

Vein Preservation and Alternative Venous Access

Exploring the options for patients with chronic kidney disease.

BY THEODORE F. SAAD, MD

Since the inception of chronic hemodialysis and the introduction of the Brescia-Cimino arteriovenous fistula,¹ there has been a strong culture favoring vein preservation in the nephrology and hemodialysis community. During the past 3 decades, there has been continuous growth in the patient population with chronic kidney disease (CKD), as well as advances in many medical therapies requiring venous access devices. Many alternatives for venous access now exist, including conventional peripheral intravenous catheters, peripherally inserted central catheters (PICCs), nontunneled central venous catheters, tunneled central venous catheters (with or without a subcutaneous cuff), and subcutaneously implanted ports utilizing either central or peripheral veins. As a result, there is considerable pressure on the limited venous “real estate” available for placement of these devices and creation of arteriovenous access. Recently, there has been increasing recognition of the importance of vein preservation for creation of future arteriovenous access in CKD patients and strategies proposed to optimize practice in this area.²⁻⁴ There are several important concepts that must be considered by the practitioner placing venous access devices in order to provide optimal care to CKD patients.

Many veins are of potential importance to CKD patients requiring future arteriovenous hemodialysis access and warrant preservation. These include:

Superficial veins of the anterior forearm: Traditional Brescia-Cimino fistula using cephalic vein or any other variety of creative forearm native fistulae may be constructed using basilic or median antebrachial vein.

Antecubital veins: Although rarely used for direct dialysis needle access, this vein may be valuable for drainage from any forearm fistula or graft, or may be ideal for construction of the arterial portion of any upper arm fistula.

Upper arm basilic and cephalic veins: For patients without suitable forearm vasculature, these are the preferred vessels for construction of native arteriovenous fistulae, either in situ or transposed.

Central veins: Subclavian and brachiocephalic: A continuous unobstructed pathway to the right atrium is necessary

in most cases, although some patients with adequate collateral venous outflow may develop a functional arteriovenous fistula despite ipsilateral central vein stenosis or occlusion.

Nondominant versus dominant arm: The nondominant arm is generally preferred for construction of arteriovenous access. However, depending upon individual patient anatomy and circumstance, the dominant arm is frequently used for hemodialysis access. Therefore, all the same considerations apply.

DAMAGE CONTROL

Venous access devices damage veins. This is true for any intravenous device that is introduced into any peripheral or central vein. This damage may involve direct trauma to the actual puncture site of the vessel, or there may be damage induced by contact of the device and the vein wall at points along the device path. This damage may induce immediate thrombosis of the vein.^{5,6} Alternatively, the vein may remain patent, but the device may incite local inflammatory and fibrotic responses that change the vein wall structure in such a way that it is unsuitable for later arteriovenous fistula, possibly planting the seeds of future fistula stenosis.⁷ The most appropriate veins to use for routine peripheral venous access in CKD patients are the dorsal hand veins. Peripheral intravenous catheters should never be placed into the cephalic, median antebrachial, antecubital, basilic, or subclavian vein. PICCs are “relatively contraindicated.”

CKD AND GLOMERULAR FILTRATION RATE

The stages of CKD are well defined and categorized based upon the glomerular filtration rate (GFR).⁸ The five recognized stages of CKD are:

- Stage 1: GFR >90 mL/min, kidney damage with normal GFR
- Stage 2: GFR 60 to 89 mL/min, mild decrease in GFR
- Stage 3: GFR 30 to 59 mL/min, moderate decrease in GFR
- Stage 4: GFR 15 to 29 mL/min, severe decrease in GFR
- Stage 5: GFR <15 mL/min, kidney failure or end-stage renal disease (ESRD)

These stages are of particular clinical utility because they correlate well with common associated disorders of kidney failure, such as anemia, hypertension, volume homeostasis, secondary hyperparathyroidism, and so forth. Furthermore, they help to guide patient management, particularly preparations for renal replacement therapy, including early construction of arteriovenous fistulae in patients expected to require hemodialysis.⁹

Ideally, GFR would be measured by use of a precise and accurate clearance study. However, to date, there is no readily available, clinically practical assay for measurement of the glomerular filtration. Creatinine clearance as measured by 24-hour urine collections is time-consuming, inconvenient, and notoriously prone to error. Currently, the most widely accepted clinically validated method for estimating glomerular filtration is based upon the formula derived from data collected in the Modification of Diet in Renal Disease (MDRD) study.¹⁰ The MDRD-estimated glomerular filtration rate (eGFR) is based upon serum creatinine, patient age, gender, and race. This calculation is reported by most clinical laboratories when supplied with the necessary patient data. Otherwise, there are readily available Web-based calculators that can be used.¹¹

