Chapter 12

Damage Control Surgery

Introduction

Historically, the approach to the victim of severe trauma from combat wounding was surgical exploration with definitive repair of all injuries. This approach is successful when there are a limited number of injuries, the patient is not physiologically impaired, and if there are adequate resources. Extensive experience in both civilian and military trauma dictates an abbreviated surgical approach in patients with extensive injuries directed at control of hemorrhage and contamination, followed by resuscitation to normal physiology with definitive repair in a delayed fashion. This approach, termed damage control surgery (DCS), is designed to restore normal physiology prior to normal anatomy. It is well established that patients who develop the lethal triad of coagulopathy, acidosis, and hypothermia have significantly increased mortality. DCS is designed to prevent or limit the triad through rapid control of bleeding and shortened operative time.

Damage control surgery is defined as the rapid initial control of hemorrhage and contamination, temporary abdominal closure, resuscitation to normal physiology in the ICU, and subsequent reexploration and definitive repair after normal physiology has been restored. Damage control techniques can also be applied in extremity, thoracic, and head trauma.

A **decision to apply damage control should be made early**, and, in many circumstances, even before the operation is begun.

General Considerations

- Philosophy of damage control is "a live patient above all else."
  - Avoid hypothermia.

- Rapidly achieve hemostasis.
- Perform initial bowel resections without anastamosis. Control contamination and reconstruct at the second operation after the patient has been stabilized and can tolerate a prolonged operation.

- **When to employ damage control.**
  - Use damage control in patients who present with or are at risk for developing:
    - Multiple life-threatening injuries.
    - Acidosis (pH <7.25).
    - Hypothermia (temperature <34°C).
    - Shock on presentation.
    - Combined hollow viscus and vascular or vascularized organ injury.
    - Coagulopathy (INR >1.4).
    - Mass casualty situation.

The use of specific physiological criteria/lab values to determine when to employ damage control is of questionable utility because these represent borderline physiological states in which the patient may already be unsalvageable. The earlier DCS is applied in patients at risk, the better the outcomes.

- Take into account ability to control hemorrhage, severity of liver injury, and associated injuries.
- Pack **before** massive blood loss (10–15 units of packed red blood cells) has occurred.
- Injuries that typically require damage control techniques:
  - Upper abdominal injuries that are not isolated spleen injuries (duodenal, large liver injuries, pancreas, etc).
  - Penetrating pelvic injury with vascular involvement.
  - Any retroperitoneal vascular injury.

The goal of damage control is to restore normal physiology rather than normal anatomy. It is used for the multiply injured casualty, with combinations of abdominal, vascular, genitourinary, neurological, orthopaedic, and/or thoracic injury in **four separate and distinct phases.**

Phase 0 (Ground 0): Prehospital and Early Resuscitation
The emphasis of Phase 0 is the early recognition of patients who are at risk of developing the lethal triad and those in whom damage control techniques may be indicated. Phase 0 includes the following steps:

- Stop bleeding using tourniquets or direct pressure.
- If the patient has noncompressible bleeding, practice permissive hypotension.
- Rapid transfer to the medical treatment facility.
- Initiate damage control resuscitation.
- Prevent hypothermia.
- Measure blood gases.
- Rapid transfer to the OR.

Phase 1: Primary Damage Control Operation

- Control of hemorrhage.
- Exploration to determine extent of injury.
- Control of contamination.
- Therapeutic packing.
- Temporary abdominal closure.

General Points

- Control of hemorrhage.
  - Hemorrhage from blood vessels can be controlled by ligation, shunting, or repair of injured vessels as they are encountered.
  - The initial goal is hemorrhage control, not maintenance of blood flow.
  - For the patient in extremis, clamping or shunting of major vessels is recommended over repair.
    - THINK: ⇒ fasciotomy.
  - Additional methods of hemorrhage control include balloon catheter tamponade of vascular or solid viscus injuries.
- Exploration to determine extent of injury.
  - Damage control laparotomy.
    - Perform only essential resections or pack solid organs to diminish blood loss.
    - Rapidly terminate the procedure to minimize hypovolemia, hypothermia, acidosis, and coagulopathy.

