PANEL DISCUSSION

Strategies for Cephalic Arch Stenosis

Experts tackle best practices for encountering cephalic arch stenosis, including when to intervene, tips for overcoming obstacles, must-have tools, and hopes for management of the future.

With Robert G. Jones, MRCP, FRCR; Allison Tan, MD; Robert Shahverdyan, MD; and Bharat Sachdeva, MD

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When you encounter cephalic arch stenosis, what main factors do you consider when deciding if and how to intervene?

Dr. Tan: The decision to intervene on cephalic arch stenosis depends on whether the angiographic findings correlate with the physical exam findings and presenting concerns. If the imaging appearance is borderline significant and discordant with the reasons for presentation, then intervention is likely not necessary. Additionally, evidence of hemodynamic significance with ancillary findings (such as presence of collateral vessels) and more concrete findings (such as abnormal pressure measurements across the area of concern) support intervention. Finally, choice of intervention depends on the length and severity of stenosis, response to angioplasty, and whether the lesion is an initial presentation or recurrent issue.

Dr. Jones: I would first want to know if the cephalic arch stenosis is symptomatic. I would then confirm that it is actually the culprit lesion, given the individual clinical scenario. I would be cautious in treating unless it fits the symptoms, such as high venous pressures, prolonged postdialysis bleeding, and pulsatile fistula. Then, having an idea of previous interventions and associated clinical response is important, as well as the time interval between these. Review of previous fistulograms and clinical response to treatment is really important. If there have been frequent prior interventions, I would have a much lower threshold for using a stent graft during the current intervention.

Dr. Shahverdyan: The decision to treat cephalic arch stenosis depends heavily on whether it is symptomatic (high venous pressure and/or prolonged bleeding). If asymptomatic, it will not be treated; if symptomatic, the decision is based on the volume flow (Qa) of vascular access. When the Qa is > 1.2 L/min, a flow reduction procedure (banding) is performed first (target Qa, 600-800 mL/min). If it remains symptomatic after that, then we will treat the cephalic arch stenosis.

Dr. Sachdeva: The cephalic arch is a common site of stenosis in upper arm dialysis arteriovenous fistula (AVF). Its distinctive anatomy (passing under the clavicle and turning sharply to pierce the clavipectoral fascia to join the axillary vein), complex valves, uremic inflammation with neointimal hyperplasia, and high turbulent flows all contribute to a high incidence of recurrent stenosis and make it prone to complications, including complete rupture.

Nephrologists managing patients with upper arm AVF and suspected cephalic arch stenosis should monitor patients for the following signs and symptoms suggestive of access dysfunction:

- Pulsatile cephalic vein on examination
- Reduction of access blood flow rates (< 600 mL/min or > 25% reduction from prior access flow)
- Prolonged bleeding after needle withdrawal
- Inadequate dialysis clearance (Kt/V < 1.4)
- High venous pressures
- Rapidly developing aneurysms of the cephalic vein and/or aneurysms with thin, ulcerated wall
- Swelling of the access arm

Before intervention at the cephalic arch stenosis, it is vital to assess the history of the access, prior interventions at the cephalic arch, presence of a stent in the access circuit/at the cephalic arch, and access blood flow. Cephalic arch stenosis has a very high risk of recurrence. Prior angioplasty, with or without use of a drug-coated balloon (DCB) or stent graft, will help delineate the need for additional procedures.

The incidence of cephalic arch stenosis is significantly high in upper arm brachiocephalic AVF. Prior to any intervention, it is crucial to check the access flows if the dialysis access exhibits strong pulsatile flow with high pressures. If the access flow exceeds 1,500 mL/min, any attempt to reduce outflow resistance will only further increase the total access flow. High flow through the cephalic arch has been identified as a major contributor to high recurrence rates. Therefore, instead of opting for angioplasty on the outflow stenosis, it is advisable to constrict the inflow by banding it to effectively reduce the total access flow.

What are the common obstacles encountered during intervention for cephalic arch stenosis, and how can they be avoided?

