Chapter 23
Musculoskeletal Care

Learning Objectives

- Describe function of muscular system
- Describe function of skeletal system
- List major bones/bone groupings of spinal column, thorax, upper & lower extremities
- Differentiate between open & closed painful, swollen, deformed extremity

Learning Objectives

- State reasons for splinting
- Explain rationale for splinting at scene vs. "load and go"
- Explain rationale for immobilization of painful, swollen, deformed extremity
- List general rules of splinting
Learning Objectives

- List complications of splinting
- List emergency medical care for patient with painful, swollen, deformed extremity

Introduction

- Injuries to bones, ligaments, tendons, and muscles account for significant number of all traumas
  - Common causes
    - MVCs
    - Falls
    - Sports injuries
    - Age

- Musculoskeletal injuries can result in:
  - Swelling and deformity
  - Temporary or permanent loss of function
  - Death
Introduction

- Bones provide support and protection for the body
  - Forces needed to break a bone can result in underlying damage to soft tissues or organs
    - Hemorrhage
    - Damage to nearby vessels and nerves

Introduction

- Mechanism of injury
  - Provides clues for evaluation and treatment

- Injuries occur in patterns
  - One injury can raise suspicion for injury to another part of the body

Introduction

- Search for complications of musculoskeletal trauma as part of assessment
  - Neurologic injury
  - Vascular injury

- Life-threatening conditions take priority
Introduction

- Musculoskeletal injury treatment
  - Immobilize and support injured extremities
    - Rigid splinting
    - Traction splinting
    - Use of sling and swathe
    - Use of long spine board

Anatomy & Physiology

- Skeletal system
  - Provides support and protection of the body
  - Attached muscles allow movement
  - Size and functions of bones vary
  - 206 bones

- Appendicular skeleton
  - Composed of:
    - Upper, lower extremities
    - Shoulder
    - Pelvis
  - Primary concern
    - Movement
    - Support of body in erect position
Anatomy & Physiology

- Skeletal system
  - Axial skeleton
    - Skull
    - Face
    - Spinal column
    - Thoracic cavity
    - Supports & protects internal organs

Anatomy & Physiology

- Skeletal system
  - Appendicular skeleton
    - Upper and lower extremities
    - Shoulder
    - Pelvis
    - Moves and supports the body in the erect position

Anatomy & Physiology

- Skeletal system
  - Composed of connective tissue
    - Bone
    - Bone marrow
    - Cartilage
    - Ligaments
    - Tendons
Anatomy & Physiology

- Skeletal system
  - Bone
    - Calcified connective tissue gives strength to skeleton
    - Bone marrow
      - Source of blood cells
      - Inside bone

- Cartilage
  - Softer precursor to the bony skeleton in the fetal stage
  - Persists in adult life, until old age
  - Present at joints of 2+ bones
  - Serves as cushion
  - Provides friction-free surface
  - Articular cartilage
  - Present within the respiratory tract and in the ears
Anatomy & Physiology

- Skeletal system
  - Ligaments
    - Tough connective tissue bands bind one bone to another at joints
    - Injuries are called sprains

- Skeletal system
  - Tendons
    - Tough connective tissue bands that connect muscle to bone
    - Serve to pull/move bones as muscles contract
    - Can be torn after trauma or violent muscle contraction
    - Injuries are called strains

Anatomy & Physiology

- Muscular system
  - Muscles
    - Tissues capable of contraction/shortening
  - Types of muscles
    - Voluntary (skeletal)
      - Contraction results in movement of the skeleton
      - Under conscious control
      - Attached to bone directly or by tendons
Anatomy & Physiology

- Muscular system
  - Involuntary (smooth)
    - Contraction results in automatic functions
    - Not under conscious control
    - Found within internal organs
      - Blood vessels
      - Digestive system
      - Urinary system
      - Respiratory system

- Upper extremities
  - Shoulder
    - Formed by joining of the humerus with the scapula (shoulder blade)
    - Receives support from attachments between the scapula and clavicle
    - Scapula

