Chapter 28
Musculoskeletal Trauma

Objectives

- Describe the features of each classification of musculoskeletal injury
- Describe the features of bursitis, tendonitis, and arthritis
- Given a scenario, outline prehospital assessment of the musculoskeletal system
- Outline general principles of splinting

Objectives

- Describe the significance and management principles for:
  - Upper extremity injuries
  - Lower extremity injuries
  - Open fractures
  - Angular fractures
  - Dislocations
- Outline the process for referral of patients with minor musculoskeletal injury

Scenario

You respond to a soccer field for an “accidental injury.” Your patient is a 33-year old male who is complaining of severe right ankle pain. You note gross angulation and deformity of the ankle and carefully remove his shoe to assess his distal circulation. Your examination reveals that there is almost no perfusion to his foot.

Discussion

- What exam findings would lead you to believe that perfusion to the extremity is poor?
- Describe actions that should be taken immediately to improve blood flow to the foot.
- How will you determine if your actions are successful?
- What anatomical structures are likely involved in this injury?

Properties of Muscle

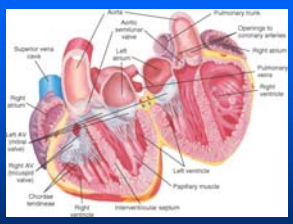
- Contractility
- Excitability
  - Capacity of muscle to respond when stimulated by nerve impulse
- Extensibility (stretchability)
  - Capacity of muscle to stretch beyond its relaxed length
- Elasticity
  - Ability to return to original length after contraction or stretching

Skeletal Muscle

- Conscious control
- 40% of total body mass
- Two attachments
  - Origin: More fixed and proximal attachment
  - Insertion: More movable and distal attachment
- Contractions are rapid and forceful

Cardiac Muscle

- Myocardium
  - Forms middle layer of heart
- Innervated by autonomic nervous system but contracts spontaneously without any nerve supply
- Contractions are strong and rhythmic



Smooth Muscle

- Walls of hollow organs (e.g., urinary bladder and uterus)
- Walls of tubes (e.g., respiratory, digestive, reproductive, urinary, and circulatory systems)
- Innervated by autonomic nervous system
  - Regulates size of lumen of tubular structures
- Contractions strong and slow

Tendons

- Bands of connective tissue
  - Bind muscles to bones
- Allow for power of movement across joints
- Supplied by sensory fibers that extend from muscle nerves

Bursae

- Flattened, closed sacs of synovial fluid
- Where tendon rubs against bone, ligament, or other tendon
- Reduce friction
- Act as shock absorber
- Fill with fluid when infected or injured

Cartilage

- Connective tissue covering epiphysis
- Surface for articulation
- Allows for smooth movement at joints

Ligaments

- Connective tissue that crosses joints
- Attaches bone to bone
- Stretch more easily than tendons
- Allow for stable range of motion

Fascia

- Dense fibrous connective tissue
- Forms bands or sheets
- Covers muscles, blood vessels, and nerves
- Supports and anchors organs to nearby structures

Bones

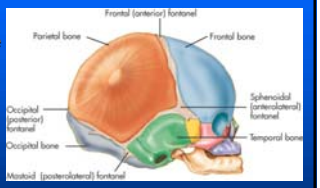
- Supporting framework
- Protect some internal organs
- Points of attachment for tendons, cartilage, and ligaments
- Levers on which muscles act to produce movements
- Calcium and phosphorus reservoir
- Red bone marrow

Biomechanics of Body Movement

- Every bone connects to at least one other bone
  - Except hyoid bone
- Three major classifications of joints
  - Fibrous joints
  - Cartilaginous joints
  - Synovial joints

Fibrous Joints

- Two bones united by fibrous tissue that have little or no movement
- Sutures (seams between flat bones)



Fibrous Joints

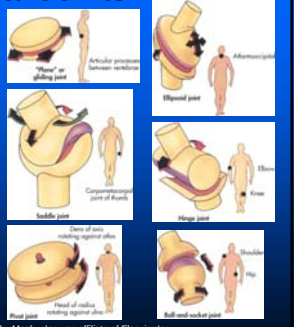
- Syndesmoses
- Gomphoses

Cartilaginous Joints

- Unite two bones by:
  - Hyaline cartilage (synchondroses)
  - Fibrocartilage (symphyses)
- Synchondroses
- Symphyses

