Endovascular Treatment of Complex Aortic Aneurysm

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Disclosures

• I have no relationship(s) with industry to disclose relevant to the content of this CME activity.
Background

- Endovascular repair (EVAR) has become the method of choice for repair of AAA and TAAA

- Randomized-controlled trials comparing EVAR and open repair for infra-renal AAA
  - Superior perioperative and medium-term outcomes
  - Long-term outcomes comparable
  - EVAR is associated with surveillance and secondary intervention

Open Aortic Aneurysm Repair
Endovascular Aortic Aneurysm Repair (EVAR)
Background

• Up to 60% of EVARs are complex cases due to difficult aneurysmal neck anatomy
  – Length < 15 mm
  – Angulation > 60 degree
  – Thrombus or calcification > 50%
  – > 32 mm in diameter
  – Reverse taper morphology

What we wish to see
Challenging Anatomy
Complex EVAR

- Endovascular repair of complex abdominal aortic aneurysms are technically challenging
- Chimney or Snorkel technique
- Hybrid repair (Debranching and endovascular placement of endograft)
- Fenestration technique
  - Fenestrated EVAR (fEVAR) with ZFEN endograft
  - Physician modified fEVAR
Snorkel Technique

- Placement of parallel stents or stent grafts adjacent to main body endograft
- Maintain perfusion to renal and visceral branches after aneurysm exclusion

Snorkel/ Chimney Technique

From the Western Vascular Society

Early experience with the snorkel technique for juxtarenal aneurysms

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Objective: The lack of readily available branched and fenestrated endovascular aneurysm devices created an opportunity for creative deployment of endograft components to treat juxtarenal aneurysms with “snorkel” or “chimney” techniques in the endovascular management. Methods: We retrospectively reviewed planned snorkel procedures for juxtarenal aneurysms from 2009 to August 2011. Our standardized technique included auxiliary or brachial cutdown access and mostly percutaneous femoral access for the main body endograft. Results: Fifty-six snorkel grafts were placed in 28 consecutive patients (mean ± standard deviation). Mean aneurysm size was 64.8 ± 14.8 mm (median, 33.5 mm; range, 17.5–90.0 mm). The snorkel configuration zone was the infrarenal neck for all cases (median diameter, 33.5 mm; range, 17.5–90.0 mm). The snorkel neck was 24.5 mm in length (median, 18.0 mm; range, 9.0–36.0 mm). Five patients had unilateral renal stenoses, and six had celiac/superior mesenteric artery/renal combinations. Technical success was 98.2%, with no loss of wire access leading to one renal stent deployment failure. Thirty-day mortality was 1 week postoperatively with pneumonia and died of sepsis; one patient hemispheric stroke. Other major complications included perinephric hematoma, 7.1%; pelvic injury, requiring endovascular therapy; 3.6% and brachial plexus nerve injury, included self-limited arthralgias (14.3%) and one non-Q-wave myocardial infarction (3.6%) requiring intervention. Mean follow-up was 16.7 months (range, 3–25 months). One patient died of causes at 3 months (89.3% survival). Postoperative imaging revealed one renal stent at 3 months (98.2% overall primary patency). Seven (25%) early endoleaks were noted on postoperative imaging: two type I, two type II, and two type III (25%), leading to one with bridging coil placement (type III). The small type Ia endoleaks and other type III endoleak. Mean sac regression at the latest follow-up was 7.3 mm. No aneurysm has enlarged since.

Conclusions: Early success with the snorkel technique for juxtarenal aneurysms has made it a complex short-neck to no-neck EVAR. Although long-term follow-up is needed, the flexible and lack of requirement for custom-built devices may make this approach more attractive to stent grafts. (J Vasc Surg 2012;55:935–46.)

Technical considerations and results of chimney grafts for the treatment of juxtarenal aneurysms

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Objective: To present our initial experience and technical considerations for the use of chimney grafts in the treatment of patients who require endovascular aneurysm repair with aortic branch preservation. Methods: All patients treated with a chimney procedure between October 2009 and June 2011 were included in our analyses. Chimney procedures were only performed in patients that were unsuitable for open repair and without the opportunity to use fenestrated grafts (because of unsuitable anatomy or emergency operation). Open or auxiliary access was used to deploy covered chimney grafts in the target vessels, and subsequently, a stent graft was deployed via femoral cut-down access.