ESRD

CKD is typically progressive. There is a risk that any patient with CKD will progress to ESRD, requiring renal replacement therapy, including hemodialysis, peritoneal dialysis, or renal transplantation. The degree of risk for progression to ESRD is related to the current stage of CKD, the etiology of kidney failure, patient age, and other comorbid factors. In many patients, the rate of progression is fairly constant, allowing the nephrologist to reliably predict when and whether a patient may be expected to reach ESRD, barring fresh insults to the kidneys that might accelerate the rate of progression. Diabetic patients may have a more accelerated form of CKD, although modern aggressive therapies may modify what was previously an inexorable course. Advanced age makes it less likely that the patient will survive to reach ESRD versus a younger patient at a similar stage CKD, with a longer time horizon to reach ESRD. With these factors in mind, the following CKD patients may benefit from vein preservation and future arteriovenous hemodialysis access construction:

CKD stage 4 (eGFR <30 mL/min) or greater, per National Kidney Foundation Dialysis Outcomes Quality Initiative (NKF-K/DOQI) guideline.¹²

CKD stage 3 (eGFR 30–59 mL/min) or greater, per American Society of Diagnostic and Interventional Nephrology (ASDIN) and Association for Vascular Access (AVA) guidelines.¹³ By considering successively “lower” stages of CKD for vein preservation strategies, there is sub-

stantial increase in the number of patients to be considered, lower individual risk for progression to ESRD, and therefore potentially lessened benefit to vein preservation.

Patients with ESRD already receiving hemodialysis: Presence of a functional arteriovenous fistula or graft in one limb does not mean “open season” for venous access devices in the contralateral limb. Access failure is common, and future options must be considered.

Patients with ESRD receiving peritoneal dialysis: Failure of peritoneal dialysis is common for technical, anatomical, or social reasons. Attrition from peritoneal dialysis programs may be as high as 30% to 35% annually. Therefore, many peritoneal dialysis patients will one day require an arteriovenous fistula. For this reason, some programs encourage fistula construction in all peritoneal dialysis patients.

Patients with ESRD and a functional renal transplant: Transplant failure is common, despite advances in therapy and longer allograft survival. The average survival of a cadaveric renal transplant is approximately 7 years. After transplant failure, retransplantation is not always possible, and many of these patients return to hemodialysis requiring new arteriovenous access.

INTRAVENOUS ACCESS REQUIREMENTS

Requirements for intravenous access are not always absolute. It should not be assumed that because an intravenous treatment is ordered that it is necessarily the only alternative. Whenever venous access is requested, it is the responsibility of the ordering physician to carefully consider all the alternatives, risks, and benefits of both the treatment proposed and the venous access device required. Unfortunately, this is not universally the case. Therefore, the practitioner placing the venous access device may need to involve him or herself in the decision process. The dynamics of this may vary from practice to practice, but in the end, the venous access specialist has a duty to do the right thing for the patient, not simply follow a request to perform a procedure that may not be in the patient’s best interests. To this end, the following should be considered:

Blood sampling phlebotomy: Is every blood draw medically necessary? Can blood be obtained periodically at hemodialysis using the patient’s existing access device? Can blood drawing orders be consolidated?

Indications for intravenous therapy: Are these relative or absolute? Many conditions can be optimally treated with oral therapy. It cannot be assumed that intravenous is always preferred or necessary. For many conditions, effective alternative enteral regimens exist.

Ability to treat with intravenous therapy associated with hemodialysis treatments: Many infections can be effectively treated with intravenous agents administered only at dialysis sessions. When such a regimen is available, it should be con-

sidered in lieu of a frequent intravenous dosing regimen.

It is important to make the decision to place a venous access device as soon as possible once the need for intravenous therapy is identified. Too frequently, establishment of definitive venous access is delayed until all peripheral veins have been exhausted, or until the patient is nearing hospital discharge. It is far preferable to recognize the need for venous access at the outset and establish the optimal venous access device as soon as possible. This approach has multiple benefits. In addition to vein preservation, the patient will not suffer multiple venipunctures, the nursing staff and intravenous team will not struggle with marginal venous access, the venous access specialist will have the opportunity to place a venous access device electively at a convenient time, and hospital discharge will not be delayed for lack of suitable venous access to complete outpatient therapy.

