Managing Cephalic Arch Stenosis

How to diagnose and treat this condition in patients with hemodialysis fistulas to minimize complications and maintain patency.

BY ANTHONY G. VERSTANDIG, MB, BS, AND DAVID SHEMESH, MD

Vascular access for hemodialysis is the lifeline of most patients with chronic renal failure worldwide, and a well-functioning access is essential to their survival. The National Kidney Foundation Kidney Disease Outcomes Quality Initiative guidelines for vascular access recommend primary placement of autogenous hemodialysis accesses.[1] The preferred access is a radiocephalic arteriovenous fistula (AVF). When the cephalic vein in the forearm is inadequate, a brachiocephalic fistula is the next best choice.

In the forearm, radiocephalic AVFs drain via the basilic, brachial, and cephalic veins. From our data collected by Doppler ultrasound studies, only 30% of the total flow drains via the cephalic vein in the forearm, whereas the major portion of the flow drains via the basilic vein. The more proximal brachiocephalic fistulas have a higher flow rate and, in general, drain exclusively via the cephalic vein. This high flow predisposes to stenosis, especially in the cephalic arch, which is the perpendicular portion of the cephalic vein in the region of the deltopectoral groove before its confluence with the axillary vein. Shear forces caused by the high flow combined with the change in direction in the cephalic arch, as well as the lack of compensatory dilatation due to the surrounding rigid structures, combine to cause intimal hyperplasia, which results in hemodynamically significant stenoses in up to 39% of patients.[2] If there are no branches arising from the cephalic vein before the stenosis to allow collateral flow to maintain patency, the entire fistula can thrombose.

In radiocephalic fistulas, with their multiple draining forearm veins, the incidence of these stenoses is significantly lower. Rajan et al reported a cephalic arch stenosis rate of 39% for upper arm fistulas versus 2% for lower arm fistulas.[2] In addition, in lower arm fistulas, even if cephalic arch stenosis occurs, it is less significant because it affects only one of the draining veins. Notwithstanding the superiority of radiocephalic AVFs, brachiocephalic AVFs are commonly constructed, especially in elderly patients, due to the frequent lack of healthy forearm veins and the more rapid maturation time.

Cephalic arch stenosis may be symptomatic, presenting with a strong pulse due to increased pressure, weak thrill, or abnormal dialysis monitoring and surveillance criteria; high static pressure; and decreased dialysis efficiency (calculated as Kt/V). Timely dilatation of symptomatic cephalic arch stenosis not only treats the symptoms but also prevents progression to thrombosis and thus prolongs the life of the fistula. Surgical treatment with transposition of the cephalic vein to the axillary veins provides good initial results but is prone to developing anastomotic stenosis. Prospective studies comparing surgery to balloon angioplasty have not yet been performed.

The mainstay of treatment for this common lesion is percutaneous transluminal angioplasty (PTA) with a simple balloon catheter. Restenosis after PTA is common, with 6-month primary patency rates of < 50%.[3,4] The use of bare-metal stents has not increased this patency rate due to in-stent restenosis caused by cellular proliferation through the bare stent fenestrations. This proliferation can be prevented by using stent grafts in which the lining material interposes a mechanical barrier between the vessel wall and the flowing blood. In 2008, our center published a randomized trial of bare stents versus stent grafts in patients with symptomatic cephalic arch stenosis, which showed primary patency rates at 6 and 12 months of 82% and 32% for stent grafts versus 39% and 0% for bare-metal stents, respectively.[5] The number of interventions per patient-year after placement was 0.9 for stent grafts and 1.9 for bare-metal stents. In light of these results, we now exclusively use stent grafts rather than bare-metal

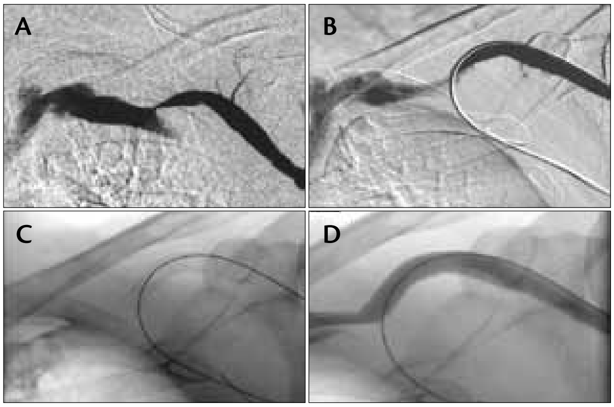

Figure 1. Severe recurrent cephalic arch stenosis at the confluence with the axillary vein (A). A stiff wire has been passed retrograde into the axillary vein, increasing the perpendicularity of the confluence (B). Stent graft deployment before final PTA (C). Completion angiogram showing satisfactory position of the stent graft (D).

stents in this location. The possible role of drug-eluting balloons in preventing this cellular proliferation has yet to be determined.

