Chapter 44
Orthopedic Trauma

Learning Objectives

• Describe the features of each class of musculoskeletal injury.
• Describe the features of bursitis, tendonitis, and arthritis.
• Given a specific patient scenario, outline the prehospital assessment of the musculoskeletal system.
Learning Objectives

• Outline general principles of splinting.
• Describe the significance and prehospital management principles for selected upper extremity injuries.
• Describe the significance and prehospital management principles for selected lower extremity injuries.

Learning Objectives

• Identify prehospital management priorities for open fractures.
• Describe the principles of realignment of angular fractures and dislocations.

Review of Musculoskeletal System

• Made up of
  – Bones
  – Nerves
  – Vessels
  – Muscles
  – Tendons
  – Ligaments
  – Joints
Review of Musculoskeletal System

- Skeletal system contains 206 individual bones
  - Divided into axial and appendicular skeleton
  - Axial skeleton
    - Skull
    - Hyoid bone
    - Vertebral column
    - Thoracic cage
  - Appendicular skeleton
    - Bones of upper and lower extremities
    - Girdles, by which extremities are attached to body

Review of Musculoskeletal System

- Muscular system provides for
  - Movement
  - Postural maintenance (muscle tone)
  - Heat production
- Major types of muscles
  - Skeletal
    - Most common type of muscle in body
  - Cardiac
  - Smooth muscle
Classifications of Musculoskeletal Injuries

- Injuries that result from traumatic forces to musculoskeletal
  - Fractures
  - Sprains
  - Strains
  - Joint dislocations
- Patients suspected of having trauma to extremity should be managed as though fracture exists

Classifications of Musculoskeletal Injuries

- Problems associated with musculoskeletal injuries
  - Hemorrhage
  - Instability
  - Loss of tissue
  - Simple laceration and contamination
  - Interruption of blood supply
  - Nerve damage
  - Long-term disability
How could long-term disability result from a musculoskeletal injury?

Classifications of Musculoskeletal Injuries

- Musculoskeletal injuries can result from
  - Direct trauma
    - Blunt force applied to extremity
  - Indirect trauma
    - Vertical fall that produces spinal fracture distant from site of impact
  - Pathological conditions
    - Forms of arthritis
    - Malignancy
- Consider kinematics when caring for patient with musculoskeletal injury and carefully evaluate scene

Fractures

- Any break in continuity of bone or cartilage
  - May be complete or incomplete, depending on line of fracture through bone
  - Also are classified as open or closed, depending on integrity of skin near fracture site
Fractures

- Fractures of long bones may result in moderate to severe hemorrhage within first 2 hours
  - As much as 550 mL of blood may be released in lower leg from tibial or fibular fracture
  - 1000 mL of blood in thigh from femoral fracture
  - 2000 mL of blood from pelvic fracture
Fractures

- Head of long bones in children is separated from shaft of bone by epiphyseal plate until bone stops growing
  - Fractures that involve epiphyseal plate are called epiphyseal fractures
  - Serious injuries that may result in separation or fragmentation of growth plate
  - May result in permanent bending or deformity of extremity
    - Known as torus (buckling of cortex of bone)

Sprains

- Partial tearing of ligament
  - Caused by sudden twisting or stretching of joint beyond its normal range of motion
  - Two common areas for sprains are knee and ankle
  - Graded by severity
    - First-degree sprain has no joint instability
    - Because only few fibers of ligament are torn
    - Swelling and hemorrhage are minimal
    - Repeated first-degree sprains can result in stretching of ligaments
Sprains

- Second-degree sprain causes more disruption than first-degree injury
  - Joint usually is still intact
  - Swelling and bruising are increased
- Third-degree sprain ligaments are completely torn
  - If accompanied by dislocation, nerve or blood vessel compromise to extremity is possible
  - Some second-degree sprains and most third-degree sprains have same presentation as fracture
Sprains

- Application of ice to an injury during the first 24 hours generally reduces pain and swelling.
  - After that time, heat (e.g., warm soaks) often is prescribed to increase circulation

Strains

- Injury to muscle or its tendon from overexertion or overextension
  - Commonly occur in back and arms
  - May be accompanied by significant loss of function
  - Severe strains may cause avulsion of bone from tendon attachment site

