A modified nontransposed brachiobasilic arteriovenous fistula versus brachiocephalic arteriovenous fistula for maintenance hemodialysis access

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Objective: **With the growing need for reliable and durable upper arm hemodialysis access, we sought to compare the performance of a novel modified nontransposed brachiobasilic arteriovenous fistula (mNT-BBAVF) with that of the more traditional brachiocephalic arteriovenous fistula (BCAVF).**

Methods: **Briefly, to construct an mNT-BBAVF, an incision is made on the ulnar side of the elbow. The brachial artery and basilic vein are then isolated, and a side-to-side anastomosis is performed without transposition of the basilic vein. Next, the proximal basilic vein and the perforating veins within the surgical field are ligated. In this study, we retrospectively reviewed the medical records of all patients who underwent either an mNT-BBAVF or a BCAVF between January 2011 and October 2014 to compare 1-year primary unassisted patency, cumulative patency, and complications. We also examined hemodynamic parameters of vessels in each fistula type.**

Results: **We identified a total of 84 patients: 45 had a BCAVF, and 39 had an mNT-BBAVF. The two groups were well matched for baseline characteristics. Maturation rates at 1 month were 97% for mNT-BBAVF and 96% for BCAVF. The 1-year primary unassisted patency was significantly higher in the mNT-BBAVF group than that in the BCAVF group (87% vs 67%; hazard ratio, 2.86; 95% confidence interval, 1.11-6.40; $P = .03$), although cumulative patency did not differ (90% vs 73%; hazard ratio, 2.80; 95% confidence interval, 0.98-6.96 ; $P = .06$). There were no differences in thrombosis, failure of maturation, bleeding, steal syndrome, arm swelling, aneurysm, and stenosis between the two groups during the 12-month study. Importantly, diameters and blood flow volumes of the proximal cephalic vein, distal cephalic vein, and distal basilic vein in patients who received an mNT-BBAVF increased significantly after 12 months. All three vessels met the Kidney Disease Outcomes Quality Initiative (KDOQI) criteria for fistula maturation and were available for dialysis cannulation, whereas only the proximal cephalic vein in the BCAVF group met the maturation criteria and could be used for cannulation.**

Conclusions: **mNT-BBAVF appeared to be an effective alternative to BCAVF for upper arm hemodialysis access. (J Vasc Surg 2016;■:1-7.)**

A well-functioning vascular access is essential for effective hemodialysis. Native arteriovenous (AV) fistula (AVF) is the preferred vascular access because of a lower rate of risks of thrombosis and infection compared with either synthetic AV grafts or central venous catheters.[1,2] The type of AVF chosen varies depending on the anatomical structure (Fig 1, *A*). The 2008 Clinical Practice Guidelines from the Society for Vascular Surgery recommend forearm autogenous AVF as the first choice for primary hemodialysis access.[3] Upper arm accesses, including brachiocephalic AVF (BCAVF; Fig 1, *B*) and transposed brachiobasilic AVF (T-BBAVF; Fig 1, *C*), are reserved for AV access when a patient is not a suitable candidate for a forearm fistula.[3] With the increasing emphasis on AVF and the changing dialysis population, which includes more elderly patients with cardiovascular comorbidities, upper arm fistulas have gained popularity in recent years.

However, there are many limitations to the upper arm fistulas that are commonly placed. The cephalic vein of BCAVF is frequently cannulated at the antecubital fossa. As a result, the risks of stenosis and thrombosis are high, which might compromise proper fistula function and survival.[4] In the T-BBAVF, an end-to-side anastomosis is made between the basilic vein and brachial artery. This requires the basilic vein to be dissected out and tunneled through subcutaneous tissue for superficialization, a procedure that is technically challenging and often causes arm swelling.[5] The 2008 Clinical Practice Guidelines from the Society for Vascular Surgery recommend that the autologous access configurations should include, in