Dr. Jones: The cephalic arch is one of the most challenging areas to treat in a dialysis access circuit due to the anatomic constraints, vessel curvature, and direct communication with the central vein. Cephalic arch stenosis is prone to immediate recoil, even with full inflation of a high-pressure balloon. Rupture is also not uncommon here either, especially if the stenosis is very tight. High rates of recurrent stenosis are also observed. Thus, having an appropriate stent graft on hand is a good idea to manage recoil, early recurrence, and even rupture that doesn't respond to prolonged balloon inflation.

Having a clear understanding of the anatomic configuration is key, and it's important to remember that the cephalic arch doesn't necessarily insert into the cranial aspect of the central vein and oblique fluoroscopic projections during fistulography are required to delineate this junction. Also, a guidewire can straighten the arch, and this can have implications when placing a stent graft, the configuration of which can look very different when the wire is removed after deployment. For this reason, I always obtain a completion fistulogram with the wire out. If using a stent graft, precise delivery is essential, and a fluoroscopic roadmap can be very beneficial during deployment. The most common location for an arch stenosis is at the junction with the central vein. A degree of protrusion of the stent graft is often necessary, but this should be avoided wherever possible. If a stent graft is deployed, it is equally important to ensure it complies to the full extent of the arch; if it is too short, it can "stand up" in the arch, which in turn can lead to occlusion of the fistula.

Patient factors are of the utmost importance and fistuloplasty in this region can be painful, so it is necessary to apply appropriate intravenous sedation and analgesia in these cases.

Dr. Sachdeva: The challenges encountered during cephalic arch stenosis interventions are distinct to the cephalic vein segment and can be intensified by variations in the vein's anatomy, including the existence of bifid/trifid veins and the presence of multiple collaterals draining to adjacent neck veins. Imaging in two planes and/or the use of roadmap imaging can assist in mapping the stenosed cephalic arch, ensuring that the wire crosses the desired branch into the subclavian vein. Complete total occlusion of the cephalic arch makes crossing the lesion especially challenging. Guiding

catheters with specialized wires to cross the occlusion will be required.

Additionally, cephalic arch stenosis lesions require a high-pressure balloon with an average pressure > 20 to 25 atm and are more likely to have partial or total rupture of the vein. Despite relatively good outcomes reported with percutaneous transluminal angioplasty (PTA) in managing other hemodialysis accesses, cephalic arch stenosis appears highly resistant to angioplasty and has a tendency for recurrent stenosis, often requiring multiple angioplasty procedures, sometimes with high-pressure balloons to overcome resistant lesions.

Placing a stent across the cephalic arch stenosis can pose challenges, so it is vital to have a clear understanding of the anatomy in the area, including the relationship between the axillary and cephalic vein, as well as any adjacent draining veins and collaterals.

Additionally, diligent follow-up care with regular access monitoring and surveillance and, if indicated, prompt imaging, is essential to monitor for any signs of recurrence.

Dr. Shahverdyan: The main obstacles are the high reintervention rates as well as recoil and/or perforation during the angioplasty.

Dr. Tan: Restenosis after cephalic arch stenosis treatment is a common occurrence that is difficult to avoid. PTA is a typical first intervention but rarely durable. I will frequently utilize a DCB in this location to try to delay restenosis and avoid stent deposition if possible.

Severely stenotic cephalic arch lesions are prone to rupture, which can be mitigated with serial upsizing of angioplasty balloons. Fortunately, vein rupture is frequently responsive to prolonged inflation and rarely causes access loss.

If proceeding with stent deployment, the cephalic arch can be extremely challenging. Proper sizing and careful placement of a stent across the cephalic arch with minimal protrusion into the central vein is crucial to avoid long-term complications such as axillary vein obstruction, arm swelling/pain, access site loss, and prevention of future access creation. Road map guidance and flared stents are extremely useful for meticulous stent positioning.

What do you always have on your shelf in these cases?

