The current best technical practices for parallel branch grafts: How to avoid endoleaks with CHIMPS

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Faculty Disclosure

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I disclose the following relationships:

Clinical Research/Consultant/Speaker
   Aptus, Bolton, Cordis, Cook, Endologix, Medtronic, Terumo,
   Trivascular, WL Gore
Limitations of Infrarenal EVAR

Current technology may be applicable in 80% of patients

A. Proximal Neck Morphology
B. Iliac Access
C. Distal Seal - Common Iliacs
Initial Series with FDA approved Devices

- Approximately 40% of our current EVAR’s are being performed with at least one parameter outside the IFU

- Significant difference in the aneurysm related mortality 0% vs 4%

- As the number of parameters outside the IFU increased, there was a greater likelihood that the pt would require a reintervention.

Options for Repair of Juxtarenal AAA

- Open Repair
- Hybrid Debranching
- Snorkel or Chimney Graft
- Fenestrated Stent Graft
- Branched Stent Graft
The Chimney Graft: A Technique for Preserving or Rescuing Aortic Branch Vessels in Stent-Graft Sealing Zones

Tomas Ohrlander, MD; Björn Sonesson, MD, PhD; Krasnodar Ivancev, MD, PhD; Timothy Resch, MD, PhD; Nuno Dias, MD, PhD; and Martin Malina, MD, PhD

Vascular Center Malmö-Lund, Malmö University Hospital, Malmö, Sweden.

Purpose: To report an alternative to the fenestrated stent-graft for preserving blood flow to side branches in the sealing zones of aortic stent-grafts.

Technique: A covered stent is deployed parallel to the main aortic stent-graft, protruding somewhat proximally, like a chimney, to preserve flow to a vital side branch covered by the aortic stent-graft. Use of a chimney graft makes it possible to use standard off-the-shelf stent-grafts to instantly treat lesions with inadequate fixation zones, providing an alternative to fenestrated stent-grafts in urgent cases, in aneurysms with challenging neck morphology, and for reconstituting an aortic side branch unintentionally compromised during endovascular repair. This technique has been used successfully in 10 patients, combining chimney grafts in the renal, superior mesenteric, left subclavian, left common carotid, and innominate arteries with stent-grafts in the abdominal (n=6) or thoracic (n=4) aorta. There has been no late chimney graft–related endoleak on imaging studies up to 8 months.

Conclusion: The use of chimney grafts is feasible in the renal and superior mesenteric arteries, as well as in the supra-aortic branches, to facilitate stent-graft repair of thoracic or abdominal aortic lesions with inadequate fixation zones.

J Endovasc Ther 2008;15:427–432
Complete Endovascular Renal and Visceral Artery Revascularization and Exclusion of a Ruptured Type IV Thoracoabdominal Aortic Aneurysm

Mario Lachat, MD\textsuperscript{1}; Thomas Frauenfelder, MD\textsuperscript{2}; Dieter Mayer, MD\textsuperscript{1}; Roger Pfiffner, MD\textsuperscript{2}; Frank J. Veith, MD\textsuperscript{1,3}; Zoran Rancic, MD, PhD\textsuperscript{1}; and Thomas Pfammatter, MD\textsuperscript{2}

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Another Way to Look at it

- CHIM - mney’s
- Periscopes
- Snorkels
- Sandwiches
- CHIMPSS

Chuter – ICON 2012
Greenberg – SAVS 2012
Potential Advantages / Disadvantages

Snorkel - Chimney

• Uses currently available off the shelf grafts
• No modification and repackaging of the devices
• Can customize number of snorkel grafts
• Available to treat ruptured AAA / TAAA
• No proven long term patency / risk of thrombosis / fracture/ endoleaks
Methods

- 21 Ch-EVAR
  - 4 single renal
  - 8 double renal
  - 8 SMA/renal
  - 1 SMA

- 21 anatomically matched, consecutive reverse-chronological order, open surgical controls
## Short Term Results