Results: Thirteen patients (12 males; mean age, 77.3 ± 6.2 years; mean maximal diameter, 71.4 ± 10.2 mm) underwent a chimney procedure with the preservation of 22 aortic side branches. Primary technical success was 92.3% due to occlusion of one renal artery within 24 hours. Thirty-day mortality was 0%. Infrarenal mean neck length was 26.6 ± 6.2 mm (range, 18.0–36.0 mm) and could be extended to 27.3 ± 9.9 mm (range, 18.0–36.0 mm) by the use of chimney grafts. During follow-up (median, 10.8 months; interquartile range, 7.4–19.4), one patient died from complications from mesenteric ischemia based on a stenosis of the celiac trunk attributable to the bare stent of the stent graft, and one patient died from aneurysm rupture. Other complications included late occlusion of one renal artery and a type II endoleak, which was unsuccessfully treated with coil embolization and required laparotomy. If we disregard the ruptured patient who had an enormous increase of aneurysm diameter, mean aortic aneurysm diameter reduced from 70.7 ± 10.3 mm (range, 54–89 mm) to 66.7 ± 13.9 mm (range, 48–96 mm) during follow-up (P = .03). In three patients, the aneurysm diameter decreased by more than 5 mm and in two patients, the diameter increased by more than 5 mm. The aneurysm diameter remained stable in the other eight patients.

Conclusions: Until off-the-shelf fenestrated or branched stent grafts become available, the chimney procedure offers a minimally invasive treatment option to patients requiring aneurysm exclusion with side branch revascularization. Although long-term follow-up is awaited, the initial results show that chimney grafts can help to decrease or stabilize the aneurysm diameter in most patients, but aneurysm rupture was not prevented in all patients. (J Vasc Surg 2013;58:607–15.)
Hybrid Aortic Debranching and Endovascular Repair of AAA and TAAA
Arch and visceral/renal debranching combined with endovascular repair for thoracic and thoracoabdominal aortic aneurysms

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Objective: We report a single-center experience using the hybrid procedure, consisting of open debranching, followed by endovascular aortic repair, for treatment of arch/proximal descending thoracic/thoracoabdominal aortic aneurysms (TAAA).

Methods: From 2005 to 2010, 51 patients (33 men; mean age, 70 years) underwent a hybrid procedure for arch/proximal descending thoracic/TAAA. The 30-day and in-hospital morbidity and mortality rates, and late endoleak, graft patency, and survival were analyzed. Graft patency was assessed by computed tomography, angiography, or duplex ultrasound imaging.

Results: Hybrid procedures were used to treat 27 thoracic (16 arch, 11 proximal descending thoracic) and 24 TAAA (Crawford/Safi types I to III: 3; type IV: 12; type V: 9). The hybrid procedure involved debranching 47 arch vessels or 77 visceral/renal vessels using bypass grafts, followed by endovascular repair. Seventy-five percent of debranching and endovascular repair procedures were staged, with an average interval of 28 days. Major 30-day and in-hospital complications occurred in 39% of patients and included bypass graft occlusion in four, endoleak reintervention in two, and paraplegia in one. Mortality was 3.9%. During a mean follow-up of 13 months, three additional type II endoleaks required intervention, and one bypass graft occluded. No aneurysm rupture occurred during follow-up. Primary bypass graft patency was 95.3%. Actuarial survival was 86% at 1 year and 67% at 3 years.

Conclusion: The hybrid procedure is associated with acceptable rates of mortality and paraplegia when used for treatment of arch/proximal descending thoracic/TAAA. These results support this procedure as a reasonable approach to a difficult surgical problem; however, longer follow-up is required to appraise its ultimate clinical utility. (J Vasc Surg 2011;54: 30-41.)
Fenestrated Stent Graft

- Commercially available versus. “Home-made” (Physician-modified) device

- Cook Zenith stent graft is the only FDA approved commercially available for treatment of infrarenal AAA
  - it is not available for urgent or emergent case
  - Waiting time up to 6 weeks

- Approved fenestrated device for treatment of TAAA is not currently available
Results of the United States multicenter prospective study evaluating the Zenith fenestrated endovascular graft for treatment of juxta renal abdominal aortic aneurysms

Gustavo S. Oderich, MD,1 Roy K. Greenberg, MD,1,2 Mark Farber, MD,3 Sean Lyden, MD,4 Luis Sanchez, MD,2 Ron Fairman, MD,3 Feiyi Jia, PhD,1 and Priya Bharadwaj, PhD,1 on behalf of the Zenith Fenestrated Study Investigators, Rochester, Minn; Cleveland, Ohio; Chapel Hill, NC; St. Louis, Mo; Philadelphia, Pa; and West Lafayette, Ind

Objective: This study reports the results of a prospective, multicenter trial designed to evaluate the safety and effectiveness of the Zenith fenestrated endovascular graft (Cook Medical, Bloomington, Ind) for treatment of juxta renal abdominal aortic aneurysms (AAAs).

