

## ROUNDTABLE DISCUSSION

# AV Use of Covered Stents: Dos and Don'ts

Experts share their tips on when, how, or if to deploy covered stents in the setting of arteriovenous grafts and/or fistulas.

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**What are your key dos and don'ts for placing covered stents in each of the following settings?**
**Arteriovenous (AV) Graft Venous Anastomosis**

**Dr. Saad:** Several randomized controlled trials have demonstrated superior primary patency with primary stenting at the venous anastomosis.<sup>1-3</sup> With this level 1 evidence, one could argue to use a stent graft for treatment of every venous anastomotic stenosis. I have not adopted such a universal practice of stenting; in fact, I have been challenged by colleagues as to why not. I suspect there were mixed lesion behaviors in these stent graft trials (ie, some stenoses respond well to conventional angioplasty with prolonged primary patency, while others behave very poorly with rapid restenosis). There are no data to help us make this distinction when treating a lesion. My approach is to first treat stenosis with angioplasty alone and give the lesion a chance to declare itself. If I can achieve an excellent initial response with no early recoil and a clean appearance of the angioplasty site and draining vein with no extravasation, I am inclined to leave it alone. Rapid or repeated restenosis at the anastomosis would suggest a pattern likely to continue and support the need for a stent graft. Other case-specific or anatomic considerations

may favor earlier or primary stent graft use, particularly for long and severe stenosis of the draining vein or a very ragged and disrupted appearance of the vessel after percutaneous transluminal angioplasty (PTA).

When stenting at the venous anastomosis, it is important to preserve as much healthy draining vein as possible for potential future surgical revision and/or secondary fistula construction. Choose a stent graft length that encroaches no more than 1 cm into healthy-appearing vein.

Finally, it hardly needs mention, but to be clear, there is no role for bare-metal stents at the venous anastomosis. Old studies reporting this practice before the publication of major stent graft research were not rigorous trials and were small and uncontrolled.

**Dr. Wasse:** My approach to placing a stent graft at the venous anastomosis is largely informed by the patency interval achieved in response to ultra-high-pressure balloon angioplasty, as well as opportunities for and surgical interest in surgical revision. If the patient experiences signs or symptoms of clinically significant restenosis at the venous anastomosis within a short time period, I'm more prone to use a stent graft. Considering that venous draining vein length is limited, it is appropriate to plan for stent graft extension of at least 1 cm into the draining vein; however, only stent what you have to and try to leave room for subsequent options (ie, surgical creation of a more proximal venous anastomosis).

**Dr. Haskal:** Practice a data-driven practice, where data exist. The “do” for AV graft anastomotic stent grafts is that repeated multicenter controlled studies have shown consistently marked superiority over PTA (of any form) if the patient is similar to those in the reported study cohorts. There is no justification for offering suboptimal therapies to patients.

Deploy your stent graft using a roadmap so that you can slowly and precisely position the device. I bring the stent graft just up to the sheath and get my roadmap then; this provides less time for the patient to move their arm, which could render the procedure useless. Every device has some slight motion forward or backward during the initiation of deployment. I deploy the first few millimeters under a roadmap and assure the positioning is perfect while there remains time to reposition slightly. The unpredictability of the “grip it and rip it” deployment is best kept for your reserve parachute release, not a stent graft.

Land the stent graft at least a centimeter into “good” vein. The vein just beyond the stenosis is already developing fibrosis—a “stenosis in training.” There is no

need to offer the patient a less than maximal chance at longer durability.

### Cephalic Arch

**Dr. Haskal:** This is the trickiest place to land a stent graft. The stenosis almost always reaches the axillary junction, meaning that the stent graft needs to land 1 to 2 mm in the subclavian vein; otherwise, the peripheral edge of the stenosis will be uncovered by the stent graft. However, the risk of overstenting and jailing the axillary vein can be a devastating error. To provide a visible marker for this junction, I use the “Haskal bent-wire” technique, which I have been teaching for 15 years.

