Management of Traumatic Aortic Injury

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Disclosures

WL Gore

Objectives

Traumatic Aortic Injury

- Focus on Blunt Aortic Injury (BAI)
- Management of BAI
  - Classification and patient triage
  - Timing of Repair
  - Current Status of Endovascular Repair

EPIDEMIOLOGY OF BAI IN HOSPITAL ADMISSIONS

- 5,838 pedestrian injuries: TA rupture 0.3%
  Demetriades D, Murray J, Martin M.
- 1,613 high-level fall injuries: TA rupture 0.1%
  Demetriades D, Murray J, Brown C, Velmahos
  J Trauma. 2005;58:342-5
- 1,450 pelvic fractures: TA rupture 1.4%
  Demetriades D, Karaiskakis M, Toutouzas K.
Fatalities of the 2008 Los Angeles Train Crash: Autopsy Findings
S. Shackelford, T. Noguchi, S. Lakshmanan, K. Inaba, D. Demetriades

25 fatalities
Thoracic aortic rupture: 8 cases (33%)

Blunt Aortic Injury
Mechanism of Injury

- Definition: Injury to the aorta from sudden deceleration incident
- Motor Vehicle Collision (MVC)
- Fall from significant height
- Location: at ligamentum arteriosum

CHANGING PERSPECTIVES -Definitive Diagnosis-

<table>
<thead>
<tr>
<th></th>
<th>AAST$_1$</th>
<th>AAST$_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>253</td>
<td>193</td>
</tr>
<tr>
<td>Aortogram</td>
<td>87%</td>
<td>8%</td>
</tr>
<tr>
<td>CT Scan</td>
<td>35%</td>
<td>93%</td>
</tr>
<tr>
<td>TEE</td>
<td>12%</td>
<td>1%</td>
</tr>
</tbody>
</table>
BAI
Multi-slice CTA With 3D recon

MANAGEMENT OF BLUNT AORTIC INJURIES

- Stabilization and injury assessment
- Timing of repair
- Type of repair

Delayed Repair of BAI
- Management Principles-
  - Pressure control (fluid restriction, beta blockers)
  - Treatment of other life-threatening injuries

Large, aortic injuries may rupture during observation despite pressure control!

“We simply had confidence in the adventitia, and I see no reason to change my mind about that.”


One of the ultimate challenges for the trauma surgeon is the management of a patient with either a passing or a thoracic or a blunt injury disruption. The injury results in a disruption of the thoracic aorta. Treatment of the thoracic aorta is essential. Of the 38 injuries, 16 were penetrating (gunshot wounds and stab wounds) and 22 were secondary to blunt trauma (12 automobile and motorcycle accidents and 16 falls). All of the blunt injuries involved the thoracic aorta (1 ascending, 1 arch, and 16 descending), as were all six of the abdominal injuries. Blunt abdominal injuries are rare but they do occur.
Early vs. Delayed Repair
No Major Associated Injuries
N=108

<table>
<thead>
<tr>
<th></th>
<th>Adjusted OR</th>
<th>Adjusted p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaths</td>
<td>9.08 (0.88-93.78)</td>
<td><strong>0.06</strong></td>
</tr>
</tbody>
</table>

*Multivariable analysis adjusting for GCS, hypotension, and open vs. endovascular procedure

UTAH TRAUMA REGISTRY
145 Repairs of BTAI

Delayed repair: The only independent factor protective against mortality


Treatment Options
- Nonoperative
- Open surgical repair
- Endovascular repair

University of Washington
Management of BAI 140 patients

Ben Taub
BAI Classification
Azizzadeh, J Vasc Surg 2009;49:1403-08

All patients with radiographic evidence of blunt aortic injury (BAI) should undergo anti-impulse therapy with β-blockade...

Observation alone with interval follow-up computed tomography angiography (CTA) within 30 days is appropriate for all intimal tears <10 mm.

Selective management of large intimal flaps (>10 mm) is appropriate with repeat imaging within 7 days to assess for progression. Evidence of progression should be managed, when possible, with endovascular repair.

All patients with an aortic external contour abnormality should be considered for semi-elective (≤1 week) endovascular repair if there is a high likelihood of survival from other associated... Patients with hypotension on presentation and aortic arch hematoma >15 mm should be repaired with endovascular methods on a more urgent basis.

Intentional left subclavian artery coverage without revascularization is well tolerated...

