Vascular surgeons are an innovative group and during the last decade we have seen unparalleled advances in the endovascular treatment of extensive aortic pathologies. Collaborative efforts between surgeons and industry have introduced fenestrated and branched devices which are becoming more widely used with wider regulatory approval, wider availability, and less need for customization. Prior to this, parallel stent approaches had been developed to fill the void where this technology was not available or for urgent cases. A separate and distinct body of evidence and expertise subsequently developed for both strategies. This debate explores where these approaches now sit in the armamentarium of vascular surgeons.

*Corresponding author.

Email-address: ross.naylor@uhl-tr.nhs.uk (A.R. Naylor)

1078-5884/

http://dx.doi.org/10.1016/j.ejvs.2015.07.023

Part One: For the Motion. Branched/Fenestrated EVAR Procedures are Better than Snorkels, Chimneys, or Periscopes in the Treatment of Most Thoracoabdominal and Juxtarenal Aneurysms

A. Hertault, S. Haulon *

Aortic Centre, CHRU de Lille, INSERM U1008, Université Lille Nord de France, Lille, 59037, France

INTRODUCTION

The use of complex endovascular repairs to treat aneurysms involving the visceral vessels has increased in popularity in the last 10 years. A variety of methods of branch vessel incorporation have been described that can be broadly characterized as fusing of devices (i.e., branched or fenestrated repairs) or layering of devices (i.e., chimney or sandwich repairs [chimneys, periscopes, snorkels {CHIMPS}]). In the following sections, we will analyze the literature evaluating fenestrated, branched, and CHIMPS repairs. We have separated the analysis of juxtarenal (JAA) and pararenal (PAA) aortic aneurysms from the analysis of thoracoabdominal aortic aneurysms (TAAA), as the clinical heterogeneity between these two groups is too great for comparison.

PAA AND JAA

The chimney technique was first described in 2003 by Greenberg et al., and was intended as a technique to raise the sealing zone while ensuring renal artery patency in patients with “short neck” infrarenal aneurysms when no other options were available. It was later proposed by Hiramoto et al. as a rescue procedure after accidental renal coverage during endovascular aneurysm repair (EVAR). Since its original description, this technique has widely spread as an option for JAA and PAA endovascular repairs, in situations where fenestrated EVAR (FEVAR) would cause
 unacceptable cost or manufacturing delays. It has also been claimed that chimney graft EVAR (Ch-EVAR) could be used in patients deemed unsuitable for F-EVAR, especially where tortuous aortic anatomy is present.3

**Evidence for Ch-EVAR**

Many case reports and small series reporting single-center experiences with Ch-EVAR have been published. The most relevant are listed in Table 1.2–11 While most of them agree that Ch-EVAR is technically feasible, they also stress that these procedures can be technically challenging, particularly in emergency settings performed by inexperienced operators.

The best published evidence for Ch-EVAR comes in the form of two meta-analyses that report early outcomes. The first, published in 2011 by Moulakakis et al.,12 evaluated the outcomes of 93 patients from 15 studies. Among those patients, 24.7% of procedures were performed in an emergency setting for symptomatic or ruptured aneurysms. A total of 134 chimney grafts were analyzed. Technical success, defined by the authors as completion of the chimney procedure, was reported in all cases. However, several studies included in this meta-analysis reported persistent type I endoleaks at the end of the procedure (13/93 patients; 14.0%), target vessel occlusions (3/134 vessels; 2.2%),5,6 and perioperative deaths (1/93 patients; 1.1%). Taking these outcomes into consideration, with a more accepted definition of technical success,13 the outcomes for the chimney procedure are less favorable. The incidence of type I endoleak during early follow-up was 10.8% (10/93). Four were treated during a secondary intervention, while six were considered as “low-flow” endoleaks and managed without intervention. Early mortality was 4.3% (4/93), associated with one acute mesenteric ischemia after superior mesenteric artery (SMA) stenting, two patients with hemorrhagic shock secondary to retroperitoneal hematoma, and one myocardial infarction. After a mean follow-up of 9 months, target vessel patency was 97.8% (131/134; occlusion of two renal and one SMA stents).

