Achieving AV Access

The number of these procedures steadily increases and is accompanied by a shift toward safe and effective outpatient treatment.

BY SHAHRIAR MOOSSAVI, MD, PHD; JOHN R. ROSS, MD; DONALD P. BERLING, MD; AND SUMIT KUMAR, MD


Shahriar Moossavi


John R. Ross


Donald P. Berling


Sumit Kumar

During the past decade, the incidence of end-stage renal disease (ESRD) continues to rise. This increase in incidence is fueled by the epidemic of diabetes and hypertension. Data published by the US Renal Data System in 2006 reported a 2004 population of approximately 336,000 patients with ESRD.[1] Of this population, approximately 309,269 were maintained with hemodialysis. The choice of modality, hemodialysis, or peritoneal dialysis is dependent upon patient age, comorbidities, personal choice, and variations in regional practices.

The health and longevity of a dialysis patient is largely predicated on the success of the dialysis access. Vascular access patency is a constant struggle and is certainly one of the most significant clinical challenges of long-term hemodialysis. To improve patient care and survival, the National Kidney Foundation (NKF) and Centers for Medicare & Medicaid Services (CMS) are currently proactive in the access arena. Not only did patient outcomes prompt the KDOQI Vascular Access Guidelines and Fistula First Initiative, but health care costs enter the arena of access creation and management. Both KDOQI and the Fistula First Initiative advocate the radiocephalic or brachiocephalic arteriovenous fistulae (AVF) as the primary choice for access, followed by the basilic vein transposition (BVT). The AVF provides greater patency rates, increased survival, lower infection rates, and lower hospitalization rates. Thus, AVF use results in lower maintenance costs. Medicare data supports a lower health care cost for patients with fistulae. The per-patient-per-year (PPPY) costs were lower for patients with fistulae ($55,112 PPPY). Synthetic graft PPPY costs were reported as $65,556, and catheter PPPY costs were reported as $75,345. Moreover, Dhingra et al report that mortality risks were greater for patients utilizing grafts and catheters for hemodialysis.[2] The Fistula First Initiative sets forth a goal of 65% fistula creation by 2009.

AV grafts are acceptable long-term hemodialysis access for patients who do not have suitable vessels for AV fistulae creation. Grafts are made from a synthetic (PTFE, polyurethane) or a biologic material (bovine). PTFE grafts may be cannulated 2 to 3 weeks after implantation. The polyurethane grafts are self-sealing and can be cannulated immediately if the outflow vein diameter is 6 mm or greater. Bovine grafts are best used in patients with low flow states (eg, low cardiac output) and small vessels.

Precise preoperative assessment is vital to the creation of AV access. The KDOQI guidelines offer specific assessments prior to determining the type of access. These guidelines include a thorough history, physical examination, and vascular assessment of both the arterial and venous systems. Vital to the access choice process is the knowledge of the patient's cardiopulmonary status, presence of transvenous pacemakers, implantable defibrillators, and the use of previous central venous catheters.

The history, coupled with the physical examination, provides the primary tool necessary for the physician to determine the appropriate access type. The arterial physical examination must address evaluation of pulses, differential blood pressure, Allen test, and duplex ultrasonography. The examination of the venous system focuses on the presence of edema, collateral veins, differential extremity size, tourniquet dilation of the veins, and Doppler ultrasound. Venography may be required occasionally to evaluate for central stenosis. In the patient with residual renal function who is not yet undergoing dialysis, the benefit/risk ratio would need to be determined prior to the infusion of intravenous contrast.

The NKF KDOQI Vascular Access Guidelines target not only the choice of access but also the monitoring and surveillance of the access. The KDOQI guidelines suggest weekly and monthly monitoring of fistulae and grafts. This weekly exercise involves the physical examination, with attention to inspection and palpation of the arterial, mid, and venous segments of the access. Predictive indicators of venous stenoses may be edema of the access extremity, prolonged bleeding after venipuncture (in the absence of excessive anticoagulation), and changes in the thrill or pulse.

