

# Challenges of EVAR in Highly Angulated and Short Infrarenal Neck Anatomies

This difficult clinical presentation remains one of the few roadblocks to a higher standard of success with endovascular repair.

BY ROBERT Y. RHEE, MD

Endovascular repair of abdominal aortic aneurysm (EVAR) has evolved to become the treatment of choice for patients with infrarenal aortic aneurysms (AAAs). It has become very clear within the last 10 years that the currently available stent-grafts are used in challenging aortic neck situations throughout the world.<sup>1-6</sup>

EVAR, when utilized within the instructions for use, is extremely effective in preventing aneurysm-related death, rupture, and AAA sac expansion in the long term. Recent studies, however, have revealed that even patients with hostile anatomy can benefit from EVAR when performed at experienced centers.<sup>3-5,7</sup> Currently, hostile neck anatomy is the only absolute deterrent to successful infrarenal EVAR. With the introduction of hydrophilic introducer sheaths from most manufacturers and lowered device profiles in the latest EVAR system generations, iliac access problems have become less of an issue.

An angulated neck  $> 60^\circ$  and/or a neck length  $< 15$  mm remain the two most common reasons why a vascular specialist might not be able to offer EVAR.<sup>3,4</sup> This is particularly true if both factors are present in the same patient. Reports of successful treatment of patients with isolated short infrarenal necks (10–15 mm) are increasing in the literature.<sup>5,7,8</sup> EVAR is also possible in severely angulated necks ( $> 60^\circ$ ), provided the neck length is adequate to maintain stent-graft neck wall apposition (Figure 1). However, when one or more of the hostile neck factors are present, the challenge becomes intensified and demands extreme precision in order to deliver the stent-graft into the exact position that would allow it to remain effective in the long run. It becomes increasingly important to take advantage of every millimeter of the infrarenal sealing zone when multiple hostile neck features are present.

Although many of these patients with hostile necks can be managed with fenestrated or branched stent-graft systems, recent reports reveal that fenestrated EVAR (FEVAR) with the currently available systems have



Figure 1. A severely angulated neck with multiple left renal arteries. An example of a hostile proximal sealing zone.

significantly higher risk than standard EVAR.<sup>9</sup> Thus, infrarenal EVAR remains the gold standard for most patients with AAA disease, even with hostile necks.

## THE HIGHLY ANGULATED NECK

The current stent-graft systems were designed primarily as straight neck sealing zone systems. Although some of the systems are “more flexible” than others, most of the current devices were not engineered to seal in necks  $> 60^\circ$ . Even if the US Food and Drug Administration indication states  $> 60^\circ$ , other concurrent hostile neck attributes were not taken into account for these situations, such as a short ( $< 15$  mm), reverse taper of  $> 30\%$ , extensive thrombus or calcifications, etc. When the proximal sealing zone displays

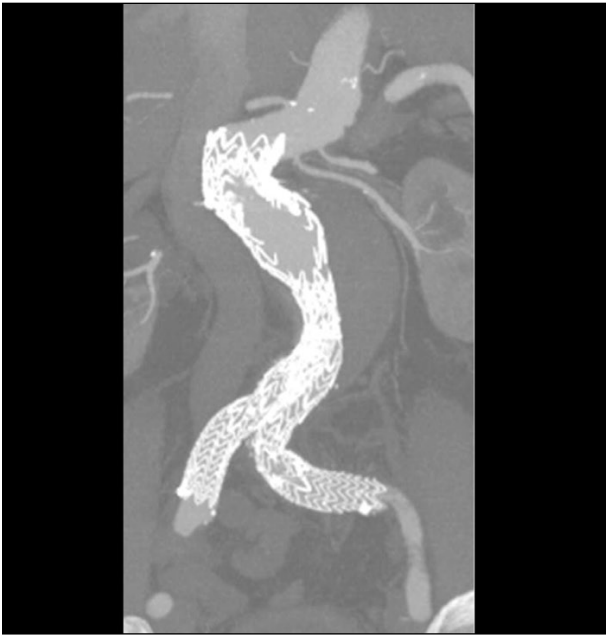


Figure 2. The same patient as in Figure 1, after placing an infrarenal stent-graft system with a proximal cuff extension. Note the bird beaking of the stent-graft on the inner curve.



Figure 3. A suprarenal fixation stent-graft system placed into an angulated short neck. Note the lack of apposition of the fixation system on the inner curve.

multiple hostile factors, the probability of successful short- and long-term outcome diminishes significantly. The following is an overview of maximizing outcomes in select patients with one or more hostile neck features.

## DEPLOYMENT ACCURACY

### Flexibility

The main challenge in treating patients with hostile necks lies in accurately positioning the stent-graft to maximize its inherent ability to conform to the neck and form an adequate sealing for proper AAA exclusion. This is particularly true for a severely angulated neck. Although it is true that most stent-grafts “bend” more readily in one direction versus another outside the body, this inherent property of the system is usually not possible in real-life clinical situations within the confines of a severely angulated neck. This is related to multiple factors, including the tortuosity of the iliac system as well as the actual bending properties of the stent-graft itself. When significant tortuosity exists in the access vessels, the stent-graft cannot bend proximally without creating tension in the infrarenal sealing zone. This ultimately contributes to the inability of the stent-graft to conform to the native anatomy, and it can create zones of separation in the proximal neck with bird beaking (Figure 2) and loss of fixation apposition to the aortic wall (Figure 3). The challenge is to create a stent-graft system with almost independent flexibility in the limbs compared to the proximal main body zones.