In 2013, another meta-analysis, which evaluated 234 patients from 24 studies, was published by Wilson et al.14 This study reported results from JAA, thoracic aneurysms, and TAAA repairs. Among the 176 patients treated for JAA, postoperative target vessels patency was 98.7%. Type I endoleaks were diagnosed in 13 patients (7.4%) at the end of the procedure, and in 18 patients in total (10.2%) on the postoperative computed tomography. The 30-day mortality rate was 3.4%. These authors did not report technical success. The 6-month patency rate was 97.7% (three more chimneys had occluded).

Midterm outcomes with Ch-EVAR have also been published and are summarized in Table 2. Recently Usai et al. published a review of seven studies evaluating chimney patency.15 At a mean follow-up of 14.4 months, a 4.5% chimney occlusion rate was reported (15/334). The mean time from procedure to chimney graft occlusion was 3.5 months.

In the meta-analysis published by Wilson et al.,14 after a mean follow-up of 12.1 months, two patients still had persistent type I endoleaks, although of the 13 initially diagnosed only five had been treated. Three more patients required secondary interventions for late type I endoleaks depicted during follow-up, and one for a type III endoleak. Thirteen other undifferentiated type II or III endoleaks were reported; all were managed conservatively. During follow-

<table>
<thead>
<tr>
<th>Reference</th>
<th>n</th>
<th>Target vessels (n)</th>
<th>Emergency cases (n)</th>
<th>Technical success (n)a</th>
<th>Type of endoleak</th>
<th>Primary branch patency</th>
<th>Early re-intervention</th>
<th>30-d mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ohrlander et al. (2008)3</td>
<td>6</td>
<td>11</td>
<td>5</td>
<td>6/6</td>
<td>—</td>
<td>—</td>
<td>11/11</td>
<td>None</td>
</tr>
<tr>
<td>Hiramoto et al. (2009)2</td>
<td>29</td>
<td>31</td>
<td>—</td>
<td>29/29</td>
<td>3</td>
<td>8</td>
<td>—</td>
<td>31/31</td>
</tr>
<tr>
<td>Donas et al. (2010)4</td>
<td>15</td>
<td>15</td>
<td>5</td>
<td>15/15</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>15/15</td>
</tr>
<tr>
<td>Bruen et al. (2011)5</td>
<td>21</td>
<td>37</td>
<td>—</td>
<td>20/21</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>36/37</td>
</tr>
<tr>
<td>Coscas et al. (2011)6</td>
<td>16</td>
<td>26</td>
<td>4</td>
<td>14/16</td>
<td>2</td>
<td>—</td>
<td>1</td>
<td>25/26</td>
</tr>
<tr>
<td>Lee et al. (2012)7</td>
<td>28</td>
<td>57</td>
<td>—</td>
<td>56/57</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>56/57</td>
</tr>
<tr>
<td>Schiro et al. (2013)8</td>
<td>9</td>
<td>9</td>
<td>2</td>
<td>9/9</td>
<td>2</td>
<td>—</td>
<td>—</td>
<td>9/9</td>
</tr>
<tr>
<td>Lachat et al. (2013)9</td>
<td>77</td>
<td>169</td>
<td>NR</td>
<td>53/77</td>
<td>19</td>
<td>14</td>
<td>1</td>
<td>165/170a</td>
</tr>
<tr>
<td>Ducasse et al. (2014)10</td>
<td>22</td>
<td>22</td>
<td>—</td>
<td>21/22</td>
<td>1</td>
<td>4</td>
<td>—</td>
<td>22/22</td>
</tr>
<tr>
<td>Scali et al. (2014)11</td>
<td>41</td>
<td>76</td>
<td>8</td>
<td>38/41</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>76/76</td>
</tr>
</tbody>
</table>

*Note.* UK = unknown; NR = not reported.

a As defined by reporting standards.13
up, three additional vessel occlusions were depicted at 6 months (patency rate 97.7%), but clinical outcomes were not reported. Eight patients died during follow-up, all from nonaneurysm-related causes, which represented a global mortality of 11.4%. As the authors acknowledge, this study represents a small sample size when compared with the recent FEVAR meta-analysis, and is comprised of small series or case reports, which suggests early operator experience. The generalizability of these results is therefore limited. Only three studies reported results over 12 months (Table 2). The first, published by Ducasse et al., included 22 patients, with a mean follow-up of 18 months (range 7–35 months). The second was published in 2013 by Lachat et al. The authors report their experience in 77 patients with a mean follow-up of 25 months (range 1–121 months). Technical success was 99% (only one renal artery with early occlusion), but 20 patients (26.0%) were discharged with a type I/III endoleak. A secondary procedure for chimney-related complications was performed in 13 patients (17.0%). At the end of follow-up, three patients still had a persistent type I/III endoleak. The overall mortality rate was not clearly stated in their article. The third study was published by Scali et al. It included 41 patients with a median follow-up length of 18.2 months. Despite promising early outcomes, the authors raised concerns regarding the mid- and long-term rates of major adverse events (including stent thrombosis and re-intervention) and recommended restricting CHIMPS to patients who cannot benefit from another treatment. In 2015, a meta-analysis published by Li et al. pooled 12 studies (236 patients, 355 chimneys). The mean follow-up length was 12 months. The type I endoleak and mortality rates during follow-up were 11.8% and 13.0%, respectively.

