# The Role of Endovascular Stents in Dialysis Access Maintenance

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**Vascular stenosis is most often the culprit behind hemodialysis vascular access dysfunction, and although percutaneous transluminal angioplasty remains the gold standard treatment for vascular stenosis, over the past decade the use of stents as a treatment option has been on the rise. Aside from the 2 Food and Drug Administration-approved stent grafts for the treatment of venous graft anastomosis stenosis, use of all other stents in vascular access dysfunction is off-label. Kidney Disease Outcomes Quality Initiative recommends limiting stent use to specific conditions, such as elastic lesions and recurrent stenosis; otherwise, additional adapted indications are in procedure-related complications, such as grade 2 and 3 hematomas. Published reports have shown the potential use of stents in a variety of conditions leading to vascular access dysfunction, such as venous graft anastomosis stenosis, cephalic arch stenosis, central venous stenosis, dialysis access aneurysmal elimination, cardiac implantable electronic device-induced stenosis, and thrombosed arteriovenous grafts. Although further research is needed for many of these conditions, evidence for recommendations has been clear in some; for instance, we know now that stents should be avoided along cannulation sites and should not be used in eliminating dialysis access aneurysms. In this review article, we evaluate the available evidence for the use of stents in each of the aforementioned conditions leading to hemodialysis vascular access dysfunctions.**

**Key Words:** Stents, Dialysis access dysfunction, Cephalic arch stenosis, Aneurysms, CIED

## INTRODUCTION

Although the tools and equipment used in endovascular treatment of hemodialysis vascular access dysfunction have seen important advances over the last decade, we strongly believe that the road of discovery and innovation is still in the early stages. Hemodialysis vascular access complications contribute to ESRD patients' morbidity and mortality[1] and significantly add to their cost of care.[2] Hemodialysis vascular access is the lifeline of ESRD patients on hemodialysis, which is essentially a life-sustaining treatment. Arteriovenous fistulas (AVFs) are the preferred hemodialysis access because of superior patency rates, longevity, and lower rates of complications,[3] with arteriovenous grafts (AVGs) coming in second in preference, although AVGs do have occasional unique advantages over AVFs.[4,5] Vascular (arterial and venous) stenosis is the main culprit for arteriovenous access dysfunction, and neointimal hyperplasia is the main pathology behind the development of venous stenosis.[6]

Advances in endovascular procedures for hemodialysis vascular access, improved outcomes, and the convenience of performing these procedures in the outpatient settings make percutaneous transluminal angioplasty (PTA) the gold standard treatment for hemodialysis vascular access dysfunctions. Stents, however, have emerged as a potential additional therapeutic intervention in vascular access dysfunction and have been the subject of retrospective and prospective studies examining their efficacy compared with PTA. The role of stents in treating vascular access dysfunction has been debated, and evidence is clearer in some specific clinical conditions compared with others. Flair endovascular stent grafts[7] (Bard Peripheral Vascular, Inc., Tempe, AZ) and Viabahn endovascular stent grafts[8] (W.L. Gore & Associates, Inc., Flagstaff, AZ) are the only known stents approved by the Food and Drug Administration (FDA) for use in the hemodialysis vascular access for venous graft anastomosis (VGA) stenosis, whereas use of other stents in dialysis access dysfunction has been mostly off-label.

## INDICATIONS FOR STENT USE IN HEMODIALYSIS VASCULAR ACCESS PROCEDURES

In addition to the earlier mentioned indications for Flair and Viabahn graft stents for venous graft anastomosis stenosis, there are other indications that were adapted based on clinical practice guidelines and position paper recommendations. One such indication is the use of stents as treatment for procedure-related grade 2 and 3 hematomas.[9,10] It is important to mention that grade 1 hematomas usually respond to balloon tamponade intervention. The recommendation for stent use in grade 2 and 3 hematomas came from clinical practice committee position papers because of the major advantage of salvaging arteriovenous access and avoiding the need for urgent surgery. Another indication for stent use is elastic lesions (recoil) after angioplasty.[11] This recommendation was based on the evidence that median access survival was inversely related to the residual stenosis in both elective angioplasty and thrombectomy.[12] A third indication is rapid recurrence of stenosis, which is defined by Kidney Disease Outcomes

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Quality Initiative (KDOQI) as recurrence of the lesion in a period of less than 3 months.[11]

## COMPLICATIONS ASSOCIATED WITH STENT USE

There are several reported complications associated with stent placement. Stent migration has been reported as one of the complications; migration can be local, that is, "displacement migration" (at time of placement or delayed after placement) or distal, ie, "major migration." Local migration can result in obstruction of downstream vessels. A example for such scenario is a stent placed at the cephalic arch migrating into the subclavian vein, which can result in partial or total occlusion, impeding future creation of an AVF or AVG using the basilic or axillary vein (Fig 1). Distal migration, which has also been reported,[13] can involve the pulmonary artery or intracardiac vessels, which are common locations for distal migrations.[14-16] This requires extensive procedures to remedy, in addition to procedures for the removal of the migrated stent.

