Traumatic Aortic Transection: Who, How and When?

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• NO DISCLOSURES
Blunt Aortic Injury: Background

- The second most common cause of death in trauma patients
- 80 - 85% patients die before being at hospital
- 50% patients die within 24 hours
- High mortality rate related to significant severe associated injuries

Blunt Aortic Injury: mechanism

- Injury to the aorta from sudden deceleration
  - Motor vehicle collision
  - Fall from significant height
Blunt Aortic Injury: locations

- Ascending aorta: 1%
- Aortic arch: 7%
- Aortic isthmus: 70%
- Descending aorta: 9%
- Abdominal aorta: 12%

Starnes B. W. et al. JVS 2010
Blunt Aortic Injury: grade
Blunt Aortic Injury: classification

- Aortic transection of thoracic aorta:
  - Acute: delay to trauma $\leq 14$ days
  - Chronic: delay to trauma $> 14$ days

Tako et al. classification
Blunt Aortic Injury: treatment options

- Non operative
- Conventional surgery
- Endovascular procedure
Blunt Aortic Injury: Operative Techniques

- Conventional surgery:
  - Technique « clamp and sew »
  - Technique using ECC
  - Technique using a left-left shunt
Blunt Aortic Injury: Operative Techniques

• Endovascular procedure:
  – Anatomical
    • Aortic arch anatomy
    • Pre-procedural sizing
    • Neck
  – Material
    • Stent-graft technology / Diameter
Blunt Aortic Injury: Endoprosthesis type

Cook  Gore  Medtronic
WHO ?
A new classification scheme for treating blunt aortic injury

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Samantha Quade, MD,a Thomas S. Hatsukami, MD,a Nam T. Tran, MD,a Nahush Mokadam, MD,a and
Gabriel Aldca, MD,a Seattle, Wash
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<table>
<thead>
<tr>
<th>Absent External Contour Abnormality</th>
<th>Present External Contour Abnormality</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of Aortic Injury</strong></td>
<td><strong>Example</strong></td>
</tr>
<tr>
<td>Intimal Tear</td>
<td>No aortic external contour abnormality: tear and/or associated thrombus is &lt;10mm</td>
</tr>
<tr>
<td>Large Intimal Flap</td>
<td>No aortic external contour abnormality: tear and/or associated thrombus is &gt;10mm</td>
</tr>
</tbody>
</table>
Aortic thoracic transection: classification

Starnes B. W. et al. JVS 2010

Proportion
- Rupture: 6%
- Intimal Tear: 16%
- Large intimal flap: 6%
- Pseudoaneurysm: 72%

Related death
- Rupture: 22%
- Intimal Tear: 8%
- Large intimal flap: 6%
- Pseudoaneurysm: 64%

N = 140 patients
N = 35 patients
Management of aortic transection

- Intimal flap: Follow-up (1 month)
- Large intimal tear: Follow-up (1 week)
- Pseudoaneursym: Delayed repair
- Rupture: Early repair

IF:
- Hypotension
- Traumatic brain injury
- Aortic arch hematoma > 15 mm
- Extension

- Associated lesions control
- Blood pressure control

Starnes B. W. et al. JVS 2010
HOW ?
Management principles

• Patient triage +++
• Management of aortic transection
  – Classification: grade / location
  – Pressure control (fluid restriction, beta blockers)
  – +/- Specific operative repair
• Treatment of other life-threatening injuries
# Aortic thoracic transection: management associated injuries

