The place of open surgery for AAA in my view

JP Becquemin
Henri Mondor Hospital, University Paris XII Creteil France
I have marvelled often at the fine line that divides success from failure
European Vascular and Endovascular Monitor (EVEM)
EVAR vs OPEN 2003-2012*
Line Chart

*only until and inclusive of Q3 2012

Abstract

OBJECTIVE: Broad application of endovascular aneurysm repair (EVAR) and improved patient survival, albeit at a higher operative risk, have resulted in an increase in the incidence of unruptured and ruptured abdominal aortic aneurysms (AAAs), their management by EVAR and OAR, and to compare overall patient characteristics and clinical outcomes between these two approaches.

METHODS: A retrospective analysis of the cross-sectional National Inpatient Sample (2000-2010) was used to evaluate patient characteristics and outcomes related to EVAR and OAR for unruptured and ruptured AAAs. Data were extrapolated to represent population-level statistics through the use of weights. Comparisons between groups were made with the use of descriptive statistics.

RESULTS: The National Inpatient Sample affected by AAAs over the 11-year span of this study; the average age was 73 years. In-hospital mortality rate was 7%, with a median length of stay (LOS) of 5 days and median hospital charges of $63,000. In-hospital mortality rate was 13 times greater for ruptured patients, with a median LOS of 9 days and median charges of $84,744. For both unruptured and ruptured patients, EVAR was associated with a lower mortality rate (1% for unruptured and 41% vs 27% for ruptured; P < .001 for each), shorter median length of stay (3 vs 7 days), and lower median hospital charges ($27,500 vs $92,841).

CONCLUSIONS: The overall use of EVAR has risen sharply in the past 10 years, with an increase from 5% in 2000 to 74% in 2010. In-hospital mortality rates for both ruptured and unruptured cases have fallen by more than 50% during this time period. Lower mortality rates and shorter LOS despite a 27%-36% higher cost of care continues to justify the use of EVAR over OAR. For patients with suitable anatomy, EVAR should be the preferred management of both ruptured and unruptured AAAs.
Endovascular repair of abdominal aortic aneurysm

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### Analysis 1.1. Comparison of EVAR versus OSR in the management of fit individuals: all-cause mortality

**Outcome:** Short-term mortality (30-day or in-hospital) (excluding participants who died before surgery and those who did not undergo any intervention)

**Review:** Endovascular repair of abdominal aortic aneurysm

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>EVAR n/N</th>
<th>Open repair n/N</th>
<th>OR (M-H,Fixed, 95% CI)</th>
<th>Weight</th>
<th>OR (M-H,Fixed, 95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACE (1)</td>
<td>2/150</td>
<td>1/148</td>
<td></td>
<td>1.7%</td>
<td>1.99 [0.18, 22.15]</td>
</tr>
<tr>
<td>DREAM (2)</td>
<td>2/171</td>
<td>8/174</td>
<td></td>
<td>13.7%</td>
<td>0.25 [0.05, 1.17]</td>
</tr>
<tr>
<td>EVAR1 (3)</td>
<td>14/614</td>
<td>36/602</td>
<td></td>
<td>62.2%</td>
<td>0.37 [0.20, 0.69]</td>
</tr>
<tr>
<td>OVER</td>
<td>2/427</td>
<td>13/437</td>
<td></td>
<td>22.4%</td>
<td>0.15 [0.03, 0.68]</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>1362</strong></td>
<td><strong>1361</strong></td>
<td><strong>0.33 [0.20, 0.55]</strong></td>
<td><strong>100.0%</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Total events: 20 (EVAR), 58 (Open repair)*

- Heterogeneity: $\chi^2 = 3.38, df = 3 (P = 0.34), I^2 = 11%$
- Test for overall effect: $Z = 4.21 (P = 0.000026)$
- Test for subgroup differences: Not applicable

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1. One patient in OSR did not undergo surgery
2. 2 in EVAR and 4 in OSR did not undergo surgery
3. Of the 626 patients in each group, 12 in EVAR died prior to repair and 19 in OSR died before surgery and 5 refused surgery
## Analysis 11.1. Comparison of EVAR versus OSR in the management of fit individuals: length of hospital stay, Outcome 1: Length of hospital stay.

