Blunt Traumatic Aortic Injury: Current Concepts

James Ravenel, MD
Medical University of South Carolina

Blunt Traumatic Aortic Injury: Current Concepts

Blunt Traumatic Aortic Injury:
- Mid-20th century:
  - Thought to be universally fatal unless immediately operated upon
- Late 20th century:
  - Earlier recognition
  - Improved imaging and operative techniques
    - “Clamp and sew”
    - “Bypass”
- 21st century:
  - Selective operative repair
  - Endovascular techniques
  - Non-operative management

Blunt Traumatic Aortic Injury:

- Mechanism is related to extreme acceleration/deceleration
  - Motor vehicle collisions
  - Pedestrians struck
  - Motorcycle collisions
  - Falls

Blunt Aortic Injury:

- 0.06% of MVC
- 11% Fatalities
- 2nd leading cause of trauma related deaths (TBI #1)

Blunt Traumatic Aortic Injury:

- Three categories of patients
  1. Death at scene (50-70%)
  2. Hemodynamically unstable, or rapidly become unstable
  3. Hemodynamically stable
     - Aortic injury diagnosed 4 to 18 hrs post injury
     - Mortality 25%
     - 3% isolated injury

Signs/Symptoms

- Sudden hemodynamic instability
  - “Get Dead”
- Concomitant Abdomino-pelvic injury
- Concomitant Thoracic injury
- Hypotension
- > 50% No seatbelt; 20% No Airbag
  - Front > Side Impact
- 50% normal physical exam findings
• CIREN-Crash Injury Research Engineering Network

• NASS-National Automotive Sampling System Crashworthiness Data System

Blunt Aortic Injury: Biomechanism

• Predominant Mechanisms
  • Archimedes Lever
  • Deceleration with shear forces at points of fixation
  • Acute hypertension in aorta
  • Diaphragm compression
  • Torsion of the aorta
  • "osseous pinch"
  • Compression between sternum and spine

95% of injuries occur at the aortic isthmus
All CIREN Cases with an Aorta Injury (N=183)

<table>
<thead>
<tr>
<th>Injury</th>
<th>1990-1994 (N=124) (%)</th>
<th>1995-2010 (N=69) (%)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Injury</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intimal Tear</td>
<td>10.6</td>
<td>27.2</td>
<td></td>
</tr>
<tr>
<td>Laceration/orificial/rupture</td>
<td>9.6</td>
<td>17.4</td>
<td></td>
</tr>
<tr>
<td>Major/severe/tear/transaction</td>
<td>79.8</td>
<td>59.4</td>
<td>0.06</td>
</tr>
<tr>
<td>Severity of Injury</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minor</td>
<td>9.6</td>
<td>23.2</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>49.4</td>
<td>17.4</td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>45.4</td>
<td>42.0</td>
<td></td>
</tr>
<tr>
<td>Fatal</td>
<td>26.3</td>
<td>17.4</td>
<td>0.02</td>
</tr>
</tbody>
</table>

CIREN Annual Meeting
University of Maryland CIREN Center
September 2012

NASS Analysis: odds of aorta injury

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>Frontal</th>
<th>Near Side</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994-1997</td>
<td>1.13 (0.34-4.14)</td>
<td>1.84 (1.02-3.33)</td>
<td>0.50 (0.25-0.99)</td>
</tr>
<tr>
<td>1998-2004</td>
<td>1.13 (0.34-4.14)</td>
<td>1.84 (1.02-3.33)</td>
<td>0.50 (0.25-0.99)</td>
</tr>
<tr>
<td>2005-2010</td>
<td>1.05 (0.60-1.84)</td>
<td>1.99 (0.93-3.16)</td>
<td>0.27 (0.09-0.83)</td>
</tr>
</tbody>
</table>

* Odds ratio and 95% confidence intervals. *p*-value: <0.05, significant.

