Open Conversion for Failed EVAR
Increasing Need and Different Strategies

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Co-Director, UPMC Heart and Vascular Institute
Professor and Chair, Division of Vascular Surgery
University of Pittsburgh School of Medicine
No Financial Compensation or Conflicts

Industry Relationships:
WL Gore: Aortic Scientific Advisory Board
Medtronic: Aortic Scientific Advisory Board

Current Research Grants:
WL Gore, Cook, Medtronic
Most patients do well with EVAR

15% still require reintervention, usually of minor intensity

- Most are for endoleaks
- Most are endovascular
- Most are percutaneous

Not all Failed EVAR need Open Conversion

Treated with New Endograft inside first one

Treated by Extension
Not all Failed EVAR need Open Conversion

✓ Most patients do well with EVAR
✓ 15% still require reintervention, usually of minor intensity
  - Most are for endoleaks
  - Most are endovascular
  - Most are percutaneous

Treated with Endoanchors

Type I A Resolved

Aneurysm neck wall

Failed Extension

Palmaz

Two Chimneys

All Endovascular
Not all Failed EVAR need Open Conversion

- Most patients do well with EVAR
- 15% still require reintervention, usually of minor intensity
  - Most are for endoleaks
  - Most are endovascular
  - Most are percutaneous
Which Failed EVAR needs Open Conversion?

- However Open Conversion is still required on occasion
- **Acute** and **Early** conversion are rare in modern day EVAR. They are usually related to errors in technique or judgment!
Which Failed EVAR needs Open Conversion?

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Coverage of 3 of 4 renal arteries
Two by intentional coiling

Graft occlusion: Emergency Ax Bifem
Elective Conversion to Aorto Bi-Iliac
Which Failed EVAR needs Open Conversion?

- However Open Conversion is still required on occasion
- **Acute** and **Early** conversion are rare in modern day EVAR. They are usually related to errors in technique or judgment!

Short neck: Two bifurcated devices + Multiple cuffs

Type IA endoleak / Thrombosed limb / Ischemic leg

Urgent Open Conversion
Late Open Conversion is more common and mostly related to arterial degeneration and/or material fatigue.

Threshold center specific.

Indications for Open Conversion:

- Aortic Rupture
- Graft Infection
- Type I A or III
- Graft Thrombosis
- More and more often, Type II endoleaks with sac enlargement not responding to endovascular Interventions.
Mounting FRUSTRATION with Rx of Type II Endoleaks

Type II endoleak is an enigmatic and unpredictable marker of worse outcome after endovascular aneurysm repair

Enrico Cieri, MD, PhD, Paola De Rango, MD, PhD, Giacomo Isernia, MD, Gioele Simone, MD, Andrea Ciucci, MD, Gianbattista Parlani, MD, Fabio Verzini, MD, PhD, FEBVS, and Piergiorgio Cao, MD, FRCS, Perugia and Rome, Italy

“Type II endoleaks have more growth and lead to many interventions that seem ineffective in stopping the expansion and eliminating the endoleaks compared to those left alone”.
Results of Rx of type II with *Enlarging Sacs*

We noticed that our success rate in coiling Type II Endoleaks fell from 80% to around 40% over a decade.

<table>
<thead>
<tr>
<th>Indication for Tx</th>
<th>Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 5mm sac growth</td>
<td>44% no sac increase</td>
</tr>
<tr>
<td>80% with sac growth</td>
<td>43% no endoleak</td>
</tr>
<tr>
<td>sac growth</td>
<td>28% no endoleak</td>
</tr>
<tr>
<td>74% with sac growth</td>
<td>31.5% no endoleak</td>
</tr>
</tbody>
</table>

| Sarac 2012 | 95 | > 5mm sac growth | 44% no sac increase |
| Abularrage 2012 | 51 | 80% with sac growth | 43% no endoleak |
| Aziz 2012 | 42 | sac growth | 28% no endoleak |
| Walker 2015 | 111 | 74% with sac growth | 31.5% no endoleak |
New UPMC Review

