A novel approach to autogenous hemodialysis access: paired brachial vein transposition in series

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ABSTRACT

Autogenous arteriovenous fistula (AVF) creation is the preferred method for long-term hemodialysis access. This report describes the novel use of paired brachial veins for the creation of an autogenous AVF in a patient without a traditional superficial venous conduit available. Application of this general concept might serve to expand the options for autogenous AVF creation. (J Vasc Surg Cases Innov Tech 2023;9:101316.)

Keywords: Arteriovenous fistula; Brachial vein; Hemodialysis access

The cephalic vein and basilic vein are the preferred conduit choices for creation of an autogenous arteriovenous fistula (AVF). Both are superficial veins with favorable anatomic relationships compared with deep veins. However, clinical scenarios are often encountered that preclude the use of these superficial veins. Examples include scarring from the trauma of repetitive blood sampling or intravenous drug abuse, phlebitis, and small vein diameters.[1] To the best of our knowledge, this report details the first case in which paired brachial veins (BrVs) were transposed and arranged in series to create an autogenous AVF of appropriate length for a patient with no superficial vein options. The research ethics board at our institution waives formal approval for case reports. The patient provided written informed consent for the report of his case details and imaging studies.

CASE REPORT

A 70-year-old left-handed man with stage V chronic kidney disease was referred for long-term hemodialysis access. His comorbid conditions included hypertension, type 2 diabetes mellitus, obesity, and chronic viral hepatitis C. He was formerly afflicted by intravenous drug abuse from which he had been recovered for >20 years. He had no history of prior central venous catheter placement. Normal and symmetric arterial pulses were present throughout the upper extremities. No difference in blood pressure was identified between the arms. The Allen test results were negative for both hands. Preoperative and/or intraoperative vein mapping are routinely performed to delineate and mark the available venous domain. The presence of deep vein thrombosis in the absence of clinical stigmata is not routinely ruled out; however, patient factors such as intravenous drug use, a history of thrombosis, and hypercoagulable states are considered when assessing an available vein before incision. No superficial veins were identified in either arm on clinical examination. Vein mapping with duplex ultrasound of both arms showed the cephalic and basilic veins were sclerotic and occluded. Ultrasound showed normal paired BrVs were present in the upper arm, each with a diameter of 6 mm and a length of 15 cm. Arteriovenous graft placement and autogenous AVF creation with the paired BrVs were discussed as long-term access options. Direct autogenous brachial–brachial transposition was elected because this option best fit the patient's end-stage kidney disease (ESKD) life plan.

The use of deep upper extremity veins for AVF creation can prove challenging owing to the difficulty of the dissection.[2] The risk of nerve injury is inherently higher and can be affected by factors such as vein length and inadequate mobility.[2] Surgery was performed in two stages. The anatomic variability, including the depth, length, and diameter of the BrV, can result in difficulty in manipulation during transposition.[2] When deciding between a one or two-stage procedure, the vein length, diameter, and depth should be considered, in addition to the timeline and circumstances of the patient requiring dialysis access. The timeline permitted; thus, a two-stage procedure was reasonable for our patient. This allowed maturation of the vein before superficialization, which is perceived to provide more resistance to torque and facilitate mobilization (Fig 1).

The first stage was performed through a transverse incision at the antecubital fossa. The brachial artery and one of the paired BrVs (BrV 1) were circumferentially dissected and an end-to-side, venous-to-arterial anastomosis was created. The site was closed in layers, and the patient was discharged. One month later, the patient returned for the second stage. A lengthwise incision was made on the medial arm over the brachial artery and paired BrVs. BrV 1 was mobilized from the antecubital area to the midpoint of the upper arm. BrV 2 was mobilized in its entirety and divided at the antecubital area (Fig 2).

