous access for hemodialysis. Semin Dial 2010;43:440-4.
3. Marzelle J, Gashi V, Nguyen HD, Mouton A, Becquemin JP, Bourquelot P. Aneurysmal degeneration of the donor artery after vascular access. J Vasc Surg 2012;55:1052-7.
4. Mesters G, Fontsere N, Yugueros X, Tarazona M, Ortiz I, Riambau V. Aneurysmal degeneration of the inflow artery after arteriovenous access for hemodialysis. Eur J Vasc Endovasc Surg 2014;48:592-6.
5. Kordzadeh A, Barbara RMD, Ahmad AS, Hanif MA, Panayiotopoulos YP. Donor artery aneurysm formation following the ligation of haemodialysis arteriovenous fistula: a systematic review and case reports. J Vasc Access 2015;16:5-12.
6. Teixeira S, Pinto PS, Veiga C, Silva I, Almeida R. Aneurysmal degeneration of the brachial artery after vascular access creation: surgical treatment results. Int J Angiol 2017;26:186-90.
7. Eugster T, Wigger P, Bolter S, Bock A, Hodel K, Stierli P. Brachial artery dilation after arteriovenous fistulae in patients after renal transplantation: a 10-year follow-up with ultrasound scan. J Vasc Surg 2003;37:564-7.
8. Hale PC, Linsell J, Taylor PR. Axillary aneurysm: an unusual complication of hemodialysis. Eur J Vasc Endovasc Surg 1994;8:101-3.
9. Nguyen DQ, Ruddle AC, Thompson JF. Late axillo-brachial arterial aneurysm following ligated Brescia-Cimino haemodialysis fistula. Eur J Vasc Endovasc Surg 2001;22:381-2.
10. Murphy J, Bakran A. Late acute presentation of a large brachial artery aneurysm following ligation of a Brescia-Cimino arteriovenous fistula. Eur J Vasc Endovasc Surg 2001;39:123.
11. Schunn CD, Sullivan TM. Brachial arteriomegaly and true aneurysmal degeneration: case report and literature review. Vasc Med 2002;7:25-7.
12. Maynar M, Sanchez-Alvarz E, Qian Z, Lopez-Benitez R, Long D, Zerolo-Saez I. Percutaneous endovascular treatment of a brachial artery aneurysm. EJVES Extra 2003;6:15-9.
13. Keuter XH, Planken RN, van der Sande FM, Tordoir JH. Brachial artery thrombosis due to haemodialysis arteriovenous fistula. Nephrol Dial Transplant 2006;21:829-30.
14. Adachi I, Matsuda H, Ogino H, et al. A case of a true aneurysm of the brachial artery in a patient with a radio-cephalic fistula and cholesterol apheresis. Eur J Vasc Endovasc Surg 2006;31:112.
15. Battaglia L, Bucci F, Battaglia M, Reddler A. Late occurrence of a large brachial artery aneurysm following cosure of a hemodialysis arteriovenous fistula. Ann Vasc Surg 2006;20:533-5.
16. Ventura M, Perilli L, Pisani F, Cucciolillo L, Franceschini E. True aneurysm of the brachial artery in a kidney transplant patient: case report. Italian J Vasc Endovasc Surg 2006;13:15-9.
17. Sultana A, Torella F, McWilliams R, Bakran A. Axillary artery aneurysm following closure of haemodialysis fistula. A case report. J Cardiovasc Surg 2007;48:197-9.
18. Basile C, Antonelli M, Libutti P, Teutonico A, Casucci F, Lomonte C. Is there a link between the late occurrence of a brachial artery aneurysm and the ligation of an arteriovenous fistula? Semin Dial 2011;24:341-2.
19. Dinto E, Bracale UM, Vitale G, et al. Late, giant brachial artery aneurysm following hemodialysis fistula ligation in a renal transplant patient: case report and literature review. Gen Thorac Cardiovasc Surg 2012;60:768-70.
20. Bahia SS, Tomei F, Ozdemir BA, Chemla ES. Acute limb ischemia due to focal brachial artery aneurysms complicating brachiocephalic arteriovenous fistula ligation: two recent case reports. J Vasc Access 2014;15:427-30.
21. De Santis F, Martini G, Mani G, Bernhard O. Diffuse aneurysmal degeneration of the brachial artery after long-standing high-flow arteriovenous fistula closure for hemodialysis at elbow level. Ann Vasc Surg 2014;28:1311-5.
22. Khalid U, Parkinson F, Mohiuddin K, Davies P, Woolgar J. Brachial artery aneurysms following brachio-cephalic AV fistula ligation. J Vasc Access 2014;15:22-4.
23. Marconi M, Adami D. Giant true brachial artery aneurysm after hemodialysis fistula closure. Eur J Vasc Endovasc Surg 2015;49:531.

24. Fendri J, Palcau L, Cameliere L, et al. True brachial artery aneurysm after arteriovenous fistula for hemodialysis: Five cases and literature review. Ann Vasc Surg 2017;39:228-35.
25. Akuta S, Yonekura K, Sugano N. A surgical case of true brachial artery aneurysm associated with vascular access for dialysis. Jpn J Vasc Surg 2019;28:361-5.
26. Alejandro G, Adolfo FG, Hugo TA. Digital embolization from a thrombosed aneurysmal hemodialysis arteriovenous fistula. Nefrologia 2021;41:593-4.
27. Toyota S, Inoue K, Kurose S, et al. True brachial artery aneurysm after arteriovenous fistula closure following renal transplantation: a case report and literature review. Surg Case Rep 2019;5:188.
28. Patel M, D'Addario J, Ahmed A, Bose S. Thrombosis of a true brachial artery aneurysm after long term immunosuppressive therapy-etiology and implications. Ann Vasc Surg Brief Rep Innov 2022;2:100035.

Submitted May 15, 2023; accepted Sep 9, 2023.