- Muscular system
  - Cardiac
    - Functions automatically to pump blood with each heartbeat
    - Not under conscious control
    - Functions under own pacemaker
    - Directed by involuntary nervous system
Upper extremities
  - Shoulder
    - Glenoid fossa (cavity)
    - Clavicle (collar bone)

Humerus
  - Bone of the upper arm
  - Long bone extending from the glenoid process of the scapula
  - Rounded head of humerus forms a ball-and-socket joint
  - Rounded head forms ball-and-socket joint
  - Main portion is the shaft
  - Medial & lateral epicondyles
Anatomy & Physiology

- **Upper extremities**
  - Elbow, forearm
    - Elbow is made up of the articulation of the lower humerus and the proximal ends of the radius and ulna
    - **Ulna**
      - Located medially along length of the forearm
      - Superficial bone
      - Can be palpated along its entire length from the olecranon to the wrist
    - **Olecranon**
    - **Radius**
Anatomy & Physiology

- Upper extremities
  - Elbow, forearm
    - Elbow
      - 3 bones articulate with one another in different ways
      - Hinge of the joint allow flexion and extension
      - Other articularions allow for rotation of the forearm

- Upper extremities
  - Elbow, forearm
    - Biceps
      - Principal muscle that flexes the arm
    - Triceps
      - Muscle that extends the arm

- Upper extremities
  - Wrist, hand
    - Carpal bones
    - Metacarpals
    - Phalanges
Anatomy & Physiology

- Lower extremities
  - Pelvis
    - Ring-like structure consisting of:
      - Sacrum
      - Coccyx posteriorly
      - Pubic symphysis anteriorly
      - Ilium
      - Ischium
      - Pubis

- Acetabulum
  - Protects the internal organs in the pelvic cavity
  - Supports the weight of the body
Anatomy & Physiology

- Lower extremities
  - Femur
    - Longest and strongest bone in the body
    - Has rounded head which articulates with the acetabulum to form the hip joint
    - Femoral neck extends for 2 inches
    - Trochanters
    - Shaft widens distally before articulation at the knee joint
    - Condyles

- Lower extremities
  - Knee & lower leg
    - Tibia
      - Major weight-bearing bone of lower leg
      - Widened proximally and distally for articulation at the knee and ankle joints
      - Runs anteriorly along the entire lower leg
      - Proximally, the medial and lateral tibial condyles form surface for articulation with the femoral condyles
      - Strong ligaments hold the joint together
Anatomy & Physiology

Lower extremities

Knee & lower leg

- Patella (kneecap)
  - Small, flat bone
  - Easily palpable anteriorly
  - Contained within the tendon on the quadriceps muscle
  - Permits flexion and extension when the knee is in flexed position

- Fibula
  - Smaller long bone
  - Runs parallel, lateral, and posterior to the tibia
  - Proximal head articulates with the tibia
  - Can be palpated on lateral and posterior aspect of the lower leg just below the knee
  - Not weight bearing
  - Serves as point of attachment for muscle
  - Forms part of ankle joint
Anatomy & Physiology

- Lower extremities
  - Ankle & foot
    - Bones of the foot
      - 7 tarsal bones
      - 5 metatarsal bones
      - 14 phalanges
    - Ankle joint
      - Formed by articulation of the tibia and fibula and the talus bone

Anatomy & Physiology

- Lower extremities
  - Ankle & foot
    - Talus
      - Rests on the calcaneus (heel bone)
      - Attached to the rest of the foot through the other 5 tarsal bones
      - Transmits the weight of the body to the foot
      - Ligaments attach the palpable lateral and medial malleoli to the talus and calcaneus
      - Primary movement is flexion and extension
      - Articulation permits complex motions of the ankle & foot

Anatomy & Physiology

[Diagram of the ankle and foot showing individual bones and articulations]
Anatomy & Physiology

- Lower extremities
  - Major muscles
    - Gluteus maximus
      - Extends from the pelvis to the femur
      - Extends and abducts thigh and rotates it laterally
    - Quadriceps
      - 4 muscles inserted by a common tendon on the tibia
      - Muscular thickness extends from the ilium to the tibia
      - Helps protect thigh