Selected Results in 279 procedures with mean FU 7.1 yrs

- Of 130 patients with initial diagnosis of Type II
  38 (29%) were ultimately treated for occult type I or III

- In 118 patients treated first for a Type II
  Rate of growth until type II treatment was significantly associated with occult Type I or III endoleak (p=.003)
  \[ \geq 5\text{mm} / \text{year} \quad 47.8\% \\
  < 5\text{mm} / \text{year} \quad 14.1\% \]
Likelihood of Occult Type I or III Endoleaks vs # Attempts at Type II Rx

Initial Attempt: 22%
2nd Proc.: 35.1%
3rd proc.: 44.8%
4th procedure: 66.6%

Type II interventions
2018 SVS Guidelines recommendations

We suggest open repair if endovascular intervention fails to treat a type II endoleak with ongoing aneurysm enlargement.

<table>
<thead>
<tr>
<th>Level of recommendation</th>
<th>2 (Weak)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of evidence</td>
<td>C (Low)</td>
</tr>
</tbody>
</table>
What do we mean by Open Conversion?

✓ No accepted definition. Generally refers to a laparotomy with a direct surgical intervention on the aorta or the endograft

✓ Three general categories:
  o *Total Graft Explanation* often leaving some hooks behind
  o *Partial Graft Explantation* usually leaving portions of the endograft such as limbs behind
  o *A variety of Graft Preserving procedures of all kind*:
    ▪ Ligation of Lumbars or IMA
    ▪ Improving Neck Fixation with external sutures
    ▪ External narrowing of aortic Neck (banding) for Type I A endoleak
Total Graft Explantation

- Usually for Rupture, Graft Infection or major Graft defects
- It is actually **Required** for some endografts unsuitable for suturing, or without fixation elements allowing endograft to “*float out*” such as Endologix AFX or Nellix
Total Graft Explantation

- Clamp is often supra-celiac because of inflammation or presence of suprarenal stents (*which may or may not be left behind*)
- Neck is usually thinned out by device. Use Pledgets.
Partial Graft Explantation

- Usually for significant arterial degeneration on one end like Type IA endoleak while the other end is quite stable.
- Adherent limbs may be left behind instead of injuring iliacs.
- Sutures to graft also should preferably include arterial wall.
Partial Graft Explantation

Type IA and Migration Of Ancure Device with Fixed Distal Limbs

Courtesy W Jordan
Graft Sparing and Preserving Procedures

- Usually for Type II with suturing of lumbar, or difficult small Type I endoleaks with wrapping or reinforcing of neck or both.
- Can be done with limited incision and no clamping.
- Lumbar can be difficult if high in neck. Excessive bleeding.
Graft Sparing and Preserving Procedures

Rupture with no obvious endoleak
Graft Sparing and Preserving Procedures

Rupture with no obvious endoleak (IMA bleeding in wall)
Graft Sparing and Preserving Procedures

WRAP: Type IA endoleak / dilating neck, multiple Renals and CAD
WRAP: Type IA endoleak / dilating neck, multiple Renals and CAD
Graft Sparing and Preserving Procedures

WRAP: Type IA endoleak / dilating neck, multiple Renals and CAD

14 months later
Shrunken AAA

WRAP
UPMC Review (accepted in JVS not published yet)