### Evidence for FEVAR

There is growing evidence for FEVAR emerging in the literature: two meta-analyses evaluating FEVAR results have included 660 and 629 patients, respectively. The first was published in 2012 by Cross et al. The 30-day pooled proportion mortality was 2.0% (95% confidence interval [CI] 1.1–3.2). Target vessel patency rates ranged from 90.5% to 100.0%, while type I/III endoleaks did not exceed 3.0. The

### Table 2. Mid-term outcomes of chimney graft endovascular aneurysm repair (suprarenal aortic aneurysm/juxtarenal aortic aneurysm).

<table>
<thead>
<tr>
<th>Reference</th>
<th>n</th>
<th>Target vessels (n)</th>
<th>Mean follow-up, mo (range)</th>
<th>Type of endoleak</th>
<th>Primary branch patency</th>
<th>Re-intervention</th>
<th>Chronic dialysis</th>
<th>Aneurysm-related death</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follow-up &lt; 12 mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ohrlander et al. (2008)</td>
<td>6</td>
<td>11</td>
<td>NR (0–24.0)</td>
<td>1 2 3</td>
<td>10/11</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Hiramoto et al. (2009)</td>
<td>29</td>
<td>31</td>
<td>12.5 (0–74.7)</td>
<td>1 2 3</td>
<td>31/31</td>
<td>1 renal additional stenting for stenosis (9 mo)</td>
<td>0/29</td>
<td>1/29</td>
</tr>
<tr>
<td>Bruen et al. (2011)</td>
<td>21</td>
<td>37</td>
<td>NR</td>
<td>1 2 3</td>
<td>One SMA occlusion One SMA stenosis</td>
<td>Repeated angioplasties</td>
<td>0/21</td>
<td>1/21</td>
</tr>
<tr>
<td>Coscas et al. (2011)</td>
<td>16</td>
<td>26</td>
<td>10.5 (2.0–19.0)</td>
<td>1 2 3</td>
<td>25/26</td>
<td>25/26</td>
<td>0/14</td>
<td>2/16</td>
</tr>
<tr>
<td>Donas et al. (2012)</td>
<td>72</td>
<td>127</td>
<td>12.1 (1.0–26.0)</td>
<td>1 2 3</td>
<td>One left renal occlusion (J45) One renal stenosis</td>
<td>One iliorenal bypass Repeated renal angioplasties One proximal cuff for persistent type Ia endoleak</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Lee et al. (2012)</td>
<td>28</td>
<td>57</td>
<td>10.7 (3.0–25.0)</td>
<td>2 3 4</td>
<td>56/57</td>
<td>One extender cuff for treatment of type III endoleak</td>
<td>1/28</td>
<td>2/28</td>
</tr>
<tr>
<td>Schiro et al. (2013)</td>
<td>9</td>
<td>9</td>
<td>12.0 (5.0–24.0)</td>
<td>2 3 4</td>
<td>9/9</td>
<td>None</td>
<td>0/9</td>
<td>2/9</td>
</tr>
<tr>
<td>Follow-up &gt; 12 mo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lachat et al. (2013)</td>
<td>77</td>
<td>169</td>
<td>25.5 ± 16.0</td>
<td>3 4 5</td>
<td>165/170</td>
<td>12/77</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Ducasse et al. (2014)</td>
<td>22</td>
<td>22</td>
<td>18 (7–35)</td>
<td>2 3 4</td>
<td>22/22</td>
<td>None</td>
<td>0/22</td>
<td>1/22</td>
</tr>
<tr>
<td>Scali et al. (2014)</td>
<td>41</td>
<td>76</td>
<td>18.2 (1.4–41.5)</td>
<td>3 4 5</td>
<td>76/76</td>
<td>3/41</td>
<td>2/41</td>
<td>NR</td>
</tr>
</tbody>
</table>

Note. UK = unknown; NR = not reported; SMA = superior mesenteric artery.