Joint Dislocations

- Occur when normal articulating ends of two or more bones are displaced
  - Joints that often are dislocated
    - Shoulders
    - Elbows
    - Fingers
    - Hips
    - Knees
    - Ankles
Joint Dislocations

• Occurs when normal articulating ends of two or more bones are displaced
  – Dislocation should be suspected when joint is deformed or does not move with normal range of motion
  – Complete dislocation is called luxation
  – Incomplete dislocation is called subluxation
  – All dislocations can result in great damage and instability

Why are dislocation injuries associated with a high incidence of vascular or nerve damage?
Extremity Trauma

• Signs and symptoms vary
  – May be subtle complaints of discomfort
  – Obvious deformity or open fracture
  – Field evaluation should be rapid, assuming significant injury

Extremity Trauma

• Signs and symptoms vary
  – Common signs and symptoms
    • Pain on palpation or movement
    • Swelling, deformity
    • Crepitus
    • Decreased range of motion
    • False movement (unnatural movement of an extremity)
    • Decreased or absent sensory perception or circulation distal to injury (evidenced by alterations in skin color and temperature, distal pulses, and capillary refill)

How can a paramedic distinguish between a serious sprain and a fracture in the prehospital setting?
Assessment of Musculoskeletal Injuries

- For purposes of musculoskeletal assessment, patients can be divided into four classes, including those with
  - Life- or limb-threatening injuries or conditions, including life- or limb-threatening musculoskeletal trauma
  - Other life- or limb-threatening vascular injuries and only simple musculoskeletal trauma
  - No other life- or limb-threatening injuries but with life- or limb-threatening musculoskeletal trauma
  - Only isolated injuries that are not life or limb threatening

Assessment of Musculoskeletal Injuries

- Perform primary survey to determine whether patient has any conditions that pose threat to life
  - Such conditions must be dealt with first
  - Must never overlook musculoskeletal trauma
    - Grotesque, but noncritical, musculoskeletal injury should never distract from priorities of care

Assessment of Musculoskeletal Injuries

- Evaluation of injured extremity should always include
  - Checking “six Ps”
    - Pain
    - Pallor
    - Paresthesia
    - Pulses
    - Paralysis
    - Pressure
Assessment of Musculoskeletal Injuries

- Evaluation of injured extremity should always include
  - Extremity's neurovascular status by assessing
    - Distal pulse
    - Motor function and sensation (before and after movement or splinting)
  - Inspect and palpate for surface trauma, tenderness, and swelling
  - If possible, assessment should include comparison with opposite, uninjured extremity
  - If trauma to extremity is suspected, extremity should be splinted

General Principles of Splinting

- Goal of splinting is immobilization of injured body part
  - Helps alleviate pain
  - Decreases tissue injury, bleeding, and contamination of open wound
  - Simplifies and facilitates transport of patient
- Principles of splinting and immobilization are same for both children and adults
Types of Splints

• Wide variety of splints and splinting materials are available
• Can be broadly categorized as
  – Rigid splints
  – Soft or formable splints
  – Traction splints

Types of Splints

• Rigid splint
  – Shape cannot be changed
  – Body part must be positioned to fit splint’s design
  – Examples
    • Board splints
    • Contoured metal and plastic splints
    • Some cardboard splints
  – Should be padded before use to accommodate for shape and patient comfort
Types of Splints

- **Soft splint or formable splint**
  - Can be molded into variety of shapes and configurations to accommodate injured body part
  - Examples
    - Pillows
    - Blankets
    - Slings and swathes
    - Vacuum splints
    - Some cardboard splints
    - Fire ladder splints
    - Padded, flexible aluminum splints

Types of Splints

- **Traction splint**
  - Specifically designed for midshaft femoral fractures
  - Do not apply or maintain enough traction to reduce femoral fracture
  - Provide enough traction to stabilize and align it
  - Useful to tamponade bleeding and reduce pain
  - Examples
    - Thomas half-ring
    - Hare traction
    - Sager traction splints
Upper Extremity Injuries

• Can be classified as fractures or dislocations to
  – Shoulder
  – Humerus
  – Elbow
  – Radius and ulna
  – Wrist
  – Hand
  – Finger
• Most upper extremity injuries can be adequately immobilized with sling and swathe
Shoulder Injury