- 15 years
- 102 patients

102 Conversions

85 for Endoleak
- 20 Ruptured
- 65 Non-Ruptured

15 for Infection
## UPMC Review

| EVAR graft and History | Mean ± SD or Percentage  
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>N = 102</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Endograft</strong></td>
<td></td>
</tr>
<tr>
<td>Gore Excluder</td>
<td>28.9%</td>
</tr>
<tr>
<td>Ancure</td>
<td>15.7%</td>
</tr>
<tr>
<td>Medtronic AneuRx</td>
<td>14.5%</td>
</tr>
<tr>
<td>Endologix AFX</td>
<td>12.1%</td>
</tr>
<tr>
<td>Cook Zenith</td>
<td>10.8%</td>
</tr>
<tr>
<td>Others</td>
<td>18.0%</td>
</tr>
<tr>
<td><strong>Time from EVAR to Conversion</strong></td>
<td>3.8 ± 3.1 years</td>
</tr>
<tr>
<td><strong>Endo Re-Interventions</strong></td>
<td>48.5%</td>
</tr>
<tr>
<td><strong>Number of Interventions</strong></td>
<td>1.9 ± 1.0</td>
</tr>
<tr>
<td><strong>Reasons for Intervention (more than 1)</strong></td>
<td></td>
</tr>
<tr>
<td>Type IA Endoleak</td>
<td>43.2%</td>
</tr>
<tr>
<td>Type IB Endoleak</td>
<td>22.7%</td>
</tr>
<tr>
<td>Type II Endoleak</td>
<td>60.0%</td>
</tr>
<tr>
<td>Type III Endoleak</td>
<td>6.8%</td>
</tr>
</tbody>
</table>
## Operative Details

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD or Percentage N = 102</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA Size at Conversion, cm</td>
<td>7.0 ± 2.2</td>
</tr>
<tr>
<td>Operative time, min</td>
<td>265.9 ± 130.0</td>
</tr>
<tr>
<td>Estimated blood loss, L</td>
<td>3.0 ± 3.9</td>
</tr>
<tr>
<td>Clamp Location</td>
<td></td>
</tr>
<tr>
<td>Supraceliac</td>
<td>23.5%</td>
</tr>
<tr>
<td>Suprarenal</td>
<td>34.3%</td>
</tr>
<tr>
<td>Infrarenal</td>
<td>15.7%</td>
</tr>
<tr>
<td>None</td>
<td>26.5%</td>
</tr>
</tbody>
</table>
Increasing Incidence
42% of total were in last 3 years alone
Slight Increase in use of Graft Preservation
**UPMC Review**

Type IA Endoleaks

*Majority are for Type IA endoleaks Ruptured or Not.*

![Graph showing Type IA and No Type IA endoleaks from 2003 to 2017.](image)
### Outcome

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Infection N = 15</th>
<th>Endoleak, Ruptured N = 20</th>
<th>Endoleak, Non-Ruptured N = 65</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>40.0%</td>
<td>40.0%</td>
<td>6.2%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>LOS, median/IQR</td>
<td>12 [8-28]</td>
<td>12 [9-30]</td>
<td>7 [6-11.5]</td>
<td>0.001</td>
</tr>
<tr>
<td>Any complication</td>
<td>66.7%</td>
<td>45.0%</td>
<td>38.5%</td>
<td>0.14</td>
</tr>
<tr>
<td>AKI</td>
<td>33.3%</td>
<td>15.0%</td>
<td>7.7%</td>
<td>0.03</td>
</tr>
</tbody>
</table>

### Predictor of mortality

<table>
<thead>
<tr>
<th>Predictor of mortality</th>
<th>Multivariate OR</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rupture</td>
<td>6.70</td>
<td>1.75 – 25.60</td>
<td>0.005</td>
</tr>
<tr>
<td>Infection</td>
<td>8.48</td>
<td>1.99 – 36.20</td>
<td>0.004</td>
</tr>
<tr>
<td>Supraceliac clamp</td>
<td>4.80</td>
<td>1.47 – 15.66</td>
<td>0.009</td>
</tr>
<tr>
<td>Outcome</td>
<td>Graft Explantation (N = 37)</td>
<td>Graft Preservation (N = 28)</td>
<td>P-value</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------------</td>
<td>----------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Death</td>
<td>8.1%</td>
<td>3.6%</td>
<td>0.63</td>
</tr>
<tr>
<td>LOS, median/IQR</td>
<td>7 [6-12]</td>
<td>6 [5-10]</td>
<td>0.39</td>
</tr>
</tbody>
</table>

❖ For the 65 Elective Cases for Endoleaks: Limited procedures with graft preservation (ligation of lumbars or neck banding...) appeared to have a reduction of operative mortality in half.
Some Reinterventions have occurred in survivors: We are still learning!

