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DAMAGE CONTROL SURGERY AND RESUSCITATION

Figure 1. LEFT: Large wound resulting from GSW of the thigh *(ICRC)*

Figure 2. FAR LEFT: Displaced femur fracture following GSW to the thigh *(ICRC)*

SCENARIO

A 25-year-old man presents with a gunshot wound to the medial thigh. There is an obvious open fracture of the shaft of the femur, and no distal pulses. The time of the injury is unclear, but at least two hours and perhaps four hours have passed.

» **Which injury should be addressed first?**
» **Should a shunt be placed or definitive vascular repair be attempted?**
» **Does the patient require fasciotomies?**

TYPE 1

- Avoid hypothermia by removing wet clothing, applying cloth or heat blankets.
- Cover the head or scalp, especially in children
- Gain haemostasis of life threating bleeding with pressure. Consider a tourniquet ***if a transfer to a higher level of care is feasible***

TYPE 2

- All fluids contacting the patient should be warmed to 39-42 °C.
- Any air conditioning should be turned off for trauma patients.
- On table warming should be used if possible to avoid hypothermia.

TYPE 3

- Prepare to accept complex patients from type 1 and type 2 teams
- This will likely include undertaking completion and reconstruction of damage control procedures done to avoid loss of life and limb at type 2 facilities.

KEY POINT

» **All trauma patients must have a full primary and secondary survey to ensure all injuries are identified. The physiology of the patient as a whole must be managed and not just the anatomical aspects of the injuries.**

PRINCIPLES
OF DAMAGE CONTROL SURGERY AND RESUSCITATION

The principles of damage control surgery and resuscitation listed below are of tantamount importance for the care of the patient who is hypothermic, coagulopathic, acidotic, and resistant to fluid resuscitation. The goal is to minimize surgery by performing rapid control of hemorrhage and ongoing contamination. Once these goals are achieved, surgery is stopped to allow for physiologic recovery through resuscitation and intensive care with anatomical correction of injuries to be addressed later.

In its essence, damage control surgery is surgery with the goal of maintaining physiology compatible with life. Successful practice requires constant communication between the surgeon and anesthetist in order to:

- Minimize time to surgery and time on the operating table
- Limit the early use of crystalloids for resuscitation and use blood products if available
- Utilize permissive hypotension, particularly in victims of penetrating trauma
- Manage coagulopathy using tranexamic acid if necessary and appropriate
- Prevent and manage hypothermia
- Reduce contamination
- Improve oxygenation

KEY POINT

- Tranexamic acid (TXA) has been shown to reduce all cause mortality in bleeding trauma patients with, or at risk for, life-threatening hemorrhage.
- The medication should be given only in patients whose injury occurred within 3 hours of evaluation.
- Type 1 institutions must be aware of these constraints if administering TXA to patients with plans to transfer patients to a type 2 or 3 facility, and should ensure that the receiving facility knows TXA has been administered and when.

SPECIAL CONTEXTS

Damage control principles are applied for two reasons:

1. Individual patient considerations (above)
2. In Mass Casuality Incidents, SODs, conflicts and austere environments, due to triage considerations and unavailability of definitive care.

Sudden Onset Disasters

During disasters patients receive their injuries largely as part of a single event. EMT type 2 and 3 teams do not arrive until days later.

Many patients with severe head, thorax, and abdominal injuries have died or been dealt with by local actors on the ground. However, damage control principles can still apply to preserve limbs and spare patients the life long burdens of an amputation.

Figure 3. Severe open tibial fracture requiring rapid decision making regarding limb salvage. *(Bar-On)*

PAEDIATRIC CONSIDERATIONS

Prediction of the need for damage control surgery can be difficult but is guided by clinical signs and laboratory values. Paediatric vital signs differ from those of adults, and children must be considered as a distinct patient population when making patient triage decisions.