• Common in older adults due to weaker bone structure
  – Often result from fall on outstretched arm
• Patients with anterior fracture or dislocation (accounting for 90 percent of cases)
  – Often have affected arm and shoulder close to chest
    • With lateral aspect of shoulder appearing flat instead of rounded
    • Deep depression between head of humerus and acromion laterally ("hollow shoulder") may be visible

Shoulder Injury

• Patients with posterior fracture or dislocation may be found with arm above head
• Other injuries that may affect shoulder
  – Sternoclavicular strain (results from direct blow or twisting of extended arm)
  – Rotator cuff tendon injuries
    • Can be acute or chronic and usually involve the deltoid muscle
    • Injury can occur from violent pull on arm or abnormal rotation of shoulder
    • Can also result from fall on outstretched arm that tears and ruptures shoulder tendons
Shoulder Injury

- Management of shoulder injuries
  - Assessment of neurovascular status
  - Application of sling and swathe
  - Application of ice

Shoulder Injury

- Based on position of affected arm and shoulder, makeshift splint may need to be devised to hold injury in place
  - With some fractures or dislocations, paramedic may need to use rolled blanket with cravat at center
  - Blanket roll is positioned under elevated arm and secured like sling
  - Arm is then swathed to prevent movement
  - If patient’s arm is positioned above head, should be splinted in position
Humeral Injury

• Upper arm fractures are common in older adults and children
  – Often difficult to stabilize
  – Radial nerve damage may be present if fracture occurs in middle or distal portion of humeral shaft
  – Fracture of humeral neck may cause axillary nerve damage
  – Internal hemorrhage into joint may be complication

Humeral Injury

• Management
  – Assessment of neurovascular status
  – Realignment if vascular compromise is present
  – Application of rigid splint and sling and swathe or splinting of extremity with arm extended
  – Application of ice
Elbow Injury

- Common in children and athletes
  - Especially dangerous in children
  - May lead to ischemic contracture (Volkmann's contracture) with serious deformity of forearm and claw-like hand
  - Mechanism of injury usually involves falling on outstretched arm or flexed elbow
  - Laceration of brachial artery and radial nerve damage can occur

Elbow Injury

- Management
  - Assessment of neurovascular status
  - Splinting in position found with pillow, blanket, rigid splint, or sling and swathe
  - Application of ice
Radial, Ulnar, or Wrist Injury

- Usually result of a fall on outstretched arm
  - Wrist injuries may involve distal radius, ulna, or any of eight carpal bones
  - Most common wrist injury is fracture with "silver fork" deformity of distal radius with dorsal angulation (Colles' fracture)
  - Forearm injury is common in both children and adults

Radial, Ulnar, or Wrist Injury

- Management
  - Assessment of neurovascular status
  - Splinting in position found with rigid or formable splints or sling
  - Application of ice and elevation
What effect does application of a cold pack have on musculoskeletal injuries?

Hand (Metacarpal) Injury

- Often results from contact sports, violence (fighting), work-related crushing injuries
  - Common metacarpal injury is boxer’s fracture
  - Results from direct trauma to closed fist, resulting in fracture of 5th metacarpal bone
  - May be associated with hematomas and open wounds
  - Boxer’s fracture is most common metacarpal fracture
Hand (Metacarpal) Injury

- Hand injuries should be splinted in position of function (as with hand grasping football)
- Rigid or formable splints may be used
- Management
  - Assessment of neurovascular status
  - Splinting with rigid or formable splint (pillow, blanket) in position of function
  - Application of ice and elevation

Finger (Phalangeal) Injury

- Injured fingers may be immobilized with foam-filled aluminum splints or tongue depressors
  - May be immobilized simply by taping injured finger to adjacent one (“buddy splinting”)
  - Finger injuries are common
    • Should not be considered trivial
    • Serious injuries include fractures of thumb
    • Any open or markedly comminuted fractures of hand or fingers are serious
Finger (Phalangeal) Injury

- Management
  - Assessment of neurovascular status
  - Splinting as previously described
  - Application of ice and elevation

Lower Extremity Injuries

- Include fractures of pelvis and fractures or dislocations of
  - Hip
  - Femur
  - Knee and patella
  - Tibia and fibula
  - Ankle and foot
  - Phalanx
Lower Extremity Injuries

