Stent Graft Use in Cephalic Vein Arch Stenosis: Why, When, and How?

An overview of anatomic and patient considerations in cephalic arch stenosis and our approach to managing this complication for dialysis access.

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Adequate vascular access is essential for patients undergoing hemodialysis. When possible, the creation of an arteriovenous fistula using native veins will provide the highest long-term patency and lowest complication rates.[1-3] In patients with suitable veins, the access of choice remains the radiocephalic fistula; however, it is associated with high primary failure and nonmaturation rates. The second access of choice is the brachiocephalic fistula (BCF), but the leading cause of dysfunction and failure in this type of fistula is cephalic arch stenosis (CAS). The upper arm cephalic vein is an ideal conduit for fistula formation and needle placement during dialysis, but the complex anatomy of the cephalic arch predisposes this area to a high incidence of stenosis. It is this stenosis that induces subsequent dysfunction with a pulsatile arteriovenous fistula, high venous pressures on dialysis, prolonged bleeding upon removal of dialysis needles, and drops in access flows. Left untreated, there is a likelihood of increased morbidity in the form of venous hypertension within the arm as collateral flow opens up and, ultimately, the fistula fails.

ANATOMIC FACTORS IN CAS

The cause of CAS remains unknown, but contributing factors include the presence of valves, musculoskeletal constriction as the cephalic vein traverses the deltopectoral groove, and abnormal shear stress in the arterialized state as a result of the bend of the vein as it arches to enter the axillary vein.[4] The cephalic arch is often described as the segment of vein that commences at the transition from a superficial position to its deep terminating position at the axillary vein junction. This point of transition is at the lateral portion of the deltopectoral triangle, and the vein then passes beneath the deep fascia, behind the clavicular head of the pectoralis major, and through the clavipectoral fascia into the axillary vein. These points of constriction limit vessel expansion, resulting in hypertrophic remodeling and leading to flow-restricting lesions. In addition, the curvature of the vein leads to abnormal shear stresses, promoting intimal hyperplasia and stenosis. These anatomic points of constriction also explain the poor response to venoplasty, which has been long considered the standard treatment.

CAS TREATMENT OPTIONS

Venoplasty alone for CAS does not provide a durable solution due to the frequent reinterventions that are required. Bare-metal stent (BMS) placement has been described with variable results. In their study of 45 patients, Dukkipati et al reported a median patency of 152 days with BMSs versus 91.5 days with venoplasty alone.[5] Shemesh et al compared the use of BMSs and stent grafts in CAS.[6] The 6-month primary patency with stent grafts was 82% versus 39% with BMSs.

The use of stent grafts as a primary treatment for CAS is now being established. Jones et al reported a series of 39 patients who were treated with stent grafts for CAS.[7] They reported primary target lesion patency of 85%, 67%,

and 42% at 3, 6, and 12 months, respectively. Primary assisted patency was 95% at 3, 6, and 12 months.

In our practice, stent graft placement has become a key part of our treatment algorithm for CAS. When approaching a cephalic arch lesion, the entire fistula circuit and other patient factors must always be considered. For example, if there is recurrent CAS but the fistula is aneurysmal with multiple other areas of disease, then we may decide that fistula revision is required rather than proceeding with stenting. This is often on the grounds that stent placement, as we will discuss, could jail the drainage of the basilic vein, thereby preventing revision surgery that would utilize the basilic vein as the outflow conduit.

OUR PROTOCOLS FOR ASSESSING AND ADDRESSING CAS

In our institution, we run a surveillance program for all dialysis patients that begins with the patients themselves and the dialysis nurses. At each dialysis session, dialysis nurses "look, listen, and feel" the access and record the quality of thrill and bruit along with any features that suggest dysfunction, including a "thumpy" pulsatile nature, aneurysmal segments, or a palpable stenosis. Venous and arterial pressures on dialysis are recorded, and each month, access flow is measured using a HD03 hemodialysis monitor (Transonic). A > 20% decrease in access flow from the last reading and/or an access flow of < 600 mL per minute automatically triggers a referral to the access team. Patients are assessed by an access specialist (nurse or surgeon) and referred urgently to radiology for diagnostic fistulography and intervention.

In patients who have a BCF and a suspected and subsequently diagnosed CAS, the first stage of treatment is standard balloon angioplasty of the cephalic arch lesion up to the nominal diameter of the normal vein. If there is a good radiologic result after angioplasty coupled with a noticeable change to the BCF characteristics, including return of fistula flow, then we may not proceed with stenting at this point, particularly if this is the patient's first intervention. We do, however, believe it is vital to ensure that there is no residual "waisting" after balloon angioplasty. If this is the case, then our approach is to proceed with high-pressure and/or cutting balloons to be "waist free." It is well recognized that restenosis rates will be higher once high-pressure or cutting balloons have been used, and we therefore advocate the placement of stents at this point if there is any concern about the radiologic appearance after the balloon intervention.

In cases of early reintervention after previous standard or high-pressure/cutting balloon angioplasty (< 3 months), repeated previous interventions (> 2 per year), or a suboptimal result after venoplasty, we always proceed to stenting.

In our view, there are a number of critical considerations that must be taken into account when placing stents in the cephalic arch. We generally avoid BMSs and do not recommend their use in CAS, as the evidence shows they are inferior to stent grafts.[6] We avoid aggressive oversizing when placing stent grafts and perform venoplasty on the vessel up to the planned stent graft diameter. The length of the stent graft is chosen to ensure that the entire diseased segment is treated, ideally landing the stent graft in a relatively straight segment of vein proximal and distal to the lesion to avoid stent/vein beaking. If there is size discrepancy between the inflow and outflow vessels, stent telescoping may be required. It is particularly important to ensure a good stent-to-vessel size match at the stent inflow to avoid guttering, which can precipitate turbulent flow and lead to stenosis. Should telescoping be required, the smaller stent should always be placed first, followed by the larger one.

