Management of the Open Abdomen

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The Open Abdomen

• How did we get here?
  – abdominal compartment syndrome
  – damage control surgery
  – staged laparotomy for general surgery

• Temporary closure

• ICU considerations

• Attaining fascial closure

• Complications

Abdominal Compartment Syndrome

• 1° ACS - due to abdominal injury/condition
  – major solid organ injury
  – perforated viscus
  – ruptured AAA
  – bowel obstruction
  – postoperative hemorrhage
Abdominal Compartment Syndrome

- **2° ACS** - develops during resuscitation
  - aggressive fluid resuscitation - “iatrogenic”
  - massive transfusion
  - sepsis and capillary leak
  - pancreatitis

ACS: Physiology

- **INCREASED ABDOMINAL PRESSURE**
  - compression of kidneys
  - decreased venous return
  - increased intrathoracic pressure
  - decreased renal blood flow
  - decreased UOP
  - decreased extremity perfusion
  - decreased splanchnic perfusion
  - decreased venous return
  - decreased SV
  - increased CO
  - increased SVR

PITFALL

Physical exam is NOT reliable!
## ACS: Diagnosis

- **Bladder pressure:**
  - 3-way foley
  - installation of 50cc of saline into the bladder
  - manometer at level of pubic symphysis
  - measure pressure in cm of H₂O


## PITFALL

**bladder pressure ≠ intraabdominal pressure**
- pelvic packing  - bladder rupture
- neurogenic bladder  - adhesions
- ? unparalyzed patient

## KEY POINT

ACS = ↑ bladder pressure
AND deranged physiology
- ↓ urine output  ↑ airway pressures
- ↓ cardiac output  ↑ ICP

If the patient has ACS
DECOMPRESS!!
ACS: Decompression Options

Formal Operative Decompression

Bedside Decompression in the ICU

Decompression via drainage of ascites

Reed et al. J Trauma 2006
Parra et al. J Trauma 2006
### PITFALL

Just because the abdomen is open doesn’t mean they don’t have ACS!

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#### Damage Control Surgery

<table>
<thead>
<tr>
<th>Abbreviated operation:</th>
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<tbody>
<tr>
<td>control hemorrhage</td>
</tr>
<tr>
<td>limit contamination</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Indications:</th>
</tr>
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<tbody>
<tr>
<td>hypothermia ( T &lt; 35^\circ )</td>
</tr>
<tr>
<td>acidosis ( pH &lt; 7.2, \text{base def} &gt; 15 )</td>
</tr>
<tr>
<td>coagulopathy ( PT/PTT &gt; 50% \text{ nl} )</td>
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</tbody>
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Stone et al. *J Trauma* 1985
Rotondo et al. *J Trauma* 1993

#### Damage Control General Surgery

<table>
<thead>
<tr>
<th>Similar principles:</th>
</tr>
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<tbody>
<tr>
<td>control hemorrhage</td>
</tr>
<tr>
<td>limit contamination</td>
</tr>
</tbody>
</table>

| Shorten operation and resuscitate patient in the SICU |

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KEY POINT

If in doubt, leave the abdomen open.

KEY POINT

Open abdomens are temporary*.

* in the vast majority of cases.

Now What?

...
<table>
<thead>
<tr>
<th>Temporary Option #1</th>
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<tbody>
<tr>
<td>• Towel clip closure</td>
</tr>
<tr>
<td>– rapid technique</td>
</tr>
<tr>
<td>– skin only</td>
</tr>
<tr>
<td>– limits angiography</td>
</tr>
<tr>
<td>– may develop ACS</td>
</tr>
<tr>
<td>• Trial closure</td>
</tr>
<tr>
<td>– 15-30 minutes in OR</td>
</tr>
<tr>
<td>– empty urimeter → measure output</td>
</tr>
<tr>
<td>– blood products → check for surgical bleeding</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temporary Option #2</th>
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</thead>
<tbody>
<tr>
<td>• Bogotá bag closure</td>
</tr>
<tr>
<td>– temporary silo</td>
</tr>
<tr>
<td>– 3L sterile GU irrigation bag</td>
</tr>
<tr>
<td>– sewn to skin</td>
</tr>
<tr>
<td>– contains the edematous bowel</td>
</tr>
<tr>
<td>– no issues with angiography</td>
</tr>
<tr>
<td>– suturing - time consuming</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Temporary Option #3</th>
</tr>
</thead>
<tbody>
<tr>
<td>• “1010 drape &amp; ioban closure”</td>
</tr>
<tr>
<td>– temporary covering</td>
</tr>
<tr>
<td>– no issues with angiography</td>
</tr>
<tr>
<td>– less time consuming</td>
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</tbody>
</table>
ICU Management

