

Proximal ulnar artery arteriovenous fistula inflow is an uncommon but useful vascular access option

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ABSTRACT

Introduction: A proximal ulnar artery arteriovenous fistula (PUA-AVF) is a logical vascular access option when the distal ulnar artery is occluded or inadequate in addition to other specific vascular anatomic variants. This study reviews a series of patients where the proximal ulnar artery was used for AVF inflow in establishing a reliable autogenous access for these uncommon patients.

Materials and methods: All new patients referred for vascular access with a PUA-AVF created during an eight-year period were evaluated. In addition to physical and ultrasound examinations, all patients had an Allen's test performed augmented with Doppler evaluation of the palmar arch. Analysis placed these patients into three anatomic groups: 1) A dominant radial artery with distal ulnar artery occlusive disease; 2) No cephalic or basilic vein option with an isolated and intact brachial vein originating from the ulnar vein for later staged transposition; 3) A proximal radial artery ≤ 2 mm in diameter and a normal Doppler augmented Allen's test.

Results: PUA-AVFs were created in 32 new patients during an eight-year period. Primary and cumulative patency rates were 80% and 94% at 12 months and 55% and 81% at 36 months. Follow-up was 2-62 months (mean 14 months). No patients developed steal syndrome during the study period.

Conclusions: A PUA-AVF is a safe and reliable autogenous access. It is particularly important when the radial artery is the only or dominant arterial supply to the hand, in patients with small but patent radial arteries, and in selected individuals requiring a brachial vein transposition.

Keywords: Arteriovenous fistula, AVF, Brachial vein, Transposition, Ulnar, Ulnar artery

Introduction

Confirming the integrity of hand perfusion is an integral component of a comprehensive examination prior to arteriovenous fistula (AVF) construction. In our experience, Allen's test with Doppler evaluation of the palmar arch(es) coupled with ultrasound vessel imaging are reliable methods for evaluating hand perfusion by both radial and ulnar arteries (1). Occasionally, patients are discovered where the radial artery supplies most or all arterial flow to the hand while the ulnar artery is occluded or inadequate. A radiocephalic or proximal radial artery AVF should be avoided in these individuals. A proximal ulnar artery AVF (PUA-AVF) is ideal for these un-

common patients, avoiding the higher risk of steal syndrome associated with brachial artery access and maintaining adequate hand perfusion through the dominant radial artery (2). In addition, uncommon anatomical findings may lead to the selection of PUA inflow as the most likely opportunity for a reliable autogenous access. This study reviews a series of patients where the proximal ulnar artery was used for AVF inflow when creating an autogenous vascular access.

Materials and methods

All new patients referred for vascular access during an eight-year period with a PUA-AVF created for hemodialysis access were evaluated through a retrospective compiled database. In addition to physical examination, each patient underwent surgeon-performed ultrasound vessel mapping and follow-up ultrasound examinations for maturation (1). During the initial evaluation, all patients had an Allen's test performed, augmented with Doppler evaluation of the palmar arch(es). Clinical indications for constructing a PUA-AVF fell into three groups: 1) Individuals with a dominant radial artery and distal occluded or inadequate ulnar artery flow into the hand (Fig. 1); 2) Patients where a staged brachial vein transposition was planned with an isolated and intact brachial vein originating from the ulnar vein (Fig. 2); 3) Patients with a

