True brachial artery aneurysms are rare, forming only 5% of all peripheral aneurysms, with an overall incidence of 0.17%. In a small series of upper limb aneurysms, 58% that runs deep to the nerve.7

True brachial artery aneurysms in association with ipsilateral AVF shear stress effect, immunosuppression as part of a kidney transplant preservation, and duration of exposure to such factors. Similarly, the overall incidence of such aneurysms remains unknown.

Aberrant arterial blood supply to the arm is also uncommon, with numerous different variations of upper and forearm anomalies. In the most common variety, the axillary artery divides into a brachial and ulnar branch. In the second case, a 34-year-old man was referred with the diagnosis of aneurysmal left brachial artery. This turned out to be an aneurysmal brachial artery. In both patients, multiple true aneurysms of aberrant brachial arterial supply were observed. By nature, the brachial arterial variation lies superficially in the arm. We discuss the pitfalls of such an anomaly in planning an ipsilateral arteriovenous fistula. (J Vasc Surg Cases and Innovative Techniques 2019;5:248-51.)

Keywords: Brachial artery; Brachioradial artery; Aneurysm; Arteriovenous fistula; Dialysis

CASE REPORT

Case 1. A 38-year-old man presented with a 48-hour history of sudden-onset left arm pain and swelling. 18 months earlier, the patient had successful kidney transplantation, followed by closure of a left brachiobasilic AVF that he had for 15 years. On examination, the left arm was swollen but adequately perfused through a patent ulnar supply. The radial pulse was absent. A tender thrombosed vessel could be felt subcutaneously along most of the upper arm length. Soon after admission, the patient became pyretic, and blood cultures were positive for coagulase-negative staphylococci. Computed tomography angiography demonstrated an aberrant arterial supply to both arms in the form of high bifurcation of the axillary artery into brachial and ulnar branches. On the left, the brachial artery was fusiform aneurysmal and thrombosed. Also on the left, multiple small aneurysms were noted at the origins of the circumflex humeral and profunda brachii branches as well as the distal axillary artery. Venous shunting due to a previously placed dialysis fistula was noted in the mid upper arm. The patient was taking prednisolone and tacrolimus to cover his kidney transplant.

The patient underwent urgent surgery under general anesthesia. The left arm was extended to 90 degrees, and a medial longitudinal incision was made starting from the level of the lower border of the pectoralis major muscle down to the antecubital skin crease. The incision was then extended transversely and laterally along the crease, then again longitudinally for approximately 5 cm along the center of the brachioradialis muscle. The thrombosed brachioradial aneurysm was exposed throughout its length. Proximally, arterial control was achieved by clamping the third part of the axillary artery. Distally, the ulnar artery was clamped midarm, and the brachial artery was clamped in the forearm. The thrombosed brachioradial aneurysm was then excised together with the aneurysmal distal axillary and proximal ulnar arteries. The arterial supply to the forearm was reconstructed using an interposition reversed great saphenous vein graft between the remaining proximal third part of the axillary artery and the ulnar artery in the mid upper arm. Fig 1 shows the radiologic and intraoperative findings for
In this case, postoperatively, the patient had an uneventful recovery with good ulnar flow and hand perfusion. The graft remained patent at 1-year follow-up.