• General principles:
  – goal directed resuscitation
  – transfusion therapy
  – lung protective ventilation
  – limit hyperglycemia

• Abdomen specific principles:
  – fluid balance
  – nutrition support
  – management of bowel injuries

ICU Management: Fluid Management

• Correction of acidosis/lactate vs flooding with fluid
• Crystalloid vs colloid
• Do not create a hyperchloremic metabolic acidosis
• Target O2 delivery = 500 ml/min/m²
• Consider lasix drip once resuscitated

Moore et al. J Trauma 2006
McKinley et al. J Trauma 2002

ICU Management: Nutrition Support

• Benefit of enteral nutrition
  – ↓ septic complications

• Understandable hesitation
  – edematous bowel
  – associated injuries

• Enteral access possible

Moore et al. J Trauma 1986
ICU Management: Nutrition Support

- Enteral nutrition is feasible
- May decrease time to fascial closure
- Decreased rate of pneumonia
- Increase the protein given??

Collier et al., JPEN 2007
Dissanaike et al., JACS 2008
Cheatham et al., Crit Care Med 2007
Cothren et al., Am J Surg 2005

Management of Bowel Injuries

- WTA multicenter study – 10 institutions
- 204 patients

<table>
<thead>
<tr>
<th>Site</th>
<th>Number (n)</th>
<th>Overall Leak Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Bowel</td>
<td>62</td>
<td>2/62 (3%)</td>
</tr>
<tr>
<td>Right Colon</td>
<td>38</td>
<td>1/38 (3%)</td>
</tr>
<tr>
<td>Transverse Colon</td>
<td>5</td>
<td>1/5 (20%)</td>
</tr>
<tr>
<td>Left Colon</td>
<td>22</td>
<td>10/22 (45%)</td>
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</tbody>
</table>

Burlew et al., J Trauma 2011

Management of Bowel Injuries

Higher incidence of leak with closure day
Fascia closure ≥ day 5 had a 4 times higher likelihood of developing leak
ICU Management: Other Considerations

• Peritoneal resuscitation:
  – dialysis solution flushed directly into abdomen
  – increased blood flow, decreased bowel edema
  – increased fascial closure rates

  Garrison et al. JACS 2010

• Neuromuscular blockade:
  – increased primary fascial closure

  Abouassaly et al. J Trauma 2010

Open Abdomen Management

How do we go from:

To:

The Goal: Fascial Closure

• Early primary closure
• Prosthetic fascia (foreign vs biologic)
• Skin grafting and delayed repair
• Sequential fascial closure
Closure Options

• Early fascial closure
  – able to close primarily at repeat exploration

• Mesh options
  – prosthetic mesh
    • foreign body
    • infection/fistula risk
  – biologic mesh
    • incorporated by fibroblasts
    • longterm – similar to native fascia
    • resistant to infection
    • evagination

Skin Grafting

 temporary coverage

 STSG covers bowel

 granulation tissue over bowel

 PITFALL

• Don’t screw up the fascia → think twice about feeding tubes
• Place stomas FAR lateral
• No exposed suture lines
• Warn the patient it takes a year
Sequential Fascial Closure
Sequential Fascial Closure

CLOSED!! Rejoicing residents…

Abdominal Complications

- Intraabdominal abscess
- Enterocutaneous fistula
- Enteroatmospheric fistula

The Open Abdomen: Summary

- Open abdomens do save lives
  - abdominal compartment syndrome
  - damage control surgery
- ICU principles continue to evolve
- Temporary closure should be:
  - fast, covering, angio compatible
- Autologous tissue is the ideal closure
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