Some form of anatomical fixation during endovascular aneurysm repair (EVAR) is advantageous and should be considered necessary in 2012. There is a surfeit of experiential and scientific data indicating the benefits of anatomic fixation in general and suprarenal fixation in particular.

THE PROBLEM: STENT GRAFT MIGRATION
Stent graft migration is defined as distal movement > 10 mm or movement ≤ 10 mm when resulting in secondary intervention, according to the Society for Vascular Surgery reporting standards for EVAR. It is not surprising that migration is an Achilles’ heel of EVAR. Using cadaveric aorta, Resch et al showed that the tractional force required to dislodge any stent graft was much less (by a factor of 6) than that required to disrupt a sutured anastomosis. Stent graft migration is associated with type I proximal endoleak and sac pressurization; therefore, reintervention is required to avoid aneurysm growth and potential rupture. Consequently, meticulous attention to stent graft sizing, device selection, and deployment should be undertaken to minimize the risk of migration. With regard to preventing migration and proximal endoleak, two adverse outcomes that are intimately related, authorities in the field have previously advocated for transrenal bare-metal stents in aortas with short- or large-diameter proximal necks.

DEVICES WITH SUPRARENAL FIXATION: EXCELLENT RESULTS
The Zenith endograft (Cook Medical, Bloomington, IN) (Figure 1A) was the first device approved by the US Food and Drug Administration (FDA) that has suprarenal fixation. The 5-year results of its pivotal trial demonstrated very low migration rates. Owing to its pararenal bare-metal stents, attachment hooks arising from those stents, and the availability of a 36-mm proximal sealing stent (still among the largest proximal devices available and approved for EVAR), this device is reputed to be able to treat unfavorable necks. In one single-institution study comparing the clinical results of various endografts, the Zenith device had no incidence of migration.

Two Medtronic, Inc. (Minneapolis, MN) EVAR devices incorporate suprarenal stents. The Talent device incorporates suprarenal bare-metal stents without hooks or barbs and is FDA approved for use in short (10 mm) aortic necks, one of only two devices with such approval. The Endurant device (Figure 1B), meanwhile, has both suprarenal stents, as well as hooks on those stents, and is also approved for use in short (10 mm) aortic necks. There were no migrations, ruptures, conversions, or type I endoleaks during the first year of follow-up in the United States pivotal trial of the Endurant graft. Remarkably, in a small study examining patients with hostile anatomy (including proximal neck...
lengths between 5 and 10 mm and highly angulated proximal necks) treated with the Endurant device, there were no migrations and no type I endoleaks on early follow-up.

The AFX device (Endologix, Inc., Irvine, CA), the successor to the Powerlink stent graft (Endologix, Inc.), is designed to rest on the aortic bifurcation. The AFX device incorporates optional pararenal stents (Figure 1C) without fixation hooks or barbs.

**EXPERIMENTAL MODELING TO PREDICT MIGRATION FORCES**

Using electrocardiogram-gated computed tomography scans, the Utrecht group showed that patients with stent graft migration had more aortic distensibility than those who did not, although none of the patients had grafts with suprarenal fixation. Similarly, the UCSF group has demonstrated, using computational fluid dynamics data derived from patient-specific computed tomography data, that hydrostatic pressure results in larger forces on the stent graft than do sheer stresses from pulsatile flow.

In an elegant study using fluid structure interaction modeling—a combination of finite element analysis of solid structures and computational fluid dynamics of blood flow—Molony et al demonstrated that antero-posterior neck angulation increased drag forces, and presumably migration risk, in a variety of stent grafts in 10 patient-specific geometries. Using a mathematical construct, the University of Liverpool group studied factors expected to increase stent graft migration and identified—in addition to hypertension and aneurysm sac features—graft tapering from proximal neck to iliac limbs as a factor expected to increase migration forces. Similarly, Morris et al demonstrated increased drag forces with larger-diameter infrarenal sealing stents using a computational fluid dynamics model and idealized endograft geometry.

These experimental studies suggest that migration forces are increased in patients with hypertension, angulated necks, or large-diameter necks. Unfortunately, the anatomy of an individual patient’s proximal aortic neck is not modifiable. Therefore, choosing the most appropriate endograft to counteract tendencies to migrate in these clinical scenarios is crucial.

In demonstrating that the force required to dislodge an EVAR device was almost an order of magnitude smaller than that needed to disrupt a proximal aortic open surgical anastomosis, Resch et al also provided evidence that balloon-expandable stents and hooks or barbs significantly increase the proximal fixation strength of endografts.
SUPRARENAL FIXATION IN CHALLENGING INFRARENAL NECK ANATOMIES

Case 1
A 56-year-old man with an asymptomatic 6-cm abdominal aortic aneurysm (AAA) with a short trapezoidal aortic neck (Figure 2) underwent elective aneurysm repair using a 28-mm main body Endurant device. One month after surgery, his aneurysm was stable in diameter without endoleak.

Case 2
A 69-year-old man with a symptomatic 6-cm AAA with a short neck was admitted and underwent EVAR urgently. A 28-mm Zenith main body was implanted (Figure 3). On completion arteriography, flow into the right renal artery seemed sluggish; therefore, the right renal artery was stented using a 6-mm Herculink stent (Abbott Vascular, Santa Clara, CA). Two years later, there was no evidence of endoleak or migration.

Figure 2. AAA with a short trapezoidal neck treated with an Endurant device with pararenal stents and fixation hooks. Preoperative reconstruction (M2S, West Lebanon, NH) (A). Intraoperative digital subtraction angiogram (DSA) before deployment of the main body of the stent graft (B). Completion DSA showing no type I endoleak and preserved renal artery perfusion (C).

Figure 3. AAA with a short neck treated with a Zenith device with pararenal stents and fixation hooks. Intraoperative DSA before deployment of the main body of the stent graft (A). Completion DSA showing no type I endoleak but possible impingement of the top of the fabric on the ostium of the right renal artery (B). Fluoroscopic image of the right renal artery stent after deployment above the top covered stent of the EVAR device (C).
Finally, one cautionary note regarding the implantation of EVAR devices with suprarenal uncovered stents, especially with hooks or barbs. If it ever becomes necessary to explant the device, supraceliac clamping is generally required, and excision of the proximal portion of the stent graft can be difficult and require sterile wire cutters.  

CONCLUSION

Given that there is no evident disadvantage to para-
renal bare-metal stents and accompanying suprarenal
fixation, the fact that anatomic fixation is advantageous
in EVAR, and migration rates are generally extremely
low with devices featuring suprarenal fixation, it seems
prudent to recommend the routine use of grafts with
suprarenal fixation in treating AAA with EVAR.

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