BAI with rupture will die and resources should be used elsewhere.
Open vs Endovascular

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Open Surgical Repair</th>
<th>Endovascular Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>15.2% to 23.5%</td>
<td>7.6%</td>
</tr>
<tr>
<td>Paraplegia</td>
<td>2.9% to 5.6%</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

Meta analysis evaluating 699 traumatic aortic transection procedures
370 endovascular repair, 329 open surgical

Technical Challenges of Endovascular Repair
- Aortic arch anatomy
- Stent-graft technology
- Diameter sizing
- Subclavian coverage
- Vascular Access

Stent-graft Malposition

[Images showing various medical procedures and diagrams related to endovascular repair and stent-graft malposition]
3D reconstructions
Aortic undersizing (5-40%) due to hypotension
Devices
IVUS
Heparin plus minus
One piece

TAG 08-02 Traumatic Transection Study

Expanded Sizing and Oversizing Windows
Expanded sizes for the Conformable GORE® TAG® Thoracic Endoprosthesis allow treatment of a broad range of vessel diameters (16–42 mm).
- Includes small diameter, low-profile stent grafts for smaller aortic diameters
Procedural Details
Conformable TAG BAI Trial

- 57 Devices implanted in 51 subjects
  1.1 devices/subject
- 78% outside original TAG Device IFU sizing

Aortic Diameters

<table>
<thead>
<tr>
<th>Aortic Diameter at Proximal Implantation Site (mm)</th>
</tr>
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<tbody>
<tr>
<td>Mean (Std Dev)</td>
</tr>
<tr>
<td>Median</td>
</tr>
<tr>
<td>Range</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aortic Diameter at Distal Implantation Site (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (Std Dev)</td>
</tr>
<tr>
<td>Median</td>
</tr>
<tr>
<td>Range</td>
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Procedural Details

- Technical Success 100%
- Procedural Survival 100%
- Median Hospital Stay 13 days
- Procedural Data
  - Median procedure time of 91 min (Range 35-232)
  - Median blood loss of 100mL
- Access
  - Femoral 96%
- LSA Coverage 62.7% (n=32)
  - Partial 29.4%
  - Complete 33.3%
- LSA Revascularization 6% (n=2)

Study Results

- Primary Safety Endpoint
  - 30 day all cause mortality = 4 (7.8%)
    - All deaths determined to be related to trauma injuries (unrelated to device or procedure)
- Primary Effectiveness Endpoint
  - Major device events through one month follow-up = 0 (0.0%)
- Key Adverse Events
  - One ischemic stroke (2%)
  - No paraplegia
  - No ruptures
  - No major endoleaks
  - No device compression/collapse
FDA Approval

- FDA approval obtained Jan 13, 2012
- The Gore Tag Thoracic Endoprosthesis is intended for endovascular repair of isolated lesions (not including dissections) of the descending thoracic aorta in patients that have appropriate anatomy.
  Isolated lesions include, but are not limited to, aneurysms, ruptured aneurysms, traumatic transections, PAUs, and isolated intramural hematomas.

BAI Conclusions

- Major improvements in survival and paraplegia
- New standards
- Routine CT scan screening in high-risk pts
- Replacement of diagnostic angio by CT scan
- Delayed repair
- Nonoperative management in selected cases, grade I and rupture grade IV
- Endovascular Repair

BAI endovascular repair 26 months

Routine CT scan screening in high-risk pts
Replacement of diagnostic angio by CT scan
Delayed repair
Nonoperative management in selected cases, grade I and rupture grade IV
Endovascular Repair

Major improvements in survival and paraplegia
### Guidelines for TEVAR in BAI

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Consensus</th>
<th>Grade of recommendation</th>
<th>Quality of evidence</th>
</tr>
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<tbody>
<tr>
<td>Choice of Treatment</td>
<td>We suggest that endovascular repair be performed preferentially over open surgical repair or nonoperative management.</td>
<td>2</td>
<td>C</td>
</tr>
<tr>
<td>Timing of repair</td>
<td>We suggest urgent (&lt;24 hours) repair, and at the latest prior to hospital discharge.</td>
<td>2</td>
<td>C</td>
</tr>
<tr>
<td>Management of minimal aortic injury</td>
<td>We suggest expectant management with serial imaging for type I injuries.</td>
<td>2</td>
<td>C</td>
</tr>
<tr>
<td>Type of repair in the young patient</td>
<td>We suggest endovascular repair regardless of age if anatomically suitable.</td>
<td>2</td>
<td>C</td>
</tr>
<tr>
<td>Management of left subclavian artery</td>
<td>We suggest selective revascularization of the left subclavian artery.</td>
<td>2</td>
<td>C</td>
</tr>
<tr>
<td>Systemic heparinisation</td>
<td>We suggest routine heparinisation but at a lower dose than in elective TEVAR</td>
<td>2</td>
<td>C</td>
</tr>
<tr>
<td>Spinal drainage</td>
<td>We do not suggest routine spinal drainage.</td>
<td>2</td>
<td>C</td>
</tr>
<tr>
<td>Choice of anesthesia</td>
<td>We suggest general anesthesia.</td>
<td>2</td>
<td>C</td>
</tr>
<tr>
<td>Femoral access technique</td>
<td>We suggest open femoral exposure.</td>
<td>2</td>
<td>C</td>
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