Stent fracture is another complication, which is usually seen on follow-up angiograms.[17] Stents placed at the subclavian-brachiocephalic junction, ie, at the costoclavicular junction, are commonly reported locations for stent fractures, probably because of the fact that the stent is crushed between the clavicle and the body of the first rib. Stent fracture, however, can occur at other locations (Fig 2).

Infection is another major complication that can lead to catastrophic outcomes. The combination of the immunocompromised status of patients with ESRD and repetitive cannulations for dialysis treatments are likely contributing factors to infection. Stent infections have been reported in case series[18] and in large retrospective analysis.[19] It has been reported that up to16.3% of stents placed in arteriovenous accesses are surgically removed at some point because of stent infection.[19]

One unique complication, stent struts protrusion, results from placing stents in cannulation sites.[18] Repetitive cannulation can damage the metal part of the stents (struts), which might protrude through the skin and create a hazardous situation for dialysis patients' health care providers (Fig 3).[18]

**CLINICAL SUMMARY**

- Percutaneous transluminal angioplasty remains the therapeutic gold standard option for the majority of vascular stenoses resulting in hemodialysis vascular access dysfunction.
- The Food and Drug Administration has approved 2 stent grafts for the treatment of venous graft anastomosis stenosis; use of any other stents in vascular access dysfunction would be off-label.
- Stent placement should be avoided along cannulation sites.
- Stents should not be used to eliminate aneurysms because of the high risk of subsequent infections.
- Stent placement should be avoided in central venous stenosis when cardiac implantable electronic device leads are present to avoid entrapment of leads.

## STENT USE IN SPECIAL CONDITIONS

### Cephalic Arch Stenosis

Cephalic arch stenosis is a common cause of brachiocephalic AVF dysfunction.[20] The use of various types of stents as a treatment of cephalic arch stenosis has been reported.[21] A study was performed on patients with recurrent cephalic arch stenosis comparing bare stents to stent grafts.[22] Six-month primary patency for bare stents and stent grafts were 39% and 82%, respectively; 1 year primary patency was 0% and 32%, respectively, with a significant statistical difference of $p = .0023$ at 1 year. The study results were markedly limited by the small sample size ($n = 13$) and by the fact that groups were not compared with the gold standard therapeutic method of angioplasty (PTA). Additionally, many stents were used in the study patients, adding significantly to the cost of such therapy. Another retrospective cohort analysis of 45 patients was recently published comparing stent placement to PTA.[23] The authors concluded that stent placement resulted in a better patency rate compared with angioplasty alone. The retrospective design of the study, the small sample size of patients evaluated (stent $n = 20$ and PTA $n = 25$), and lack of control for stent type were identifiable weaknesses of this review. The fact that cephalic arch stenosis is a common complication of brachiocephalic AVFs highlights the need for a well-designed randomized control trial (RCT) comparing specific types of stents (and not all stents together) to PTA alone. Such a study should use primary patency, secondary patency, complication rates, and associated treatment costs as outcome measures. Until such as study is performed, PTA alone remains the gold standard treatment option for cephalic arch stenosis.

Surgery is another modality that can be considered as a treatment option for recurrent cephalic arch stenosis as it has yielded excellent patency rates.[24]

### VGA Stenosis

Despite the decline in the overall rate of AVGs among hemodialysis patients, AVG dysfunction is still a common presentation to vascular access centers, with VGA stenosis being the most common cause of this dysfunction.[25] As previously mentioned, Flair and Viabahn stents are approved for placement at VGA stenoses.[7,8] Numerous studies were published investigating the role of stents at VGA sites with variable results.[26-28] In a multicenter RCT comparing PTA alone to angioplasty with stent graft placement,[29] 190 patients with VGA stenosis were randomized to both groups. The stent graft group had significantly better primary patency at 6 months (51% for stent graft group and 23% for PTA group, $p < .001$) and better access circuit patency (38% for stent graft group and 20% for PTA group, $p = .008$). There was no significant difference between the 2 groups in access circuit-assisted patency and access circuit cumulative patency rates. A follow-up 2-year study (RENOVA) was initiated, and 270 patients were enrolled, with 138 patients randomized to the PTA with stent graft group and 132 patients to the PTA-alone group.[30] The