Suprarenal Fixation Is Required for EVAR

The advantages afforded with suprarenal fixation when treating abdominal aortic aneurysms.

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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.

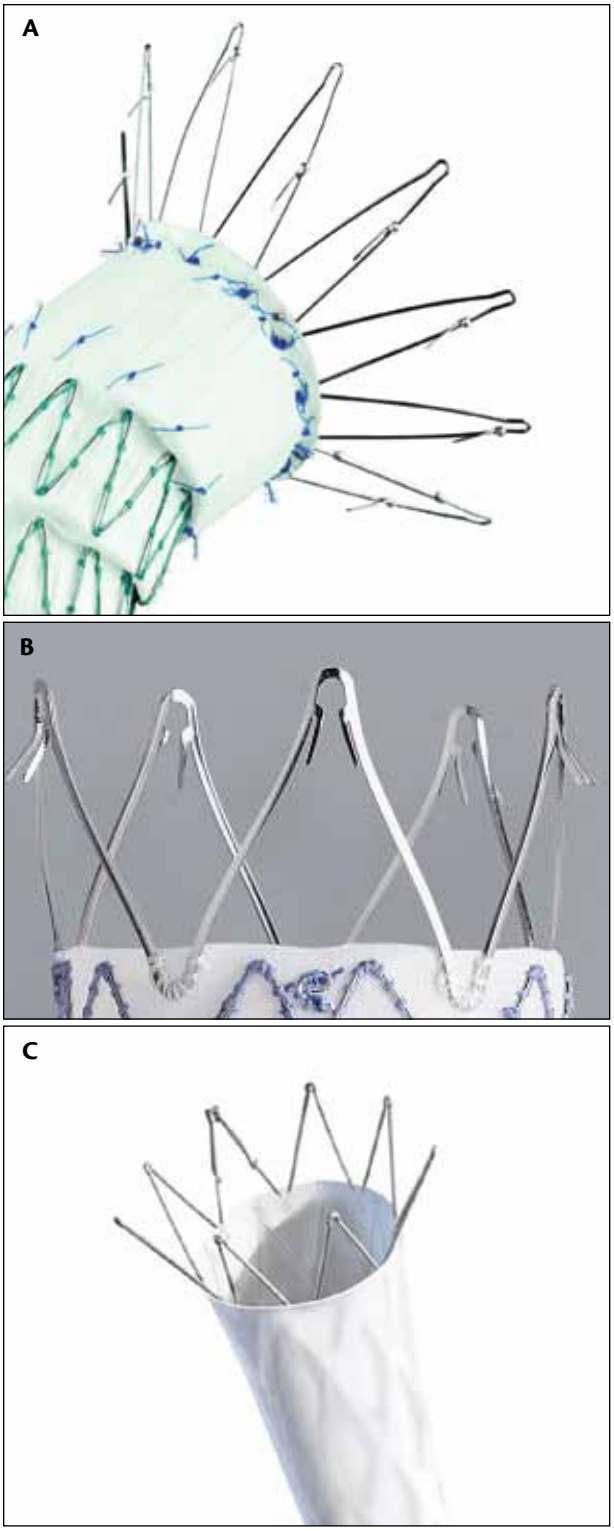
THE PROBLEM: STENT GRAFT MIGRATION

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.[1] 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.[2] 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.[3]

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.[4] 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.[5] In one single-institution study comparing the clinical results of various endografts, the Zenith device had no incidence of migration.[6]

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.[7] Remarkably, in a small study examining patients with hostile anatomy (including proximal neck



(Courtesy of Cook Medical.)
(Courtesy of Medtronic, Inc.)
(Courtesy of Endologix, Inc.)

Figure 1. Some currently available, FDA-approved EVAR devices with suprarenal stents. Zenith device with fixation hooks (A). Endurant device with fixation hooks (B). AFX device without fixation hooks (C).

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.[8]

The AFX device (Endologix, Inc., Irvine, CA), the successor to the Powerlink stent graft (Endologix, Inc.), is designed to rest on the aortic bifurcation.[9] 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.[10] 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.[11]

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 anteroposterior neck angulation increased drag forces, and presumably migration risk, in a variety of stent grafts in 10 patient-specific geometries.[12]

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.[13] Similarly, Morris et al demonstrated increased drag forces with larger-diameter infrarenal sealing stents using a computational fluid dynamics model and idealized endograft geometry.[14]

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.[2]