- Associated with greater forces
  - Associated with more significant blood loss
  - More difficult to manage in patients with multiple injuries, and may be life threatening

Pelvic Fracture

- Blunt or penetrating injury to pelvis may result in
  - Fracture
  - Severe hemorrhage
  - Associated injury to urinary bladder and urethra
- Pelvis is surrounded by heavy muscles and other soft tissues
  - Deformity may be difficult to see
  - Injury to pelvis should be suspected based on mechanism of injury or tenderness on palpation of iliac crests
Pelvic Fracture

- Trauma to abdomen and pelvic area may be complicated by pregnancy

**Management**
- Administration of high-concentration O₂
- Management for shock (pneumatic antishock garment [PASG] per protocol)
- Full-body immobilization on long spine board or scoop stretcher (adequately padded for comfort)
- Regular monitoring of vital signs
- Rapid transport (essential)
Hip Injury

• Commonly occur in older adults as result of fall
  – Common in younger patients as result of major trauma
  – If hip is fractured at femoral head and neck, affected leg usually is shortened and externally rotated
  – With hip dislocation, affected leg is usually shortened and internally rotated
Hip Injury

- Serious injury, especially in older patients
  - Complications from injury can be life threatening
  - About 25 percent of older patients die within first year following injury
- Most of these deaths result from
  - Venous thromboembolism
  - Pneumonia
  - Infection

- Majority of patients who sustain hip fracture will require prolonged specialized care
  - Long-term nursing or rehabilitation facility
  - Less than 30 percent of patients who sustain fractured hip will return to their pre-injury level of activity

- Prehospital management
  - Assessment of neurovascular status
  - Splinting with long spine board or scoop stretcher
    - Generously padding patient for comfort during transport
    - Slight flexion of knee or padding beneath knee may improve comfort
  - Frequent monitoring of vital signs
Femoral Injury

• Usually results from major trauma
  – Motor vehicle crashes
  – Pedestrian injuries
  – Child abuse accounts for 30 percent of femur fractures in children under 4 years of age

Femoral Injury

• Fractures result in powerful thigh muscle contractions
  – Contractions cause bone fragments to ride back and forth over each other
  – Generally has shortened leg that is externally rotated and mid thigh swelling from hemorrhage, which can be life threatening
  – Fractures should be immobilized in field with traction splint
Femoral Injury

• Management
  – Administration of high-concentration O₂
  – Management for shock
  – Assessment of neurovascular status
  – Application of a traction splint
  – Regular monitoring of vital signs
Femoral Injury

- When more than one injury contributes to development of shock, PASG and traction splint may be used together (per local protocol for use of PASG)
- Traction splint should be applied over PASG only after it has been inflated
- Traction devices placed under PASG may promote
  - Continued hemorrhage
  - Tissue damage
  - Compromised circulation to injured extremity

Knee and Patellar Injury

- Fractures commonly result from
  - Motor vehicle crashes
  - Pedestrian injuries
  - Contact sports
  - Falls on flexed knee
    - Popliteal artery is close to knee joint and may be associated injury
    - Particularly true with posterior dislocations
  - Other common knee and patella injuries involve nearby ligaments and tendons

Knee and Patellar Injury

- Management
  - Assessment of neurovascular status
  - Splinting in position found with rigid or formable splint that effectively immobilizes hip and ankle
    - Traction splints should not be used to immobilize knee or patellar injury
  - Application of ice and elevation
Tibial and Fibular Injury

- May result from direct or indirect trauma
  - May result from twisting injury
  - If injury is associated with knee, popliteal vascular injury should be suspected.