The most common location of a CAS is at the point where the cephalic vein joins the axillary vein.[4] In these situations, it is not possible to effectively treat the stenosis without some of the stent graft protruding into the axillary vein. There are concerns that stent protrusion can lead to axillary/subclavian stenosis or jailing of the incoming basilic vein, which may precipitate arm swelling and limit future ipsilateral fistula formation. We take the view that, if possible, the stent should not extend into the central veins, but if required, we take the stent into the subclavian vein to avoid the stent facing the inferior vein wall, which we believe precipitates turbulent flow and a higher likelihood of stenosis. Using this technique, we have not encountered any clinically significant upper limb swelling after stenting and have ensured inline flow through the stent graft.

Postdilatation is performed up to the stent diameter. We do not routinely place the patient on a new anticoagulation regimen. Follow-up is purely clinical and follows the exact same surveillance algorithm previously described, with a low threshold for reintervention if venous pressures increase, flow rates decrease, or the fistula feels more pulsatile.

Rupture after balloon angioplasty of the cephalic arch is not common and is easily treated with stent placement. Stent migration is also rare if the stent is sized appropriately. Stent reinterventions are almost always related to stenosis at the inflow or outflow ends, and these are treated with balloon angioplasty and stent graft extension if required.

CONCLUSION

Stent graft placement is a safe and effective treatment for both initial presentations and recalcitrant cephalic

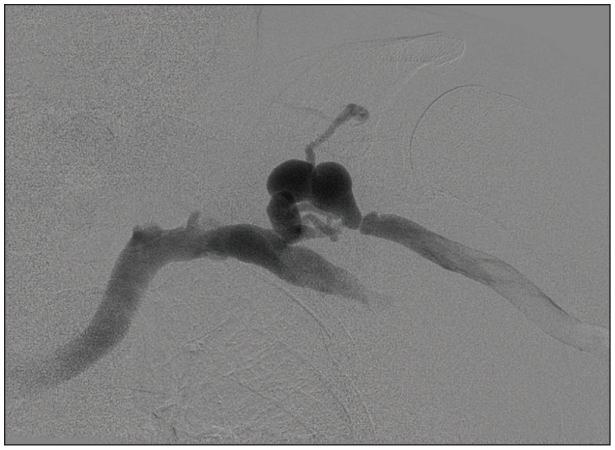

Figure 1. Preintervention fistulogram for a patient with a 3-year autologous cephalic fistula presenting with elevated venous pressures and prolonged bleeding time. On examination, the fistula was "thumpy" with a poor thrill. The image shows severe multifocal cephalic arch stenosis with associated aneurysmal segments.

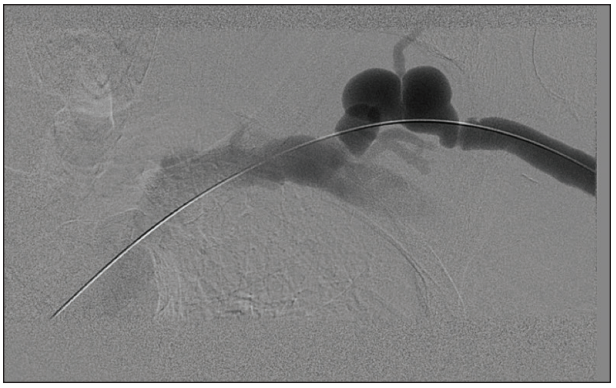

Figure 2. Postangioplasty fistulogram demonstrating significant stenotic recoil. It is unlikely this would provide any durable benefit.

arch disease. The available evidence suggests that it is more durable than venoplasty alone and is undoubtedly preferable to BMS placement. As our understanding of the disease and the hemodynamics of this complex region evolve, we will be able to adapt our understanding of the ideal stent placement technique. In addition, stent technologies will continue to evolve, enabling us to offer more durable solutions. In our view, the crucial technical points for stent graft placement include ensuring all disease is effectively ballooned prior to stent placement with no residual waisting and selecting the correct stent diameter and length to ensure all disease is treated while not introducing new points of angulation in this already tortuous vein (Figures 1–3). It is these steps that ensure inline flow and higher longer-term primary and primary-assisted patency rates. ■

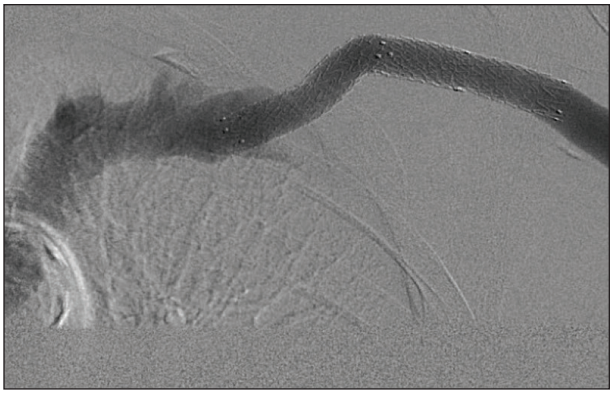

Figure 3. Completion fistulogram after placement of two stent grafts. The central stent is positioned into the subclavian vein, avoiding a tight angle against the inferior wall. There is a slight gutter at the stent inflow, but there is a long seal proximal to this; therefore, this gutter will thrombose and not be an issue. After intervention, there was an immediate palpable improvement in the fistula, and this was confirmed at dialysis.

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Disclosures: Consultancy agreement with and receives fees for educational services from Boston Scientific Corporation; consultancy agreement with Merit Medical Systems, Inc.

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