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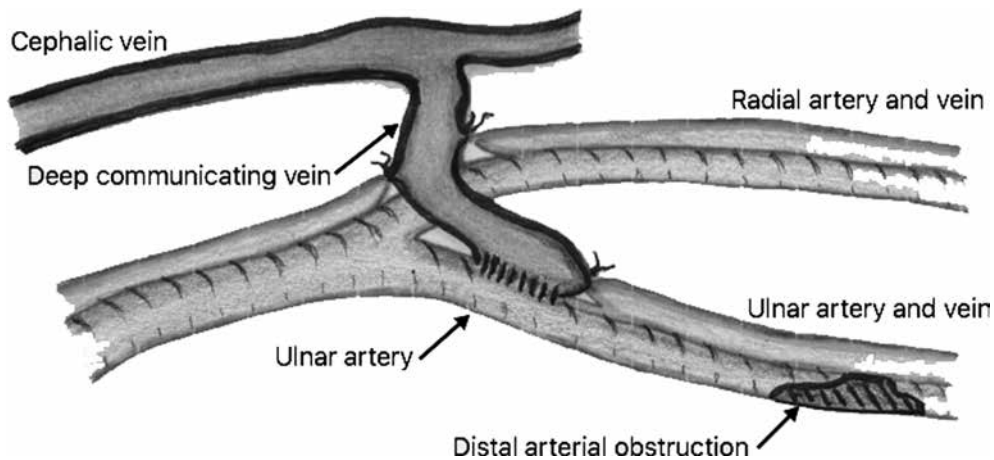


Fig. 1 - The illustration shows a proximal ulnar artery arteriovenous fistula (PUA-AVF). The ulnar artery is obstructed distally and the radial artery supplies the only significant arterial inflow to the hand. This uncommon AVF configuration avoids hand ischemia that might accompany a radiocephalic or proximal radial artery AVF.

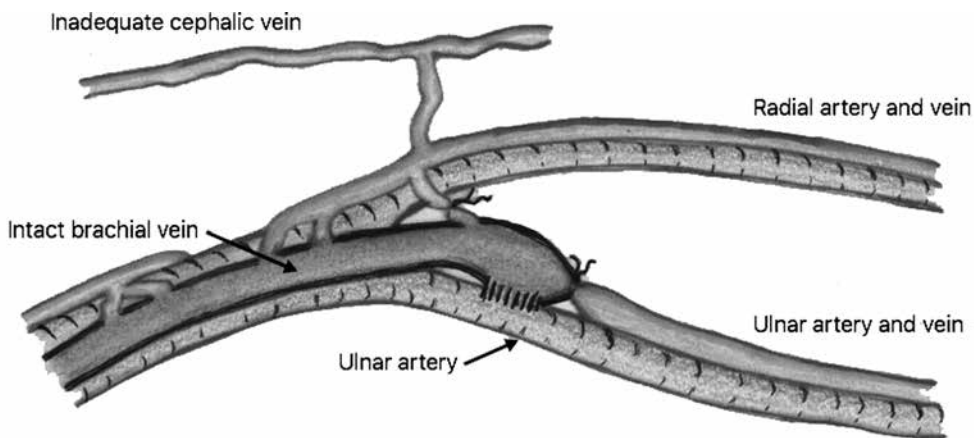


Fig. 2 - The illustration shows a proximal ulnar artery arteriovenous fistula (PUA-AVF) with outflow into the isolated intact brachial vein as the first stage of a later planned transposition. In patients where the superficial and basilic veins are not adequate, selecting an intact brachial vein is a key element for success. This process is facilitated with ultrasound examination by the operating surgeon.

proximal radial artery ≤ 2 mm in diameter and a normal Doppler augmented Allen's test.

All operations were completed as outpatient procedures at a university-affiliated tertiary medical center with local anesthetic and sedation. CV8 Gore-Tex suture (W. L. Gore & Associates, Flagstaff, AZ) was used for each vascular anastomosis. Heparin and prophylactic antibiotics were not administered (3). Primary patency was the time (months) with uninterrupted patency and without intervention. Cumulative (secondary) patency was the time period in which AVF patency was lost by thrombosis, until abandonment of the access or until completion of the study period. Statistical analysis was performed using Prism 4 (GraphPad Software, Inc, San Diego, CA). Our institutional review board approved this study.