Synovial Joints

- Contain synovial fluid
  - Movement between articulating bones
  - Most joints of appendicular skeleton
- Plane or gliding joints
- Saddle joints
- Hinge joints
- Pivot joints
- Ball-and-socket joints
- Ellipsoid joints

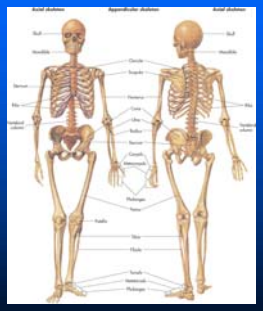


Skeletal System

- Axial skeleton (80 bones)
  - Central (longitudinal) axis of body
    - Skull (28)
      - Cranium (8)
      - Face (14)
      - Ear bones (6)
    - Hyoid bone (1)
    - Vertebral column (26)
    - Thoracic cage (25)

Skeletal System

- Appendicular skeleton (126 bones)
  - Pectoral girdle (4)
    - Clavicle
    - Scapula
  - Upper limbs (60)
  - Pelvic girdle (2)
  - Lower limbs (60)



Types of Bones

- Long bones
- Short bones
- Flat bones
- Irregular bones

Components of a Long Bone

- Diaphysis
- Medullary (or marrow) cavity
- Periosteum
- Epiphysis

Bone Markings—Terminology

- Depressions and openings
  - Foramen
  - Sinus
  - Fossa
- Projections and protrusions
  - Condyle
  - Crest
  - Epicondyle
  - Facet
  - Head
  - Process
  - Spine
  - Tubercle
  - Tuberosity (trochanter)

Pectoral (Shoulder) Girdle

- Attaches arm to axial skeleton of thorax
- Attachment for muscles of arm and chest
- Each pectoral girdle has two bones
  - Clavicle
  - Scapula

Scapula (Shoulder Blade)

- Triangular flat bone
- Glenoid fossa (glenoid cavity)
  - Arm socket
  - Receives head of humerus to form shoulder joint
  - Allows rotation of the arm at shoulder
- Spine of scapula—posterior process for muscle attachment
- Acromion—lateral end of spine of scapula articulates with clavicle

Clavicle (Collarbone)

- Most frequently broken bone
- S-shaped bone lies horizontally
- Holds upper limbs away from trunk
- Transmits forces from upper limbs to axial skeleton
- Attachment for muscles of neck, thorax, back, and arm

Humerus

- Longest, largest bone of upper extremity
- Shoulder is most commonly dislocated large joint
- Bursae around shoulder lubricate movement of shoulder joint

Radius and Ulna

- Bones of forearm connected by a flexible connective tissue
  - Pivot joint and pronator and supinator muscles
    - Supination
    - Pronation
- Palm up: Radius and ulna are parallel
- Palm down: Two bones cross

Radius

- On thumb side of forearm when palm is facing forward
- Shorter than and lateral to ulna

Ulna

- Longest forearm bone
- Little finger side of forearm
- Medial to radius

Carpals

- Wrist bones (carpus)
- Two rows of four bones
- Articulate at gliding joints
  - Permit sliding and twisting
- Carpal tunnel
  - Formed by concave anterior surface of the carpal bones
  - Flexor tendons of fingers and median nerve

Metacarpals

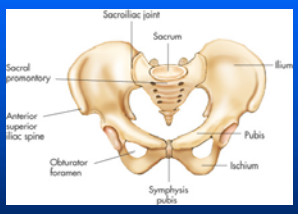
- Five metacarpal bones
  - Bones that make up palm of hand
- Metacarpal heads form knuckles
- Metacarpophalangeal (MCP) joint

Phalanges

- Finger bones
  - Miniature long bones
  - Each finger has three bones:
    - Proximal, middle, and distal phalanges
  - Each thumb has two phalanges:
    - Proximal and distal
- Joints
  - Interphalangeal joints
  - Distal interphalangeal (DIP) joints
  - Proximal interphalangeal (PIP) joints

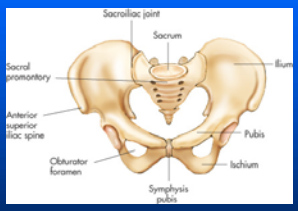
Pelvic Girdle

- Sacrum, coccyx, and two hip bones
  - Os coxae or innominate bones
- Hip bone is formed by fusion of ilium, ischium, and pubis on each side of pelvis



