

# ActiveSeal™ Endograft Technology and Aneurysm Sac Regression

New core lab analysis provides insight into clinical benefits.

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The clinical practice of endovascular repair of abdominal aortic aneurysms (EVAR) has been evolving continuously since the inception of the technique by Juan Parodi more than 2 decades ago.<sup>1</sup> Advances have been driven by ever-improving endograft designs

and the clinicians' growing comfort with the technical aspects of the procedure itself.<sup>2</sup> As designs improved, patient selection criteria were broadened, and EVAR supplanted open surgical repair as the most common technique for repair of infrarenal aortic aneurysms.<sup>3</sup>

Paradoxically, clinical outcomes did not improve in parallel with the transition to minimally invasive technology.<sup>4-7</sup> Patients with increasingly more challenging aortic anatomy were treated with EVAR, in part explaining the decoupling of technological advances and clinical results. Endografts were implanted within vascular anatomy never envisioned by the device manufacturers—anatomy well outside the instructions for use.<sup>8</sup> Furthermore, the advent of EVAR as a potentially less invasive treatment modality allowed clinicians to treat patients with medical comorbidities that, in the past, would have relegated them to observation alone (i.e., patients who would not have tolerated a major open surgical procedure).<sup>9</sup> The inclusion of medically compromised patients accounts for differences in the study populations treated with EVAR versus open surgery. These differences may well increase the frequency of medical complications beyond what would have been observed in a healthier patient population suitable for open surgical repair.

## TREATMENT DECISIONS

Clinical trials designed to gain premarket approval for an endograft are, by design, limited to highly selected patients with straightforward aortic anatomy and reasonably few medical comorbidities. These premarket device approval trials conducted under investigational

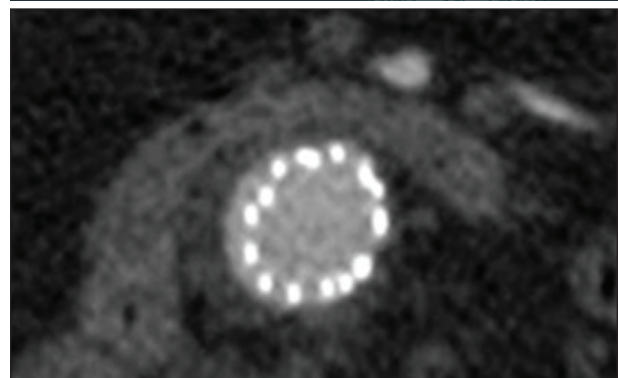
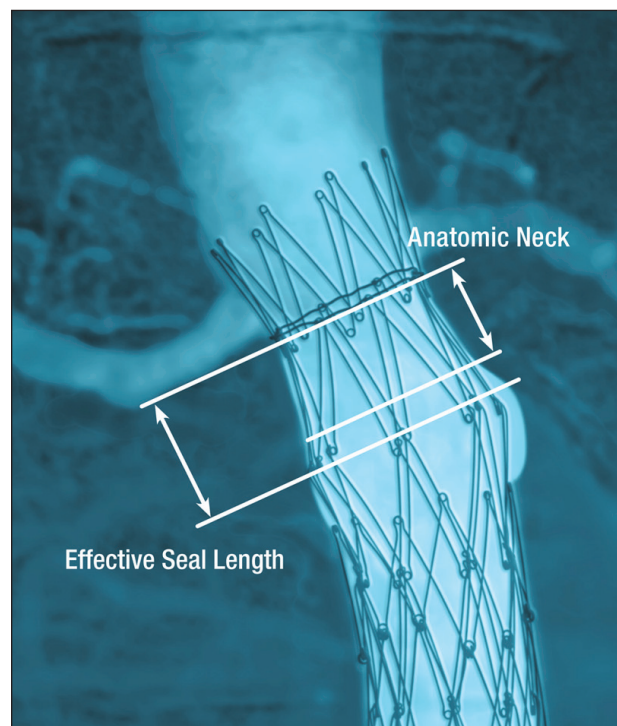


Figure 1. ActiveSeal apposition positively correlates with sac regression.