Methods: Sixty-seven patients with juxta renal AAAs were prospectively enrolled in 14 centers in the United States from 2005 to 2012. Custom-made fenestrated stent grafts were designed with one to three fenestrations on the basis of analysis of computed tomography data sets. Renal alignment was performed with balloon-expandable stents. Follow-up included clinical examination, laboratory studies, mesenteric renal duplex ultrasound, abdominal radiography, and computed tomography imaging at hospital discharge and at 1 month, 6 months, and 12 months and yearly thereafter up to 5 years.

Results: There were 54 male and 13 female patients with a mean age of 74 ± 8 years enrolled. Mean aneurysm diameter was 60 ± 10 mm. A total of 178 visceral arteries required incorporation with small fenestrations in 118, scallops in 51, and large fenestrations in nine. Of these, all 118 small fenestrations (100%), eight of the scallops (16%), and one of the large fenestrations (11%) were aligned by stents. Technical success was 100%. There were one postoperative death within 30 days (1.5%). Mean length of hospital stay was 3.3 ± 2.1 days. No aneurysm ruptures or conversions were noted during a mean follow-up of 37 ± 17 months (range, 3–66 months). Two patients (3%) had migration ≥10 mm with no endoleak, both due to cranial progression of aortic disease. Of a total of 129 renal arteries targeted by a fenestration, there were four (3%) renal artery occlusions and 12 (9%) stenoses. Fifteen patients (22%) required secondary interventions for renal artery stenosis/occlusion in 13 patients, type II endoleak in three patients, and type I endoleak in one patient. At 5 years, patient survival was 91 ± 4%, and freedom from major adverse events was 79 ± 6%; primary and secondary patency of targeted renal arteries was 81 ± 5% and 97 ± 2%, freedom from renal function deterioration was 91 ± 5%, and freedom from secondary interventions was 63 ± 9%.

Conclusion: This prospective study demonstrates that endovascular repair of juxta renal AAAs with the Zenith fenestrated AAA stent graft is safe and effective. Mortality and morbidity are low in properly selected patients treated in centers with experience in these procedures. (J Vasc Surg 2014;60:1420–8.)
Supplementary Fig 1 (online only). A, Preoperative computed tomography angiography (CTA) of a patient with juxtarenal abdominal aortic aneurysm (AAA) treated by Zenith fenestrated stent graft (B). C, Follow-up CTA with patent stent graft and no endoleak. Reproduced with permission of Mayo Foundation for Medical Education and Research. All rights reserved.
Physician modification of Gore C3 excluder endograft for treatment of abdominal aortic aneurysms anatomically unsuitable for conventional endovascular repair

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Until recently, the Cook Zenith aortic endograft (Cook Medical Inc, Bloomington, Ind) was the only device used for physician-modified fenestration because its constraining wire allowed physicians to reconstrain the device after modifications. Although the Cook Zenith fenestrated endograft has been approved by the Food and Drug Administration, it is currently not available in the majority of the hospitals and is not applicable to the patients who need urgent or emergent aneurysm repair. With the redesign of the Gore C3 delivery system, the Gore Excluder aortic stent graft (W. L. Gore & Associates, Inc, Flagstaff, Ariz) can now also be reconstrained, which makes it suitable for physician-modified fenestration. We describe the technique for modification and implantation of the Gore Excluder aortic stent graft in a patient requiring 2-vessel bilateral renal artery fenestration. This application provides an additional option for treatment of patients with abdominal aortic aneurysms who are anatomically unsuitable for conventional endovascular aneurysm repair and are at high risk for open repair. (J Vasc Surg 2014;59:1739-43.)
Physician modified Gore C3 Excluder endografts for high risk or urgent TAAA and pararenal AAA
Physician Modified FEVAR
Physician Modified FEVAR
Physician Modified FEVAR
Juxta- and suprarenal AAA

2-Vessel fEVAR for juxtarenal AAA

2-Vessel fEVAR for Para Anastomotic AAA

3-vessel fEVAR For Suprarenal AAA
How Physicians Can Modify Gore C3 Devices To Facilitate F/BEVAR In Urgent TAAAs And Pararenal AAAs: Midterm Clinical Results

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VEITH SYMPOSIUM
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## Compared with Published Data

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<th>12 Studies (60 centers)*</th>
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<td>30-day mortality</td>
<td>1.7%</td>
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<tr>
<td>Endoleaks</td>
<td>11.5%</td>
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<td>Intraoperative TV loss</td>
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<td>Total post-op TV loss</td>
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<td>Post-op renal dysfunction</td>
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<td>Dialysis</td>
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<tr>
<td>Late mortality</td>
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<td>11%</td>
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<tr>
<td>Late aneurysm-related death</td>
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TV, target vessel

Conclusion

• Complex endovascular procedures for AAA with challenging neck anatomy can be performed safely and effectively in appropriately selected patients

• Acceptable short and medium-term outcomes
Thank you

Question?