### Length of hospital stay

<table>
<thead>
<tr>
<th>Study</th>
<th>EVAR</th>
<th>OSR</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACE</td>
<td>5.8 ± 5.5 days (mean ± SD)</td>
<td>10.4 ± 8.3 days (mean ± SD)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>DREAM</td>
<td>6 days (mean)</td>
<td>13 days (mean)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>EVAR1</td>
<td>10.3 ± 17.8 days (mean ± SD)</td>
<td>15.7 ± 16.9 days (mean ± SD)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>OWER</td>
<td>3.0 days (2.0 to 5.0) (mean/range)</td>
<td>7.0 days (6.0 to 10.0) (mean/range)</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>
Analysis 1.3. Comparison 1 EVAR versus OSR in the management of fit individuals: all-cause mortality, Outcome 3 Long term mortality (beyond 4 years, ITT analysis).

Review: Endovascular repair of abdominal aortic aneurysm

Comparison: 1 EVAR versus OSR in the management of fit individuals: all-cause mortality

Outcome: 3 Long term mortality (beyond 4 years, ITT analysis)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>EVAR</th>
<th>Open repair</th>
<th>Odds Ratio</th>
<th>Weight</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td>M-H,Fixed,95% CI</td>
<td></td>
<td>M-H,Fixed,95% CI</td>
</tr>
<tr>
<td>DREAM</td>
<td>58/173</td>
<td>60/178</td>
<td></td>
<td>13.4 %</td>
<td>0.99 [0.64, 1.54]</td>
</tr>
<tr>
<td>EVARI</td>
<td>260/626</td>
<td>264/626</td>
<td></td>
<td>52.8 %</td>
<td>0.97 [0.78, 1.22]</td>
</tr>
<tr>
<td>OVER</td>
<td>146/444</td>
<td>146/437</td>
<td></td>
<td>33.8 %</td>
<td>0.98 [0.74, 1.29]</td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>1243</strong></td>
<td><strong>1241</strong></td>
<td><strong>100.0 %</strong></td>
<td><strong>0.98 [0.83, 1.15]</strong></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 464 (EVAR), 470 (Open repair)

Heterogeneity: Chi² = 0.01, df = 2 (P = 1.00); I² = 0.0%
Test for overall effect: Z = 0.28 (P = 0.78)
Test for subgroup differences: Not applicable

Favours EVAR  Favours Open repair
### Analysis 2.2. Comparison 2 EVAR versus OSR in the management of fit individuals: AAA-related mortality, Outcome 2 Long term AAA-related mortality (beyond 4 years).

**Review:** Endovascular repair of abdominal aortic aneurysm

**Comparison:** 2 EVAR versus OSR in the management of fit individuals: AAA-related mortality

**Outcome:** 2 Long term AAA-related mortality (beyond 4 years)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>EVAR n/N</th>
<th>Open repair n/N</th>
<th>Odds Ratio M-H, Fixed 95% CI</th>
<th>Weight</th>
<th>Odds Ratio M-H, Fixed 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>DREAM</td>
<td>2/173</td>
<td>8/178</td>
<td>12.7 %</td>
<td>0.25 [0.05, 1.19]</td>
<td></td>
</tr>
<tr>
<td>EVARI</td>
<td>36/626</td>
<td>40/626</td>
<td>61.5 %</td>
<td>0.89 [0.56, 1.42]</td>
<td></td>
</tr>
<tr>
<td>OVER</td>
<td>10/444</td>
<td>16/437</td>
<td>25.7 %</td>
<td>0.61 [0.27, 1.35]</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>1243</strong></td>
<td><strong>1241</strong></td>
<td><strong>100.0 %</strong></td>
<td><strong>0.74 [0.50, 1.08]</strong></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 48 (EVAR), 64 (Open repair)

Heterogeneity: \( \chi^2 = 2.75, \text{df} = 2, (P = 0.25); R^2 = 27\%

Test for overall effect: \( Z = 1.55, (P = 0.12) \)

Test for subgroup differences: Not applicable
### Analysis 3.1. Comparison 3 EVAR versus OSR in the management of fit individuals: reintervention, Outcome 1 Intermediate reintervention (up to four years).

