Arteriovenous Fistula Maturation

The specialist's experience.

BY JAMES McGUCKIN, MD; EYAL BARZEL, MD; AND GREGG MILLER, MD

The Dialysis Outcome Quality Initiative (DOQI) guidelines revised in 2000 recommend placement of native arteriovenous fistulae rather than synthetic grafts for dialysis in all patients in which this is feasible, with the goal of increasing the frequency of initial placement of fistulae to 50% for those patients new to dialysis.[1] Native fistulae are preferred because they have an increased primary patency at 3 to 4 years compared with synthetic bridge grafts.[2] After placement, a fistula must mature before it can be used. Therefore, it was also recommended that the fistula should be placed in patients with renal insufficiency before they require dialysis, allowing 3 to 4 months for fistula maturation, so that the fistula can be used immediately when needed for hemodialysis access. The team that developed the DOQI guidelines recognized that many fistulae fail to mature, and we note that in their guidelines their ultimate goal is to have successfully functioning fistulae placement in just 40% of patients.[1] This is where interventionists come in.

Although fistulae can mature in 3 to 4 months, the average fistula requires 6 to 9 months to mature before it can routinely tolerate catheterization with 15-gauge needles during hemodialysis. Fistula maturation typically has occurred when the diameter of the fistula is at least 4 mm to 5 mm in diameter, and it has a flow rate of at least 500 mL/min.[2] Nevertheless, in our experience, the vein caliber may need to be between 6 mm to 7 mm in diameter or greater, before the average technologist or nurse at a dialysis center can reliably perform repeated cannulation of the fistula, without infiltrating or damaging it. Fistulae fail to mature in at least 20% of patients. Although fistulae can be placed successfully in adults older than 65 years, maturation failure is almost twice that of younger patients.[3]

Typically, fistulae are placed in the upper extremities, after vein mapping using ultrasound or venography to determine if the veins are suitable, and after a careful peripheral vascular evaluation of the arteries. The DOQI 2000 guidelines recommend that surgeons join the radi-

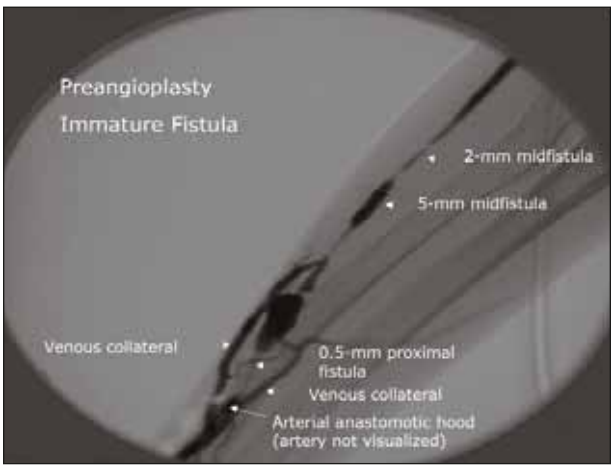

Figure 1. A long segment of a severely diseased forearm cephalic vein. Proximal stenoses result in visualization of many collateral veins. The proximal 3 cm of the fistula is not well visualized due to near occlusion of this segment.

Figure 2. An effort to decompress the outflow of the fistula first by performing angioplasty using 4-mm and 6-mm diameter balloons.

al artery with the cephalic vein near the wrist, to create a radiocephalic fistula, also known as a Brescio-Cimino fistula. A second choice is joining the brachial artery with the cephalic vein near the antecubital fossa, to create a brachiocephalic fistula. Lastly, the brachial artery can be joined with the basilic vein in the antecubital region, and then the vein can be transposed laterally, to create a basilic vein transposition fistula.

ASSESSING THE IMMATURE FISTULA

Fistulae can be immature for many reasons. Look at and palpate the fistula. A small fistula with a very weak thrill–or no thrill–suggests a stenosis at or near the arteriovenous anastamosis. A pulsatile fistula suggests a venous outflow obstruction. This fistula may be relatively large peripherally, but is collapsed central to the obstruction. A fistula with a strong thrill at the anastamosis only may have a stenosis and accessory draining veins that are stealing flow from the body of the fistula. When you compress the outflow vein of any fistula, it should become pulsatile. If not, you can be sure that it is drained by multiple veins.

