Extremity Trauma

William Schecter, MD
Approach to the Evaluation of the Patient with an Extremity Injury

- Blood Supply
- Skeleton
- Neurologic Function
- Risk for Compartment Syndrome?
- Coverage (Skin and Soft Tissue)
History

- Height
- Weight
- Handedness
- Occupation
- Avocations
- MECHANISM OF INJURY
Skin and Soft Tissue

Tidy vs Untidy Injury
Tidy Injury

- Clean cut
- No necrosis
- No dirt or grease ground into soft tissues

http://www.arenbe.org/pics/hand.html
Untidy Injury

- Extensive loss of or damage to soft tissue
- Skin or soft tissue necrosis
- Poor blood supply

http://www.trauma.org/imagebank/imagebank.html
Options for Skin and Soft Tissue Coverage

• Primary Closure
• Delayed Primary Closure
• Closure by Secondary Intention
• Skin Graft
• Flap
  – Random
  – Pedicle
  – Myocutaneous
  – Free
Arterial Supply of Upper Extremity

http://education.yahoo.com/reference/gray/213.html#36
Arterial Supply of Lower Extremity

http://education.yahoo.com/reference/gray/213.html#36
Evaluation of Arterial Inflow

• The 5 P’s
  – Pulse
  – Pallor ?
  – Pain ?
  – Perfusion ?
  – Paresthesia ?

• Doppler
  – Ankle-Brachial Index

• Duplex U/S exam

• Angiogram
How to Record the Vascular Exam

<table>
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<tr>
<th>Car</th>
<th>SC</th>
<th>Ax</th>
<th>Rad</th>
<th>Ao</th>
<th>Fem</th>
<th>Pop</th>
<th>DP</th>
<th>PT</th>
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<td>2+</td>
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Scale: 2+ normal, 1+ diminished, 0 absent

Listen for bruits over the carotid, renal, iliac and femoral arteries record their presence or absence

Listen for bruits over penetrating wounds to identify A-V fistulas
Ankle Brachial Index for Lower Extremity Injuries

<table>
<thead>
<tr>
<th></th>
<th>Dorsalis Pedis Pressure</th>
<th>Brachial Pressure</th>
<th>Ankle/Brachial Index = Pedal Pressure/ Brachial Pressure</th>
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<tbody>
<tr>
<td>Left</td>
<td>110</td>
<td>100</td>
<td>1.1</td>
</tr>
<tr>
<td>Right</td>
<td>110</td>
<td>100</td>
<td>1.1</td>
</tr>
</tbody>
</table>

0.9 or greater acceptable
Indications for further study and/or surgical exploration

- The 5 P’s
- Hematoma at sight of penetrating injury
- Auscultable bruit
- Diminished Pulse or Decreased ABI
- Penetrating Injury near major vessel
Duplex Ultrasound of false aneurysm, femoral artery

Picture provided by Samuel Zhou, Burnley General Hospital, Burnley, United Kingdom

Indications for Angiography after Trauma

• Possible Vascular Injury, situation unclear after vascular exam, ABI, and/or duplex U/S

• Proximal and/or Distal Control likely to be a problem during surgery

• Stent procedure being considered as definitive treatment
Venous Drainage of Extremities

http://education.yahoo.com/reference/gray/213.html#36
Prevention of Impaired Venous Drainage

• No tourniquets
• Elevate the Leg or Arm
• **NO TIGHT DRESSINGS!!!!!**
• If extremity is swollen and tissues tense to palpation, consider the possibility of compartment syndrome
Neurologic Evaluation of Upper Extremity

- The brachial plexus terminates in 3 nerves: median, ulnar and radial nerves.

http://education.yahoo.com/reference/gray/213.html#36
Examination of Median Nerve

Median nerve

• Sensory Exam: Radial aspect of volar finger 4 and digits 1-3, dorsal fingers 1-3 to level of PIP joint

• Motor exam: Opposition of thumb to digit 4

http://education.yahoo.com/reference/gray/210.html#79
Examination of Ulnar Nerve

Ulnar nerve

- Sensory Exam: Ulnar aspect of volar digit 4 and volar digit 5, dorsum of hand and dorsal fingers 4 and 5

- Motor Exam: Abduction and Adduction of fingers (interosseous muscles), Adduct digit 2 against resistance and palpate 1st Dorsal Interosseous Muscle next to 2nd metacarpal bone

http://education.yahoo.com/reference/gray/213.html#36
Examination of Radial nerve

- Radial Nerve
  - Sensory Exam: Radial aspect of dorsal hand
  - Motor exam: Extend wrist, thumb and fingers

http://education.yahoo.com/reference/gray/213.html#36
Innervation of Lower Extremity

Femoral Nerve
Innervates anterior And medial thigh

Tibial Nerve
(branch of Sciatic nerve)
innervates Plantar and dorsal aspect Of foot

http://education.yahoo.com/reference/gray/213.html#36
Innervation of Foot

Common Peroneal Nerve
  Superficial Peroneal Nerve, (innervates dorsum Of foot)

Deep Peroneal Nerve
  Innervates skin
  Between toes 1 and 2

Sural Nerve (innervates Skin of lateral foot)

http://education.yahoo.com/reference/gray/213.html#36
Clinical Significance

- Peroneal Nerve Injury: Weak or absent foot dorsiflexion
- Anterior Compartment Syndrome: 1st sign is numbness or paresthesia in webspace between 1st and 2nd toes
Goal of Treatment of Skeletal Injury

Stable Soft Tissue Coverage
Intact nerve and blood supply
Anatomic reduction of bone fragments
Stable internal fixation
Full range of motion of joints
Absence of infection
Pain free fully mobile and functional patient
Skeletal Injury