        - Perform definitive reconstruction only during subsequent operation(s) after the patient has stabilized and can tolerate a prolonged operation.
    - Assessment and stabilization/external fixation of major extremity and pelvic fractures.
        - Including vascular injuries and fasciotomy.
- Control of contamination.
    - Contamination control also proceeds as injuries are encountered, utilizing clamps, primary repair, or resection without reanastomosis.
    - With multiple enterotomies, if the area of injury represents <50% of the length of the small bowel, a single resection can be undertaken.
- Temporary packing.
    - Temporary packing provides tamponade of liver, pelvic, and retroperitoneal bleeding.
    - Do not use the "pack-and-peek" technique. Once packed and bleeding controlled, leave alone until second-look operation.
    - Definitive packing is based on two basic principles:
        - Pressure stops bleeding.
        - Pressure vectors should re-create tissue planes (attempt to re-create the pressure vectors created by the capsule of a solid organ or fill the space of that organ, not random pack placement).
    - Laparotomy pads are the best commonly available packing material.
    - An intervening layer—such as a bowel bag, sterile drape, absorbable mesh, or omentum—can be placed between packs and the tissue to aid in easy pack removal at relaparotomy.
- Temporary abdominal closure.
    - Multiple techniques employed:
        - Bogotá bag—sterile IV bag (3 liters) sewn to skin.
        - Vacuum pack—constructed from available materials in OR (see next page) and therefore commonly used in current combat casualties.
        - Wound VAC—commercial device not universally available in deployed setting.

- ♦ Towel clip closure—of historical interest only; NOT RECOMMENDED because there is a high incidence of associated abdominal compartment syndrome (ACS).

- o Key concepts for temporary abdominal closure.
  - ♦ Must have a nonadherent layer (eg, IV bag, sterile X-ray cover, Mayo stand cover, bowel bag) on top of the bowel and tucked under the peritoneum as far lateral as possible.
  - ♦ Perforate or "pie crust" the above layer prior to placement to allow fluid to drain out.
  - ♦ Adequate drainage tubes (eg, chest tube, Jackson-Pratt) that are interposed between gauze or towels and brought out through the top of the wound.
  - ♦ Water-tight seal over the top adherent to the skin.
  - ♦ Do not sew to the fascia.
  - ♦ Use adequate sedation.
  - ♦ Be aware that ACS can occur even if the abdomen is left open.
- o The vacuum pack technique (easy, keeps patient dry, allows for expansion):
  - ♦ With fascia open, place an OR towel that is fully plastic-covered with a bowel bag, X-ray cassette bag, or Ioban drape, etc, well under the peritoneum to cover the viscera. Place a small number of central perforations to allow fluid to egress to the drains. Alternatively, place a sterile, nonadherent, perforated plastic drape (as above) completely over the viscera and under the peritoneum and cover this with a sterile OR towel.
  - ♦ Place closed-suction drains (Jackson-Pratt, modified Foley, small chest tube) above the towel at the level of the subcutaneous tissue brought out through separate stab wounds or the inferior or superior portion of the wound.
  - ♦ Place lap sponges or another sterile towel to fill in the wound and sandwich the drain(s).
  - ♦ Cover the entire wound with a large sticky (Ioban) drape.
  - ♦ Place drains on low suction.
- o Skin closure is not recommended.