Pelvic Girdle

- Bears body weight
- Attachment for legs
- Protects pelvic organs



Femur

- Thigh bone
- Longest, strongest, heaviest bone
- Hip joint
- Head
- Neck
- Greater trochanter
- Lesser trochanter
- Shaft

Patella

- Kneecap
- Largest sesamoid bone
- Embedded in tendon of quadriceps femoris muscle
- Articulates with femur
- Knee joint

Tibia

- Shin bone
- Medial and more superficial bone of lower leg
- Articulates with femur at knee
- Weight-bearing bone of lower leg
- Shaft
- Medial “ankle bone”

Fibula

- Slenderest bone, proportional to its length
- Lateral side of lower leg
- Increases area for muscle attachments in leg
- Head
- Shaft
- Lateral “ankle bone”

Tarsals

- Seven tarsal bones form ankle
- Calcaneus
  - Heel bone
  - Largest, strongest bone of foot
  - Below talus
  - Body weight supported by calcaneus and talus
- Talus
  - Second largest bone of foot

Metatarsals

- Five long bones that form sole of foot
- Distal ends of metatarsals form ball of foot
- Metatarsophalangeal joints

Phalanges

- Toe bones
- Toes contain 14 phalanges
  - Great toe has two phalanges
  - Other toes have three phalanges each

Age-Associated Changes in Bones

- Water content of intervertebral disks decreases
- Increased risk of disk herniation
- Loss of stature is common
- Bone tissue disorders shorten trunk

Age-Associated Changes in Bones

- Vertebral column assumes arch shape
- Costal cartilages ossify, making thorax more rigid
- Shallow breathing due to rigid thoracic cage
- Facial contours change
- Fractures

Classifications of Musculoskeletal Injuries

- Injuries include:
  - Fractures
  - Sprains
  - Strains
- Joint dislocations

Associated Complications

- Hemorrhage
- Instability
- Loss of tissue
- Simple laceration and contamination
- Interruption of blood supply
- Nerve damage
- Long-term disability

Musculoskeletal Injuries

- Direct trauma
  - Blunt force applied to an extremity
- Indirect trauma
  - Vertical fall that produces spinal fracture distant from site of impact
- Pathological conditions
  - Some forms of arthritis
  - Malignancy

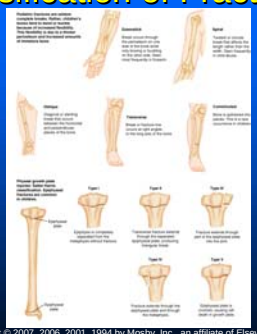
Fractures

- Break in continuity of bone or cartilage
- Complete or incomplete
  - Line of fracture through bone
- Open or closed
  - Integrity of skin near fracture site

Classification of Fractures

- Open
- Closed
- Comminuted
- Greenstick
- Spiral
- Oblique
- Transverse
- Stress
- Pathological
- Epiphyseal

Classification of Fractures



Sprains

- Partial tearing of ligament
- Caused by sudden twisting or stretching of joint beyond normal range of motion
- Common in ankle and knee
- Graded by severity
  - First-degree sprain
  - Second-degree sprain
  - Third-degree sprain

Strains

- Injury to muscle or its tendon
- Overexertion or overextension
- Common in back and arms
- May have significant loss of function
- Severe strains may cause avulsion of bone from attachment site

Joint Dislocations

- Normal articulating ends of two or more bones are displaced
  - Luxation: Complete dislocation
  - Subluxation: Incomplete dislocation
- Frequently dislocated joints
- Suspect joint dislocation when joint is deformed or does not have normal range of motion
- Dislocations can result in great damage and instability

Bursitis

- Inflammation of bursa
  - Small, fluid-filled sac acts as cushion at a pressure point near joints
  - Most important bursae are around knee, elbow, and shoulder

Bursitis

- Bursitis is usually from:
  - Pressure
  - Friction
  - Injury to membranes surrounding the joint
- Treatment
  - Rest, ice, and analgesics

Tendonitis

- Inflammation of tendon
  - Often caused by injury
- Symptoms include:
  - Pain
  - Tenderness
  - Restricted movement of muscle attached to affected tendon
- Treatment
  - Nonsteroidal antiinflammatory drugs (NSAIDs)
  - Corticosteroid medications

