Damage Control in Abdominal and Pelvic Injuries

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Damage Control

“... the ability to sustain, control and repair combat damage and allow a warship to return to offensive action ...”

U.S. Navy
Damage Control

“… a concept of temporary measures that can be applied as a part of a staged approach to a complex problem …”

Hirshberg and Mattox
Surg Clin North America
1997
Historical Perspective

- The traditional approach to penetrating trauma of the abdomen has been exploratory laparotomy for control of hemorrhage and contamination.
- If physiological stability is maintained definitive repair of injuries should be accomplished.

Rotondo MF, et al
J Trauma 1993
Historical Perspective

- Feliciano and co-workers in 1988 evaluated 300 consecutive abdominal gunshot wounds:
  - Tried and true approach
  - Definitive repair achieved in majority of cases
  - Overall survival ~ 88%
    - GSW with major vascular injury ~ 60%
    - Multiple visceral injuries survival plummeted
- Concluded that acidosis, hypothermia and coagulopathy contributed to ~ 85% of deaths
The Cycle of Death

- You do not need to do everything at the initial operation.....
Potential Solutions

• H. Harlan Stone, in 1983, described the use of a rapidly terminated laparotomy after abdominal packing was undertaken at the onset of clinically apparent coagulopathy followed by SICU stabilization and delayed operative correction of major injuries

Stone HH, et al
Ann Surg 1983
The term “Damage control” was coined at the University of Pennsylvania in 1993 by Rotondo and Schwab.

Described three separate and distinctive phases:
- Control of hemorrhage and contamination with temporary abdominal closure
- Core rewarming, correction of coagulopathy, ventilatory support, identification of associated injuries and maximization of hemodynamic values
- Re-exploration and definitive surgical repair
Potential Solutions

• Retrospective study evaluating 46 patients with penetrating abdominal trauma requiring laparotomy and massive transfusion (> 10u PRBC’s)

• No significant difference between definitive repair and “damage control” surgery
  – Subset analysis of 22 patients with major vascular injury, however, revealed a statistically significant difference in survival:
    – Damage control 10/13 = 77%  (p < .02)

• Definitive repair 1/9 = 11%
Damage Control Strategy

**PART I - OR**
- Control Hemorrhage
- Control Contamination
- Intraabdominal Packing
- Temporary Closure

**PART II - ICU**
- Core Rewarming
- Correct Coagulopathy
- Maximize Hemodynamics
- Ventilatory Support
- Injury Identification

**PART III - OR**
- Pack Removal
- Definitive Repairs
Damage Control – When?

- Patient too sick – Altered Physiology
  - Hemorrhage induced- lethal triad
- Bowel too edematous
  - Aggressive resuscitation – too much crystalloid
  - Risk of IAH / ACS
- Second Look for diseases other than trauma
  - Mesenteric Ischemia, Severe Pancreatitis, Peritonitis
Patient Selection

**Table 5. KEY FACTORS IN PATIENT SELECTION FOR DAMAGE CONTROL**

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Complexes</th>
<th>Critical Factors</th>
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<tbody>
<tr>
<td>High-energy blunt torso trauma</td>
<td>Major abdominal vascular injury with multiple visceral injuries</td>
<td>Severe metabolic acidosis (pH &lt; 7.30)</td>
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<tr>
<td>Multiple torso penetrations</td>
<td>Multifocal or multicavitary exsanguination with concomitant visceral injuries</td>
<td>Hypothermia (temperature &lt; 35°C)</td>
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<tr>
<td>Hemodynamic instability</td>
<td>Multiregional injury with competing priorities</td>
<td>Resuscitation and operative time &gt; 90 minutes</td>
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<tr>
<td>Presenting coagulopathy and/or hypothermia</td>
<td></td>
<td>Coagulopathy as evidenced by development of nonmechanical bleeding</td>
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<td></td>
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<td>Massive transfusion (&gt; 10 units packed red blood cells)</td>
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WHAT IS PRIMARY ACS?

“Primary ACS is a condition associated with injury or disease in the abdominopelvic region that frequently requires early surgical or interventional radiological intervention.”
WHAT IS SECONDARY ACS?

“Secondary ACS refers to conditions that do not originate from the abdominopelvic region.”

Sepsis / Capillary Leak  Burns  Massive Resuscitation
Damage Control - Abdomen

- Spillage Control – Staple off bowel
- Packing for solid organ bleeding
- Ligation or shunt for vascular injury
- Temporary closure of abdomen.
Temporary Abdominal Closure

vacuum pack/ loban closure
Postoperative Management

• Resuscitation
  – Adequate oxygen delivery is the goal and is achieved with continue transfusion

  – Response monitored by observing HR, SBP, UOP, pH, serum lactate levels and correction of coagulopathy

  – Inotropic support may be necessary for those who do not respond to volume
Postoperative Management

- Pulmonary function
  - Goal is to achieve $\text{SaO}_2 > 92\%$ with $\text{FiO}_2 < 0.6$

  - Conventional volume ventilation may require high PEEP with the resulting decline in cardiac filling pressures and barotrauma

  - Pressure control ventilation can achieve oxygenation and ventilation goals with significantly reduced airway pressures
Postoperative Management

• Hemostasis
  - PBRC:FFP:Platelets = 1:1:1
  - Judicious use of fresh frozen plasma and platelets is warranted
  - Most common cause of persistent coagulopathy is surgical bleeding. Reevaluate the need to go back to the OR for bleeding control