**Review:** Endovascular repair of abdominal aortic aneurysm

**Comparison:** 3 EVAR versus OSR in the management of fit individuals: reintervention

**Outcome:** 1 Intermediate reintervention (up to four years)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>EVAR n/N</th>
<th>Open repair n/N</th>
<th>Odds Ratio M-H,Random,95% Cl</th>
<th>Weight</th>
<th>Odds Ratio M-H,Random,95% Cl</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACE</td>
<td>24/150</td>
<td>4/149</td>
<td>6.90 [2.33, 20.44]</td>
<td>25.3%</td>
<td></td>
</tr>
<tr>
<td>EVARI</td>
<td>121/626</td>
<td>46/626</td>
<td>3.02 [2.11, 4.33]</td>
<td>37.5%</td>
<td></td>
</tr>
<tr>
<td>OVER</td>
<td>61/444</td>
<td>55/437</td>
<td>1.11 [0.75, 1.64]</td>
<td>37.1%</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>1220</strong></td>
<td><strong>1212</strong></td>
<td><strong>2.56 [1.04, 6.33]</strong></td>
<td><strong>100.0%</strong></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 206 (EVAR), 105 (Open repair)

Heterogeneity: $\tau^2 = 0.53; \chi^2 = 18.93, df = 2 (P = 0.00008); I^2 = 89\%$

Test for overall effect: $Z = 2.04 (P = 0.041)$

Test for subgroup differences: Not applicable
Ruptures (1-3%) are mostly Graft related.

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Univariate hazard ratio [95% CI]</th>
<th>P</th>
<th>Multivariate hazard ratio for all 4 factors [95% CI]</th>
<th>P</th>
<th>Adjusted multivariate hazard ratio for all 4 factors [95% CI]</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top neck diameter, cm</td>
<td>1.91 [0.55-6.59]</td>
<td>0.308</td>
<td>1.71 [0.50-5.82]</td>
<td>0.392</td>
<td>2.07 [0.59-7.20]</td>
<td>0.253</td>
</tr>
<tr>
<td>Neck length, cm</td>
<td>0.87 [0.34-2.22]</td>
<td>0.763</td>
<td>0.88 [0.34-2.28]</td>
<td>0.794</td>
<td>0.82 [0.28-2.38]</td>
<td>0.711</td>
</tr>
<tr>
<td>Maximum common iliac diameter, cm</td>
<td>1.38 [0.47-4.02]</td>
<td>0.55</td>
<td>1.07 [0.33-3.54]</td>
<td>0.908</td>
<td>0.97 [0.30-3.17]</td>
<td>0.956</td>
</tr>
<tr>
<td>Complication†</td>
<td>8.94 [3.88-20.57] &lt;0.0001</td>
<td></td>
<td>8.70 [3.77-20.11] &lt;0.0001</td>
<td></td>
<td>8.83 [3.76-20.76] &lt;0.0001</td>
<td></td>
</tr>
</tbody>
</table>

*Hazard ratios represent change in hazard per unit increase in covariate. Neck length and maximum common iliac diameter were log transformed because of skewness, so hazard ratios represent change in hazard per 2.7-unit increase in covariate.

†Complication defined as endoleak type 1, type 2 with sac expansion, type 3, migration, or kinking. Time-dependent Cox model accounted for time before and after diagnosis of complication.