TABLE 1. PREDICTORS OF EARLY SAC REGRESSION

Variable	Median	Effect on Sac Regression
Age	76 y	Younger: no effect
Sex	70%	Male: no effect
AAA diameter	47 mm	Smaller: no effect
Suprarenal neck angulation	9°	Less: no effect
Infrarenal neck angulation	16°	Less: no effect
Proximal neck diameter	22 mm	Smaller: no effect
Anatomic aortic neck length	18 mm	Longer length: increased regression ( $P = .019$ )
Conical neck	27%	Conical: no effect
Apposition length	24 mm	Longer: no effect
Apposition surface area	18 cm <sup>2</sup>	Greater area: increased regression ( $P = .039$ )

device exemptions typically exclude patients with anatomic and medical risk factors commonly encountered in routine clinical practice.<sup>10,11</sup> Although it is easy to decry the off-label use of endografts in real-world, postmarket use, there remains no consensus on precise guidelines for when EVAR is appropriate.

Retrospective analyses of patients with “hostile” versus “friendly” aortic neck anatomy have not consistently identified predictive thresholds for anatomic variables such as neck length, neck diameter, angulation, reverse-tapered configuration, and mural thrombus or calcification.<sup>12-14</sup> Absent specific guidance beyond the manufacturers’ instructions for use, endovascular specialists must rely on their individual experience with the specific endograft systems to guide patient selection and the choice of therapy.

### AFX ANALYSIS DATA

The AFX® Endovascular AAA System (Endologix) was designed to address some of the limitations of previous endografts. AFX has high-conformability multilayer expanded polytetrafluoroethylene graft material built external to the stent frame. The material is attached to the frame only at its proximal and distal margins, allowing independent movement of the graft material during the cardiac cycle. This ActiveSeal™ technology has the potential to enhance graft-to-aortic wall apposition from the pressure gradient between the endograft lumen and aortic sac.

In a recent article published in the *Journal of Vascular Surgery*, Welborn et al reported a real-world retrospective observational analysis of 108 sequential patients implanted with the AFX System at two United States centers.<sup>15</sup> Independent core laboratory analysis was performed in 87 patients with follow-up CT images at  $9 \pm 6$  months

The main takeaway of the analysis is that in a diverse, contemporary, real-world cohort of patients treated with the AFX System, the ActiveSeal effect augments the effective seal length.

(mean  $\pm$  SD) after EVAR. Furthermore, precise aortic neck anatomic characteristics were assessed in an imaging cohort of 37 patients with adequate high-resolution baseline and early ( $5 \pm 2$  month) follow-up CT images suitable for an in-depth analysis of ActiveSeal geometry in the proximal aortic neck. A slice-by-slice analysis of graft-to-aortic wall apposition was performed to determine the effective seal length (aortic length with consecutive 360° graft apposition) and apposition surface area (the product of aortic circumference and slice thickness, summed for each slice over the effective seal length).

Although the indications for the AFX device are limited to patients with proximal neck length  $\geq 15$  mm, 40% of the patients in the Welborn et al series presented with neck lengths  $< 15$  mm, and 26% presented with neck lengths  $< 10$  mm. Proximal neck mural thrombus and calcium were present in 36% and 40% of patients and exceeded 50% of the circumference in 7.9% and 2.4% of patients, respectively. This distribution of the neck length is concordant with other recently published real-world series.<sup>8,16,17</sup> As such, the AFX study likely reflects patient selection in the contemporary practice of EVAR.

Despite the frequency of challenging aortic neck anatomy, only two type Ia (2.3%) endoleaks were observed on the 87 follow-up CT scans assessed by the core laboratory. Each occurred in patients with neck lengths < 10 mm, and one had severe neck angulation and significant mural thrombus. The rate of type II endoleaks on CT performed more than 30 days after EVAR was 6.7%, which is appreciably lower than that of other series. In the imaging cohort, the mean effective seal length was  $25 \pm 17$  mm, exceeding the average length of the anatomic neck by  $5 \pm 13$  mm. The apposition surface area was  $19 \pm 13$  cm<sup>2</sup>. In a univariate analysis, the apposition surface area was found to be a statistically significant predictor of early sac regression (mean,  $0.4 \pm 0.7$  mm diameter reduction per month; Table 1 and Figure 1).

