Flow Disturbances of Upper Arm Graft Outflow Uncovered by Positional Studies

Stent-graft flexibility must be considered when stenting upper arm access dysfunction.

BY MARC WEBB, MD, FACS

One of the advantages of the current paradigm of dialysis access maintenance and rescue by percutaneous means is the ability to diagnose, treat, and restore access functionality quickly, at a lower cost, and more conveniently without interval catheter placement, hospitalization, or incisional surgery. In our area, a clotted access is most often restored by one of a dozen interventional practices within 24 hours of patient presentation. The benefit to the patients is obvious. Less obvious is the truth that an array of practitioners—interventional radiologists, vascular surgeons, interventional nephrologists, and even cardiologists—are becoming more expert, adept, and successful in managing access problems percutaneously with a variety of tools, including the placement of stent-grafts. In 2010, a seminal paper was published in *The New England Journal of Medicine* on FDA approval of primary stenting for arteriovenous graft venous anastomotic stenosis.[1] Finally, there was evidence suggesting that stent-grafts need not be reserved for failure of venoplasty, but could perhaps be used as a primary treatment option.

I had my doubts. As early as 2005, I experienced an unwanted effect of a venous anastomotic stent, leading me to believe that stents were not totally benign in the axilla. A rigid stent was placed in the venous anastomosis and outflow vein of an arm graft. Repeated thrombosis of the graft was experienced in the ensuing 6 months. Finally, when the freshly declotted graft thrombosed in the recovery room, and was reopened the same evening with no signal finding, it occurred to me to reimage the functioning graft with the arm at the side, rather than in the 90° abducted position. Angulation of the vein at the trailing end of the stent suggested a compliance mismatch. Unfortunately, I did not immediately realize the importance of what I was seeing and did not have the presence of mind to capture this image. My solution was to extend the stent further, hoping to find a more central zone of the vein where movement of the arm would not lead to a kink at the trailing end of the stent. The graft experienced further events and was replaced within the year.

Later, I ran into a similar situation with a left arm graft placed 10 months earlier. In this case, I observed a similar phenomenon where the compliance mismatch of a rigid body stent led to kinking of the vein at the trailing end. This time I extended the rigid stent with a more flexible device that could better match the vessel compliance. That case report is described subsequently.

Figure 1. Placement of the arm extended out 90° from the body (A), lying at the side (B), and across the chest (C).

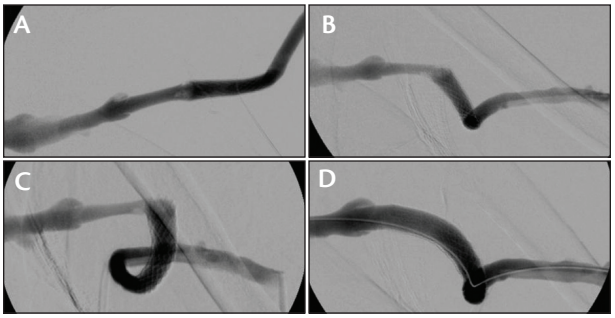

Figure 2. Angiographic images represent the kinking that can occur in the upper arm graft with a rigid stent-graft in response to the placement of the arm extended out 90° from the body (A), lying at the side (B), and across the chest (C). Correction of the kinking with a more flexible stent-graft (D).

CASE REPORT

The patient underwent one fistulagram for dysfunction and two percutaneous thrombectomies, with a BARD FLAIR® Stent-Graft (Bard Peripheral Vascular) placed in the venous anastomosis during the second thrombolysis. However, the patient experienced clotting a third time.

After successfully declotting the graft with the arm positioned out over the arm board (as represented in Figure 1A), I placed the patient's arm in two anatomically normal positions—at the side (Figure 1B) and with the arm folded over the chest (Figure 1C). Contrast injection images obtained in these positions demonstrate progressive angulation of the outflow vein at the central end of the stent, as the arm is brought in toward the body, as shown in Figure 2A through C. Access blood flow measurements obtained in these same positions demonstrated changes in flow commensurate with the angulation of the outflow vein: arm straight out from body, 1,365 ± 151 mL/min flow; arm on chest, 775 ± 170 mL/min flow. In general, flow was reduced as the arm was adducted.

My conclusion was that a hemodynamically significant compliance mismatch existed, and that it was unreasonable to expect the patient to live her life keeping her arm extended to 90° for the sake of a well-functioning dialysis graft. My solution was to extend the stent, but this time with a more compliant and flexible stent (Figure 2D).

DISCUSSION

The axilla is a soft tissue component of the shoulder girdle/upper extremity, and the vessels traversing this space are subject to angulation, torsion, and foreshortening as a result of abduction or adduction of the arm at the shoulder,[2] medial or lateral rotation of the arm, and pronation or supination of the forearm. Noncompliant foreign bodies in the vessels may constrain these vessels unnaturally, as in the previous example. In another example with an arm loop graft, it is apparent that in bringing the arm to the side, one adducts and rotates the arm from a supinated palm up to a neutral hand position (Figure 3A and B), distorting the outflow. In placing the forearm on the chest, one further adducts and medially rotates the arm (Figure 3C), torsing the vessels in the upper arm and making the arm graft look complicated. In this case, where a drop in access flow was measured with the arm on the chest, the outflow was restented with a more flexible stent-graft (Figure 3D).