**Dr. Wasse:** This location is particularly prone to stenosis and resistant to angioplasty due to extrinsic compression by the clavipectoral fascia and pectoralis major muscle, which prevent its dilatation. It is important to select a stent graft that is long enough to conform to the arch to avoid turbulent flow. In addition, it is key to avoid inadvertently jailing the ipsilateral axillary vein. I often double wire and pass one wire up to the cephalic-axillary vein junction and then retrograde into the axillary vein so I know how far I can extend the proximal end of the stent graft to avoid jailing the axillary vein. There are data demonstrating that AV fistula flow reduction reduces the cephalic arch intervention rate in patients with high flow and symptomatic cephalic arch stenosis, so this can be an effective alternative treatment.

**Dr. Saad:** The cephalic arch is arguably an ideal site for stent grafts. Stenosis of the arch is often poorly responsive to angioplasty alone, angioplasty-induced rupture may be more common than at other locations, and there is rarely anything to lose in terms of vein that may be beneficial for future revisions.

There are anatomic variations of cephalic arch stenosis that may impact decisions on stent graft use.<sup>4</sup> In particular, the junction with the axillary vein should be such that the leading edge of the stent graft will cover the lesion without jeopardizing the integrity of the axillary or subclavian vein. The device must have sufficient flexibility and length to avoid “tenting” at the peripheral end after deployment, which would likely induce rapid edge stenosis. The trailing stent graft edge needs to extend into a healthy vessel; otherwise, new edge stenosis will surely develop, requiring repeat angioplasty or additional stent grafts extending peripherally. Eventually, these extensions will encroach on the puncture segment, limiting the viability of the access. Furthermore, the creation of a long noncompliant conduit may promote the formation of needle-site aneurysms, even without outflow stenosis.

Cephalic vein surgical “turndown” is an option to eliminate a stenotic arch from the outflow pathway altogether.<sup>5</sup> Reports have claimed superiority over percutaneous interventions at the arch. However, the procedure is not insubstantial, requires a long segment of the healthy cephalic vein, results in a new “swing site” and vein-vein anastomosis that is prone to stenosis, and may jeopardize the basilic vein for future fistula construction. My strategy is to exhaust percutaneous methods of treating arch stenosis before turning to this more invasive surgery.

### The First Rib

**Dr. Wasse:** The problem of subclavian vein stenosis resulting from mechanical compression by the first rib and clavicle is particularly vexing because there are limited data and few centers have surgeons with expertise in bone decompression. When assessing stenosis at the costoclavicular junction, it is useful to obtain a central vein angiogram during both arm abduction and adduction because subclavian vein compression can be positional (McCleery syndrome) and result in intermittent venous obstruction. In general, I avoid stent graft placement at this location because of the risk of stent fracture and persistent stenosis. If the AV access is high flow and has a usable cannulation segment, it is worth considering inflow reduction.

**Dr. Saad:** There has been much talk about performing first rib or clavicular resection for mechanical stenosis at this challenging location.<sup>6,7</sup> In expert hands, this may be a good option. However, this is not a trivial procedure, and many centers do not have ready access to the surgical expertise required to perform it well.

Stent grafts may perform quite well here but can also be problematic. There are little data, and it is difficult to determine how, when, or if to go beyond simple angioplasty and place a stent graft. Sizing the device may be challenging because there is often a mismatch between peripheral and central target vessels, and these may be much larger than the vein at the rib-clavicle space, resulting in an hourglass appearance even after successful angioplasty. Excessive oversizing will lead to stent graft compression with pleating or other deformations, potentially contributing to restenosis or thrombosis. Fear of immediate or delayed migration and embolization of the stent graft may lead to excessive oversizing. This risk can be mitigated by always maintaining a guidewire through the atrium into the inferior vena cava during deployment, careful lesion measurements and device selection, and vigilant imaging during device deployment. It is also critical to understand the relationship with the ipsilateral internal jugular (IJ) vein; one must determine the precise location

and patency of the IJ vein before considering placement of a stent graft that may jeopardize or occlude the vessel.

### The Elbow Joint

**Dr. Haskal:** I tend to run from placing stents or stent grafts in the elbow. Although the REVISE trial showed that the Viabahn endoprosthesis (Gore & Associates) did work across the joint (ie, compressed to an oval shape but still providing an advantage over PTA),<sup>3</sup> I work hard to avoid devices in this area. Placing one often means picking one of the two smaller veins across the elbow (ie, landing the central end of the device in a vein that might be smaller than the graft), which is a bad prognosis for long-term patency. Furthermore, it jails veins that might be used in a future secondary fistula. I'll exhaust all forms of PTA in this area when possible.