- Management
  - Assessment of neurovascular status
  - Splinting with rigid or formable splint
  - Application of ice and elevation
Foot and Ankle Injury

• Fractures and dislocations may result from
  – Crush injury
  – Fall from height
  – Violent rotating or twisting force
  – Injuries to nearby tendons also can occur
  – Patient usually complains of point tenderness
    • Hesitant to bear weight on extremity

Foot and Ankle Injury

• Management
  – Assessment of neurovascular status
  – Application of formable splint, such as pillow, blanket, or air splint
  – Application of ice and elevation
Phalangeal Injury

• Often are caused by “stubbing” toe on immovable object
  – Usually managed by buddy taping toe to adjacent toe
  – Helps to support and immobilize injury

• Management
  – Assessment of neurovascular status
  – Buddy splinting
  – Application of ice and elevation

Open Fractures

• Require special care and evaluation
  – May be opened in two ways
    • May be opened from within, as when bone fragment pierces skin
    • May be opened from without (e.g., after gunshot wound)
  – May have made contact with skin some distance from fracture site
Open Fractures

• Most open fractures are obvious because of associated hemorrhage
  – Small puncture wound may not be immediately apparent
  – Bleeding may be minimal
  – Must consider any soft tissue wound in area of suspected fracture to be evidence of open fracture

Open Fractures

• Considered true surgical emergency because of potential for infection
  – Should be covered with sterile, dry dressings
  – Should not be irrigated in field or soaked with any type of antiseptic solution
  – Hemorrhage should be controlled with direct pressure and pressure dressings

Open Fractures

• If bone end or bone fragment is visible, should be covered with a dry, sterile dressing and splinted
  – Bone ends that slip back into wound during immobilization should be noted and reported to receiving hospital so that bone can be cleaned in surgery
Stages of Fracture Healing

• Healing of fracture proceeds in several different stages
• How quickly fracture heals depends on how severe and how large fracture is
  – In earliest stage following fracture, hematoma forms at fracture site
  – Followed by formation of fibrovascular tissue (scar tissue) that replaces hematoma and stabilizes fracture area
  – Genes and proteins in bone marrow then signal production of osteoblasts (immature bone cells) and chondrocytes (cartilage cells)

Stages of Fracture Healing

• Stages
  – Membrane around bone and immature bone cells form callus at fracture site
    • Newly formed cartilage cells begin to replace scar tissue
  – In final stage of healing, immature bone cells held in place by membrane grow and mature
    • Newly formed bone replaces cartilage (remodeling) and healing is completed
Stages of Fracture Healing

• How quickly fracture heals depends on
  – How severe and how large it is
  – Where it occurs
  – How broken bone is used
  – How strong bone was before fracture
• Some small fractures in the hands heal in few weeks

Stages of Fracture Healing

• Large fractures in legs or pelvis may take many months to heal
  – Partly because these bones must bear person’s weight
• Most fractured bones are immobilized with casts, braces, or surgical fixation devices while they heal
• Complications of fractures
  – Formation of fat embolism
  – Non-union
  – Osteomyelitis

Straightening Angular Fractures and Reducing Dislocations

• May pose significant problems in splinting, patient extrication and transport
• When manipulation of fracture is required to aid in transport or to improve circulation to injured extremity, consult with medical direction
Aside from narcotic analgesics, what other drugs may be indicated to relieve muscle spasm, provide amnesia, and relax the patient while reducing a dislocation or fracture?

**Straightening Angular Fractures and Reducing Dislocations**

- Fractures and dislocated joints
  - Should be immobilized in position of injury
  - Transport as quickly as possible to emergency department for x-ray films and realignment (reduction)
  - If transport is delayed or prolonged, and if circulation is impaired, attempt should be made to reposition grossly deformed fracture or dislocated joint
    - Exception is elbow

- Elbow should never be manipulated in prehospital setting
  - Grossly deformed fracture or dislocation elsewhere often can be realigned if required
  - Usually can be done without causing more damage or extreme discomfort to patient
  - Injury should be handled carefully
    - Gentle, firm traction should be applied in direction of long axis of extremity
    - If obvious resistance to alignment is felt, extremity should be splinted without repositioning
Specific Techniques for Specific Joints

- Only one attempt at realignment should be made in prehospital setting, and only if severe neurovascular compromise is present (e.g., extremely weak or absent distal pulses)
  - Should be made only after consultation with medical direction
  - Manipulation (if indicated) should be performed as soon as possible after injury

Specific Techniques for Specific Joints

- Should not be performed if patient has other severe injuries, including potential for associated fracture
  - If not contraindicated by other injuries, use of IV analgesics (e.g., fentanyl, morphine), and benzodiazepines (e.g., midazolam) should be used before realignment
  - Always assess and document before and after manipulating any injured extremity or joint
    - Pulse
    - Sensation
    - Motor function