In Figure 4, adduction and internal rotation of the arm placed on the chest "uncovers" a stenosis at the trailing end of the outflow stent—or does it? It is just as likely that the long outflow stent-graft prevents the vein from making a gentle twist over several inches, forcing it to accommodate the turn in the short distance between the end of the stent and fixation points of the vein (branches). More subtle than outright angulation, this is a torsion effect. In this case, flow measurements did not demonstrate a significant change in access flow when the arm was adducted and internally rotated, and an intervention was not indicated.

Like most practitioners confronted with multiple problems of access dysfunction on a daily basis, I have placed a large number of stents (more than 2,000 noted in an accounting performed several years ago). Through my experience, I have become aware of several benefits and also various limitations of stenting. The immediate outcome can be gratifying, but the long-term consequences are more difficult to predict. For that reason, and for reasons of economy and wise stewardship of resources, I am deeply hesitant to embrace fuzzy or questionable indications for axillary stenting. When axillary stenting is truly indicated, a flexible stent-graft such as the GORE VIABAHN Device is my device of choice.

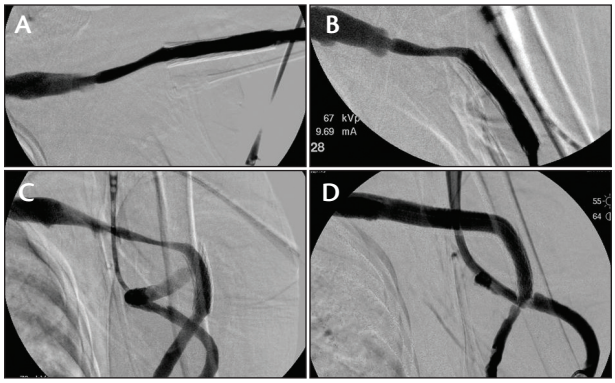

Figure 3. Angiographic images represent the torsion that can occur of the upper arm graft with a rigid stent-graft in response to the placement of the arm extended out 90° from the body (A), lying at the side (B), and across the chest (C). Correction of the torsion with a more flexible stent-graft (D).

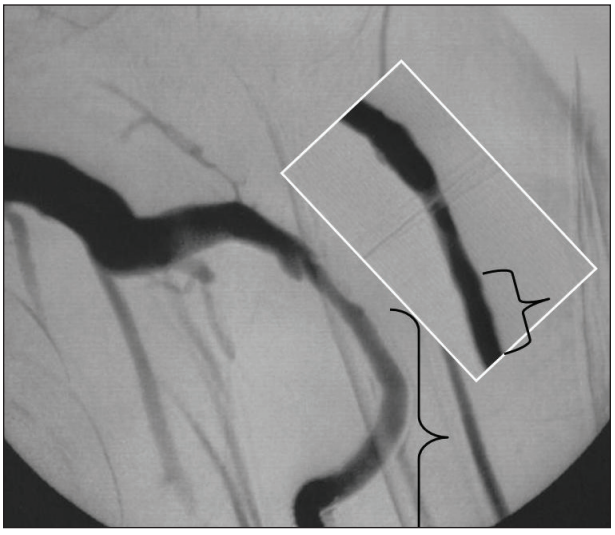

Figure 4. Angiographic image represents the ability of the GORE VIABAHN Device (bracket) to conform to the changing orientation of the upper arm graft when the arm is laid across the chest. Some torsion was observed when compared to the arm extended 90° from the body (inset), but was not determined to be clinically significant.

CONCLUSION

Although we typically examine accesses in the arm in an abducted position, the arm is normally at the side, and there can be significant changes in the length and course of the vein in different arm positions. These changes can be hemodynamically significant. Stents or stent-grafts should be used with caution in the axilla, as there is a downside to stiff foreign bodies in the veins. Stents and stent-grafts can solve many problems in dialysis access management, but they can also cause problems that might not be immediately obvious. Positional studies can uncover these complications, and flow measurements can confirm their significance. ■

Marc Webb, MD, FACS, is with Michigan Vascular Access, PC in Detroit, Michigan. He has disclosed that he has been on a Medical Advisory Council for C. R. Bard, Inc., and provided data on central venous stenting to W. L. Gore & Associates, Inc. Dr. Webb may be reached at (248) 355-1100.

1. Hazkal JZ, Trerotola S, Dolmatch B, et al. Stent graft versus balloon angioplasty for failing dialysis-access grafts. *N Engl J Med*. 2010;362:494-503.
2. Forauer AR, Alonzo M. Change in peripherally inserted central catheter tip position with abduction and adduction of the upper extremity. *J Vasc Interv Radiol.* 2000;11:1315-1318.