Arthritis

- Joint inflammation
  - Pain, swelling, stiffness, and redness
- Joint disease
  - Involving one or many joints
  - Many causes
- Varies in severity
  - Mild ache and stiffness
  - Severe pain and later joint deformity

Arthritis

- Osteoarthritis (degenerative arthritis) most common
- Pain usually managed with antiinflammatory agents

Extremity Trauma

- Signs and symptoms
  - Pain on palpation or movement
  - Swelling, deformity
  - Crepitus
  - Decreased range of motion
  - False movement (unnatural movement of extremity)
  - Decreased or absent sensory perception or circulation distal to injury

Musculoskeletal Assessment

- Four classes of patients
  - Life-/limb-threatening injuries or conditions
    - Includes life-/limb-threatening musculoskeletal trauma
  - Other life-/limb-threatening injuries and simple musculoskeletal trauma
  - Life-/limb-threatening musculoskeletal trauma
    - No other life-/limb-threatening injuries
  - Isolated, non-life-/limb-threatening injuries

Assessment

- Determine if life-threatening conditions are present
  - Care for those first
- Never overlook musculoskeletal trauma
- Don't allow noncritical musculoskeletal injury to distract from priorities of care

Six "P"s of Musculoskeletal Assessment

- **P**ain
  - On palpation (tenderness)
  - On movement
- **P**allor—pale skin or poor capillary refill
- **P**aresthesia—pins and needles sensation
- **P**ulses—diminished or absent
- **P**aralysis—inability to move
- **P**ressure

Musculoskeletal Assessment

- Neurovascular status assessment
  - Before and after movement or splinting
  - Distal pulse
  - Motor function
  - Sensation
- Assess injured area for DCAP-BTLS

Musculoskeletal Assessment

- Compare injured extremity with opposite, uninjured extremity
- If extremity trauma is suspected
  - Immobilize injury by splinting

General Principles of Splinting

- Goal of splinting
  - Immobilization of injured body part
- Immobilization by splinting
  - Helps alleviate pain
  - Decreases tissue injury, bleeding, and contamination in an open wound
  - Facilitates patient transport

General Principles of Splinting

- Splint above and below joints
- Immobilize open and closed fractures in same manner
- Cover open fractures to reduce contamination

General Principles of Splinting

- Check pulses, sensation, and motor function before and after splinting
- Stabilize extremity with gentle in-line traction to normal alignment
- Immobilize long bone extremity in a straight position to easily splint

General Principles of Splinting

- Immobilize dislocations in position of comfort
  - Ensure good vascular supply
- Immobilize joints as found
  - Joint injuries only aligned if no distal pulse
- Apply ice
- Compression
- Elevate extremity if possible
  - Reduces swelling and pain

Rigid Splints

- Cannot change shape
- Require body part to be positioned to fit splint
  - Board splints
  - Some cardboard splints
- Pad before use

Soft or Formable Splints

- Mold into various shapes to accommodate injured body part
- Pillows
- Blankets
- Slings and swathes

Soft or Formable Splints

- Vacuum splints
- Some cardboard splints
- Wire ladder splints
- Padded, flexible aluminum splints
- Inflatable splints
  - Not used for injuries proximal to knee or elbow

Traction Splints

- Midshaft femur fractures
- **Do not** apply traction to reduce femoral fracture
- **Do** provide traction to stabilize and align

Shoulder Injury

- Common in older adult because of weaker bone structure
  - Fall on an outstretched arm

Dislocation of Acromioclavicular Joint

Shoulder Injury

- Anterior fracture or dislocation
  - Patient often holds affected arm or shoulder close to chest
  - Lateral aspect of shoulder appears flat instead of rounded
  - Deep depression between head of humerus and acromion laterally (“hollow shoulder”)

Anterior Dislocation of the Shoulder

Shoulder Injury

- Posterior fracture or dislocation
  - May be positioned with arm above head

Shoulder Injury—Management

- Assess neurovascular status
- Apply sling and swathe
- Ice
- Splinting may need to be improvised to hold injury in place

Humerus Injury

- Older adults and children
- Difficult to stabilize
- Complications
  - Radial nerve damage if fracture in middle or distal portion of humeral shaft
  - Humeral neck fracture may cause axillary nerve damage
  - Internal hemorrhage into joint