**Dr. Wasse:** Before considering stenting across the elbow joint, I assess upper arm venous drainage (dual drainage to the cephalic and basilic veins or to the basilic and brachial veins) and speak to the surgeon because I want to leave the patient with as many future access options as possible. If the patient isn't deemed a surgical candidate for subsequent ipsilateral upper arm access (which is rare), then I'll use a stent graft approved for use at this location.

**Dr. Saad:** Evidence demonstrates that stenting across the elbow joint is as safe and effective as for other anatomic locations.<sup>3</sup> In most cases, the basilic vein is more favorable for this than the cephalic, which tends to form a more acute angle with arm bending. Before placing a stent across the elbow, it is useful to obtain lateral images with elbow flexion to evaluate angulation and determine the likelihood of graft kinking. The major caveat is to avoid encroachment into an otherwise healthy upper arm vein that should be preserved for a secondary fistula.

### Thoracic Central Vein Obstruction

**Dr. Wasse:** Treatment of central vein occlusion requires a plan if considering stent graft placement, incorporating either symptomatic relief and existing AV access salvage or placement of a de novo access. Given this, effort should be made to avoid stent graft placement at a location that precludes central venous drainage for a future access.

**Dr. Saad:** If recanalization of chronic occlusion has been particularly challenging and risk for reocclusion is believed to be high, it is easy to justify placing a stent graft. When doing so, the relationship to other central veins must be fully defined to cover the offending lesions

without jeopardizing other central veins. Many dialysis patients have had previously failed accesses, multiple jugular vein catheters, and limited redundancy of cranial or peripheral drainage. Unwittingly blocking a crucial central vein with a stent graft may result in severe cranial or peripheral venous hypertension.

**Dr. Haskal:** Deploy from above, that is, an upper extremity or jugular approach to avoid stenting too deeply into the atrium—a disappointingly easy thing to do given the imprecise fluoroscopic ability to mark the superior vena cava (SVC)/right atrial junction. However, measure with a marking catheter first to choose the proper length, and never jail the contralateral brachiocephalic vein—under virtually any instance. That means careful marking of the left and right brachiocephalic junction with the SVC, often by injecting a larger sheath within one, and a 5-F catheter crossed retrograde into the other brachiocephalic vein simultaneously, resulting in unbeatable imaging.

### Which patients and anatomies are nonstarters in terms of candidacy for a covered stent and why?

**Dr. Saad:** If there is any chance of a local or systemic infection, a stent graft should not be deployed. If needed, this procedure can almost always wait until the infection is treated and resolved. Aneurysms or pseudoaneurysms of the fistula or graft puncture area should rarely (if ever) be stented. There have been scattered reports of doing so, but I believe this is folly. There is a reason that needle-site pseudoaneurysms develop, usually with few other sites available for needle access. Placing a stent graft in a pseudoaneurysm renders it unsuitable for needle access, and other needle sites may be difficult to recruit. Pseudoaneurysms should be considered surgical lesions and treated with revision, aneurysmorrhaphy, or interposition graft.

**Dr. Haskal:** Large veins ending in small ones and unaddressed downstream occlusions are nonstarters. The stent graft is like an aircraft—it needs a good takeoff runway and a great landing strip. I treat access pseudoaneurysms with a healthy reluctance because of an underappreciated risk of colonized infection in partially thrombosed ones. I never treat it during an active infection unless it's a life-threatening emergency.

**Dr. Wasse:** I avoid placing a stent graft in patients with (1) local infection or bacteremia; (2) within the cannulation zone, unless there is sufficient area to avoid cannulation of the stent; and (3) in the draining vein of a patient whose cannulation segment is end stage (highly

aneurysmal, hypopigmented, ulcerated) and who is not a candidate for AV access revision that would allow for continued use of the draining vein in question.

### What are your tips for optimal imaging, sizing, and placement?

**Dr. Haskal:** Follow the device instructions for use for precise sizing and correct (ie, mild) but not excessive oversizing to avoid luminal encroachment due to folds or pleats of expanded polytetrafluoroethylene.