* Including 30-d mortality.

* Mean ± SD.

* Median.
second meta-analysis was published the same year by Linosen et al.\textsuperscript{18} A total of 1622 target vessels perfused by fenestrations were analyzed. Technical success, as described by Chaikoff et al.,\textsuperscript{13} was 90.4% (95% CI 87.7–92.5). The incidence of type I or III endoleak was 4.6%, and the preservation of target vessels reached 99.0% (1603/1622). Thirty-day mortality was comparable with what had been previously reported (2.1%; 95% CI 1.2–3.7).\textsuperscript{17}

Longer-term follow-up is also available for FEVAR. In the meta-analysis published by Linsen et al.,\textsuperscript{18} after a follow-up ranging from 15 to 25 months, all-cause mortality was 16.0% (95% CI 12.5–20.4), among which only six deaths were considered as aneurysm- or procedure-related. Estimated target vessel patency rate was 93.2% (95% CI 90.4–95.3) during follow-up.

The durability of branches in fenestrated and branched endografts was thoroughly assessed by Mastracci et al. on 650 patients,\textsuperscript{19} although this group contained a mix of JAA and TAAA repairs. At a mean follow-up of 3 years, only 30 (1.7%) target vessel stent occlusions were reported. Freedom from branch instability, defined as the absence of branch occlusion, device migration affecting a branch, branch-related growth, or need for any secondary intervention was >80.0% at 2 years. Kaplan–Meier-estimated freedom from re-intervention at 5 years was 89.0% (95% CI 78.0–90.0). We recently analyzed renal patency after FEVAR (376 target renal vessels, mean follow-up of 28.8 months).\textsuperscript{20} The estimated patency and freedom from re-intervention rates were 95.0% and 86.7% at 3 years, respectively.

**Direct comparison**

Although there have been no prospective, randomized data collected, three recent papers have compared Ch-EVAR and FEVAR. In 2013, Katsargyris et al. published a literature review comparing early outcomes of F-EVAR (931 patients) and Ch-EVAR (94 patients) for JAA repairs.\textsuperscript{21} Primary target vessel preservation was 98.6% for FEVAR and 98.0% for Ch-EVAR (nonsignificant [NS]), and 30-day mortality was 2.4% versus 5.3% (NS), respectively. Even if not significant, there was a trend towards a higher early mortality in the Ch-EVAR group, but patients may have been treated in an emergency setting in this group. This bias was not specifically investigated. No differences were depicted regarding renal impairment and new-onset dialysis. Early proximal type I endoleaks were 4.3% in the FEVAR group and 10.0% in the Ch-EVAR group (p = .002). No comparisons on mid- and long-term data were available.

In 2014, Banno et al. reported a monocentric experience with 80 patients treated with FEVAR and 38 with Ch-EVAR.\textsuperscript{22} After a median follow-up of 14 months in the FEVAR group and 12 months in the Ch-EVAR no differences were found regarding target vessel event, freedom from re-intervention, and overall estimated survival. However, the average number of target vessels in the FEVAR group was 2.4, while it was 1.6 in the Ch-EVAR group (p < .0001). The proximal extent of the aneurysm was described as higher in the FEVAR group (p < .001). This supports the fact that the Ch-EVAR group was mostly composed of short-neck infrarenal aneurysms, whereas the FEVAR group had more true pararenal aneurysms, biasing the analysis. Lee et al. compared their early experience with FEVAR (n = 15) with their previous experience with CHIMPS (n = 15).\textsuperscript{23} In this study, with a limited follow-up and a small cohort, technical success and early outcomes were comparable.