In addition to weekly surveillance, the KDOQI guidelines recommend monthly assessments. Multiple methods are available for access surveillance, including intra-access blood flow, static venous pressure, and dynamic venous pressure monitoring. Decreases in the Kt/V or urea reduction ratio**,** elevated arterial pressures, and measurement of recirculation are valuable to the surveillance process. Decreasing blood flow rates or rising venous pressures may be the harbinger of impending thrombosis. Blood flow rates less than 600 mL/min in both fistulae and grafts indicate increased risk for thrombosis. Static pressures >25% above the baseline in either venous or arterial segments are a warning of the possibility of a hemodynamically significant stenosis. If the difference between arterial and venous pressure ratios is >0.5 in grafts or >0.3 in fistulae, the question arises as to the presence of an intra-access stricture. Dynamic venous pressure monitoring utilizes venous pressures measured at blood flows of 200 to 255 mL/min. Schwab et al found that a dynamic pressure of >150 mm Hg is a predictor of venous stenosis >50% in 86% of the patients undergoing angiography.[3]

Identification of changes either in the physical character of the access or changes in any of the surveillance methods dictates referral for angiography and appropriate intervention. Studies demonstrate that intervention with PTA both reduce the graft thrombosis rate and ultimately increase the overall life span of the access.[3-6]

The failure modes of AV accesses vary. The radiocephalic AVF is prone to arterial inflow stenosis. The failure mode of the brachiocephalic AVF is the outflow at the cephalic arch. The stenosis of the inflow and outflow swing segment is commonly the reason for BVT malfunction. Most AVG failures are due to outflow stenosis. Catheter failures are usually due to malposition or fibrin sheaths.

INTERVENTIONAL PROCEDURES ASSOCIATED WITH AV ACCESS

Angiography

The indications to perform angiography include increased venous pressure during hemodialysis (HD), low bloodflow with HD, ischemic hand, aneurysm formation, hematoma, swollen extremity, follow-up on previous procedure, or as directed by physical examination or by surveillance method.

Typically, an angiogram can be obtained using an 18-gauge angiocatheter. If there is difficulty handling the 18-gauge needle, a .035-inch guidewire is advanced into the angiocatheter, and the angiocatheter can be exchanged for a 4-F or 5-F introducer.

Angioplasty

The majority of balloons used in arteriovenous access procedures are noncompliant balloons. The size of angioplasty balloons is determined by the vessel size. In the lower arm,

The access vascular suite.

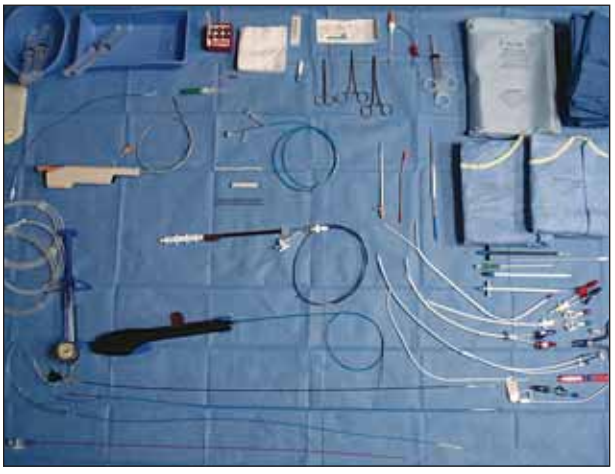
6-mm balloons are commonly chosen. In the upper arm, a 7-mm or 8-mm balloon can be used. For the cephalic arch, going beyond a 7-mm balloon requires the availability of a stent graft because the risk of rupture drastically increases. The angioplasty balloon can be taken up by hand or by a mechanical insufflator. The nominal pressure and burst pressure of each balloon is specified by the manufacturer. In general, once the balloon has been fully effaced, there is no benefit of increasing the insufflation pressure. The introducer size may need to be adjusted for the balloon. A cutting balloon may be used if the lesion is refractory to repeated angioplasty.

Thrombectomy

A venous access is established approximately 2 cm above the arterial anastomosis, as described in the angiography procedure. Thrombectomy can be done using a mechanical device or with thrombolytics. Once the venous limb of the arteriovenous access is declotted, an angiogram is obtained to determine the size of the outflow vein and the area of stenosis. The arterial access is then established approximately 4 cm or more away from the venous anastomosis using the standard needle/wire introducer technique. The guidewire is moved past the arterial anastomosis. A 4-F, 80-cm Fogarty thrombectomy catheter (Edwards Lifesciences, Irvine, CA) is then passed distal to the arterial anastomosis, and the arterial plug is pulled. If there is difficulty passing the guidewire, an over-the-wire thrombectomy balloon is helpful. The balloon is hand-insufflated in the arterial system.