**Dr. Wasse:** I'm a big advocate for obtaining images of an upper extremity limb in both supine and prone positions to get a more informed view of stenosis severity, side branch location, vessel angulation, and to confirm the landing zone. To allow for this, the patient's entire arm is prepped and exposed on the draped arm board, and a sterile glove is placed on the patient's hand so I can easily rotate the arm without adjusting the C-arm. I also dilute my contrast, which gives me a more nuanced view of peripheral draining vein stenosis, especially around venous valves and points of angulation.

**Dr. Saad:** Get it right, and strive for perfection. Perform high-quality imaging of the lesion and related anatomy using appropriate magnification and orthogonal views.

Don't be stingy with contrast; use whatever it takes to get the necessary images to define the anatomy. Large quantities of contrast should not be necessary to characterize most peripheral lesions, where low-volume dilute injections may suffice. For central lesions, larger volumes and full-concentration contrast may be necessary.

Measure lesions and vessels quantitatively whenever possible. Use the appropriate marker, ruler, or other calibration methods. I like to perform a cine run with an uninflated balloon in the vessel for this purpose, making sure the imaging angle is perpendicular to the balloon. Document the lesion length and diameter of healthy vessel peripheral and central to the lesion.

Do not "over oversize." Recommendations to size up to 1 mm greater than the vessel diameter may lead to injury of otherwise healthy vein and induce new stent-edge stenosis. As long as the stent can be confidently secured by compressive force at the target lesion site, it may be preferable not to oversize at the ends.

If I do not have the optimal device on the shelf, rather than "settle" for a less than ideal choice, I will defer stent graft intervention to a subsequent procedure and make sure I have the needed device available at that time.

Image fastidiously while situating and deploying the stent graft. Identify distinct, fixed anatomic landmarks,

and use short “puffs” of contrast to confirm precise positioning of the device before initiating and during deployment. I will take as many of these images as necessary to achieve perfect placement. Roadmap imaging may be helpful but must be used carefully and expertly to avoid misplacement of the device.

At the time of thrombectomy, it can be very difficult to accurately define and measure anatomy, particularly for a fistula where venous spasm or vessel injury are contributing to the appearance of stenosis. It may be difficult or impossible to select the optimal stent graft under these circumstances. Very often, if the access is reimaged at a later time without confounding thrombosis, the anatomy looks much different, and the culprit lesion can be more clearly identified, measured, and targeted. Furthermore, at the end of a long and/or challenging thrombectomy procedure, the operator and the patient may not be best suited for a deliberate optimized stent graft insertion. If the patient needs dialysis and has volume overload, hypertension, or other immediate medical considerations, these should be prioritized. When in doubt, accept the result and bring the patient back at an appropriate time to reassess and perform optimal intervention using the optimal device under the optimal circumstances.

### What does optimal follow-up surveillance entail for covered stents?

**Dr. Wasse:** Like any other patient with an AV access, the patient is instructed to return for evaluation only if the dialysis unit or patient notes a clinical problem, such as decreased blood flow, high venous/arterial pressures, prolonged bleeding, decreased dialysis adequacy, or limb edema.

**Dr. Saad:** We do not routinely do anything different for these patients. If I am particularly interested or concerned about the outcome, I will schedule the patient to come back for an office visit to review performance history and perform physical examination and ultrasound of the access. Our dialysis clinics perform routine access flow monitoring surveillance, so this parameter can help identify and track problems. Depending on the relationships with dialysis facilities and nephrology practices, the model for procedure follow-up may differ.

**Dr. Haskal:** It is the same as all access follow-up: dialysis efficacy and physical exam. I require no routine follow-up with me; these patients spend enough time with doctors' visits. The only exception is my mandatory insistence on routine follow-up with all SVC syndrome patients that I treat. The cost of overlooking

a recurrence (a ready intervention) is anguish over a missed opportunity to preserve that patient's quality of life.

### Beyond those already discussed, what are the keys to pitfall avoidance (either procedural or down the road)?

**Dr. Wasse:** Just as in sewing and carpentry, the proverb “measure twice, cut once” applies to stent graft placement. Ensure lesion measurements are accurate by double-checking the lesion length and vein angulation on different imaging views, particularly in the case of central venous lesions, and avoid undersizing the stent. In addition, pay attention to cannulation segment integrity (I take photos and place them in the electronic medical record at each visit), document the access intervention history, and note alternative future AV access options, as it makes little sense to place a stent graft when there are options for a new access with a greater likelihood of enduring patency.