**TAAA**

The sandwich EVAR (SEVAR) technique was initially reported to preserve blood flow in the internal iliac artery in patients with aneurysms involving the iliac bifurcation.\textsuperscript{24} It was then proposed by Lobato and Camacho-Lobato for the “off-the-shelf” treatment of TAAA.\textsuperscript{25} Few data are available on the subject, and results of the two main studies (total of 19 patients) are presented in Table 3.\textsuperscript{25,26} The largest cohort included 15 patients,\textsuperscript{25} with two patients treated emergently. One patient was excluded from the analysis as both renal arteries could not be cannulated and the procedure was aborted. Thirty-day mortality rate was 20.0%, and reached 100.0% in the emergency subset. Among the 54 targeted vessels, five could not be cannulated (9.2%), and one more occluded during early follow-up. Technical success, according to the reporting standards, was not recorded. Eleven patients were available to follow-up, with a mean follow-up of 16 months but one was lost after 6 months. Two other patients died of unrelated causes at 10 and 12 months, respectively. One re-intervention was performed for a persistent type II endoleak with sack enlargement, which was, surprisingly, sealed with an additional stent between the previous one and the SMA. No spinal cord ischemia was reported.

On the contrary, early and mid-term outcomes after TAAA repair with branched EVAR have been reported in several studies.\textsuperscript{27–30} Technical success rates ranged from 90.9% to 96.6%, and 30-day mortality from 5.5% to 9.1%. In our published experience, after the initial learning curve, spinal cord ischemia occurred in 1.2% of patients (2.1% when excluding type 4 TAAA), 30-day mortality rate was 5.6% and overall 1-year survival rate was 81.9%.\textsuperscript{31} These results confirm the feasibility of such a repair and are associated with promising early and mid-term outcomes.

**DISCUSSION**

The literature reporting early and mid-term outcomes for branch vessel incorporation in aneurysm repair is very heterogeneous and describes an early experience reflective of the novelty of this technology. It is probably too soon for such an analysis, but we do not believe that a monitored prospective randomized study will ever be performed. This thorough analysis of the literature has raised specific issues associated with CHIMPS that need to be emphasized.

First, the gutters created between the main graft and the chimneys may limit the durability of this technique. As stated by Schiro et al.,\textsuperscript{9} aneurysm exclusion is not achieved with gutters and they are associated with type I endoleaks. In theory, the more chimneys, the higher the risk of
leakage. Long overlaps between the chimney stents and the endograft are probably associated with better gutter thrombosis rates; however, this was not demonstrated in vivo, and length is also correlated with in-stent thrombotic risk. FEVAR branched stents are generally shorter, straighter, and in a position more representative of native anatomy. In contrast, Ch-EVAR has stents that are generally longer and have a tortuous pathway, often with an acute bend at the target vessel ostium. A longer and kinked stent is going to have lower patency in the long term. Long-term data are not available but these fundamental issues will probably lead to significant differences in patency rates and translate to the ultimate utility of each technique. Type I endoleaks are considered the “Achilles’ heel” of CHIMPS. Up to 10.2% of patients are discharged with type I endoleaks after CHIMPS repair. Schiro et al. report, among nine patients treated with chimneys, two patients with type Ia endoleaks who died of aneurysm rupture during follow-up, despite uneventful procedures and early outcomes. Therefore, it appears that the “Achilles’ heel” of CHIMPS is more likely a “sword of Damocles”. Reporting standards consider (low-flow) type I endoleaks a technical failure. How else should we consider a postoperative perfused aneurysm?

CHIMPS procedures require extensive navigation in the arch. It is thus associated with an increased incidence of stroke, as stated by several authors. In the Ch-EVAR meta-analysis, postoperative stroke rate reached 3.2%, while it was only 0.3% in the FEVAR meta-analysis performed by Katsargyris et al. (p = .012).

Ch-EVAR has spread widely in the field of PAA and JAA treatment. The highlighted reasons were that F-EVAR was too expensive and time-consuming to manufacture, and thus not an option in emergency cases. However, the development of manufactured “off-the-shelf” fenestrated and branched endografts will soon overcome this issue for most patients. Moreover, standardization should allow for a decrease of manufacturing costs. In addition, FEVAR is now reimbursed in many countries, unlike CHIMPS, which are considered “off-label” techniques. In an anatomic study of 206 patients with ruptured aneurysms, Dias et al. reported 33 patients (24.0%) with short necks, of whom 25 (76.0%) were potential candidates for a chimney repair. This compares well with the 70.0% suitability of “off-the-shelf” fenestrated endografts reported in a study evaluating “nonruptured” juxtarenal aneurysms.

The argument that CHIMPS are a treatment option for patients with anatomy unsuitable for FEVAR, in particular in those with angulated necks, is not supported by specific analysis. Currently, most patients deemed unsuitable for FEVAR are probably unsuitable for any other endovascular treatment.