## SUMMARY

The main takeaway of the analysis is that in a diverse, contemporary, real-world cohort of patients treated with the AFX System, the ActiveSeal effect augments the effective seal length. Effective seal length augmentation appears to be clinically significant and correlated with early sac regression. Intuitively, effective seal length is an amalgamation of multiple anatomic characteristics of the proximal neck that interact with the specific endograft design. As such, it is an index that may be used to better understand hostile and friendly neck anatomies. Additional research is required to confirm the clinical significance of the effective seal length on long-term clinical outcomes and to establish prospective algorithms to relate effective seal length to anatomic variables and endograft design. ■

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1. Parodi JC, Palmaz JC, Barone HD. Transfemoral intraluminal graft implantation for abdominal aortic aneurysms. *Ann Vasc Surg.* 1991;5:491-499.
2. Buck DB, van Herwaarden JA, Schermerhorn ML, Moll FL. Endovascular treatment of abdominal aortic aneurysms. *Nat Rev Cardiol.* 2014;11:112-123.
3. Levin DC, Rao VM, Parker L, et al. Endovascular repair vs open surgical repair of abdominal aortic aneurysms: comparative utilization trends from 2001 to 2006. *J Am Coll Radiol.* 2009;6:506-509.
4. Giles KA, Landon BE, Cotterill P, et al. Thirty-day mortality and late survival with reinterventions and readmissions after open and endovascular aortic aneurysm repair in Medicare beneficiaries. *J Vasc Surg.* 2011;53:6-12, 13.e1.
5. Stather PW, Sidloff D, Dattani N, et al. Systematic review and meta-analysis of the early and late outcomes of open and endovascular repair of abdominal aortic aneurysm. *Br J Surg.* 2013;100:863-872.
6. Galinanes EL, Dombrovsky VY, Graham AM, Vogel TR. Endovascular versus open repair of popliteal artery aneurysms: outcomes in the US Medicare population. *Vasc Endovascular Surg.* 2013;47:267-273.
7. Becquemini JP, Pillet JC, Lescalie F, et al. A randomized controlled trial of endovascular aneurysm repair versus open surgery for abdominal aortic aneurysms in low- to moderate-risk patients. *J Vasc Surg.* 2011;53:1167-1173.
8. Schanzer A, Greenberg RK, Hevelone N, et al. Predictors of abdominal aortic aneurysm sac enlargement after endovascular repair. *Circulation.* 2011;123:2848-2855.
9. Schermerhorn ML, Finlayson SR, Fillinger MF, et al. Life expectancy after endovascular versus open abdominal aortic aneurysm repair: results of a decision analysis model on the basis of data from EUROSTAR. *J Vasc Surg.* 2002;36:1112-1120.
10. Hoshina K, Kato M, Hosaka A, et al. Middle-term results of endovascular aneurysm repair in Japan: does intraoperative endovascular management against the hostile aneurysmal neck prevent the proximal type I endoleak? *Int Angiol.* 2011;30:467-473.
11. Torsello G, Troisi N, Donas KP, Austermann M. Evaluation of the Endurant stent graft under instructions for use vs off-label conditions for endovascular aortic aneurysm repair. *J Vasc Surg.* 2011;54:300-306.
12. Dillavou ED, Muluk SC, Rhee RY, et al. Does hostile neck anatomy preclude successful endovascular aortic aneurysm repair? *J Vasc Surg.* 2003;38:657-663.
13. Aburahma AF, Campbell JE, Mousa AY, et al. Clinical outcomes for hostile versus favorable aortic neck anatomy in endovascular aortic aneurysm repair using modular devices. *J Vasc Surg.* 2011;13-21.
14. Antoniou GA, Georgiadis GS, Antoniou SA, et al. A meta-analysis of outcomes of endovascular abdominal aortic aneurysm repair in patients with hostile and friendly neck anatomy. *J Vasc Surg.* 2013;57:527-538.
15. Welborn MB 3rd, McDaniel HB, Johnson RC, et al. Clinical outcome of an extended proximal seal zone with the AFX endovascular aortic aneurysm system [published online ahead of print May 27, 2014]. *J Vasc Surg.* doi: 10.1016/j.jvs.2014.04.017.
16. Hyhlik-Durr A, Weber TF, Kotellis D, et al. The Endurant stent graft system: 15-month follow-up report in patients with challenging abdominal aortic anatomies. *Langenbecks Arch Surg.* 2011;396:801-810.
17. Stark M, Suresh A, Alexander J, Cragg A. An analysis of variables affecting aortic neck length with implications for fenestrated endovascular repair of abdominal aortic aneurysm. *Ann Vasc Surg.* 2014;28:808-815.