Sometimes a fistula may actually be mature, but still difficult to palpate. A patient with arm swelling from a central venous obstruction may have enough edema to obscure the fistula. An obese patient may simply have a cephalic vein that is very deep to the skin.

An ultrasound evaluation is useful in all cases and helps to corroborate your initial diagnosis. Doppler and color flow imaging can also occasionally be helpful. The astute diagnostician will know the causative lesion prior to puncturing the shunt. Diagnosing the problem before fistulagraphy helps determine access location and direction, and helps in the preparation of the sterile field. It also reduces contrast load and increases procedural efficiency. Ultrasound guidance is very useful, and sometimes critical in gaining access into the immature fistula. The fistulagram will confirm your diagnosis.

TREATING STENOSES

Think about your own experience. Did you ever feel one of those fistulae starts off great and just dies somewhere distal to the arterial anastomosis? Come on–we all have! Diagnose and treat. Is there a swing point stenosis? Is there anastomotic stenosis? Is there/are there outflow stenoses or even central stenoses? It is time to perform angioplasty, and you don't have to be a hero. Gradual serial dilation by angioplasty is our recipe for success. The worst-case scenario is that you perform a high-pressure dilation, do not rupture the vessel, and the patient returns for a follow-up visit. If, in the weeks following percutaneous transluminal angioplasty (PTA), a repeat fistulagram suggests persistent stenosis, repeat dilation with the next larger size balloon will be required.

Figure 3. Image obtained immediately after angioplasty of approximately 15 cm of the main channel of the fistula. No extravasation of contrast is noted.

Determining vein size can be tricky. The preliminary ultrasound seemingly gives an accurate assessment of luminal diameter, but the lumen may become larger if a tourniquet is placed. The vein may be still more distensible and with injection of contrast for angiography, may be much larger than noted on ultrasound. However, spasm often occurs during angiography. Spasm is common just central to the access entry site, and guidewire spasm can be diffuse, resulting in a much more narrow appearance than noted on ultrasound. Keep nitroglycerin handy. Know your patient's blood pressure because nitroglycerine can cause hypotension. Often 100 µg in divided doses can be administered. Manually occlude the arteriovenous anastamosis for 30 seconds while administering nitroglycerine, to give the drug time to interact with the vein wall. Alternatively, give nitroglycerine through the sheath while the balloon is inflated to treat and prevent vasospasm proximal or distal to the balloon.

Typically use regular pressure-rated balloons to treat the arterial anastomotic stenoses. Try to place the balloon proximal and distal to the anastomosis in the native artery during inflations so that you do not miss a focal stricture. Try to avoid overdilating the artery, because this could lead to arterial rupture. The veins are much more forgiving and can often be overdilated. Controlled injury and subsequent distension may be the goal in treating veins. A fistulized vein may be very tough. High-pressure balloons are a mainstay in fistulized veins. Remember to always assess the whole vas-

Figure 4. Vascular sheaths (6 F) are used in an opposing manner and angioplasty is performed across the proximal fistula using 4-mm and 6-mm diameter balloons.

cular circuitarterial inflow to the heart and treat appropriately. If the entire length of the fistula is small, treat the underlying problem, and let it mature, or consider dilating the whole fistula diligently over time with serial dilation.

ACCESSORY VEINS

Accessory veins are usually present because there is an underlying stenosis somewhere in the outflow system. If a stenosis is present and subsequently treated by PTA, the collaterals will typically resolve on their own. If a significant steal remains, it can be surgically ligated, percutaneously ligated, or embolized with coils.[4] For the faint of heart during embolization, an upstream tourniquet will work well for you and your staff!

PHYSICIAN EXPERIENCE

Dr. Gregg Miller is an interventional nephrologist in Brooklyn, New York, with many years of fistula maturation experience. He attempts to treat all referrals and has great success. He summarized his fistula maturation experience in 100 consecutive patients as follows: the median age of the fistula at the time of the first evaluation for failing or immature fistula was 16 weeks. Each patient required an average of 2.2 treatment sessions (PTA and/or embolization) for his or her fistula to mature. The shortest time to increase the balloon size by 2 mm was 3 weeks, yielding "controlled perforation" in nearly every case and the development of only 2% pseudoaneurysms, which required covered stent placement. Perivascular hematomas are not uncommon, not unexpected, and definitely disappointing. Dr. Miller treats his fistulae aggressively but has never lost a fistula secondary to a perforation. He has performed distal radial artery PTA in 60% to 75% of patients, arterial anastomotic PTA in 80%, intrafistula PTA in all patients, and central venous angioplasty in 5% of patients. He commonly embolizes collaterals in up 50% to 60% of his patients. Dr. Miller's success rates in Brescio-Cimino fistulae and transposed basilic fistulae are both 92% with a 95% primary patency at 6 months. The upper arm cephalic fistulae mature on average 80% of the time with a 70% primary patency at 6 months.