TUNNELED CATHETERS

A tunneled internal jugular catheter is the optimal venous access solution for most CKD patients. This may be a cuffed or noncuffed catheter, or a subcutaneous port. There are numerous catheters suitable for this application. Generally, the interventionist should place the smallest-bore catheter

with the minimum number of lumens required to serve the intended purposes. It is important that the tip of the catheter is placed well into the superior vena cava near the right atrium. Some interventionists advise placing venous catheter tips into the right atrium based on supine imaging, due to predictable cephalad migration of catheter tips when the patient is in the erect position.¹⁴ One device option is a Hickman catheter (Bard Access Systems, Salt Lake City, UT), which is specifically designed for long-term central venous access. Catheters designed for use as a PICC can also be adapted as a tunneled internal jugular vein catheter. These are available as 5 or 6 F; and single-, double-, or triple lumen devices (4-F PICCs are too delicate to be used as a tunneled catheter and are not recommended for this reason). Many such catheters are now available with an attached cuff and a tunneling tool to facilitate their use in this application. A 7-F 20-cm triple-lumen central venous catheter, such as the Spectrum (Cook Medical, Bloomington, IN), can also be tunneled on the right side when multiple lumens are required and when the length is sufficient to reach the desired tip position. Any of these devices should be placed with nearly 100% success and 0% complication rates by an expert practitioner using ultrasound-guided vein puncture and fluoroscopy.^{15,16} In capable

hands, this procedure typically can be performed using local anesthesia, with minimal or no sedation. The entire procedure should take 15 to 30 minutes of operator time.

Tunneling from the neck to the anterior chest wall is an essential component of this procedure. Nontunneled jugular catheters are very poorly tolerated by patients and are uncomfortable, unsightly, unstable, and difficult for nursing staff to maintain. There is also a higher rate of infection associated with typical jugular venous catheters that may be reduced by tunneling the catheter to the chest. Most patients tolerate tunneled jugular catheters very well, with very minimal limitation on their activities and lifestyle. It may be a common misconception in the medical community that a PICC procedure is associated with less morbidity than a properly placed central venous catheter. In fact, for many patients with poor peripheral veins, the placement of a PICC may be considerably more difficult, uncomfortable, and time-consuming compared with placement of a tunneled internal jugular vein catheter.

Venous access devices are requested by primary care doctors, internists, hospitalists, infectious disease specialists, and others. The treatment plan is typically guided by the therapy indicated, not always considering related venous access issues. The ordering physician may be more or less knowledgeable about the benefits of venous preservation. Most physicians do not have strong opinions on precisely what form of venous access patients receive, as long as it is effective and allows them to provide the desired treatment. Therefore, it is essential that the interventional physician be equipped to provide the patient with the optimal form of venous access, not simply to perform the exact procedural service as requested. In this regard, the interventional physician should function as the "vascular access expert" and provide the patient and consulting physician with the benefit of his or her knowledge and expertise in this area. Such a role can be substantially enhanced by developing a local institutional policy that outlines the guidelines for venous access in CKD patients, and substantiates the role of the interventional physician in this area.¹³

The simplest and most conservative policy to implement and enforce would be to prohibit the use of PICCs and subclavian vein catheters in all patients with CKD stage 3 or higher, according to the ASDIN-AVA guidelines.¹³ Such patients would then receive a tunneled internal jugular vein catheter, which would preserve veins for the greatest number of patients at risk of progression to ESRD. In practice, however, this approach may be overly restrictive; the ability to provide such alternative venous access services will also depend upon limited local institutional resources. A more nuanced strategy that accounts for individual patient circumstances and variables may be warranted:

- Assess the patient's likelihood of requiring an arteriove-

nous fistula for treatment of end-stage renal failure. This may require input from a nephrologist or other knowledgeable practitioner and should consider a variety of clinical factors, including:

- Current stage of CKD
- Known rate of CKD progression
- Etiology of CKD, particularly diabetes mellitus
- Life-limiting comorbid conditions, including cardiac disease, cancer
- Age
- Apply the same considerations to patients with end-stage renal failure currently treated with hemodialysis, peritoneal dialysis, or renal transplant who may require new arteriovenous hemodialysis access in the future

CONCLUSION

Ultimately, successful vein preservation for patients with CKD with attendant long-term outcome benefits can only be achieved if there is agreement and close collaboration between primary care physicians, nephrologists, vascular access nurses, interventional physicians, and hospital administrators. It is incumbent on us all to take the necessary simple steps to protect precious veins in these highly vulnerable patients with advanced CKD. ■

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