Management of Crush & Blast Injuries to the Extremities

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*I have no financial interests to disclose with regard to this subject or the contents of the presentation.*
Objectives

- Demonstrate the principles of management of a trauma patient with Orthopedic related injuries.
- To understand, identify, and properly manage blast injuries of an extremity.
- To understand, identify, and properly manage crush injuries of an extremity with concurrent systemic and soft tissue complications.

*Some images may be graphic*
Picture yourself…

- You are the PA with an Army unit who’s on foot patrol performing perimeter sweeps when all of a sudden, an IED explodes
First things first...

- How do you respond?
KEEP CALM AND CHECK YOUR PULSE

- Relay on training and experience
- Tactile Casualty Care Combat (TCCC)
TCCC: Care Under Fire Guidelines

1. Return fire and take cover.

2. Direct or expect casualty to remain engaged as combatant if appropriate.

3. Direct casualty to move to cover and apply self-aid if able.

4. Try to keep the casualty from sustaining additional wounds,

5. If needed, move casualty to safety.

6. **Stop life-threatening external hemorrhage (tourniquet)**

7. Airway management usually deferred until next phase.
Priorities: MARCH
Tactical Field Care

• Massive Hemorrhage: control life threatening bleeding
• Airway: establish and maintain patient airway
• Respiration: decompress suspected tension PTX, seal open chest wounds, and support ventilation/oxygenation as required
• Circulation: establish IV/IO access, fluids to treat shock
• Head Injury/Hypothermia:
  • prevent/treat hypotension and hypoxia to prevent worsening of brain injury
  • prevent/treat hypothermia
Other considerations..

- What equipment do you have with you?
  - M: Tourniquets, Combat Gauze/QuickClot
  - A: Airway: Jaw Thrust, NPA, OPA, ET
  - R: Occlusive dressing, Needle
  - C: IV Access, IO, Hextend, LR
  - H: Blanket
  - Splints, Pelvic Binder or PASG
  - Pain Control: Combat Pill Pack
    - Mobic, Tylenol, Abx, TXA?
- Evacuation options? Timing?
Secondary Survey (Hospital)

- History
  - Mechanism of Injury
  - Environment
  - Preinjury Status & Predisposing Factors
  - Prehospital observations and care, timing

- Physical Exam: Head to toe exam
  - Assess: Skin, Neuromuscular Function, Circulatory Status, Skeletal & Ligamentous Injury
  - Look & Ask, Palpate, Distal Pulses, X-Ray
Ortho Exam

- Inspect & Assess: Skin, Neuromuscular Function, Circulatory Status, Open Wounds, Contamination, Open Fractures
- Eval extremity for vascular status
- Detailed motor and sensory exam before any intervention
- XR: at least 2 views of long bone along with joint above and below
- Prophylactic ABX & Tetanus status
- Removal any gross contamination/irrigation
- Reduction, if indicated, & splint before taken to OR
- OR for operative debridement & stabilization
Blast Injuries
Blast Injury Types

- **Primary:** Direct effect of blast wave
  - MC in air-filled organs due to pressure changes
  - Middle Ear, Lungs, GI Tract

- **Secondary:** Objects strike individual
  - Fragments (nails, glass, metal)

- **Tertiary:** Individual strikes objects
  - Blunt trauma

- **Quaternary:** Burns, Infections, Crush Injuries, Delayed Collapse
Umbrella Effect

- Soft tissues, vessels, and nerves are stripped from the bone.

- Resulting in a more proximal injury than may be clinically apparent and requires a reasoned approach to amputation.
Blast Injury Work Up

- MARCH, Secondary Survey
- Systematic MSK, Neuro, Vascular exam for each extremity
- Open Wounds: document size, exposed bone, type of contamination, ideally photographed
- Radiologic exam: ID bony injury & foreign bodies
Blast Injury Management

- Open fractures = contaminated
  - Early ABX (1\textsuperscript{st} gen Cephalosporin &/or Aminoglycocide, extended spectrum PCN)

- Contaminated wounds
  - Remove gross contamination
  - Copiously irrigated with sterile saline
  - Dress w/ moist to dry sponges until taken to OR*

- Tetanus Prophylaxis

- Splint Extremity Fractures
Surgical Management

- Initial debridement
  - Aggressive debridement of necrotic and contaminated tissue
  - Low pressure pulse lavage

- Bony Stabilization: External Fixator

- Soft Tissue: Wound Vac

- Repeat Debridements q24-72h

- Permanent Fixation of fractures

- Soft Tissue Reconstruction: Flaps/Grafts (Plastic Surgery)
Crush Injuries
Crush Injuries

- MARCH, Secondary Survey
- Time since injury (Pre-hospital phase)
- Systematic MSK, Neuro, Vascular exam for each extremity
- Document Exams, Photographs, XR
- Gross Decon, Irrigate, Cover, Splint
- Surgical Management
  - Serial Irrigation & Debridements
  - Bony Stabilization (External Fixator)
  - Soft tissue coverage (Wound Vacuum)
Crush Syndrome

• Crush injury: compression of extremities that causes muscle swelling &/or neurologic disturbances
  • Most Common: Lower Extremities

• Crush Syndrome: localized crush injury with systematic manifestations
  • Traumatic rhabdomyolysis (muscle breakdown) releases toxic muscle cell components and electrolytes into circulatory system
Crush Syndrome

- Clinical Presentation
  - Hypotension
  - Renal Failure
  - Hypocalcemia
  - Hyperkalemia
  - Metabolic Acidosis
  - Cardiac arrhythmias/arrest due to K & Ca imbalance
Crush Syndrome Tx

- Prehospital
  - Administer IV fluids before releasing crushed body part or consider Tourniquet until IV initiated

- Hypotension: IV up to 1.5L/h

- Renal Failure: Hydration via IV & Mannitol to maintain diuresis (Hemodialysis prn)

- Metabolic Abnormalities
  - Acidosis: alkalization of urine = critical (Sodium Bicarb)
  - Hyperkalemia/Hypocalcemia: Ca Gluconate or Ca Cl

- Monitor for Compartment Syndrome
Compartment Syndrome

- May occur in any site in which muscle is contained within a closed fascial space
  - Tibial & Forearm Fractures
  - Crush injury to muscle
  - Tight dressings/cast, excessive exercise

- Develops when pressure within the osteofascial compartment of muscle causes ischemia & subsequent necrosis
Compartment Syndrome S/Sx

- 5 P’s: Pain, Pallor, Paresthesia, Pulselessness, Paralysis
  - #1: Pain out of proportion to exam, increases by passive stretching of involved muscles
  - Pallor: pale color
  - Paresthesia: sensation/functional loss of nerves that transverse involved compartment
  - Palpable, tense swelling of involved region
  - Peripheral pulses: can be present
    - If absent = Late sign
  - Paralysis of involved compartment (late sign)
Timing of Crush Injury…

- Documentation of time from the prehospital phase to the hospital phase is **CRITICAL!!!**

- New Research Suggests:
  - Closed injury & presents >8h after injury:
    - Fasciotomy may not be needed
    - Muscle is already necrotic
    - Increase risk of infection, surgical complications

- Joints splinted in functional positive and ROM started ASAP
  - Avoids contractures and paralysis
Compartment Syndrome

- Compartment Pressure Monitor (unconscious patients)
- Inadequate perfusion/relative ischemia when tissues pressure rises to within 10-30 mm Hg of the diastolic BP
Compartment Syndrome

- Treatment: Fasciotomy of affected compartments*
Wrap Up:

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References