DIAGNOSING CEPHALIC ARCH STENOSIS

The development of clinical signs or abnormal dialysis monitoring criteria leads to early referral to Doppler ultrasound. Patients with abnormal findings (blood flow velocity > 4 m/s at the cephalic arch with an insonation angle of 60° or a peak systolic velocity ratio between the stenosis and an adjacent normal segment of > 3) are referred for angiography and angioplasty. Patients with asymptomatic cephalic arch stenosis detected on Doppler ultrasound are carefully followed and referred for treatment at the first appearance of clinical findings.

BALLOON ANGIOPLASTY

On diagnostic venography, the stenosis is usually obvious, but it may be obscured by overlapping at the junction of the horizontal and arched segments of the vein. Rather than striving to visualize the stenosis with oblique projections, we proceed directly to PTA. With experience, the balloon size can be determined by estimation, but user-friendly, inbuilt measuring software makes it very simple to assess size more objectively. The cephalic arch has a significant rate of rupture during PTA, so we do not initially oversize balloons. Rajan et al reported a 6% rate of cephalic arch rupture during PTA, whereas Turmel-Rodrigues et al reported a 14.9% rupture rate in patients with upper arm autologous AVFs that were mostly in the cephalic arch and at the end of the transposition in brachiobasilic AVFs.[2,4]

Before PTA, we routinely administer 3,000 to 5,000 units of intravenous unfractionated heparin. When inflation to low pressure shows a waist caused by the stenosis, we gradually increase the pressure until it is effaced. These stenoses frequently require high pressures to achieve full dilatation. During the gradual pressure increase, we usually observe that effacement of the stenosis occurs in a number of stages rather than in one sudden expansion of the balloon. In our experience, this staged dilatation reduces the rate of vein rupture. If the stenosis is not dilated by a gradual increase in pressure to 30 atm, we exchange to a peripheral cutting balloon (Boston Scientific Corporation, Natick, MA). If there is significant residual stenosis after initial total effacement, we perform low-pressure dilatation for at least 2 minutes to distinguish between reversible spasm and elastic recoil. If there is no improvement, we may repeat PTA with a slightly larger balloon but avoid doing this if the initial PTA was accompanied by significant pain.

STENT GRAFTS

In our unit, indications for stent graft placement include significant residual stenosis after PTA, rupture not controlled by prolonged low-pressure balloon dilatation, and recurrent symptomatic stenosis within 3 months after successful PTA. Stent graft deployment in the cephalic arch is challenging for two reasons. First, the segment is curved, requiring a flexible device that should be long enough to extend to the straight portion of the vein. We invariably use Viabahn stent grafts (Gore & Associates, Flagstaff, AZ) in this location due to their superior flexibility and complete coverage of the metal stent and favor the 10-cm-long devices. The less-flexible Fluency Plus stent graft (Bard Peripheral Vascular, Inc., Tempe, AZ) has 2-mm flared extremities where the nitinol skeleton is uncovered. This makes it prone to the development of in-segment stenosis.

Second, accurate deployment of the graft at the confluence with the axillary vein is challenging due to both the angle of entry and the anteroposterior orientation of the confluence. To overcome these difficulties, we pass a stiff Amplatz guidewire (Cook Medical, Bloomington, IN) retrograde into the axillary vein from the confluence (Figure 1). This increases the perpendicularity of the confluence, and by observing the widest opening of the curve during different degrees of craniocaudal angulation, the correct plane of entry can be determined, ensuring accurate deployment at the confluence. We deploy the stent graft slowly under magnified fluoroscopy using roadmapping, bony landmarks, and digital acquisition runs where necessary.

Before using this technique, we had difficulty placing

TAKE-HOME POINTS

- Cephalic arch stenosis is common in brachiocephalic fistulas.
- If untreated, they can result in fistula thrombosis.
- Simple balloon angioplasty is the mainstay of treatment.
- Where stenting is indicated, stent grafts are more durable than bare-metal stents.
- Accurate deployment at the axillary vein confluence is improved by retrograde catheterization of the axillary vein.

the stent graft exactly at the cephalic-axillary confluence without either extension into the axillary vein or failure to cover the confluence with development of recurrent stenosis at the confluence itself. In the four patients in whom we have used this technique, the results have been excellent.

CONCLUSION

Cephalic arch stenosis can cause access dysfunction and may progress to thrombosis of brachiocephalic fistulas. This complication can be avoided with close surveillance and prompt angioplasty for symptomatic stenoses. The mainstay of treatment is balloon angioplasty. When this produces an inadequate immediate result, causes rupture that is not amenable to conservative management, or if there is rapid recurrence, stent graft placement is currently our method of choice and provides a more durable solution than using bare-metal stents. ■

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