• Normalizing temperature

• Tertiary survey
Damage Control Resuscitation in Combination With Damage Control Laparotomy: A Survival Advantage
J Trauma 2010: 69:46-52
Juan C. Duchesne, MD, Katerina Kimonis, MS, Alan B. Marr, MD, Kelly V. Rennie, MD, Georgia Wahl, MD, NREMT-P, Joel E. Wells, MS, Tareq M. Islam, MD, MPH, Peter Meade, MD, MPH, Lance Stuke, MD, MPH, James M. Barbeau, MD, JD, John P. Hunt, MD, MPH, Christopher C. Baker, MD, and Norman E. McSwain, Jr., MD

<table>
<thead>
<tr>
<th>TABLE 2. Outcomes Between Resuscitation Strategies in DCL Patients</th>
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<tbody>
<tr>
<td>Outcomes</td>
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<tr>
<td>Mean transit time to OR (min), mean (SD)</td>
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<tr>
<td>Emergency department crystalloids (L), mean (SD)</td>
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<tr>
<td>Intraoperative crystalloids (L), mean (SD)</td>
</tr>
<tr>
<td>Intraoperative PRBC (units), mean (SD)</td>
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<tr>
<td>Intraoperative FFP (units), mean (SD)</td>
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<tr>
<td>Intraoperative PLT (units), mean (SD)</td>
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<tr>
<td>Intraoperative FFP:PRBC ratios</td>
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<tr>
<td>Intraoperative PLT:PRBC ratios</td>
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The Take Back – Phase 3

- Timing
- Definitive surgical care for intra-abdominal injuries
- Many will remain with open abdomen and will require multiple take backs
Postoperative Complications

- Missed injuries
- Abdominal wound
  - Suture temporary prosthetic material to the skin vice the fascia
  - Never close under tension
- Fistula
- Infection
  - Multiple procedures results in a 12 - 67% intra-abdominal infection rate
Postoperative Complications

- Nutrition
  - Enteral nutrition preferred route of administration
- Thromboembolism prophylaxis
- Skin complications
Damage Control - Pelvic
Hemorrhage in Pelvic Fractures

- Retroperitoneal bleeding
  - Up to 4 L of blood
  - Tamponade
  - Direct surgical control usually not indicated

- Early stabilization
  - Decrease volume of pelvis
  - Reopposes bleeding surfaces
  - Clot formation
Control of Pelvic Bleeding

- Fracture reduction techniques
- Angiography
- Operative control
  - Reserved for large vessel bleeding
- Retroperitoneal packing
- Open Fractures
  - Packing, packing, packing
Fracture Reduction

- Pneumatic Antishock Garment
- Bed sheet, taping knees together
- External fixation
  - 15 minutes
  - Anterior frame, two pins in each iliac crest
  - Decreases pelvic volume, confers bony stability
  - Interference with abdominal exam, CT scan, and surgical exposure
  - Improved outcomes, decreased mortality?
  - No prospective data
Fracture Reduction

- Pelvic clamps
  - Posterior fixation
  - Greater compression posteriorly
  - Little data
Angiography

• Arterial bleeding, embolization: 10%
• APC II or III
• Criteria: no clear consensus
  – Contrast extravasation on CT
  – Continued blood loss (4U in 24 hrs, 6U in 48 hrs)
  – Hemodynamically unstable
  – Large, expanding retroperitoneal hematoma
  – Prior placement of external fixator?
Embolization as part of Damage Control
Pelvis Fractures with Hemorrhage
Pelvic Packing
Pelvic Packing
Pelvic Packing
Pelvic Packing
Open Pelvis: Pack First, Angio After
Open Pelvis: Pack First, Angio After
The “new” kid on the block
REBOA
Hypotensive (SBP < 90)
partial or non-responder

Access common femoral artery for a-line
or REBOA

No REBOA

CXR possible aortic injury?

Yes

Position REBOA in ZONE 1, inflate
and proceed to Emergent Laparotomy

Position REBOA in ZONE I and inflate

No

Pelvic xray fracture?

No

Yes

Position REBOA in ZONE III and inflate
The role of REBOA in the control of exsanguinating torso hemorrhage

Walter L. Biffl, MD, Charles J. Fox, MD, and Ernest E. Moore, MD, Denver, Colorado

Algorithm for Control of Torso Hemorrhage

Localize Hemorrhage with CXR, FAST, Pelvis X-Ray

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<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
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<tbody>
<tr>
<td>SEP</td>
<td>CPR</td>
<td>&lt;60</td>
<td>60-80</td>
<td>&gt;80</td>
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</table>

1. **Thoracic Hemorrhage**
   - EDT
   - EDT vs OR
   - OR Thoracotomy

2. **Abdominal Hemorrhage**
   - EDT
   - EDT vs REBOA
   - OR vs REBOA
   - OR Laparotomy

3. **Pelvic Hemorrhage**
   - EDT
   - REBOA vs EDT
   - REBOA
   - OR Pelvic Packing

*Figure 1. Algorithm for torso hemorrhage control. EDT, emergency department resuscitative thoracotomy.*
Conclusions

- Paradigm shift in the care of critically injured trauma patients within the last 15 years
- Elimination of acidosis, coagulopathy and hypothermia paramount to patient survival
- Multiple intensive and expensive resources required along with dedicated surgeons, nurses and ancillary personnel
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