## Immediate endovascular repair injuries of the thoracic aorta

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of patients (Delay of repair)</th>
<th>Stent graft-related mortality (%)</th>
<th>Comorbid mortality (%)</th>
<th>Injury severity score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melnitchouk et al&lt;sup&gt;35&lt;/sup&gt;</td>
<td>15 (&lt;14 d)</td>
<td>0</td>
<td>2 (13.4%)</td>
<td>ND</td>
</tr>
<tr>
<td>Amabile et al&lt;sup&gt;36&lt;/sup&gt;</td>
<td>9 (&lt;14 d)</td>
<td>0</td>
<td>0</td>
<td>ND</td>
</tr>
<tr>
<td>Dunham et al&lt;sup&gt;37&lt;/sup&gt;</td>
<td>7 (&lt;24 h)</td>
<td>0</td>
<td>1 (6.3%)</td>
<td>36.9 ± 12.0</td>
</tr>
<tr>
<td>Lachat et al&lt;sup&gt;15&lt;/sup&gt;</td>
<td>16 (&lt;14 d)</td>
<td>1 (10%)</td>
<td>0</td>
<td>ND</td>
</tr>
<tr>
<td>Bent et al&lt;sup&gt;33&lt;/sup&gt;</td>
<td>9 (&lt;24 h)</td>
<td>0</td>
<td>0</td>
<td>ND</td>
</tr>
<tr>
<td>Buz et al&lt;sup&gt;39&lt;/sup&gt;</td>
<td>10 (&lt;14 d)</td>
<td>0</td>
<td>1 (2.9%)</td>
<td>41 (range 13-66)</td>
</tr>
<tr>
<td>Marceix et al&lt;sup&gt;19&lt;/sup&gt;</td>
<td>9 (&lt;24 h)</td>
<td>0</td>
<td>0</td>
<td>40.2 ± 10.7</td>
</tr>
<tr>
<td>Hoornweg et al&lt;sup&gt;20&lt;/sup&gt;</td>
<td>12 (&lt;14 d)</td>
<td>0</td>
<td>4 (14.3%)</td>
<td>37.1 ± 7.8</td>
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<tr>
<td>Canaud et al&lt;sup&gt;38&lt;/sup&gt;</td>
<td>21 (&lt;24 h)</td>
<td>0</td>
<td>0</td>
<td>ND</td>
</tr>
<tr>
<td>This series</td>
<td>28 (&lt;12 h)</td>
<td>0</td>
<td>5 (17.9%)</td>
<td>49.3 ± 13.2</td>
</tr>
</tbody>
</table>
Aortic thoracic transection: management

• Specific operative repair
  • Open surgery (OS)
  • Endovascular repair (TEVAR)

• TEVAR >>> OS
  – Mortality
  – Paraplegia
  – Blood loss
  – Intensive care unit

• OS >>> TEVAR
  – Repeated controls
  – Follow-up unclear

Fox, N et al. J. Trauma Care Surg 2014
Endograft follow-up
High motion (red)

Low motion (blue)

Learning deformation and structure simultaneously: in situ endograft deformation analysis. Langs et al. Med Image Anal. 2011
WHEN ?
Blunt Traumatic Thoracic Aortic Injuries: Early or Delayed Repair—Results of an American Association for the Surgery of Trauma Prospective Study