BrV 1 was divided at the mid-portion, leaving the central (proximal) portion of the vein in situ and undisturbed to not compromise the potential collateral venous drainage pathways in the extremity. The venous ends were spatulated, and an end-to-

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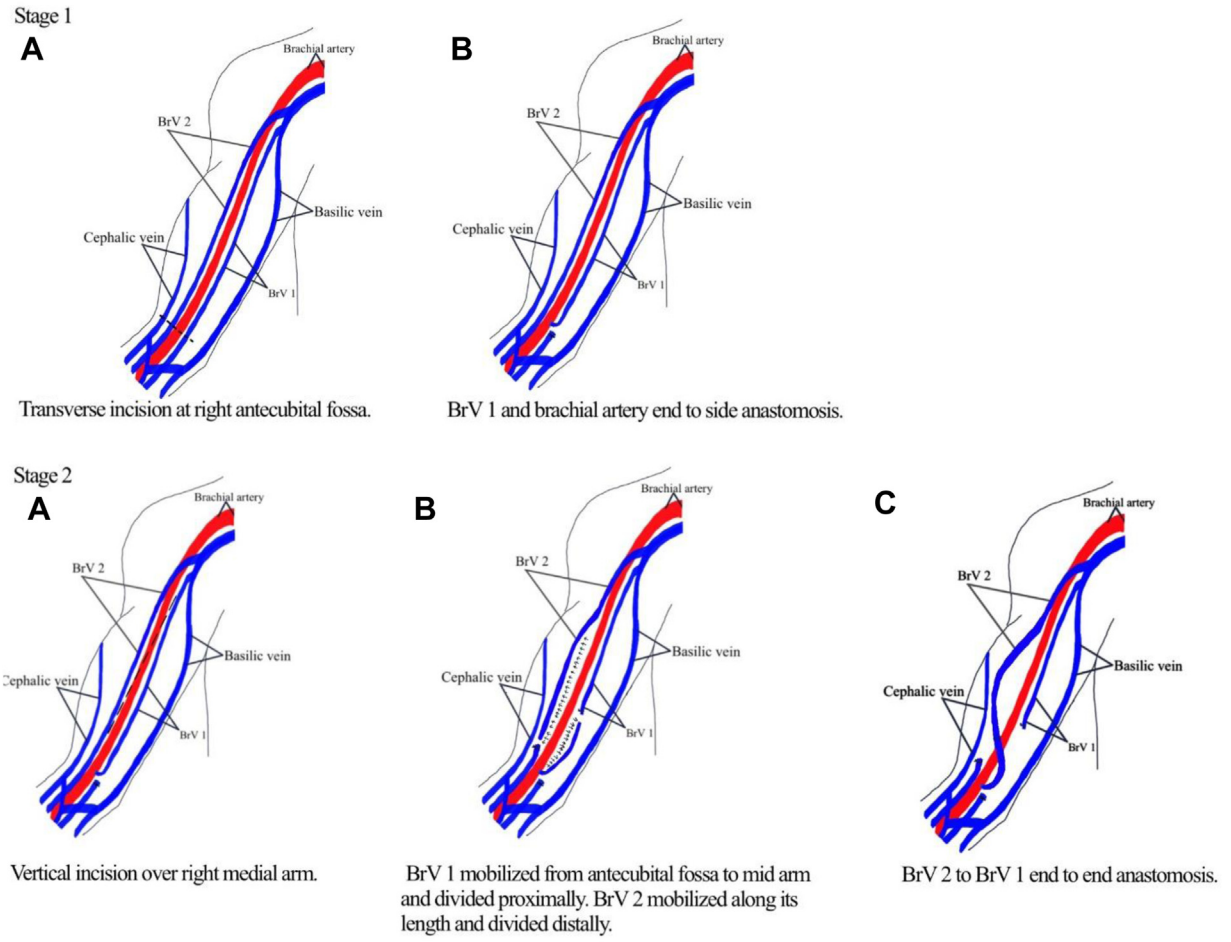

Fig 1. Depiction of two-stage operative technique. Stage 1: brachial vein (BrV) 1 to brachial artery end-to-side anastomosis (**A,B**). Stage 2: BrV 2 to BrV 1 end-to-end anastomosis and transposition (**A-C**).

end anastomosis was created between BrV 1 and BrV 2 (Fig 3). A subcutaneous flap was created into which the AVF was transposed. The site was closed in layers and the patient was discharged to home.

The patient had no complaints of pain, numbness, or swelling after surgery. The surgical site had healed without complications at the first postoperative visit. The AVF had matured and was available for use when evaluated at 2 months after surgery. Physical examination was used to assess the maturation and patency after the first and second stages. The AVF was first accessed for hemodialysis 4 months after surgery and has been in continuous use since then. At 15 months after surgery, primary access patency remained intact, and the patient was free of complaints at the last follow-up.

