Arteriovenous Access by Nephrologists
Percutaneous Creation of Arteriovenous Fistula

By Umar Waheed

Arteriovenous fistulae (AVF), compared with prosthetic arteriovenous grafts and central vein catheters, are the most effective hemodialysis vascular access option for patients who require renal replacement therapy because of ESKD (1). The effects of autologous AVF include lower thrombosis and infection rates, fewer hospital admissions for access revision, significantly lower mortality rates, increased life expectancy, and lower healthcare-related costs (2, 3).

However, there are many challenges to the successful use of an autologous AVF. One hindrance is the relatively high early thrombosis and failure to mature rate. Surgically created AVF failure rates are high, and primary/secondary patency rates are low (4). Thus, an important logistic challenge is the well-timed placement and maturation of a functional AVF. Unfortunately, early loss of patency leads to high central venous catheter use, lengthy catheter contact time, additional procedures to maintain catheter patency, and attempts at AVF maturation and salvage. These additional procedures adversely affect fistula patency and lead to further frequent interventions (5).

Percutaneous creation of AVF (pAVF) for hemodialysis access in patients with kidney disease now allows for AVF creation in the outpatient setting. This provides nephrologists the opportunity to create an AVF in dialysis access centers in a safe and effective manner. Inasmuch as these procedures are entirely percutaneous, the advantages include quicker initiation of hemodialysis, quicker maturation times, and reduced costs and complications. Two devices are currently available to create pAVF.

Ellipsys Vascular Access System

The Ellipsys percutaneous arteriovenous fistula device (Avenu Medical, Inc., San Juan Capistrano, CA) (Figure 1) is a single venous catheter vascular access system that uses thermal resistance energy to create an arteriovenous anastomosis with fusion of the arterial and venous walls in the proximal part of the forearm (6). Overall, it has demonstrated good cumulative patency rates for as long as 2 years (7).

Ellipsys catheter. Bottom, Ellipsys power controller.

The procedure is straightforward. First, with continuous ultrasound guidance, a retrograde venous puncture is made into the median cephalic or median basilic vein. The needle is advanced over a micropuncture guidewire to the perforating vein (Figure 2).

Figure 2. Procedure for percutaneous arteriovenous vascular access

Left, perforator anatomy. Right, access.

Then, the needle is advanced into the adjacent proximal radial artery (PRA). Next, a 6-Fr Glidesheath Slender (Terumo Interventional Systems) is inserted through the perforating vein into the PRA. The Ellipsys catheter is now introduced. The sheath is retracted to the more superficial part of the perforating vein, and gentle traction is applied to the Ellipsys catheter until the tip of the device engages the anterior wall of the PRA. This provides tactile resistance to further traction. Next, the catheter is closed, which captures the arterial and venous walls between the tip and the base (Figure 3). To confirm proper positioning of the device, a display on the power controller can verify correct tissue capture. Next, the device is activated with thermal energy, and a side-to-side elliptical anastomosis is formed between the perforating vein and the PRA.

After the device is removed, immediate improvement of flow and acceleration of maturation is induced by angioplasty balloon dilatation of the anastomosis with a 4- × 20-mm or a 5- × 20-mm monorail balloon catheter (Boston Scientific Corporation) (Figure 4). This may reduce the postanastomotic stenosis observed in earlier studies (Figure 5).

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Figure 3. Wall capture, application of thermal energy, and anastomosis creation

Figure 4. Left, Anastomotic narrowing. Right, creation of percutaneous transluminal angioplasty showing balloon waist

With a single entry into a low-pressure venous system and short procedure times (most cases require 10 to 20 minutes, and several have been performed in under 10 minutes), the procedure is highly effective. The use of real-time ultrasound guidance eliminates radiation exposure for both the physician and the patient. In addition, the pAVF in the setting of advanced chronic kidney disease eliminates the risk of radiocontrast nephropathy.

WavelinQ endoAVF System

The WavelinQ endoAVF system (Figure 6) consists of a 4-Fr venous catheter, a 4-Fr arterial catheter, and an electrosurgical generator (Becton Dickinson, Franklin Lakes, NJ). The catheters are lined with square magnets and have rotational indicators that help with alignment during AV access creation (Figure 7).

Figure 5. Left, complete balloon effacement. Right, flow of 770 mL/min after percutaneous transluminal angioplasty

Under ultrasound guidance, the selected vein and artery are accessed. Next, under fluoroscopy, the arterial catheter is placed into the creation site in the proximal forearm over a 0.014-inch guidewire through an introducer sheath. The venous catheter is then similarly placed.

Figure 6. WavelinQ endoAVF system

The anastomosis site will vary on the basis of the patient’s anatomy but is typically a proximal ulnar–ulnar or proximal radial–radial anastomosis. As both catheters traverse their respective vessels to reach the creation site, they are rotationally aligned so that the electrode and ceramic backstop are facing each other (Figure 8). Once they reach...
the creation site, confirmation of placement is made by the operator with the help of the rotational indicators.

Figure 8. Arterial and venous catheters aligned

The magnets attract, coapting the catheters together. The device is then activated to deliver 60 W of radiofrequency energy for 0.7 seconds through the venous electrode to cut a precise channel to the arterial backstop. The devices are removed, and a fistulogram is performed to confirm success of the creation site, confirmation of placement is made by the operator with the help of the rotational indicators.

Advantages of pAVF

The side-to-side anastomosis configuration of pAVF leads to a modest flow to various outflow veins. This is excellent because it leads to lower access pressure and may contribute to fewer complications such as aneurysm formation, steal syndrome, recurrent access stenosis, and the resultant need for frequent reintervention. The perforating vein flows from the deep veins of the forearm to the superficial venous system, which allows for vessel maturation. Multiple outflow veins can potentially be developed for cannulation, including the cephalic vein, median cubital vein, median basilic vein, and basilic vein. Thus, different cannulation options may be available for accessing the pAVF to provide dialysis.

The path forward for patients requiring creation of a traditional AV access with open surgery is one of many complexities and potential delays. Several steps can negatively affect the timeline to a functional AVF, including vessel mapping, referral to surgery, surgical consultation along with additional anesthetic and associated investigations, surgical time in the operating room, surgical follow-up, and return referral for maturation evaluation and access cannulation. However, pAVF creation significantly reduces the time from recognition of the need for AV access creation to the creation of a pAVF. Additionally, it gives the nephrologist more control over the access process. Ultimately, this technique has demonstrated its success by allowing nephrologists to create an AV access within 1 to 2 days after patient referral. In some cases, the achievement of ultrasound maturation criteria and use has occurred as early as 2 weeks after pAVF creation (8).

In brief, pAVF technology is a useful tool for dialysis access creation because it allows for more direct involvement by the nephrologist and lower-cost procedures in the outpatient setting. It has many advantages over traditional surgical AVF creation and is a feasible alternative to open surgical AVF creation for patients with favorable vascular anatomy. [3]

Umar Waheed, MD, specializes in nephrology and vascular surgery and is affiliated with Banner University Medical Center, Phoenix.

References