‡Univariate models include each covariate adjusted for trial 1 or 2. Multivariate models include all 4 covariates adjusted for trial 1 or 2. Adjusted multivariate models include all 4 covariates adjusted for trial 1 or 2, baseline age, sex, abdominal aortic aneurysm diameter, log (length of primary EVAR procedure), time since August 31, 1999 (as a marker of early or late iterations of device), shape of graft (straight and uni-iliac vs bi-iliac) and graft manufacturer (Cook/Zenith, Medtronic/Talent, Gore/Excluder, other).

Real Life outside RCTs
Predictors of Abdominal Aortic Aneurysm Sac Enlargement After Endovascular Repair

Andres Schanzer, MD; Roy K. Greenberg, MD; Nathanael Hevelone, MPH; William P. Robinson, MD; Mohammad H. Eslami, MD; Robert J. Goldberg, PhD; Louis Messina, MD

41% at 5 years

Outside IFU
## IFU
### Infra renal EVAR

<table>
<thead>
<tr>
<th>Device</th>
<th>Length</th>
<th>Diameter</th>
<th>Angulation</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Endurant</strong> (Medtronic)</td>
<td>15 mm</td>
<td>18 - 32 mm</td>
<td>&lt; 60 °</td>
<td>&lt; 25% thrombus calcification cone shaped &gt; 2 mm</td>
</tr>
<tr>
<td><strong>Excluder C3</strong></td>
<td>15 mm</td>
<td>18 - 32 mm</td>
<td>&lt; 60 °</td>
<td>No thrombus/calcification</td>
</tr>
<tr>
<td><strong>Zenith</strong></td>
<td>15 mm</td>
<td>18 - 32 mm</td>
<td>&lt; 60 °</td>
<td>Circular thrombus calcification cone shaped</td>
</tr>
<tr>
<td><strong>Anaconda</strong> (Vascutek)</td>
<td>15 mm</td>
<td>17.5-31 mm</td>
<td>no limit</td>
<td>Anatomically unsuitable for EVAR 40%</td>
</tr>
<tr>
<td><strong>AFX</strong> (Endologix)</td>
<td>15 mm</td>
<td>18 - 32 mm</td>
<td>&lt; 60 °</td>
<td>or calcification</td>
</tr>
</tbody>
</table>

Anatomically unsuitable for EVAR 40%
Survival with and without type II endoleak

At least one El 2, n=201

No El 2, n=499

p=0.49

Type II endoleaks after endovascular repair of abdominal aortic aneurysm are not always a benign condition.

El Batti S, Cochennec F, Roudot-Thoraval F, Becquemin JP.
Department of Vascular Surgery, Henri Mondor Hospital, University of Paris XII, Créteil, France.
Clinical significance: Complications

Type II endoleak
No type II endoleak

$p<0.001$
Failure of EVAR

- Graft related in RCT
- Poor respect of IFU in real life
- Type II endoleaks
Does Latest Generation of Stent-grafts Change the Issue?

YES
Migration
Better proximal fixation for infra renal AAA
Short neck
Fenestration
Chimney
Type II endoleak
Nellix
Endologix
Our Unit

2003 54%
2014 90%
2003 54% rupture
2014 0% rupture

Total AAA chir EVAR
What does open surgery achieve that evar does not?
Clot removed

Lumbar and IMA sutured

Fixation secured
Fixation secured

No Migration nor type I or III endoleak

Lumbar and IMA sutured

No type II endoleak

Clot removed

No need for sac surveillance
Is Open Surgery the Holly Grail of Current and Future Stent Graft?

- No type II endoleak
- No migration nor type I or III endoleak
- No need for sac surveillance
I have marvelled often at the fine line that divides success from failure
How does this sentence apply to AAA repair

Success: Favourable Anatomy for EVAR, Fitness for Open

Failure: Poor anatomy for Evar, Unfit for Open

The thin line: Sound reasoning, Experience
Open repair has still a place.
The place of open surgery for AAA in my view

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