Mean follow-up: 3.0 years

- In Explantation group (1/37):
  - Rupture from type IB endoleak at 1.8 years (limbs were partially explanted in the initial conversion)

- In Graft preservation group (2/28):
  - Type II endoleak from lumbar artery at 11.7 months, after initial isolated IMA ligation; treated by embolization
  - Type IA endoleak at 1.7 years, after initial isolated IMA ligation; treated with proximal cuff
Increasing Use of Open Conversion

Late graft explants in endovascular aneurysm repair

Eric J. Turney, MD, Sean P. Steenberge, MS, Sean P. Lyden, MD, Matthew J. Eagleton, MD, Sunita D. Srivastava, MD, Timur P. Sarac, MD, Rebecca L. Kelso, MD, and Daniel G. Clair, MD, Cleveland, Ohio

- 1999-2012
- 100 patients with total or partial explantation
- Median length of time from EVAR: 41 Months
- Mortality 17%
  - Ruptures: 56%
  - All Non Elective cases: 37%
  - Elective Mortality: 10%
Open Conversion is still required in many EVAR failures.

Frustration with ineffective endovascular solutions is driving an increase in utilization of Open Conversion.

Conversion carries a higher mortality and morbidity than de novo repair especially in patients with ruptures or infection.

Explantation is not required in all cases. Limited interventions with suturing of lumbers and neck wrapping are effective, safe and may reduce mortality and morbidity of conversions.

Proper patient selection for graft preservation is key to success.
Interest in Open Conversions Increasing: 2018

- Open surgical repair suitable
  - Do not routinely start beta blockers. [1.4.7]
  - Do not offer remote ischaemic preconditioning [1.4.8]
  - Offer open surgical repair [1.5.2]
  - Do not offer EVAR [1.5.3; 1.5.5]
  - Offer referral to stop smoking services if the person smokes. [1.3.1] Follow NICE guidance on secondary prevention of cardiovascular disease [1.3.2; 1.4.6]

- Open surgical repair unsuitable because of anaesthetic or medical contraindications
  - Do not offer EVAR [1.5.4; 1.5.6]
Predicted shortfall in open aneurysm experience for vascular surgery trainees

Anahita Dua, MD, MS, MBA, Gilbert R. Upchurch Jr, MD, Jason T. Lee, MD, John Eidt, MD, and Sapan S. Desai, MD, PhD, MBA, Houston, Tex; Milwaukee, Wisc; Charlottesville, Va; Stanford, Calif; Greenville, SC; and Durham, NC

- Open AAA cases 42,872 in 2000 decreased to 10,039 in 2011
- EVAR increased from 2,358 (5.2%) to 35,028 (76.5%)
- In 2011 6,055 cases in teaching institutions
- Vascular trainees will complete about 10 open AAA cases in 2015 and 5 in 2020
2016 Board examinees Operative Experience
Open Aortic Experience

Progressive shortfall in open aneurysm experience for vascular surgery trainees with the impact of fenestrated and branched endovascular technology

Anahita Dua, MD, MS, MBA, Steven Koprowski, BS, Gilbert Upchurch, MD, Cheong J. Lee, MD, and Sapan S. Desai, MD, PhD, MBA, Milwaukee, Wisc, Charlottesville, Va, and Springfield, Ill

Updated prediction with more recent data including FEVAR / BEVAR

Trainees will perform 2-3 open AAA by 2020

J Vasc Surg 2017;65:257-61
Take Home Message

We better maintain our Open Skills and ensure the transfer of those skills to the new generation of surgeons