**Dr. Saad:** The universal principle of “do no harm” must be central in the decision to place each stent graft. There is only one opportunity to perform the optimal stent graft intervention for the first time, and there is almost always a choice to defer this irreversible step to a future procedure. Once placed, the device is never coming out and will be a part of that access circuit for the duration. Therefore, I always pause to consider: Is this the right time? Do I have the right device? Will there be better circumstances to perform an optimal intervention later? Am I burning any bridges?

Don't use a stent graft as a Hail Mary pass for terminal access failure when the anatomy or clinical circumstances predict poor long-term outcome benefit. It is better to cut one's losses and look for a new, better access alternative.

Stent grafts represent a significant financial investment in the future of an AV access. As payment models and risk-sharing entities evolve, it is essential to consider who bears the cost and who derives the economic risk or benefit of the intervention. The interventional physician needs to be a careful steward of this resource and work with other stakeholders to assure that this investment generates the best return, both clinically for the patient and economically for the health care system.

### Has your decision-making regarding the use of covered stents changed in any way due to coronavirus considerations?

**Dr. Wasse:** Interestingly, in contrast to hypercoagulable COVID-19–positive inpatients dialyzing with catheters, COVID-19–positive, end-stage kidney dis-

ease (ESKD), hospitalized patients with AV fistulas or AV grafts aren't currently being noted to experience increased thrombosis of their AV access, likely due to its continuous high flow. Therefore, to date, I don't have any evidence to support changing my approach to stent graft use in ESKD patients with permanent AV access.

**Dr. Haskal:** No. We have, as with everyone, seen fewer patients for elective and semiurgent interventions for access. I worry about the downstream consequences of the mandated restrictions on longer-term access care in ESKD patients. But we are quickly ramping up to catch up with and take care of anyone who has been held back. It will be interesting times for a while.

**Dr. Saad:** Fundamentally, there has been no change in my approach to vascular access care due to COVID-19. We are making extra efforts to minimize interactions and exposures. Thus, I may have a lower threshold for plac-

ing a stent graft when I suspect a high likelihood of rapid restenosis and will be less inclined to wait for the natural history of a lesion to unfold over time. Also, because it has become much more challenging to arrange elective access surgery, I am more inclined to extend the life of a failing access by minimally invasive means. ■

1. Haskal ZJ, Saad TF, Hoggard JG, et al. Prospective, randomized, concurrently-controlled study of a stent graft versus balloon angioplasty for treatment of arteriovenous access graft stenosis: 2-year results of the RENOVA study. *J Vasc Interv Radiol*. 2016;27:1105-1114.e3. doi: 10.1016/j.jvir.2016.05.019
2. Haskal ZJ, Trerotola S, Dolmatch B, et al. Stent graft versus balloon angioplasty for failing dialysis-access grafts. *N Engl J Med*. 2010;362:494-503. doi: 10.1056/NEJMoa0902045
3. Vesely T, DaVanzo W, Behrend T, et al. Balloon angioplasty versus Viabahn stent graft for treatment of failing or thrombosed prosthetic hemodialysis grafts. *J Vasc Surg*. 2016;64:1400-1410.e1. doi: 10.1016/j.jvs.2016.04.035
4. Bennett S, Hammes MS, Blicharski T, et al. Characterization of the cephalic arch and location of stenosis. *J Vasc Access*. 2015;16:13-18. doi: 10.5301/jva.5000291
5. Sigala F, SaBen R, Kontis E, et al. Surgical treatment of cephalic arch stenosis by central transposition of the cephalic vein. *J Vasc Access*. 2014;15:272-277. doi: 10.5301/jva.5000195
6. Glass C, Dugan M, Gillespie D, et al. Costoclavicular venous decompression in patients with threatened arteriovenous hemodialysis access. *Ann Vasc Surg*. 2011;25:640-645. doi: 10.1016/j.avsg.2010.12.020
7. Auyang PL, Chauhan Y, Loh TM, et al. Medial claviculotomy for the treatment of recalcitrant central venous stenosis of hemodialysis patients. *J Vasc Surg Venous Lymphat Disord*. 2019;7:420-427. doi: 10.1016/j.jvsv.2018.10.024