CASE PRESENTATION

A 72-year-old man with end-stage renal disease due to long-standing diabetes had a fistula created in his right forearm approximately 4 months prior to presentation. The patient was undergoing hemodialysis through a

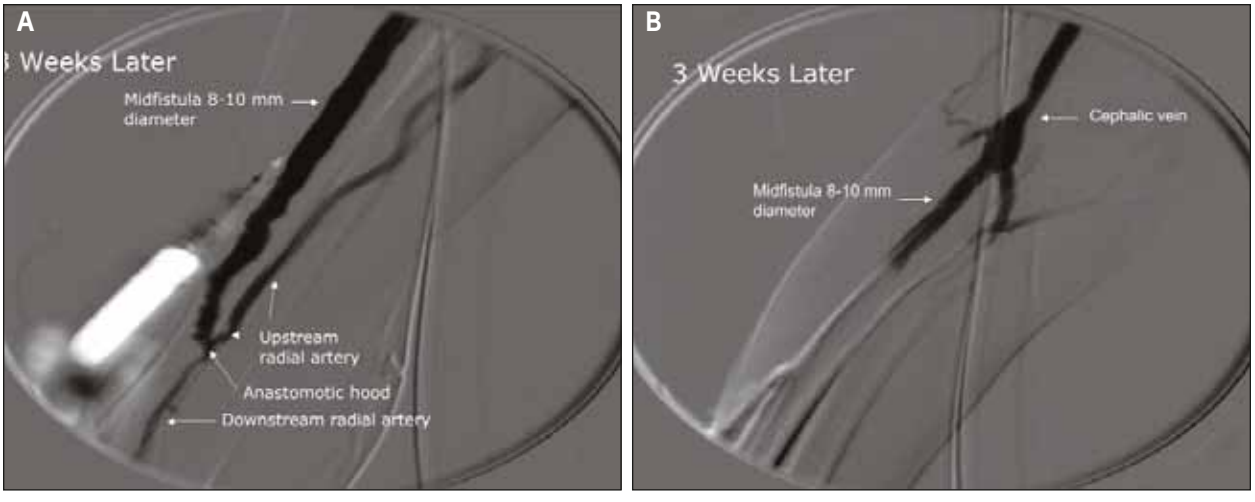

Figure 5. Images obtained 3 weeks after the initial angioplasty. Dramatic venous remodeling has taken place resulting in a fistula system of 8 mm to 10 mm in diameter.

right-side permanent hemodialysis catheter. One failed attempt to use the fistula resulted in a large hematoma. The patient was then referred evaluation for a fistula maturation procedure.

Figure 1 illustrates a long segment of a severely diseased forearm cephalic vein. Proximal stenoses resulted in visualization of many collateral veins. The proximal 3 cm of the fistula is not well visualized due to near occlusion of this segment. Figure 2 shows a conscious effort to decompress the outflow of the fistula first by performing angioplasty using 4-mm and 6-mm-diameter balloons. Figure 3 was obtained immediately after angioplasty of approximately 15 cm of the main channel of the fistula. No extravasation of contrast is noted (controlled extravasation is normal). Six-French vascular sheaths are utilized in an opposing manner and angioplasty is performed across the proximal fistula using 4-mm and 6-mm-diameter balloons (Figure 4). Figure 5 shows images obtained 3 weeks after the initial angioplasty. Dramatic venous remodeling has taken place, resulting in a fistula system of 8 mm to 10 mm in diameter. The patient subsequently had good use of the fistula and the catheter was removed 2 weeks later.

CONCLUSION

So, the next time your surgeon or nephrologist refers a patient in for an ailing fistula don't peek, shriek, and run! Dig in. Diagnose and treat the whole vascular circuit and treat with serial dilation over time if needed. Try to avoid tunneled catheter and synthetic bridge graft placement as you help your patient and the DOQI bandwagon to keep rolling along! Get that fistula to mature using all your tools and skill sets. ■

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