Results

PUA-AVFs were created in 32 individuals identified from the 1476 consecutive new patients with a vascular access created during an eight-year period. Ages for the PUA-AVF patients were 14-86 years (mean = 52 years). Twenty-one (66%) patients were women and 23 (72%) were diabetic. Twelve (38%) individuals had previous access operations and 14 (44%) were obese. Seventeen (53%) patients were in Group

1 (severe occlusive disease in the distal ulnar artery). Four (13%) individuals were in Group 2 (isolated brachial vein for staged transposition). Eleven (34%) patients were in Group 3 (small but otherwise normal radial artery with normal Allen's test). Four of the Group 3 patients had a high brachial bifurcation in the proximal arm. Overall, direct AVFs were created to establish flow into the cephalic vein for eventual cannulation in 24 patients. Among these cephalic outflow AVFs, the venous component of the PUA-AVF anastomosis utilized the deep communicating vein in 13 patients, the median cubital vein in 8, or the median antebrachial vein in 7 individuals. Five PUA-AVFs also established reverse access flow into a forearm cephalic vein. Eight individuals required a transposition (four basilic vein and four brachial vein AVFs). A planned staged lipectomy was required for two of the cephalic outflow AVFs. An end-to-side anastomosis with a branch-batch technique was used routinely for all PUA-AVFs.

Two PUA-AVFs failed at 3 and 44 months. Primary and cumulative patency rates were 80% and 94% at 12 months, 73% and 94% at 24 months, and 55% and 81% at 36 months (Fig. 3). Follow-up was 2-62 months (mean 14 months). No patients were excluded. Two patients were lost to follow-up at 3 and 14 months. No patients developed steal syndrome during the study period. No grafts were placed in any new patient during the study period.

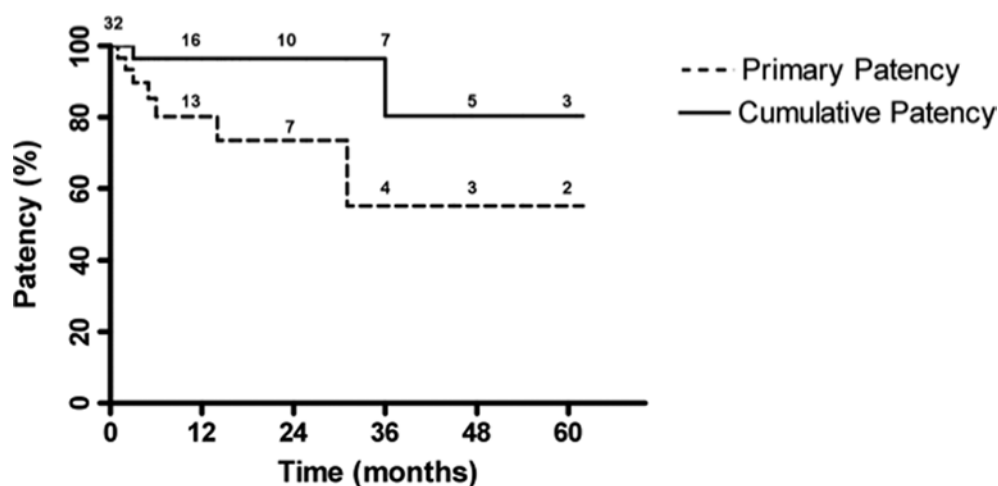


Fig. 3 - Kaplan-Meier access patency curves show proximal ulnar artery arteriovenous fistula primary patency and cumulative patency. The numbers at risk are shown along each line.

Discussion

A complete vascular access examination should include an evaluation of arterial sufficiency in the palmar arch(es), detecting the uncommon combination of a dominant radial artery and inadequate ulnar artery. In such patients, either a distal or proximal radial artery AVF will likely result in symptomatic or more threatening hand ischemia. Allen's test augmented by Doppler interrogation of hand perfusion offers a quick and reliable clinical assessment.