Some authors consider Ch-EVAR as an easy procedure compared with FEVAR, but there is no consensus on this matter. It is easy to argue that the treatment of a true TAAA requiring four chimneys is not less challenging than a four-fenestrated endograft procedure. We believe that it is more convenient to access four vessels from the contralateral iliac than it is from the arm where there is much less space for

<table>
<thead>
<tr>
<th>Table 3. Short- and mid-term outcomes of the sandwich technique (thoracoabdominal aortic aneurysm repair)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reference</strong></td>
</tr>
<tr>
<td>Lobato et al. (2012)</td>
</tr>
<tr>
<td>Kolvenbach et al. (2011)</td>
</tr>
</tbody>
</table>

Note: NR = not reported. a Mean ± SD. b Mean (range).
multiple sheaths. In the experience of Lachat et al., the mean ± SD procedure time, including surgical access and skin closure, was 248 ± 104 minutes. In comparison, in 2012, our mean procedure time (skin-to-skin) for JAA and PAA repairs with fenestrated endografts was 150 minutes (range 40–330 minutes; 54 patients). No prospective randomized trial has or will be performed to compare operative times between both techniques, but it is clearly biased to consider FEVAR as technically more challenging than Ch-EVAR.

In addition, we would also like to emphasize that in the development of an endovascular graft there are specific tests required as defined by international standards. Worldwide regulatory bodies require compliance to these standards for approval to sell and market the technology. When devices are combined together to treat a patient, evaluation of devices in bench-top testing and clinical studies are required. In approved therapies this testing has been completed, and clinical data developed and reviewed for approval. For approved therapies, such as FEVAR, potential variations in graft and bridging stent configurations allowed for in the instructions for use have been thoroughly evaluated. When one considers the use of endovascular grafts in combination with bridging stents to perform CHIMPS, two specific problems arise: (1) there are nearly an infinite number of potential graft combinations and deployment configurations that need to be evaluated on the bench top; and (2) there exist little bench-top evidence that has evaluated potential deployment complications, or that this is a durable combination in the long term. There are certainly not many data that have been reviewed by any regulatory bodies, as no approvals exist anywhere in the world for CHIMPS.

The literature exhibits solid data regarding feasibility, and early, mid-, and long-term outcomes after FEVAR. On the contrary, proof levels regarding Ch-EVAR only allow a conclusion of its feasibility, especially as mid- and long-term outcomes have not yet been evaluated. However, the high rate of type I endoleaks (ranging from 10.0% to 26.0%) after Ch-EVAR is a major concern, as patients are still exposed to aortic branch vessels in stent-graft sealing zones. J Endovasc Ther 2008;15(4):427–32.


REFERENCES


3 Ohrlander T, Sonesson B, Ivancek K, Resch T, Dias N, Malina M. The chimney graft: a technique for preserving or rescuing
Endovascular aneurysm repair (EVAR) has rapidly overtaken open surgery worldwide for the treatment of anatomically suitable aortic aneurysms. It was inevitable that endovascular technology and strategies would be developed to further treat juxtarenal (JAA) and thoracoabdominal (TAAA) aneurysms. Centers of excellence and early adopters outside the USA and US centers with physician-sponsored investigator device exemptions gained much experience in using fenestrated and branched (FEN-BR) devices with excellent results. However, the lack of widespread availability of branched devices and the only recent US Food and Drug Administration approval of fenestrated technology in mid-2012 have encouraged an alternative strategy utilizing parallel, or snorkel, periscope, and chimney grafts (Ch-EVAR). The snorkel/chimney/periscope technique has gained increasing popularity since the first publications in 2003 and 2007.\(^1\)\(^2\) These techniques have emerged from the basic idea of creating a “snorkel/chimney” conduit from above or a “periscope” conduit from below using available “off-the-shelf” stents deployed into target visceral branches adjacent to the main intra-aortic stent-graft. Initially described as a bail-out technique for inadvertent coverage...

**Part Two: Against the Motion. Fenestrated EVAR Procedures are not Better than Snorkels, Chimneys, or Periscopes in the Treatment of Most Thoracoabdominal and Juxtarenal Aneurysms**

Jason T. Lee

Division of Vascular Surgery, Stanford University Medical Center, 300 Pasteur Drive, Suite H3600, Stanford, CA 94305, USA

---