Closed Fracture

Reduce Fracture if necessary

Fix Fracture reduction to maintain alignment

Elevate, observe for compartment syndrome

Open Fracture

Irrigate and Debride wound
Reduce Fracture Fragments
Hold Alignment with External Fixation

Definitive Closure when wound clean
Options for Stabilization of the Skeleton

- Splint
- Cast
- Traction
- External Fixation
- Internal Fixation
Splint/Cast for Immobilization and External Fixation

• NO CIRCUMFERENTIAL DRESSINGS in significant extremity trauma until swelling has subsided
• Splints and casts MUST be WELL PADDDED to avoid pressure sores
Traction

• Used to reduce, align and immobilize fracture
• Previously used as definitive treatment
• Currently used in most patients as temporary immobilization until internal fixation
External Fixation

http://www.emedicine.com/plastic/topic199.htm
Internal Fixation of Fractures

ORIF of Ankle Fracture

Internal Fixation
Midshaft Fracture of Femur
Compartment Syndrome

- Elevation of pressure within a closed anatomic space resulting in decreased perfusion of the soft tissues located within that space.
- Examples of compartments
  - Skull
  - Abdomen
  - Extremity
    - Cast
    - Circumferential dressing
  - Burn eschar
  - Skin
  - fascia
Treatment of Compartment Syndrome: Release of Pressure

- Skull – Craniectomy
- Cast – Splitting the cast and cast padding
- Burn – Escharotomy
- Skin – Incision
- Fascia – Fasciotomy
Anterior Compartment

- Contains the Tibialis Anterior Muscle, the Extensor hallucis muscle, Extensor Digitorum, the Tibial artery and the Deep Tibial Nerve (which innervates the space between the 1st and 2nd toes)

- Pain on dorsiflexion of foot and numbness between 1st and 2nd toes

http://www.bartleby.com/107/129.html
Superficial and Deep Posterior Compartments

- Tibialis anterior
- Extensor digitorum longus
- Soleus muscle
- Gastrocnemius muscle
- Tibia
- Fibula

Measure compartment pressure

- A compartment pressure above 30 mm Hg requires decompression
Significant Extremity Injury

- THINK: Compartment Syndrome
- No circumferential tight dressings
- Elevate Extremities
- Palpate compartments
- Evaluate neurovascular status of the limb
  - REMEMBER: an absent pulse is the last physical finding
  - Search for hypesthesia and pain on motion
- Measure compartment pressures
- Timely fasciotomy is an emergency procedure!!!
The Mangled Extremity

Reconstruction vs. Amputation?
The Mangled Extremity Score

<table>
<thead>
<tr>
<th>Type</th>
<th>Characteristics</th>
<th>Injuries</th>
<th>Points</th>
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<tbody>
<tr>
<td>Skeletal/Soft Tissue Group</td>
<td>Low energy</td>
<td>Stab wound, simple fracture</td>
<td>1</td>
</tr>
<tr>
<td>2&amp;1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Medium energy</td>
<td>Open or multiple-level fractures, dislocations,</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>moderate crush injuries</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>High energy</td>
<td>Crush, Explosion, High speed</td>
<td>3-4</td>
</tr>
<tr>
<td></td>
<td>Crush</td>
<td></td>
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# Mangled Extremity Score

<table>
<thead>
<tr>
<th>Shock Group</th>
<th>Points</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Normotensive</strong></td>
<td>0</td>
<td>BP stable in field and in OR</td>
</tr>
<tr>
<td><strong>Transient Hypotension</strong></td>
<td>1</td>
<td>Initial BP low but responds to fluids</td>
</tr>
<tr>
<td><strong>Prolonged Hypotension</strong></td>
<td>2</td>
<td>BP &lt; 90 mm Hg in field responds to fluids only in OR</td>
</tr>
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</table>
# Mangled Extremity Severity Score

<table>
<thead>
<tr>
<th>Ischemia Score</th>
<th>Description</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>None</strong></td>
<td>Pulsatile Limb, no ischemia</td>
<td>0</td>
</tr>
<tr>
<td><strong>Mild</strong></td>
<td>Diminished Pulses</td>
<td>1</td>
</tr>
<tr>
<td><strong>Moderate</strong></td>
<td>No pulse or Doppler Signal, Sluggish capillary refill</td>
<td>2</td>
</tr>
<tr>
<td><strong>Severe</strong></td>
<td>Pulseless cool paralyzed Extremity no capillary refill</td>
<td>3</td>
</tr>
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</table>
Mangled Extremity Severity Score

A MESS ≥ 7 associated with 100% incidence of amputation
Mangled Hand

http://www.eatonhand.com/complic/figures/crush.htm
Crushed Leg

Jean Dominique de Larrey
Clinical Approach to the Patient with an Extremity Injury

• Primary Survey
  – Airway
  – Breathing
  – Circulation STOP EXTERNAL HEMORRHAGE
  – Disability
  – Exposure/Environment

• REMEMBER – Unless the patient is exsanguinating, the Extremity Injury which looks impressive will not threaten the patient's life immediately. Rule out life threatening injuries first!!!!
Secondary Survey

Detailed Examination of extremities

- Palpate all extremities
- Examine and RECORD all pulses
- Do a careful sensory exam of all 4 extremities.
  - RECORD results
- Do a careful motor exam of all 4 extremities.
  - RECORD results
- If pulse absent distal to a fracture, carefully reduce fracture by gentle in line traction.
  - RECORD pulse status and neuro status after reduction of fracture

Immobilize and Elevate Extremity
Care of Extremity Injuries

Open fracture
- Wound toilet and debridement in OR – ASAP
- Antibiotics –
- Delayed wound closure –
- R/O Compartment Syndrome

Complex Injuries may require vascular, peripheral nerve as well as orthopedic and soft tissue reconstructive surgery. A team leader is essential.