Finger Realignment

- Steps
  - Apply in-line traction along shaft of finger
  - Continue with slow, steady traction until finger is realigned and patient feels relief from pain
  - Immobilize finger with splint device or by buddy splinting
Shoulder Realignment

• Steps
  – Attempt realignment only in absence of severe back injury
  – Check circulatory and sensory status
  – Apply slow, gentle longitudinal traction, with countertraction exerted on axilla
  – Slowly bring extremity to midline (do not apply force)
  – Realign in anatomical position while maintaining traction
  – Immobilize with sling and swathe

Hip Realignment

• Steps
  – Place patient supine and stabilize pelvis
  – With knee flexed, apply steady traction in-line with deformity
  – Slowly bring hip to 90 degrees of flexion with slow, steady traction and gentle rotation to relax muscle spasm
  – Successful realignment is indicated by “pop” into joint, sudden relief of pain, and easy manipulation of leg to full extension
**Hip Realignment**

- **Steps**
  - Immobilize leg in full extension with patient positioned on long spine board
    - Reevaluate pulses and neurovascular status
  - If full extension is not achieved, immobilize leg at flexion not to exceed 90 degrees with pillows or blankets
    - Place patient supine

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**Knee Realignment**

- **Steps**
  - Apply gentle, steady traction while moving injured joint into normal position
  - Successful realignment is indicated by "pop" into the joint, resolution of deformity, relief of pain, and increased mobility
  - Immobilize leg in full extension (or slight flexion for comfort)
    - Position patient supine on long spine board
Ankle Realignment

• Steps
  – Apply in-line traction on talus while stabilizing tibia
  – Successful realignment is noted by sudden rotation to normal position
  – Immobilize ankle in same manner as for fracture

Referral of Patients with Minor Musculoskeletal Injury

• Some patients with minor musculoskeletal injury (e.g., a minor sprain) do not require transport
  – To make this determination, follow guidelines
    • Evaluate need for immobilization
    • Evaluate need for radiography, based on patient’s condition and mechanism of injury
    • Evaluate need for emergency department assessment versus patient going to his or her private physician, based on patient’s condition and mechanism of injury
    • Consult with medical direction

What should be documented on these calls?
Referral of Patients with Minor Musculoskeletal Injury

- Patients who are not transported to hospital should be given advice on how to care for injury
  - Instruction sheet should explain
    - Techniques for immobilization
    - Elevation
    - Cold
    - Heat
    - Rest
    - Use of analgesics
  - If any doubt exists about seriousness of patient’s injury, transport

Summary

- Injuries that can result from traumatic force on the musculoskeletal system include fractures, sprains, strains, and joint dislocations
  - Problems associated with musculoskeletal injuries include hemorrhage, instability, loss of tissue, simple laceration and contamination, interruption of blood supply, and long-term disability

Summary

- Common signs and symptoms of extremity trauma include pain on palpation or movement, swelling or deformity, crepitus, decreased range of motion, false movement, and decreased or absent sensory perception or circulation distal to injury
  - Once paramedic has assessed for life-threatening conditions, extremity injury should be examined for pain, pallor, paresthesia, pulses, paralysis, and pressure
Summary

• Immobilization by splinting helps alleviate pain; reduces tissue injury, bleeding, and contamination of an open wound; and simplifies and facilitates transport of patient
  – Splints can be categorized as rigid, soft or formable, and traction splints

Summary

• Upper extremity injuries can be classified as fractures or dislocations of the shoulder, humerus, elbow, radius and ulna, wrist, hand, and finger
  – Most upper extremity injuries can be adequately immobilized by application of sling and swathe
• Lower extremity injuries include fractures of the pelvis and fractures or dislocations of the hip, femur, knee and patella, tibia and fibula, ankle and foot, and toes

Summary

• Most open fractures are obvious because of associated hemorrhage
  – Small puncture wound may not be initially apparent
  – Bleeding may be minimal
  – Paramedic must consider any soft tissue wound in area of suspected fracture to be evidence of an open fracture
  – Open fractures are considered a true surgical emergency, due to potential for infection
Summary

- Only one attempt at realignment should be made
  - Should be done only if severe neurovascular compromise is present (e.g., extremely weak or absent distal pulses)
  - Should be done only after consultation with medical direction

Questions?