OPEN REPAIR OF RUPTURED ABDOMINAL AORTIC ANEURYSM

THE GOLD STANDARD

1970 - 2016

35% Mortality

Advances in Repair of Aortic Aneurysms: Open 1970 - 2016

1. Surgeons experienced
2. Anesthetic management
3. Grafts
4. Retraction
5. Resuscitation
6. Critical care
7. Blood products
Advances in Repair of Aortic Aneurysms: Open 1970 - 2016

8. Imaging – planning
9. Improved management of complications – dialysis

2-3% mortality

Early EVAR results compared to that

Vascular Surgeons 1970 - 2016

Experts at open elective AAA resection

Excellent Results

- Juxtrarenal
- Thoracoabdominal

Mortality < 10%

Advances in the Treatment of Ruptured AAA - Open

1. All the same advances for elective
2. Rapid helicopter based transport
3. Massive transfusion protocols
4. Coagulation adjuncts
5. Balloon occlusion
6. Protocols, rooms, teams
7. Delayed closure, open abdomen

Experienced Surgeons
High Volume Centers
Medicare Patients – 2001-2008

10,998 patients

1126 – EVAR
9872 – Open

Mortality 33.8% 47.7%

EVAR mortality may improve
Open likely will not

Ruptured AAA

4000/year in the US

11% of all AAA repairs

VQI EVAR for ruptured AAA

2003 0%
2013 58%

Acute Ascending
Aortic Ruptured
Dissection Abdominal Aortic
Mortality Aneurysm

1970 >60% 1970 50-60%
1990 20-30% 1990 45-50%
2010 10-15% 2010 35-50%
**Improved Mortality**

- Acute Ascending Aortic Dissection
- Ruptured Abdominal Aortic Aneurysm Open

1. Retrograde Cardioplegia
2. Cerebral Perfusion
3. Circulatory Arrest

**Open Repair**

Why the continued results?  
*It’s too hard.*

1. No planning preoperatively
2. No rest intraoperatively
   - no cardiopulmonary bypass
3. Difficult and distorted
   - anatomy
4. Catastrophic bleeding
5. Comorbid conditions

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Open Repair of Ruptured Abdominal Aortic Aneurysms

Failed Experiment

No reason the results likely to improve
Less open surgery-next generation not likely to be more experienced at open repair.
### Allegheny General Results

June 2011 – August 2015

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Mortality</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
<td>37%</td>
<td>(33)</td>
</tr>
<tr>
<td>EVAR</td>
<td>12%</td>
<td>(27)</td>
</tr>
</tbody>
</table>

**Dr. Benckart**

- 8 open operations
- 4 died
- 6 EVARs
- 1 died

**EVAR = 90% of Ruptured AAA**

Mario Lachat

Since 2009

- 74 ruptures
- 4 open
- 70 EVAR
- 21% chimney

**Mortality 22%**
Lachat

Technical Innovations

1. Physician modified stent graft
2. Nellix
3. Expandable sheaths
4. Trivascular
5. Endospan

European Trials

<table>
<thead>
<tr>
<th></th>
<th>EVAR</th>
<th>Open</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPROVE</td>
<td>35%</td>
<td>37%</td>
</tr>
<tr>
<td>AJAX</td>
<td>21%</td>
<td>25%</td>
</tr>
</tbody>
</table>

No unstable patients had to consent preop.

EVAR – 90%

Problems:

1. European referral systems often different.
2. Not all ruptured AAA will end up at high volume referral center.
3. Wide disparity in technical skills.
4. Wide disparity in hospital resources.
Is This the Answer?

EVAR for every ruptured AAA

AGH - 50% open
5 years 50% EVAR


USGNE RAAA Risk Score
• Age > 76 2
• Preop cardiac arrest 2
• Loss of consciousness 1
• Suprarenal aortic clamp 1

<table>
<thead>
<tr>
<th>Risk Score</th>
<th>Low risk</th>
<th>Medium risk</th>
<th>High risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>626</td>
<td>457</td>
<td>82</td>
</tr>
<tr>
<td>EVAR 10%</td>
<td>37%</td>
<td>95%</td>
<td></td>
</tr>
<tr>
<td>Open 15%</td>
<td>48%</td>
<td>79%</td>
<td></td>
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</table>

EVAR mortality – 25%
Open mortality – 33%

1. Can we improve on open repair of ruptured aneurysms?

2. Are there subgroups where it may be the procedure of choice?
Open Repair: Ruptured AAA

Can we make it a better operation?

- Incremental improvement over 40 years but limited
- Experienced surgeons/high volume institution
- Rapid transport
- Aortic teams
- Specialized rooms
- Balloon occlusion

Make the procedure resemble an elective case

1. Rapid transport – pre hospital
   on arrival directly to O.R.

2. Dedicated cardiovascular anesthesiologists
   - Rapid line placement
   - Permissive hypotension
   - Appropriate use of blood products
   - Management of inotropes
   - TEE

3. Dedicated operating room staff

4. Adequate exposure

5. Retroperitoneal/thoracoabdominal exposure

6. Open abdomen

7. SICU care/intensivists
**Who is an open candidate?**

<table>
<thead>
<tr>
<th>Hemodynamically Unstable</th>
<th>Hemodynamically Stable</th>
<th>Hemodynamically Stable</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Arrest</td>
<td>• EVAR suitable Anatomy</td>
<td>• EVAR unsuitable Anatomy</td>
</tr>
<tr>
<td>• CPR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• BP &lt; 60</td>
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**Subgroups that would benefit from open repair**

Perhaps?

Hemodynamically stable patients with imperfect anatomy for EVAR.

• What’s imperfect
• One we wouldn’t do electively
• Iliac aneurysm

**Anatomy:**

1. Short neck
2. Angulation
3. Severe access disease
4. Complex iliac aneurysmal disease

Will depend on experience and skill of surgeon
EXAMPLES:
Open Repair

- Number will decrease as endovascular skill set improves.
- 90% may be unrealistic target in the United States.

Trainees must have excellent open skills – challenge in the future.

Demanding for the attending surgeon

High Risk Group

Multiple Definitions

Shock – hemodynamic collapse often without imaging

Ali, et al. mortality

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This group presents the greatest challenge for either type of repair.
**High Risk Group**

1. Perhaps **should not** be operated on.
2. Damage control EVAR – coverage of renal arteries.
3. Unlikely either repair the answer here.

**Open Aneurysm Repair**
**The Future**

1. All **stable** patients with appropriate anatomy
   EVAR
2. All **stable** patients without good anatomy
   Open Repair

**Conclusion**

1. EVAR the procedure of choice
2. EVAR will increase as treatment
3. Open repair for selected cases
4. Imperative that open skills be stressed in fellowship
5. High risk patients still likely to have unfavorable outcomes