Dr. Sachdeva: Beyond use of basic angiographic catheters and wires, successful dilation of cephalic arch stenosis lesions frequently demands implementation of high-pressure balloons. According to existing literature, average pressures > 15 atm are necessary to effectively open cephalic arch stenosis lesions.[1] Notably, within our practice, pressures > 25 atm are requisite for successful dilation in at least more than one-third of the patient population.

Cutting balloon angioplasty is very seldom required for lesions resistant to > 40 atm. Although rarely used, cutting balloon angioplasty increases risk of vein rupture and requires stent grafts placement postangioplasty in some patients.

Routine stent graft use at the cephalic arch is not supported by randomized controlled trials (RCTs). Stent grafts are used in cases with complete occlusion, severe critical stenosis > 90% at the cephalic arch, or when a vein rupture is noted after angioplasty. Stent grafts should be sized no more than > 10% above the normal adjacent vein diameter and should be placed with precise anatomic landing to not block the flow across the axillary vein into the subclavian vein.

Dr. Shahverdyan: For endovascular treatment of cephalic arch stenosis, we use noncompliant PTA balloons, scoring devices, DCBs, and stent grafts. Moreover, the option to perform a cephalic turndown procedure (transposition of cephalic toward basilic/axillary vein) remains possible in our center.

Dr. Tan: Essential tools to have for treatment of cephalic arch stenosis are high-pressure angioplasty balloons, DCBs, cutting balloons for highly elastic lesions, and covered flared stents. Additionally, as an interventional radiologist, it is important that I have a reliable vascular surgeon "on my shelf" as well!

Dr. Jones: High-pressure balloons as a first port of call, and having an appropriate range of stent grafts, is a necessity when treating cephalic arch stenosis. There is also some evidence that DCBs convey better patency than plain balloons, but these are only considered if there is an adequate angiographic response to the initial balloon fistuloplasty. Results with bare-metal stents have generally been suboptimal for treating this lesion and are largely superseded by stent grafts.

What is on your wishlist for the future of cephalic arch stenosis management?

Dr. Shahverdyan: I would like to see new devices and treatment options (ideally, in an RCT if possible) to improve the procedural success and patency rates of cephalic arch stenosis. Including those in the guidelines will surely benefit practitioners as well.

Dr. Tan: Even though the current pool of DCB literature is growing, it would be wonderful to see more reliable data on the efficacy of this tool (particularly its use in the cephalic arch), as well as comparison with other treatment options like stent placement. Additionally, a retrievable, repositionable stent graft would be extremely useful in general but particularly in preventing complications related to maldeployment in the cephalic arch.

Dr. Jones: Specific research into the application of DCBs in the cephalic arch is desirable, as currently these data feature as subset analyses in larger trials. Data on the application of DCBs to treat stent graft edge stenosis in dialysis access circuits in general are also lacking.

Stent graft technology development should focus on combatting edge stenosis. This is the main cause of loss of patency, irrespective of deployment location, but in the cephalic arch can include the central vein. If a specific cephalic arch stent graft were to be developed in the future, the technology should focus on how the device interacts with the central vein.

Dr. Sachdeva: The best management approach for cephalic arch stenosis should aim to maintain the integrity of the fistula for long-term patency and effective flow. Radial AVF with lower access flow is known to have a very low cephalic arch stenosis incidence compared to brachial artery inflow AVF. The role of inflow reduction prior to or simultaneously at the time of outflow intervention needs to be evaluated as an alternative to repeated outflow intervention alone.

Given the notable frequency of cephalic arch stenosis recurrence, it is imperative to conduct RCTs to comprehensively assess the long-term advantages of stent grafts compared to conventional angioplasty, as well as the efficacy of DCB angioplasty versus plain balloon angioplasty for long-term patient outcomes. ■

1. Rajan DK, Clark TW, Patel NK, et al. Prevalence and treatment of cephalic arch stenosis in dysfunctional autogenous hemodialysis fistulas. J Vasc Interv Radiol. 2003;14:567–573. doi: 10.1097/01.rvi.0000071090.76348.bc.

Disclosures
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Dr. Sachdeva: None.