VITAL SIGN	INFANT		CHILD		TEEN
age	0-6 months	6-12 months	1-5 years	6-11 years	12 years and up
heart rate	100-160 bpm		70-120 bpm		60-100 bpm
respirations	30-60 breaths/m	24-30 breaths/m	20-30 breaths/m	12-20 breaths/m	12-18 breaths/m
blood pressure	65-90/45-65 mmHg	80-100/55-65 mmHg	90-110/55-75 mmHg		110-135/65-85 mmHg
temperature	37˚C		37˚C		37˚C

Table 1. Reference for the assessment of paediatric vital signs.

SPECIAL CONTEXTS

CONFLICT

EMTs caring for patients in situations of conflict are more likely to receive patients soon after injury allowing for intervention in life threatening injuries to the head, neck, thorax, and abdomen.

The limb surgeon must apply damage control principles to remove contaminated tissue, temporarily stabilize bones, and restore circulation to muscular compartments. In these contexts, the two surgeons and the anesthetist must carefully coordinate care in order to act in the best interests of the patient given the available resources.

RESUSCITATION/TRANSFUSION

The use of crystalloids/colloids should be limited. Transfusion capability requires standard pathology services and should be based on the clinical picture rather than hemoglobin level alone. Patients in disaster prone areas may be affected by chronic anemia due to malnutrition, malaria or helminth infection.

Access to blood products will require family blood donation or a "walking blood bank." Blood banking in disasters and conflict requires significant planning in order to acquire, use, and store blood products safely.

SPECIAL CONTEXT
WHOLE BLOOD TRANSFUSION

- The "walking blood bank (WBB)" has gained popularity during recent conflicts with deployed militaries who transfuse whole blood from healthy or "walking wounded" soldiers to injured soldiers or civilians requiring massive transfusion.
- EMT standards require all type 2 and type 3 EMTs to be able to safely test and transfuse whole blood in emergencies. (*See Page 32*)

DIAGNOSIS OF PELVIC FRACTURES

A significant amount of energy is required to fracture a human pelvis, therefore suspicion should be high for additional injuries. All trauma patients must receive a primary survey (Airway, Breathing, Circulation) no matter how impressive or distracting their presenting injuries.
Pelvic fractures of hemodynamic significance can often be clinically diagnosed.

- Palpate the entire pelvic brim to identify an intact edge, tenderness over the sacroiliac joints or gaps at the pubic symphysis
- Radiographs, if available, can help. It is important to look at the width of the sacroiliac joints bilaterally
- Rectal examination is a vital part of the assessment of a pelvic fracture. Blood on the gloves indicates an intestinal injury.
- Look for bruising over the pelvis and around the scrotum in men
- Pelvic compression can identify fractures that show no obvious signs of fracture

PITFALL

Heat sensitive paper for haemoglobin testing will "self-develop" in hot environments

PITFALL

DO NOT test for stability of the pelvis when a pelvic fracture is suspected by palpation.

Figure 4. Picture demonstrating scrotal bruising denoting bleeding from a pelvic fracture. An external fixation frame can be viewed at the top of the image. *(E. de Loos)*

DIAGNOSIS AND MANAGEMENT

Pelvic fractures can present a diagnostic and management challenge for EMTs in austere environments. Treatment options available may differ significantly based on the resources available. These injuries are frequently associated with life-threatening venous bleeding or injuries to internal viscera.

TYPE 1

- Pelvic binders are the optimal initial management for suspected pelvic ring disruption.
- If a urethral injury is suspected the patient should be immediately transferred to an EMT type 2 available.
  - » If transfer time will be long then **gentle** placement of a urinary catheter should be undertaken.
  - » If passage is difficult do not proceed, a suprapubic catheter may be required.

TYPE 2

TYPE 3

- Type 2 EMTs should evaluate pelvic fractures with plain radiographs of the pelvis.
- Pelvic binders can be maintained as a treatment option when the injury is not life threatening.
- Be aware of pressure sores underneath binders left in place for prolonged periods.
- If the binder cannot be removed without hypotension, then an anterior frame should be placed. This may require transfer.

PITFALL

- While pelvic binders may cause further displacement in central fracture and dislocation of the hip. They are more likely to help than cause harm.
- Pelvic binders must be centered on the greater trochanters, they are commonly applied too high.