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
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<tbody>
<tr>
<td>Primary Graft Patency</td>
<td>93% - 100%</td>
</tr>
<tr>
<td>(F/U 3-17 months)</td>
<td></td>
</tr>
<tr>
<td>30 Day Mortality</td>
<td>4.8%</td>
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<tr>
<td>30 Day Morbidity</td>
<td>14% (Renal)</td>
</tr>
<tr>
<td>1 Year Mortality</td>
<td>11%</td>
</tr>
<tr>
<td>Type I endoleak</td>
<td>10.7%</td>
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<tr>
<td>(60% resolve by 6 months)</td>
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Comparison of Outcomes With Open, Fenestrated, and Chimney Graft Repair of Juxtarenal Aneurysms: Are We Ready for a Paradigm Shift?

Athanasiou Katsargyris, MD; Kyriakos Oikonomou, MD; Chris Klonaris, MD, PhD; Ingolf Töpel, MD, PhD; and Eric L.G. Verhoeven, MD, PhD

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21st Department of Surgery, Vascular Division, Laiko Hospital, Athens University Medical School, Athens, Greece. 3Department of Vascular Surgery, Krankenhaus Barmherzige Brüder, Regensburg, Germany. 4Department of Vascular Surgery, University Hospital Leuven, Belgium.

Purpose: To review the literature reporting open surgical and endovascular treatment of juxtarenal aortic aneurysm (JAA).

Methods: A systematic search of the PubMed database was carried out to identify English-language articles published between January 2001 and July 2012 on the management of JAA with open surgery, fenestrated endovascular aneurysm repair (F-EVAR), and the chimney graft technique (Ch-EVAR). The search found 20 studies with a total of 1725 patients (76% men; age range 60–74 years) undergoing open surgery, 10 studies detailing 931 patients (87.6% men; age range 72–75 years) receiving F-EVAR, and 5 studies comprising 94 patients (75.5% men; age range 68–82 years) reporting Ch-EVAR.

Results: A total of 2465 vessels were targeted with fenestrations and 151 with chimney grafts (ICG). Intraoperative target vessel preservation was 98.6% and 98.0%, respectively. Cumulative 30-day mortality was 3.4%, 2.4%, and 5.3% for open surgery, F-EVAR and Ch-EVAR, respectively (p=NS). Impaired renal function was noted in 16.5%, 9.8%, and 12% following open surgery, F-EVAR, and Ch-EVAR, respectively (open vs. F-EVAR: p<0.001). Nephro-onc ablation was required postoperatively in 3.9%, 1.5%, and 2.1%, respectively (open vs. F-EVAR: p<0.001). Postoperative cardiac complications were noted in 11.3%, 3.7%, and 7.4%, respectively (open vs. F-EVAR: p<0.001). The incidence of ischemic stroke was 0.1% and 0.3% following open surgery and F-EVAR, but 3.2% after Ch-EVAR (open vs. Ch-EVAR: p=0.002; F-EVAR vs. Ch-EVAR: p=0.012). Early proximal type I endoleak was lower after F-EVAR compared to Ch-EVAR (4.3% vs. 10%, respectively, p=0.002).

Conclusion: Open surgery remains a safe and effective treatment option for good-risk patients with JAA. F-EVAR is associated with low operative mortality; compares favorably to open surgery in terms of morbidity, and current midterm data indicate that it can be a valid treatment option in both low- and high-risk patients. Early results of Ch-EVAR demonstrate feasibility only. In view of the limited number of reports and the lack of long-term data, the technique should be considered only in acute poor surgical risk patients, as a bailout in case of unintentional renal artery coverage, or in elective poor surgical cases that are not suitable for F-EVAR.