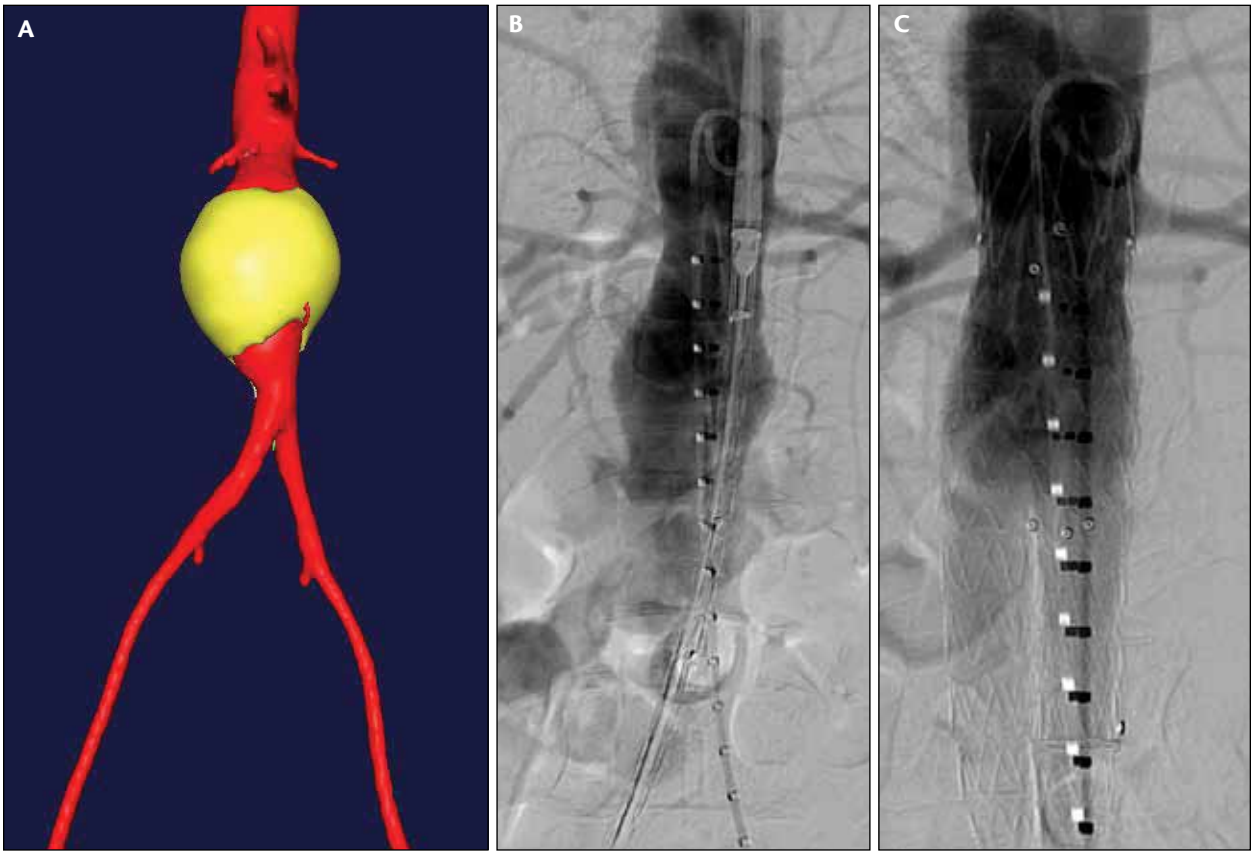


Figure 2. AAA with a short trapezoidal neck treated with an Endurant device with pararenal stents and fixation hooks. Preoperative reconstruction (M2S, West Lebanon, NH) (A). Intraoperative digital subtraction angiogram (DSA) before deployment of the main body of the stent graft (B). Completion DSA showing 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).

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.

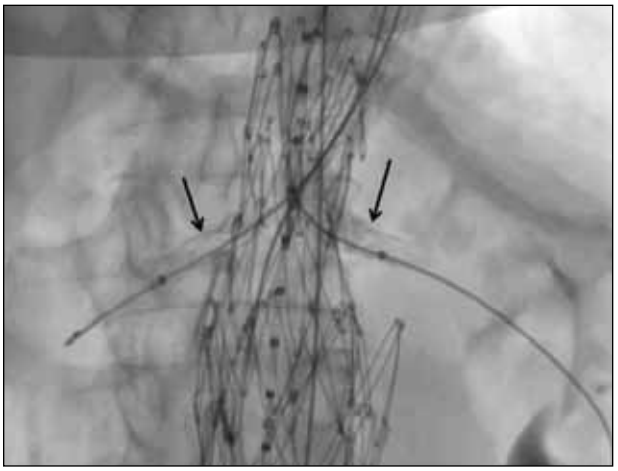


Figure 4. Fluoroscopic image of a "snorkel" procedure performed with an AFX device with a bare-metal proximal stent and 6-mm iCast covered stents in both renal arteries (arrows). Not easily visualized is a 7-mm iCast stent deployed into the superior mesenteric artery.

WHY NOT USE SUPRARENAL FIXATION?

There is no convincing evidence of renal function compromise with suprarenal stents. A meta-analysis comparing EVAR devices with and without suprarenal fixation did not detect a clear medium-term decrement in renal function in patients receiving the former.[15] Similarly, one of the larger single studies included in that analysis compared Powerlink grafts with and without suprarenal bare-metal stents and demonstrated no significant difference in postoperative creatinine clearance at 12 months.[16]

In the current era of more frequent snorkel or chimney procedures, it is remarkable that bare-metal stents above the proximal seal zone of the aortic graft do not interfere with cannulation or stenting of the aortic branches. For example, Figure 4 shows an AFX device with pararenal bare-metal stents that was used with iCast covered stents (Atrium Medical Corporation, Hudson, NH) in the renal and superior mesenteric arteries to accomplish endovascular repair of a suprarenal AAA.

Pararenal stents do not seem to adversely affect the ability of devices to conform to angulated neck anatomy. For instance, Robbins et al demonstrated that the Talent (with suprarenal bare-metal stents) did not exhibit more frequent migration or endoleak in angulated as compared to straight proximal infrarenal necks.[17]

There are clinical data to indicate that the suprarenal and visceral segments of the aorta dilate less frequently and rapidly than does the infrarenal neck after EVAR.[18] This implies that fixation in the suprarenal aorta might be more durable than fixation in the infrarenal neck alone.

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.[19]

CONCLUSION

Given that there is no evident disadvantage to pararenal 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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