DISCUSSION

The incidence of ESKD is increasing, in part because of the rising rates of diabetes and an aging U.S. population. In the past, the demand for vascular access had been increasingly met by the use of synthetic graft material, which at one time accounted for 70% to 80% of all access sites. The National Kidney Foundation published the Dialysis Outcomes Quality Initiative (DOQI) guidelines in 1997 with the goal of increasing autogenous AVF placement.[3] The guidelines were successful in that regard; however, limitations were recognized. The DOQI guidelines did not consider patient-specific factors, and the expectations for AVF outcomes were overly optimistic. In a 2021 review, injection-related venous damage was highlighted, emphasizing the difficulties in creating and maintaining access in patients with a history of intravenous drug use. Most accessed are the superficial veins of the antecubital fossa. During a prolonged period of injections, a 3% to 27% lifetime prevalence of thrombosis or emboli was found.[1] Mixing agents such as citric acid can cause venous sclerosis. The social factors associated with intravenous drug use, including homelessness, also affect access to follow-up.[1] The DOQI guidelines evolved into the Kidney Disease Outcomes Quality Initiative, which later resulted in a patient-focused concept called the ESKD life Plan.[4] Despite this new paradigm, a functional autogenous AVF is still recognized as the most

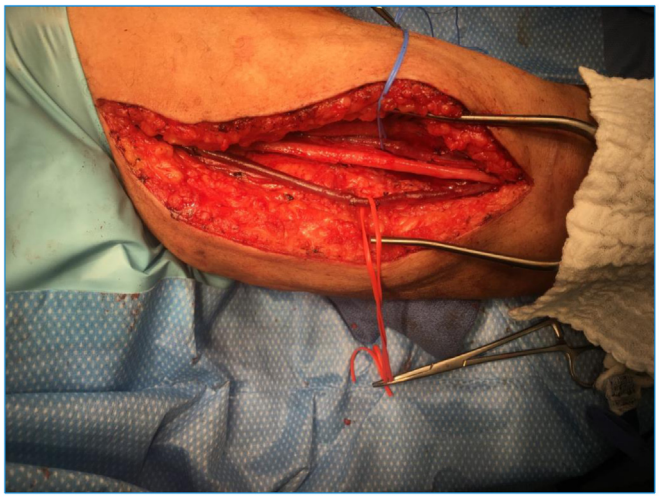

Fig 2. Photograph of the patient's right upper arm depicting operative dissection of paired brachial veins (BrVs). *Blue vessel loop* corresponds to BrV 1. *Red vessel loop* corresponds to BrV 2.

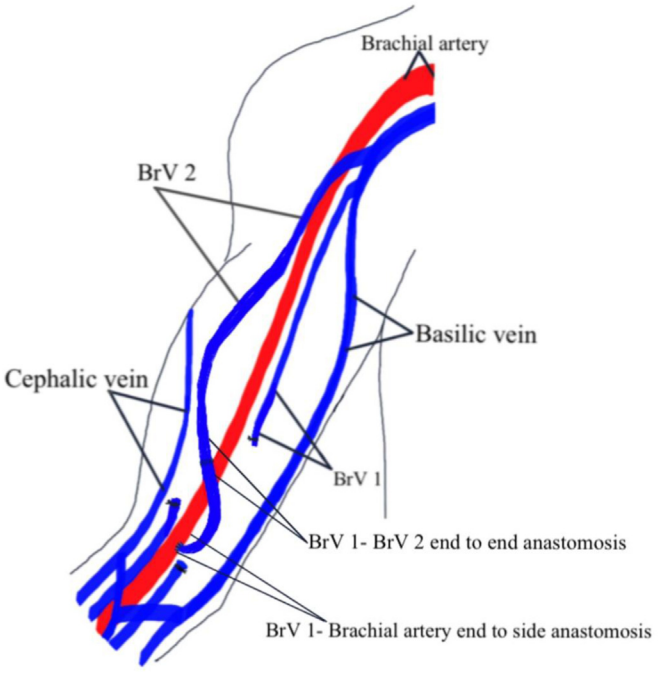

Fig 3. Depiction of final arteriovenous reconstruction. *BrV,* Brachial vein.

ideal access type by the Kidney Disease Outcomes Quality Initiative and is recommended for 65% of patients.[4] Autogenous access has been shown to have greater patency at 1 and 2 years compared with grafts.[4] Although increased patency of grafts has been accomplished with the advent of endovascular procedures, this has also increased the cost of prosthetic access compared with autogenous access over the years.[4] Thus, methods that expand the options for autogenous AVF creation that are safe and cost-effective stand to improve the quality outcomes measures such as functional patency and others.