J Endovasc Ther. 2013;20:158–169
# Results: A decade of CHEVAR

2001-2012 (CHEVAR) - 6 studies /94 pts

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<tbody>
<tr>
<td>30 day Mortality</td>
<td>-</td>
<td>5.3 %</td>
</tr>
<tr>
<td>Renal Dysfunction</td>
<td>-</td>
<td>12%</td>
</tr>
<tr>
<td>Stroke</td>
<td>-</td>
<td>3.2%</td>
</tr>
<tr>
<td>Type I Endoleak</td>
<td>-</td>
<td>10%</td>
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CT Angiography at 24 Months Demonstrates Durability of EVAR With the Use of Chimney Grafts for Pararenal Aortic Pathologies

Konstantinos P. Donas, MD, PhD; Felice Pecoraro, MD; Theodosios Bisbas, MD; Mario Lachat, MD; Giovanni Torsello, MD, PhD; Zoran Rancic, MD, PhD; Martin Austermann, MD, PhD; Dieter Mayer, MD; Thomas Pfammatter, MD; and Stefan Puchner, MD.
CT Angiography at 24 Months Demonstrates Durability of EVAR With the Use of Chimney Grafts for Pararenal Aortic Pathologies

Purpose: To present the 24-month radiological follow-up data for patients with pararenal aortic pathologies treated with chimney and periscope grafts during endovascular repair.

Methods: Between January 2008 and December 2011, 124 high-risk patients with complex pararenal aortic pathologies were treated using the chimney technique at 2 European vascular and cardiovascular centers with advanced experience of the described technique. In particular, 50 patients were treated at Site 1 and 74 at Site 2. Forty (32.2%) patients (32 men; mean age 79.2 ± 4.9 years) completed computed tomographic angiography follow-up at 24 months postoperatively.

Results: The overall technical success was 100%, and the early- and midterm procedure-related mortality was 0%. Three (2.4%) patients had a perioperative type Ia endoleak that persisted; two were treated by transbrachial perigraft embolization and cuff implantation. The last patient is under radiological surveillance due to a “low-flow” type Ia endoleak and stable sac size. A type II endoleak was detected in 7 (5.6%) patients. During the 2-year follow-up, significant shrinkage (>5 mm; n=22) or stable aneurysm diameter (n=14) was seen in 36 (90%) of the cases. Overall, mean aneurysm sac shrinkage was 12% (p=0.002) and 10% (p=0.014) for the 2 centers, respectively (overall p=0.008). The causes for sac progression in the 4 (10%) patients were a type Ia endoleak, 2 type II endoleaks, and endotension.

Conclusion: The present study demonstrates that the use of chimney and/or periscope endografts for pararenal aortic pathologies achieves and maintains successful exclusion of the aneurysm in 90% of the cases at 24 months of radiological follow-up. In centers experienced with this approach, the chimney technique may represent a reliable therapeutic modality in selected patients.
# Mid-term Results of CH-EVAR (24 Months)

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<tr>
<td><strong>2008-2011</strong></td>
<td>2 Centers - 124 pts</td>
</tr>
<tr>
<td><strong>Mortality</strong></td>
<td>- 0%</td>
</tr>
<tr>
<td><strong>Type I Endoleak</strong></td>
<td>- 2.4%</td>
</tr>
<tr>
<td><strong>Graft Occlusion 24 mth</strong></td>
<td>- 2.7%</td>
</tr>
<tr>
<td><strong>Strokes</strong></td>
<td>- 0%</td>
</tr>
<tr>
<td><strong>Freedom- Sac enlargement</strong></td>
<td>- 10%</td>
</tr>
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## Methods for Treating Complications

<table>
<thead>
<tr>
<th>Type I endoleaks</th>
<th>Embolization – Onyx</th>
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<tbody>
<tr>
<td></td>
<td>Endostaples</td>
</tr>
<tr>
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<td>Proximal Graft extension</td>
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<thead>
<tr>
<th>Stent Thrombosis</th>
<th>Open bypass</th>
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<tr>
<td></td>
<td>Thrombolysis</td>
</tr>
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<td></td>
<td>Relining</td>
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LETTERS TO THE EDITORS