**Case 2.** A 34-year-old man with ischemic heart disease and end-stage renal disease was receiving hemodialysis through a left brachiobasilic AVF. The patient presented with problems with dialysis access in the form of excessive bleeding and recurrent hematomas. In 2005, the patient had a left radiocephalic AVF; a year later, he received a kidney transplant, and the AVF was subsequently closed. In 2009, the transplanted kidney failed because of noncompliance with immunosuppression; it was eventually removed in 2010, and a new left brachioccephalic AVF was created. In 2011, the patient was admitted with congestive heart failure, a left ventricular ejection fraction of <25%, and a holodiastolic flow reversal in the descending thoracic and abdominal aorta. This was attributed to a high flow in the left arm AVF. As a consequence, the fistula was partially ligated. In 2014, the patient had a second attempt at kidney transplantation. This failed acutely, and the transplanted kidney had to be removed within days. The patient was prescribed prednisolone, tacrolimus, and mycophenolic acid for the periods during which the transplanted kidneys were in situ (4 years). However, his compliance was poor. On examination, the patient had what appeared to be an aneurysmal AVF in the left upper arm. There were two areas of extensive skin scarring and partial erosion, indicating impending rupture. Both radial and ulnar pulses were preserved at the wrist. Urgent exploration was performed with the aim of ligating the fistula and excising the aneurysm-carrying segment. Under general anesthesia, the arm was extended to 90 degrees, and a mid to upper arm incision was made along the aneurysmal vessel. Intraoperatively, it became apparent that the patient had an aberrant arterial anatomy with an aneurysmal brachioradial artery. It also became apparent that this was being used inadvertently as a dialysis access for a period of time, thus leading to the two larger saccular aneurysms at the repeated puncture sites. A second antecubital skin crease incision was then made to achieve distal control of the brachial artery. The aneurysm brachioradial segment was then excised, and the proximal and distal ends were ligated. Reconstruction was deemed unnecessary because of the adequate ulnar supply and the patient's unfavorable overall condition. Postoperative computed tomography angiography confirmed the aberrant arterial anatomy (Fig 2). This patient also made an uneventful postoperative recovery, and his arm perfusion remained adequate at 6 months of follow-up.

**DISCUSSION**

In the reported cases, both patients developed multiple upper limb arterial aneurysms on a background of ipsilateral AVF and immunosuppression after kidney transplantation. Immunosuppressive medications, particularly corticosteroids, have been associated with aneurysm
However, the period of exposure to such medications in one of the two patients in this study was relatively short (4 years in aggregate).

Another possible contributing factor to the development of the brachial artery aneurysm in the reported cases is the shear stress created by the fistula flow itself. A study by Eugster et al demonstrated that brachial arteries ipsilateral to AVFs increase in diameter over time. Immunosuppression did not appear to enhance this increase. The AVF patent-life durations in our patients were 15 and 8 (1 + 7) years in cases one and two, respectively.

Of note, both patients in this report had forearm arterial loops. The incidence of such loops ranges between 0.4% in a North American population and 1.2% in a Middle Eastern population. The mechanism of forearm arterial loop formation is not fully understood. The presence of these loops may indicate an underlying structural weakness that renders the affected arteries susceptible to aneurysmal dilation under suitable conditions. Whereas neither patient demonstrated any features of an underlying connective tissue disorder, such disorders could well be subclinical and appear only when certain environmental conditions are met.

The anatomy of the arterial supply to the upper limb is known to vary, with numerous different combinations reported. The incidence of the brachioradial variation is in the region of 11%. In the absence of preoperative arterial mapping, the relatively superficial course of this variation makes it more likely to be encountered and therefore used as an inflow vessel for a dialysis access fistula. Furthermore, because of its superficial position, an aneurysmal brachioradial artery could be mistaken for the venous arm of an AVF.

Considering the rarity of the reported cases, it is reasonable to assume that anomalous arterial supply to the arm is in itself a risk factor for brachial artery aneurysm formation. This is unlikely to be simply due to the smaller diameter of these arteries because such diameters do not differ much from those in the forearm. The more probable factor is an inherent structural weakness in these anomalous vessels. In support of this theory are the facts that the associated AVF patent-life and immunosuppression durations were relatively short and that multiple discrete aneurysms were observed in both of the patients.

CONCLUSIONS

The brachioradial variation of arm arterial supply is fairly common. These vessels appear to be susceptible to aneurysmal changes in response to increased flow.

Fig 2. I. Small aneurysm, origin of circumflex humeral; II. axillary artery; III. brachioradial artery; IV. ulnar artery with a loop distally; V. excised aneurysmal segment of brachioradial artery.

Fig 3. A. Case 1: excised specimen including the distal axillary artery, thrombosed aneurysmal brachioradial artery, and proximal ulnar artery. B. Case 2: excised aneurysmal brachioradial artery with another two saccular aneurysms at site of dialysis punctures.
In those with anomalous arterial anatomy, care should be taken not to use the more superficial branches as AVF donor arteries. Instead, the deeper, less accessible branches should be used to minimize the risk of inadvertent puncture.

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