Humerus Injury—Management

- Assess neurovascular status
- Traction, if vascular compromise
- Apply rigid splint and sling and swathe or splint extremity with arm extended
- Ice

Elbow Injury

- Common in children and athletes
- Dangerous in children
- May lead to ischemic contracture with serious deformity of forearm and clawlike hand
- Fall on outstretched arm or flexed elbow
- Complications
  - Laceration of brachial artery
  - Radial nerve damage

Posterior Dislocation of the Elbow Joint with Marked Deformity

Elbow Injury—Management

- Assess neurovascular status
- Splinting in position found with pillow, rigid splint, or sling and swathe
- Ice

Radius, Ulna, or Wrist Injury

- Often fall on outstretched arm
- Wrist injuries may involve distal radius, ulna, or any of eight carpal bones
  - Common injury is Colles' fracture
- Children and adults

Severe Open Fracture of Forearm

Penetration of Forearm Caused by Nail Gun

Greenstick Fracture With Marked Deformity

Fracture of the Distal Radius

Radius, Ulna, or Wrist Injury—Management

- Assess neurovascular status
- Splint in position found with rigid or formable splints or sling and swathe
- Ice and elevate

Hand (Metacarpal) Injury

- Mechanisms
  - Contact sports
  - Violence (fighting)
  - Crushing in industrial accident
- Boxer's fracture common
  - Direct trauma to closed fist, fracturing fifth metacarpal bone
- Injuries may be associated with hematomas and open wounds

Hand Injury from a Motorcycle Crash

Hand Injury—Management

- Assess neurovascular status
- Splint with rigid or formable splint in position of function
- Ice and elevate

Finger (Phalangeal) Injury

- Immobilize with:
  - Foam-filled aluminum splints
  - Tongue depressors
  - Taping injured finger to adjacent one
- Finger injuries common
  - Not trivial
- Serious injuries include:
  - Thumb metacarpal fractures
  - Open fractures
  - Comminuted metacarpal or proximal phalanx fracture

Finger Injury—Management

- Assess neurovascular status
- Splint
- Ice and elevate

Lower Extremity Injuries

- Greater wounding forces and more blood loss than with upper extremity injuries
  - Difficult to manage in patient with multiple injuries
  - May be life threatening
    - Femur fracture
    - Pelvic fracture

Pelvic Fracture

- Blunt or penetrating injury may result in:
  - Fracture
  - Severe hemorrhage
  - Associated injury to urinary bladder and urethra
- Deformity difficult to see
- Suspect injury to pelvis based on:
  - Mechanism of injury
  - Presence of tenderness on palpation of iliac crests

Pelvic Fracture

- Management
  - High-concentration oxygen administration
  - Treatment for shock
    - PASG per protocol
  - Immobilization on long spine board
  - Monitor vital signs
  - Rapid transport essential

Hip Injury

- Often due to fall in older adults
  - Younger patients from major trauma
- Hip fracture at femoral head and neck
  - Leg shortened and externally rotated
- Hip dislocation
  - Usually shortened and rotated leg

Hip Injury—Management

- Assess neurovascular status
- Splint with long spine board and generously pad patient for comfort during transport
- Slight flexion of knee or padding beneath knee may improve comfort
- Monitor vital signs

Femur Injury

- Usually major trauma
  - Motor vehicle crashes and pedestrian injuries
- May be child abuse
- Fractures evident when thigh muscles produce overriding of bone fragments
- Shortened leg, externally rotated
- Midthigh swelling from hemorrhage
- Bleeding may be life threatening

Femur Injury

- Diameter of right thigh represents increased blood volume of 2 to 3 L

Femur Injury—Management

- High-concentration oxygen
- Treat shock
- Assess neurovascular status
- Traction splint
  - Midshaft fracture
- Monitor vital signs

Knee and Patella Injury

- Fractures and dislocations result from:
  - Motor vehicle crashes
  - Pedestrian accidents
  - Contact sports
  - Falls on a flexed knee
- Popliteal artery in knee joint
- Posterior dislocations may lead to vascular injury

Knee Injury from a Pedestrian-Automobile Collision

Knee and Patella Injury—Management

- Assess neurovascular status
- Splint in position found with rigid or formable splint to effectively immobilizes hip and ankle
- Ice
- Elevate