Figure 5. Correctly placed pelvic binder. Note the urethral bleeding denoting a urethral injury

(E. de Loos)

PLACEMENT OF ANTERIOR FRAMES FOR PELVIC FRACTURES

- Anterior frames are generally placed with C-arm imaging control in the operating room. Single supraacetabular pins are preferred but require radiologic control.
- Pins can be placed in the sub-crystal plane but, in an austere environment this adds little beyond a pelvic binder.
- If C-arm imaging is not available, iliac crest pins are viable but have a higher rate of infection, and make for a more problematic frame. This type of frame can make sitting difficult and limit abdominal access for concomitant intra-abdominal injury.
- If C arm imaging is available, bilateral supraacetabular pins are the preferred method of external fixation placement.
- At the type 3 EMT definitive surgery may be possible if proper expertise becomes available or the situation on the ground improves or stabilizes.

PITFALL

- Plating of the pelvis is not acceptable treatment in a tent or during response to a sudden onset disaster.
- When placing the anterior frame, ensure that space is left between the skin blocks and bars to allow for post-operative abdominal distension and abdominal access.
- Patients with open pelvic fractures carry a mortality rate of 50%.

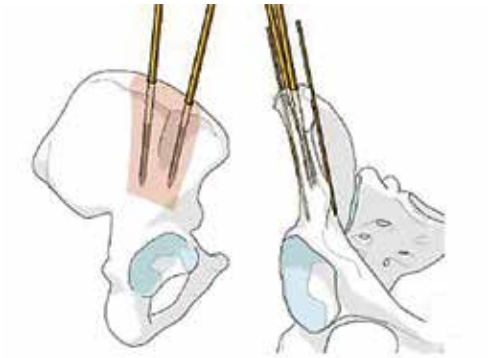

Figure 6. Proper placement of pins in the iliac crest.
(AO Foundation, Switzerland)

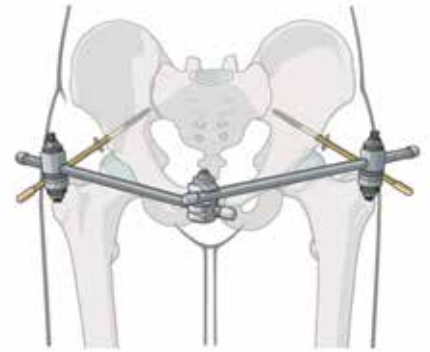

Figure 7. A line diagram denoting the proper placement of Schanz screws for external fixation.
(AO Foundation, Switzerland)

SUGGESTED RESOURCES

1. Nott D. What Can I Do Here? Understanding Your Working Environment. Orthopaedic Trauma in the Austere Environment: Springer; 2016: 13-21.
2. Nott D, Veen H, Matthew P. Damage control in the austere environment. *The Bulletin of the Royal College of Surgeons of England* 2014; **96**(3): 82-3.
3. Repine TB, Perkins JG, Kauvar DS, Blackborne L. The use of fresh whole blood in massive transfusion. *Journal of Trauma and Acute Care Surgery* 2006; **60**(6): S59-S69.

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2. Lebel E, Blumberg N, Gill A, Merin O, Gelfond R, Bar-On E. External fixator frames as interim damage control for limb injuries: experience in the 2010 Haiti earthquake. *Journal of Trauma and Acute Care Surgery* 2011; 71(6): E128-E31.
3. Giannou C, Baldan M. War surgery: Working with limited resources in armed conflict and other situations of violence, Volume 2. Geneva: International Committee of the Red Cross; 2013.
4. Lennquist S. Management of major accidents and disasters: an important responsibility for the trauma surgeons. *Journal of Trauma and Acute Care Surgery* 2007; **62**(6): 1321-9.
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6. World Health Organization. Safe Blood and Blood Products: Guidelines and Principles for Safe Blood Transfusion Practice. http://www.who.int/bloodsafety/transfusion_services/Introductory_module.pdf. Accessed 21 November 2016. 2009.

EMT Website: https://extranet.who.int/emt/page/home
AO/ICRC/WHO Training Resources: http://www.aofoundation.org/icrc