Endovascular Thrombectomy of a Renal Artery Chimney Stent-Graft Using the Solitaire Recanalization Device

Giovanni Pratesi, MD
Matteo Barbante, MD
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Monica Morelli, MD
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Unit of Nephrology and Dialysis
Endovascular Thrombectomy of a Renal Artery Chimney Stent-Graft Using the Solitaire Recanalization Device

Figure 2 ♦ Endovascular thrombectomy using the Solitaire FR Recanalization Device: (A) guidewire advancement through the occluded stent, (B) Solitaire Device deployment distal to the thrombus, and (C) retrieval into the Flexor sheath. (D) Complete flow restoration, normal patency of the stent, and renal reperfusion.
A Proof-of-Concept In Vitro Study to Determine if EndoAnchors Can Reduce Gutter Size in Chimney Graft Configurations

Wouter W. Niepoth, BSc; Jorg L. de Bruin, MD; Kak K. Yeung, MD, PhD\(^1,3\); Rutger J. Lely, MD\(^2\); Andrea N. Devrome, PhD\(^4\); Willem Wisselink, MD, PhD\(^1\); and Jan D. Blankensteijn, MD, PhD\(^1\)

Departments of \(^1\)Vascular Surgery and \(^2\)Interventional Radiology, VU Medical Center, Amsterdam, The Netherlands. \(^3\)Department of Surgery, Westfriesgasthuis, Hoorn, The Netherlands. \(^4\)University of Calgary, Alberta, Canada.
Classification of Chimney EVAR–Related Endoleaks: Insights From the PERICLES Registry

Konstantinos P. Donas, MD, Frank J. Criado, MD, Giovanni Torsello, MD, Frank J. Veith, MD, and David J. Minion, MD, on behalf of the PERICLES Registry Collaborators

Keywords
abdominal aortic aneurysm, chimney graft, chimney technique, endograft, endoleak, stent-graft

13 US and European Centers
517 Patients
Type 1A endoleak – 6% at completion
Persistent Type 1A – 2.9% @ 17 months
Identified 3 distinct patterns of Type 1 leak

and EVAR and chimney patient groups.

517 PERICLES chEVAR patients had a type Ia endoleak at
completion angiography, but the rate of persistent endo-
leaks was only 2.9% at a mean 17.1 months of follow-up.

Close review of the postoperative computed tomography
angiograms of these persistent endoleak patients revealed
distinct types and patterns of chEVAR-related type Ia
endoleaks and form the basis of a new classification pro-
posed herein. It is hoped that these observations will lead to
development of new treatment algorithms for effective
management of chimney-related endoleaks and, in some
cases, to prevent them from occurring in the first place.

Pattern A: Excessive Stent-Graft
Oversizing (Figure 1)

Stent-graft oversizing by >30% compared with the diameter
of the suprarenal aorta or malapposition to the aortic wall

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Pattern A - Too much oversizing >30%
Pattern B - Not enough oversizing <20%
Pattern C- Insufficient Proximal Neck Length < 2cm
Principles for Successful CHIMPS

• Aim for at least 2 cm of seal in normal aorta

• Minimize the number of parallel endografts to minimize gutter leaks

• I prefer a combination of a balloon expandable covered stent ICAST with reinforcement with a self-expanding stent

• Leave the Renal/Visceral balloon in place while inflating the aortic stent graft.

• Optimize oversizing of the stent graft -? 20-25%
Conclusions - CHIMPS

Useful adjunct for emergent situations where patients cannot tolerate an open operation or wait for custom graft

• Emergent bailout of covered vessel / Ruptured AAA

• Unproven Long term durability (Thrombosis, Type I endoleaks) – underreporting

• Need for standardization of techniques (ie. what type of stents, how many chimney’s, need for double stents in some patients)

• The availability of off the shelf device to treat complex anatomy may replace - CHIMPS
Chimney-EVAS
CH-EVAS
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The current best technical practices for parallel branch grafts: How to avoid endoleaks with CHIMPS

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