CIREN-ATAI: Association for the Study of Trauma. CIREN-ATAI, Annual Scientific Assembly, 2012

ATAI-CXR

- 7% “normal”
- Abnormality of aortic arch
- Loss of descending aorta
- Widened mediastinum (> 8 cm; > 25% thorax)
- Loss of AP window
- Tracheal shift to right
- Nasogastric tube shift to right
- Left apical cap
- Depressed left mainstem bronchus
**ATAI-CT**

- **Direct Signs**
  - Approaches 100% Specificity
  - Active Extravasation
  - Contour Abnormality
  - Intimal Flap

- **Indirect signs**
  - Periaortic hematoma
  - Mediastinal hematoma
  - Retrocrural hematoma on abdominal CT

---

**Diagnostic Modalities For traumatic Aortic Injury: AAST$_1$ (1997) vs. AAST$_2$ (2007)**

<table>
<thead>
<tr>
<th></th>
<th>AAST$_1$</th>
<th>AAST$_2$</th>
<th>$\rho$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aortogram (n/%)</td>
<td>220 (87)</td>
<td>16 (8.3)</td>
<td>$&lt; 0.001$</td>
</tr>
<tr>
<td>CT Scan (n/%)</td>
<td>88 (34.8)</td>
<td>180 (93.3)</td>
<td>$&lt; 0.001$</td>
</tr>
<tr>
<td>TEE</td>
<td>30 (11.9)</td>
<td>2 (1.0)</td>
<td>$&lt; 0.001$</td>
</tr>
</tbody>
</table>

---

Demitriades et al. “Diagnosis and Treatment of Blunt Thoracic Aortic Injuries: Changing Perspectives” J of Trauma 2008; 64(6): 1415-1419
**Blunt Traumatic Aortic Injury:**

**Treatment**
- Left thoracotomy with placement of cannulas for partial cardiopulmonary bypass
- Dacron interposition graft
- Paraplegia was a feared complication

**Completed Aortic Repair**
- Injured vessel resected
- Dacron interposition graft in place

**Complications:**
- Operative mortality: 0-54%
- Paraplegia: 8-30% if cross-clamping > 30 minutes
- Infection
- Aortic venous fistulae
- Aortic enteric fistulae
- Thrombosis/occlusion

**Blunt Aortic Injury:**

**Method of Repair of TAI:**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Repair</td>
<td>207 (100)</td>
<td>68 (35.2)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Clamp/Sew</td>
<td>73/207 (35.3)</td>
<td>11/68 (16.2)</td>
<td>0.003</td>
</tr>
<tr>
<td>Bypass</td>
<td>134/207 (64.7)</td>
<td>57/68 (83.8)</td>
<td>0.003</td>
</tr>
<tr>
<td>EVAR</td>
<td>0/207</td>
<td>125/193 (64.8)</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>
Complications of TEVAR

- Device Failure
- Endoleak
- Subclavian Artery Occlusion
- Access Site
- Limited long term data

Blunt Aortic Injury:

- Significant reduction in mortality: 22% in AAST1 vs. 13% in AAST2 (p = 0.02)
- Significant reduction in paraplegia: 8.7% in AAST1 vs. 1.6% in AAST2 (p = 0.001)
- No difference in rates of renal failure, pneumonia
- Significant increase in early graft related complications: 0.5% in AAST1 vs. 13.5% in AAST2 (p = 0.001).

“Minimal” Injury

- “Artifact” of increasing CT utilization
- 41 Grade I/II injuries managed non-operatively
  - 23 survived with 91% stable (mean follow up 3.8 mos)
  - 10 deaths not aorta related
  - 8 lost to f/u

Guidelines for thoracic endovascular aortic repair in traumatic thoracic aortic injuries

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Consensus</th>
<th>Grade of recommendation</th>
<th>Quality of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice of treatment</td>
<td></td>
<td>2</td>
<td>C</td>
</tr>
<tr>
<td>Timing of repair</td>
<td></td>
<td>2</td>
<td>C</td>
</tr>
<tr>
<td>Management of minimal aortic injury</td>
<td></td>
<td>2</td>
<td>C</td>
</tr>
</tbody>
</table>

We suggest that endovascular repair be performed preferentially over open surgical repair or nonoperative management.

We suggest urgent (<24 hours) repair, and at the latest prior to hospital discharge.

We suggest expectant management with serial imaging for type I injuries.

CT Pitfalls

- Anatomic
  - Left superior intercostal vein
  - Infundibula
  - Ductus variants
  - Atelectasis

- Technical
  - Motion
  - Breathing
  - Cardiac Pulsation
Blunt Aortic Injury:

- 20 year evolution
- Changing Auto Safety
- Aortography to CT
- Open Repair to TEVAR
- Watchful waiting for Grade I/II

Acknowledgement

- Bruce Crookes, MD