Venous Stents

Stents in AV access have a role that is continuing to evolve. Their use in free-standing centers is limited because of the high cost. Furthermore, there are no stents that are specifically FDA-approved for use in vascular access. In experienced hands, stents find use in specific situations, and it is recommended that all vascular access interventionists acquire proficiency in their selection, use, and placement. Venous stents are indicated if there is an inadequate response to angioplasty with an oversized balloon with recoil stenosis. If during the course of an angio-



Tools for access.

plasty, as significant dissection occurs leading to extravasation and PTA is unable to stop it, a stent may be placed across the lesion. Typically, stents are not placed across stenotic lesions when they are first detected. However, if rapid restenosis occurs within a 3-month period, a stent may be indicated to preserve patency. Also, pseudoaneurysms respond well to placement of stents.

Stents are broadly divided into two categories: bare metal (open) and stent graft (covered). The individual properties of each type of stent with regard to design, flexibility, and kink resistance dictate their use in specific circumstances. There is some suggestion that PTFE-covered stents may offer higher primary patency, however, this remains to be verified. Stents are fraught with their own sets of problems. Intrastent neointimal proliferation is common, and stenoses before and after stent placement are noted frequently.

Tunneled Dialysis Catheters

The catheters are the last choice for dialysis access given the high incidence of catheter-related infections and the associated comorbidities and complications. There are two major techniques for catheter placement: antegrade and retrograde positioning. The placement of a retrograde catheter enables the operator to better control the tunneling and length of the catheter, however, it requires a few extra steps compared to the retrograde placement technique. The real-time visualization of the central vein continues to be the most important part of the procedure. Currently available devices are the SiteRite (Bard Access Systems, Salt Lake City, UT), SonoSite iLook, or SonoSite Titan (Bothell, WA). All operators are encouraged to use a SafeSheath (Pressure Products, Inc., San Pedro, CA) after using the sequential dilation to avoid air embolism. The new addition this year has been the availability of a heparin-coated catheter. Silicone catheters are especially valuable if the catheter has to make a sharp angle under the skin.

CONCLUSION

The number of vascular access procedures has increased more than fivefold in the past 12 years, with expenditures more than doubling during the same period. In 2004, the total number of vascular access procedures on hemodialysis patients reached nearly 1.5 million. The financial implications are staggering having reached the $1 billion level for vascular management alone. This growth has been accompanied by an increasing trend in performing the procedures in the outpatient setting. In 1991, 77% of all access procedures were performed in an inpatient setting. By 2004, more than two-thirds of the procedures were performed on an outpatient basis. Attendant with this shift away from impatient procedures, there has been a growth in the number of outpatient hemodialysis access centers. Experience has shown that a broad spectrum of access procedures, including permanent catheter placement and removal, thrombectomy, angioplasty, and deployment of intravascular stents can all be performed effectively and safely in the outpatient access center setting. ■

Shahriar Moossavi, MD, PhD, is Assistant Professor, Department of Internal Medicine/Nephrology, Wake Forest School of Medicine, Winston-Salem, North Carolina. He has disclosed that he holds no financial interest in any product or manufacturer mentioned herein. Dr. Moosavi may be reached at (336) 716-8818; smoossav@wfubmc.edu.

John R. Ross, MD, is Chief of Surgery, Bamberg County Hospital, Bamberg, South Carolina. He has disclosed that he holds no financial interest in any product or manufacturer mentioned herein. Dr. Ross may be reached at (803) 245-4435; jrrsurgery@aol.com.

Donald P. Berling, MD, is from Metrolina Nephrology Associates and the Metrolina Transplant Clinic in Charlotte, North Carolina. He has disclosed that he holds no financial interest in any product or manufacturer mentioned herein. Dr. Berling may be reached at (704) 348-2992; nephrondon@hotmail.com.

Sumit Kumar, MD, is from Dallas Nephrology Associates in Dallas, Texas. He has disclosed that he holds no financial interest in any product or manufacturer mentioned herein. Dr. Kumar may be reached at (214) 366-6436; glomdoc@gmail.com.

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