Reports of ulnar artery inflow AVFs are rare and generally in association with other procedures (4). Proximal ulnar artery inflow for vascular access has likely been utilized by many surgeons and should offer the same benefits expected with proximal radial artery AVFs (5-7). Retrograde forearm access sites may be recruited if a cephalic or median antebrachial vein segment is available by disrupting the initial venous valve prior to completing the anastomosis (5). Brachial artery inflow is avoided with dramatically lower risk of steal syndrome and the uncommon cases of ischemic monomelic neuropathy (2, 8). In addition, these modest flow AVFs are less likely to lead to high access flow associated congestive heart failure (CHF) or arm swelling related to central vein stenosis or occlusion, and forearm cannulation sites may develop through retrograde flow (5, 9). The proximal ulnar artery is generally larger than its radial artery counterpart and may extend into an acutely posterior position (10). However, its larger size and freedom from significant arteriosclerotic disease at this proximal location results in a favorable site for an AVF anastomosis. Two percutaneous AVF creation devices have been recently developed, one utilizing the proximal ulnar artery, while the other the proximal radial artery for AVF inflow. They employ different technical methods for creating an anastomosis; however, both have reported early success in human trials and obviously have the benefits of AVFs created distal to the brachial artery (11, 12).

Brachial vein transpositions offer reliable vascular access; however, they involve more complex operations, careful planning, and are best performed in staged procedures

(13, 14). When the maturing brachial outflow vein is incomplete, establishing a functional transposed outflow vessel is much more complicated (15). Evaluation of both arms with ultrasound by the operating surgeon is the key element for identifying the largest *intact* brachial vein for eventual transposition (1, 16). Creating the first-stage AVF anastomosis distal to the brachial artery preserves important length for the later staged transposition in addition to gaining the other benefits of a more distal AVF (13). The patients in Group 2 (Fig. 2) clearly demonstrate the importance of this analysis.

Patients with a proximal brachial or axillary artery bifurcation often have radial arteries that are smaller but patent throughout the forearm and into the palmar arch, supplying important arterial inflow to the hand. In some reports, this anatomic variant is associated with the lower rates of AV fistula success (17). Four such patients were included in Group 3 of this analysis and all had successful fistulas without hand ischemia. Uncommon patients with a normal radial artery origin but smaller vessel diameter may have lower AVF success rates. Establishing a PUA-AVF is an appealing option in these patients when clinical evaluation of the radial artery may be relied upon to ensure adequate arterial flow to the hand.

Arteriography was not necessary in planning a successful AVF for these patients. Ultrasound examination of the ulnar and radial arteries combined with Allen's test augmented with Doppler evaluation of the palmar arch yielded sufficient diagnostic information. If, instead of the findings reported in these individuals, a distal radial artery occlusion had been discovered with isolated ulnar arterial supply to the hand, then a proximal radial artery AVF would be indicated. When bilateral severe atherosclerotic arterial disease is present in both brachial arteries and/or in both ulnar and radial arteries, the risk of dialysis access associated hand ischemia is significant and an axillary inflow AVF should be considered (18).

Specific indications for a PUA-AVF are uncommon, representing only 2.2% of new patient access operations in this practice during the study period. However, it represents just one of the many AVF options available for establishing a safe, functional, and reliable autogenous vascular access.

Ultrasound examination by the operating surgeon opens the door to these possible access solutions in addition to maintenance and preservation of dysfunctional AVFs (1, 19).

Conclusions

In patients where the radial artery is the only or dominant arterial supply into the palmar arch, a proximal ulnar artery AVF is a safe and effective method of constructing a moderate flow autogenous access. In addition, selected patients requiring a brachial vein transposition and individuals with patent radial arteries ≤ 2 mm in diameter and a normal Doppler augmented Allen's test may benefit from construction of a proximal ulnar artery AVF.

Disclosures

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Conflict of interest: WCJ is a consultant and stockholder with Avenu Medical.

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