The first basilic vein transposition was described in 1976; less commonly described is BrV transposition. Casey et al[5] performed a retrospective review of 59 vein transpositions between 2000 and 2006 and demonstrated comparable patency rates for BrV and basilic vein transposition at 12 months. Similarly, Kostas et al[6] performed a retrospective review of 43 patients divided into two subgroups: BrV transposition and "other access," including brachiocephalic, brachiobasilic, ulnar basilic, radiocephalic, and radiobasilic fistulas. A donor vein diameter of <3 mm, regardless of the anatomic name, was the greatest predictor of early graft failure.[6] A small vein diameter is a well-established negative predictor of fistula maturation.[7] A diameter of 2.5 mm is the threshold typically used to determine the suitability for fistula creation.[8] In cases in which the cephalic vein or basilic vein is not available, but autogenous access is desired, alternative procedures such as transposition or translocation could be viable options.

Translocation of the saphenous vein to the upper extremity was reported by May et al[9] in 1980. Their series showed a patency rate of 66% at 2 years.[9] It remains the largest series on the topic to date. Disadvantages include the need for two anastomoses and the loss of the saphenous vein for other purposes. However, little has been reported on saphenous vein translocation since then.

Bazan and Schanzer[10] provided an early description of BrV transposition when they reported on two cases in 2004. Transposition of the BrV is necessary because of its deep position; however, transposition also reduces the usable length of the conduit at the skin for access needle placement. A limited conduit length can cause recirculation and result in nonfunctional access.

Transposition of the BrV first described in 2004 was a single-stage operation.[10] Mobilizing the BrV is time intensive compared with mobilizing the basilic vein or cephalic vein because of its more complex anatomic relationships. The potential for postoperative arm swelling is another potential impediment to the broader use of the BrV. A series of 21 cases in which transposition of the BrV was performed in two stages was reported in 2007.[11] These reported experiences have shown that arm swelling is infrequently encountered. The BrV is often suitable for use in autogenous AVF creation in part because of its anatomically protected position. Ironically, the depth of the vein, especially among obese patients, could be a drawback to its use by virtue of the accessible length that can be lost after transposition. A limited vein length is undesirable, because access with close needle proximity results in recirculation, which can lead to a nonfunctional AVF. We were able to increase the accessible vein length by arranging the paired BrVs in series and, thus,

mitigate against recirculation. Additionally, the proximal portion of BrV 1 was left in situ to preserve the collateral pathways for venous drainage and reduce the risk of postoperative swelling. To the best of our knowledge, this is the first report to describe such a configuration. The advantage of an additional vein length was also recognized by Kostas et al[6] in their previously described novel technique to extend the function of an antecubital AVF by transposing the lengths of the BrV and basilic vein. The general concept of reconfiguring unrelated veins in series is a strategy that could provide additional options for autogenous AVF access creation for patients who might otherwise be relegated to synthetic graft placement. The use of deep arm veins, which largely contribute to venous drainage of the arm, necessitates consideration of the risk of severe and intractable edema. Transient postoperative edema has been observed in ≤20% of cases.[12] An alternative access should be considered before routine interruption of the upper arm BrVs. A risk/benefit analysis of prosthetic graft vs BrV use for AVF creation must be conducted. Factors to consider include the patient's dominant hand, access to routine or urgent follow-up, the patient's functional status, and the density of venous collateral vessels in the upper arm.[12]

CONCLUSIONS

When autogenous AVF access is desired, creative arm vein configurations, including the use of paired BrVs, should be considered when traditional options of the cephalic vein or basilic vein are not available.

DISCLOSURES

None.

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