Tibia and Fibula Injury

- Direct or indirect trauma or twisting injury
- If knee is injured, suspect popliteal vascular injury
- Management
  - Assess neurovascular status
  - Splint with rigid or formable splint
  - Apply ice and elevate

Open Fracture of the Lower Leg

Immobilization of the Lower Leg

Foot and Ankle Injury

- Fractures and dislocations of foot and ankle may result from:
  - Crush injury
  - Fall
  - Violent rotary force
- Point tenderness
- Unable to bear weight

Subtalar Dislocation

Foot that was Run Over by the Wheel of a Railway Coach

Foot and Ankle Injury—Management

- Assess neurovascular status
- Apply formable splint
  - Pillow, blanket, air splint
- Ice
- Elevate

Phalanx Injury

- Stubbing toe on immovable object
- Management
  - Assess neurovascular status
  - Buddy splint to adjacent toe
  - Ice
  - Elevate

Open Fractures

- Soft tissue wound around suspected fracture evidence of open fracture
- Fractures may be open:
  - From within, if bone fragment pierces skin
  - From without (e.g., after a gunshot wound)

Open Fractures

- Open fracture may make contact with skin some distance from fracture site
- Open fracture is a surgical emergency:
  - Potential for infection
  - If bone end or fragment is visible, cover with dry sterile dressing and splint

Straightening Angulated Fractures and Reducing Dislocations

- Angular fractures and dislocations may pose problems in splinting, patient extrication, and transportation
- Consult with medical direction before manipulation of fracture or dislocation

Limb-Threatening Injuries

- Knee dislocation
- Fracture or dislocation of ankle
- Subcondylar fractures of elbow
- Require rapid transport

Management

- Fractures and dislocated joints should be immobilized in position of injury
- Transport patient to emergency department for realignment (reduction)

Management

- If transport is delayed and circulation is impaired, attempt to reposition grossly deformed fracture or dislocated joint
- Elbow is never manipulated in prehospital setting

Method

- Handle injury carefully
- Gentle, firm traction in direction of long axis of extremity
- If obvious resistance to alignment, splint extremity without repositioning

Realignment Guidelines

- One attempt at realignment is made in prehospital setting
- Only if severe neurovascular compromise
- Consult with medical direction
- Perform manipulation as soon as possible after injury

Realignment Guidelines

- Avoided if other severe injuries
- Use analgesics for realignment procedure
- Assess and document pulse, sensation, and motor function before and after manipulating injured extremity or joint

Finger Realignment

- In-line traction along shaft of finger
- Slow and steady traction until finger is realigned
  - Patient feels relief from pain
- Immobilize with splint device or by buddy splinting

Shoulder Realignment

- Absence of severe back injury
- Check circulatory and sensory status
- Slow, gentle longitudinal traction with counter traction exerted on axilla
- Slowly (and without force) bring extremity to midline
  - Realign in anatomical position while maintaining traction
- Immobilize with sling and swathe

Hip Realignment

- In-line traction along shaft of femur with hip and knee flexed at 90°
- Slow and steady traction to relax muscle spasm
- Successful realignment
  - "Pop" into joint
  - Sudden relief of pain
  - Easy manipulation of leg to full extension

Hip Realignment

- Immobilize leg in full extension with patient positioned on long spine board
- Reevaluate pulses and neurovascular status

Knee Realignment

- Apply gentle, steady traction while moving joint into normal position
- Successful realignment will be noted by a "pop"
- Immobilize in full extension or slight flexion for comfort
- Position supine on long board

Ankle Realignment

- In-line traction on talus while stabilizing tibia
- Realignment noted by a sudden rotation to normal position
- Immobilize ankle as a fracture

Referral of Patients with Minor Musculoskeletal Injury

- Some musculoskeletal injuries (e.g., a minor sprain) do not require EMS transport
- To determine:
  - Evaluate need for immobilization
  - Evaluate need for an x-ray
  - Evaluate need for a physician follow-up visit versus emergency department assessment
  - Contact medical direction for advice

Referral of Patients with Minor Musculoskeletal Injury

- Patients not transported should receive advice on how to care for injury
  - Instruction sheet
- If doubt about seriousness of injury, transport to emergency department

Conclusion

Although extremity trauma is seldom life threatening, early recognition and management may prevent long-term, debilitating complications.

Questions?