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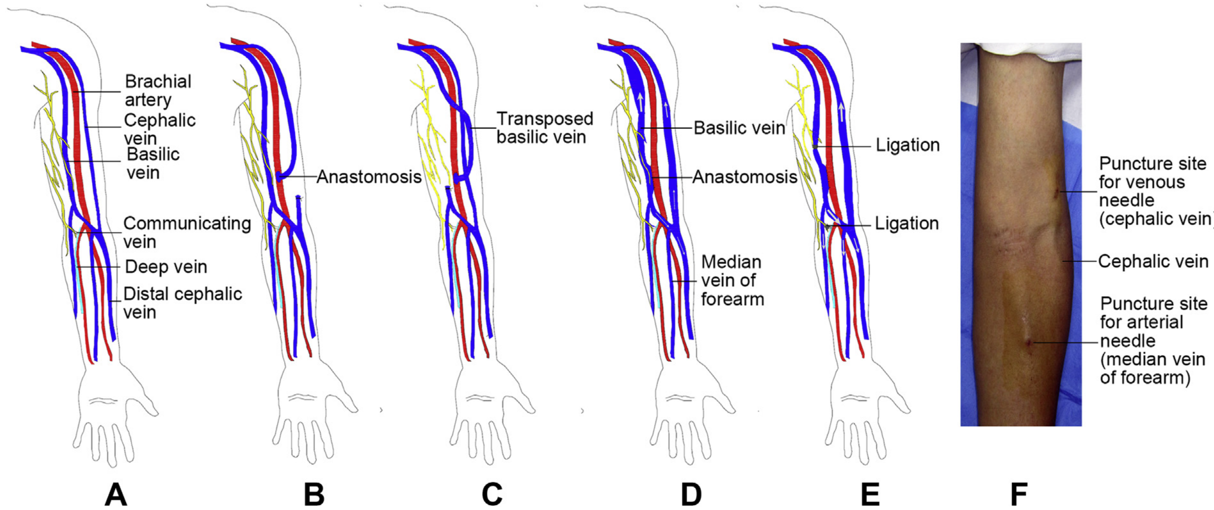

Fig 1. Illustrations for surgical anatomy. **A,** Anatomy of upper extremity; **B,** brachiocephalic arteriovenous (AV) fistula (AVF); **C,** transposed brachiobasilic AVF (T-BBAVF); **D,** traditional non-T-BBAVF; and **E** and **F,** modified non-T-BBAVF (mNT-BBAVF).

order of preference, the use of direct AV anastomosis, venous transpositions, and translocations.[3] Therefore, there is a renewed interest in exploring the clinical efficiency of non-T-BBAVF (NT-BBAVF).

The NT-BBAVF was first introduced by Geis et al[6] in 1977 and recently modified by Lomonte et al.[7] It involves a side-to-side anastomosis between the brachial artery and basilic vein, thus allowing antegrade and retrograde flows along the basilic vein from its arterial anastomosis (Fig 1, *D*). This NT-BBAVF provides more potential sites for hemodialysis cannulation because of the reversed flow into the antecubital system, which creates arterialized distal basilic and antecubital veins. However, because of the lower pressure in the proximal basilic vein, much of the blood is shunted away from the fistula into the superior vena cava. Therefore, the maximal maturation potential of the fistula is compromised.

In this report, we introduce a modified NT-BBAVF (mNT-BBAVF; Fig 1, *E* and *F*). Briefly, after an incision is made on the ulnar side of the elbow, the brachial artery and basilic vein are isolated and a side-to-side anastomosis is performed without transposition of the basilic vein. Next, the proximal basilic vein and the perforating veins within the surgical field are ligated. This creates a complete reversal of venous blood flow in the basilic vein after the total ligation of its proximal segment and the perforating vein within the surgical field. This facilitates the arterialization of the distal venous segments. To investigate its efficacy, we performed a retrospective cohort study to compare outcomes (1-year patency rates, hemodynamic parameters, and complications) between patients who underwent mNT-BBAVF and those underwent traditional BCAVF.

METHODS

Patients and measurements. We identified patients who received either the mNT-BBAVF or BCAVF in our center between January 2011 and October 2014. Subjects who had other vascular access surgeries in the ipsilateral arm were excluded. All study participants had preoperative Doppler ultrasonography showing poor distal vessels for a forearm fistula, defined as <2.0 mm for arteries or <2.5 mm for veins, as reported by previous studies.[8,9] Patients who had the fistula placed but did not receive dialysis in our center were also excluded from this study. All of the AVFs in this study were initially cannulated within 8 weeks after the procedure.

All clinical information including patients' demographic characteristics, patency-related incidences, and adverse events were retrieved from medical records.

Hemodynamic parameters of relevant blood vessels including diameter, blood flow velocity, and flow volume were assessed using Doppler ultrasonography in the upper extremity. They were performed within 3 days before surgeries in all patients. An ultrasound examination was repeated 12 months after surgeries if the fistula was still functioning. Measurements of the arteries and veins were performed by the same experienced ultrasound examiner, adopting the method previously reported.[10] Three locations along the arteries or veins were measured and the mean results were obtained. To minimize potential confounders in the measurement, we require that all patients had controlled blood pressures (baseline systolic blood pressure ± 15 mm Hg) and the ultrasound examinations were performed on nondialysis days. The average velocity was calculated using the formula: average velocity (cm/s) = (PSV − EDV)/3 + EDV, where PSV = peak systolic velocity and EDV = end diastolic velocity.[10] Blood flow volume was then calculated using the formula: flow volume (mL/min) = average velocity (cm/s) × area ($r^2\pi$) × 60 seconds.[11] This study was conducted in accord with the Declaration of Helsinki, and was approved by the institutional review board of the Shanghai Tenth People's Hospital of Tongji University (RES: SHSY-IEC-pap-15-10). Informed consent was obtained from all patients.