Table 5 Overall Outcomes According to Time of Aortic Repair

<table>
<thead>
<tr>
<th></th>
<th>All Patients (n = 178), % (n)</th>
<th>Early Repair (n = 109), % (n)</th>
<th>Delayed Repair (n = 69), % (n)</th>
<th>Odds Ratio (95% CI)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaths</td>
<td>12.4 (22)</td>
<td>16.5 (18)</td>
<td>5.8 (4)</td>
<td>3.21 (1.04–9.94)</td>
<td>0.034</td>
</tr>
<tr>
<td>Any systemic complications</td>
<td>43.8 (78)</td>
<td>41.3 (45)</td>
<td>47.8 (33)</td>
<td>1.30 (0.71–2.39)</td>
<td>0.391</td>
</tr>
<tr>
<td>Complications</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Procedure-related</td>
<td>1.7 (3)</td>
<td>1.8 (2)</td>
<td>1.4 (1)</td>
<td>1.27 (0.11–14.29)</td>
<td>1.000</td>
</tr>
<tr>
<td>paraplegia</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Pneumonia</td>
<td>32.0 (57)</td>
<td>32.1 (35)</td>
<td>31.9 (22)</td>
<td>1.01 (0.53–1.93)</td>
<td>0.975</td>
</tr>
<tr>
<td>ARDS</td>
<td>13.5 (24)</td>
<td>11.9 (13)</td>
<td>15.9 (11)</td>
<td>0.71 (0.30–1.70)</td>
<td>0.445</td>
</tr>
<tr>
<td>Septicemia</td>
<td>14.0 (25)</td>
<td>13.8 (15)</td>
<td>14.5 (10)</td>
<td>0.94 (0.40–2.23)</td>
<td>0.891</td>
</tr>
<tr>
<td>UTI</td>
<td>16.9 (30)</td>
<td>14.7 (16)</td>
<td>20.3 (14)</td>
<td>0.68 (0.31–1.49)</td>
<td>0.330</td>
</tr>
<tr>
<td>DVT</td>
<td>2.2 (4)</td>
<td>1.8 (2)</td>
<td>2.9 (2)</td>
<td>0.63 (0.09–4.55)</td>
<td>0.642</td>
</tr>
<tr>
<td>Renal failure</td>
<td>9.0 (16)</td>
<td>10.1 (11)</td>
<td>7.2 (5)</td>
<td>1.44 (0.48–4.33)</td>
<td>0.518</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD (median)</th>
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<th>Mean Difference (95% CI)</th>
<th>p</th>
</tr>
</thead>
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<tr>
<td>Ventilation days</td>
<td>9.2 ± 11.3 (5)</td>
<td>8.7 ± 10.4 (5)</td>
<td>10.0 ± 12.6 (7)</td>
<td>−1.21 (−4.69 to 2.27)</td>
<td>0.293</td>
</tr>
<tr>
<td>ICU days</td>
<td>13.3 ± 12.1 (9)</td>
<td>12.3 ± 11.8 (7)</td>
<td>14.9 ± 12.5 (12)</td>
<td>−2.58 (−6.28 to 1.11)</td>
<td>0.016</td>
</tr>
<tr>
<td>Hospital days</td>
<td>23.4 ± 33.2 (19)</td>
<td>19.9 ± 16.6 (15)</td>
<td>28.8 ± 48.4 (22)</td>
<td>−8.91 (−19.07 to 1.26)</td>
<td>0.007</td>
</tr>
<tr>
<td>Blood transfusion</td>
<td>10.8 ± 17.2 (6)</td>
<td>9.8 ± 15.8 (6)</td>
<td>12.4 ± 19.6 (6)</td>
<td>−2.58 (−8.04 to 2.89)</td>
<td>0.736</td>
</tr>
</tbody>
</table>
CASES
Case 1:
Intimal tear

Fig 4. A, Intimal tear is shown at the initial presentation on May 7, 2006. B, The tear was stable after 4 days (May 11). C, The tear was completely healed on follow-up imaging at 38 days (June 14).
Case 2: Acute aortic thoracic transection

A 21 years-old patient with spleen and renal contusions
Case 3:
Acute aortic thoracic transection and dissection of the RCA
Case 3:
Acute aortic thoracic transection and dissection of the RCA
Case 3:
Acute aortic thoracic transection and dissection of the RCA
Case 4:
Acute aortic thoracic transection associated to post traumatic subarachnoid hemorrhage
Case 4:
Acute aortic thoracic transection associated to post traumatic subarachnoid hemorrhage

Cook, diam= 26mm, lengh= 15 cm + pelvic embolization
Case 4:
Acute aortic thoracic transection associated to post traumatic subarachnoid hemorrhage.

Pelvic embolization
Case 5: Chronic thoracic transection

A 42 years-old patient
MH: Spleen trauma at the age of 12
Case 6:
Chronic aortic transection

A 69 years-old patient - Endotension
Conclusion

Angiography

CT scan

OS

TEVAR
Conclusion

- Inimal tear
  - Follow-up (1 month)
- Large intimal flap
  - Follow-up (1 week)
- Pseudoaneursym
  - Delayed repair
- Rupture
  - Early repair

IF

- Hypotension
- Aortic arch hematoma > 15 mm
- Traumatic brain injury
- Extension

- Associated lesions control
- Blood pressure control

Starnes B. W. et al. JVS 2010