### Deliverability

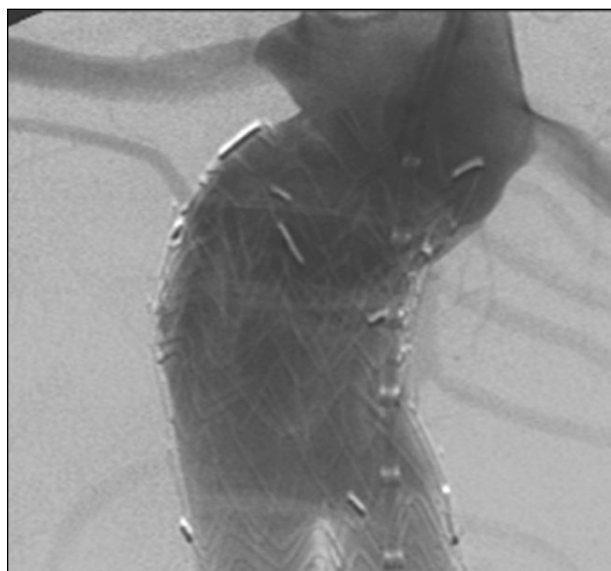
Most current stent-graft systems exhibit significantly improved flexibility in the proximal main body segment.

However, it is still challenging to deploy the stent-graft precisely to conform to every millimeter of the proximal neck. When these modern stent-graft systems are manually deployed and manipulated ex vivo, the flexibility is often more than adequate. The challenge is to achieve this conformity in vivo within the proximal neck of the patient. Initial fixation to the aortic wall is crucial in achieving the correct position during deployment as well as in maintaining the position in the long term. Without active penetrating fixation, it is virtually impossible to maintain the flexed state within the neck in the short or long term. It also appears that there is no difference between infra- and transrenal fixation for achieving this process.

### Adjustments

Except for the GORE EXCLUDER AAA Endoprosthesis featuring C3 Delivery System (Gore & Associates, Flagstaff, AZ), all current systems disallow adjustment to the position of the proximal stent-graft after the initial deployment. Therefore, the operator essentially has only one chance to achieve success in sealing.<sup>10</sup> Proximal extension with extension cuffs is never ideal because the main stent-graft system is compromised from the very beginning because of its malposition. There are exceptions with the GORE EXCLUDER Device when there is extreme angulation that is long enough to reticulate with cuffs.<sup>11</sup> This technique can often create a bend that is not possible to achieve when only the stent-graft main body is used (Figure 4). In general, however, utilization of an aortic proximal extender is failure of the device to deploy precisely just distal to the renal arteries.

A repositionable system allows the operator to try one



**Figure 4.** Reticulation technique with aortic cuffs to overcome severe angulation.

configuration initially and then several other attempts to ensure adequate sealing in the infrarenal aorta. This ability clearly allows greater success in the physician's ability to deploy the stent-graft in the ideal position, especially in challenging neck situations. Even with repositionability, the severity of the angulation may simply not allow the stent-graft to conform exactly to the correct angle of the neck. Therefore, a second, postdeployment adjustment system, which allows the operator to actually bend the proximal stent-graft to fit the patient's neck more closely, is necessary. The current COOK® ZENITH® TX2 TAA Endovascular Graft with PRO-FORM® system (Cook Medical, Bloomington, IN) is an example of a system that allows the stent-graft to bend after partial proximal deployment in order to maximize the sealing in a highly angulated proximal descending thoracic aorta. A similar ability is needed for the abdominal EVAR system for highly angulated necks.

## THE SHORT NECK

Proximal necks < 15 mm and > 10 mm can be treated successfully with most modern stent-graft systems with excellent results.<sup>7,8</sup> The actual length of neck required for best long-term success is yet to be determined because it is clearly different for different types of stent-grafts. When active fixation with metal struts that penetrate the aorta is incorporated into the stent-graft design, the performance of these stent-grafts in relatively short necks (provided that there are no other significant hostile neck features) is satisfactory.<sup>12,13</sup> The quality of the neck should also be taken into consideration. Clearly, the presence of excessive thrombus or calcium can contribute to poor outcomes. The absolute length of the infrarenal neck is not the only determinant of accurate deployment or long-term success. For example, EVAR

performed in a patient with a 10-mm, straight, uniform diameter neck is more likely to be successful than a diseased, conical-shaped, thrombus-laden neck that is 15 mm. The ideal stent-graft system should again be able to take advantage of every millimeter of the proximal neck by its deliverability attributes. If the stent-graft cannot seal within 1 mm or less in these short neck situations, the likelihood of long-term success diminishes markedly.

## SUMMARY

Successful EVAR in severely angulated and short necks is possible and can produce satisfactory long-term outcomes with good patient selection. The challenges in the treatment of highly angulated and short necks lie in being able to utilize the entire proximal seal zone. Stent-graft deliverability is the key to meeting that challenge. It is a prerequisite that the EVAR stent-graft system is flexible and compliant enough to adhere to the patient's anatomy. However, it is not enough to have a flexible system. The interventionist must be able to deliver the system accurately and precisely to seal along the entirety of the proximal infrarenal neck. ■

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*Gore does not recommend treating patients with neck anatomy that does not comply with the following:*

- Infrarenal aortic neck treatment diameter range of 19 – 32 mm and a minimum aortic neck length of 15 mm
- Proximal aortic neck angulation  $\leq 60^\circ$

*Please consult the Instructions for Use for complete indications, contraindications, warnings, and precautions.*

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