Phase 2: Critical Care

- Physiological support in the post-op DCS patient is paramount to survival.
  - **Core rewarming**: Warmed resuscitative fluids, blankets, ventilator air, and environment, or commercially available products, such as Bair Hugger, ChillBuster.
  - **Reversal of acidosis**: Appropriate resuscitation with blood products, colloids, and/or crystalloid.
  - **Reversal of coagulopathy**: Factor replacement.
  - **Ventilatory support: Using ARDSNet low tidal volume support avoiding barotrauma.**
  - **Injury identification**: Perform a tertiary survey of the patient, obtain CT scans and angiography as indicated.
  - **Monitor for ACS (see below).**
- ACS.
  - ACS is a condition in which **increased intraabdominal pressure adversely affects the circulation/ventilation, and threatens the function and viability of the viscera**.
  - Measurement is performed using urinary bladder pressure (normal = 0).
    - Measurement of bladder pressure is a good variable to test and follow; however, intervention for ACS should occur when suspected or clinically indicated.
  - Occurs in abdominal trauma accompanied by visceral swelling, hematoma, or abdominal pack use.
  - Physiology of ACS.
    - Cardiac output and venous return are decreased.
    - Reduction in blood flow to the liver, intestines, and kidneys can result in anuria.
    - The two hemidiaphragms push upward, decreasing thoracic volume and compliance leading to elevated peak airway pressures.
    - Central venous, pulmonary capillary wedge, and right atrial pressures increase with intraabdominal pressure (can lead to false pulmonary artery catheter pressures).
    - PO_2 is decreased due to increases in airway pressures and ventilation/perfusion abnormalities that worsen with positive end-expiratory pressure.

Abdominal Pressure	Degree of Elevation	Clinical Effect
10–20 mm Hg	Mild	Insignificant
20–30 mm Hg	Moderate	Oliguria and organ dysfunction
>30 mm Hg	Severe	Requires immediate attention

Phase 3: Planned Reoperation

- Packs should be left in place until the patient's hemodynamics are stable and all major sites of hemorrhage have had time to clot. When removed, packs should be taken out slowly with plans for vascular control.
- Reoperation should be scheduled when the probability of achieving definitive organ repair and complete fascial closure are highest, although an estimation that the fascia cannot be closed should not preclude initial reexploration(s).
- Reexploration must occur after correction of hypotension, acidosis, hypothermia, and coagulopathy. It typically occurs 24–48 hours following the initial operation.
- Timing can, however, be dictated by other pressing clinical concerns, such as ACS, limb ischemia, and suboptimal control of spillage at primary operation.
- In cases of a packed and drained duodenum, pancreas, kidney, bladder, or liver injuries with gross bowel contamination, packs should be retrieved within 36–48 hours.
- **This surgery may occur (and in many cases should occur) at the next echelon of care.**
  - STRATEVAC (strategic evacuation) should be weighed carefully because surgery is not available in transit.

Conduct of Relaparotomy

- It is to be presumed that injuries were unrecognized.
- **A complete exploration must be performed.**
- Feeding tube placement, either transabdominal or nasoenteric, should be performed at this time.
- Repacking may be reemployed if other measures fail to control hemorrhage.
- Radiographic images should be obtained that visualize nipples to mid-thigh to ensure that all packs have been removed from the abdomen.

- Sponge counts are unreliable in this situation.

- **Unplanned reexploration.**
  - Emergent, unplanned reexploration should be considered in any patient who remains unstable, persistently coagulopathic, or acidotic despite continued resuscitation or evidence of ACS.

Damage Control in the Chest

Thoracic Injuries

- **The goal of abbreviated thoracotomy is to stop the bleeding and restore a survivable physiology; contamination is usually not a problem.**
- In the exsanguinating patient, nonanatomical wedge resection to rapidly achieve hemostasis and control of air leaks using a large stapler is preferred over formal lung resection.
- In pulmonary tractotomy, the lung bridging the wound tract is opened between long clamps or with a linear stapler allowing direct inspection and selective control of bleeding points and air leaks.
- Great vessel injuries can be temporized with intraluminal shunts or Fogarty balloons to achieve distal control in inaccessible areas.
- Tracheal injury can be temporized with airway control placed through the site of injury.
- Extensive bronchial repairs are not feasible in the patient in extremis; therefore, rapid resection of the affected lobe would be best.
- When dealing with esophageal injury, diversion and wide drainage, not definitive repair, are the best initial courses of action.
- A single layer en masse suture closure of the chest wall should be used.

For Clinical Practice Guidelines, go to
http://usaisr.amedd.army.mil/clinical_practice_guidelines.html