Anatomy & Physiology

- Lower extremities
  - Major muscles
    - Hamstring
      - Flexion of lower leg
      - Extends from the ischium and femur to the tibia
      - Dorsiflexion of the foot is by the tibialis anterior extending from the tibia to the foot
      - Plantar flexion of the foot is by the gastrocnemius and the soleus extending from the condyles of the femur and proximal tibia and fibula to the calcaneus

Musculoskeletal Injuries

- Musculoskeletal injuries
  - Fracture
    - Break in bone continuity
      - Complete
      - Incomplete
    - Closed fracture
      - No break in skin
    - Open fracture
      - Exposed to external environment
      - Skin broken
      - Risk of infection
      - Cover with sterile dressing
Musculoskeletal Injuries

Musculoskeletal injuries
- Fracture
  - Sprains
    - Ligament injury
    - Usually result from stretching forces
  - Strains
    - Muscles/tendons injuries
    - Result from stretching or violent contractions
- Dislocation
  - Displacement of bones in joint from their normal anatomic position
  - Stretching or tearing of the joint ligaments must take place

Musculoskeletal Injuries

Mechanism of injury
- Helps predict location, type of musculoskeletal injury
- Generates suspicion of certain types & patterns of injuries
- Always include MOI in PCR and communicate to hospital staff
Musculoskeletal Injuries

- Mechanism of injury
  - Direct force
    - Applied to bone
  - Indirect force
    - Transmitted along axes of bones
    - Results in injury at a location other than the point of impact
    - Twisting force
    - Violent contractions of muscles
Musculoskeletal Injuries

Assessment

- PPE
- During scene size-up, determine the potential mechanism of injury
- Start initial assessment while considering presence of spinal injuries
- ABCs
- Control bleeding
- Identify other life-threatening conditions
Musculoskeletal Injuries

Assessment

- Begin secondary assessment with information about mechanism of injury and the conditions immediately surrounding the injury
- History of events preceding an injury may point to medical conditions that might have caused the incident
- Perform head-to-toe survey

Musculoskeletal Injuries

Assessment

- Open or cut away clothing if necessary to look for DCAP/BTLS

Musculoskeletal Injuries

Assessment

- Signs, symptoms
  - Pain, tenderness
    - Most common symptom of a bone or joint injury
    - May be distal to site of injury
    - Must examine entire extremity
  - Deformity/angulation
    - Angulation of long bones
    - Protuberance of the bone end against the soft tissues
    - Overriding or separation of bone fragments by opposing muscles
Musculoskeletal Injuries

- **Assessment**
  - Signs, symptoms
    - Swelling, discoloration
      - Caused by fluid or blood loss
      - Comparing extremities can help gauge extent of swelling
    - Loss of use
      - Do not force movement of limb
Musculoskeletal Injuries

- Assessment
  - Signs, symptoms
    - Grating/crepitus
      - Indicates bone fragments rubbing against each other
    - Exposed bone
      - Sign of open fracture
    - Joint locked into position/dislocation
      - Can result from both direct and indirect injuries
      - May be associated with a fracture
Musculoskeletal Injuries

- Assessment
  - Associated injuries
    - Bleeding
      - Can be life-threatening complication of fractures
        - Fractures of the pelvis and femur are serious, associated with blood loss
    - Vascular injuries
      - Pinched or torn by bone fragments
      - Injured by same force that caused the fracture
      - Can go into spasm, compressed by soft swelling, or occluded by clots
      - Use 5 Ps for signs of ischemia
      - Check for vascular compromise before and after splinting
    - Peripheral nerve injury
      - Nerves injured more than arteries
      - Mechanisms similar to those that injure arteries can cause nerve confusion or complete disruption
      - Must evaluate nerve & vascular function in every case
        - Distal to injury
      - Continued swelling after injury or constriction caused by tightly applied splints can cause nerve damage
Musculoskeletal Injuries

Assessment

- Injuries to internal organs
  - Force can be transmitted to underlying organs
  - Injuries to the pelvis may injure:
    - Bladder
    - Urethra
    - Rectum
    - Lower intestine
    - Reproductive organs

- Injured thorax may cause:
  - Hemothorax
  - Hemothorax
  - Pneumothorax
  - Rupture of the spleen and liver
Musculoskeletal Injuries

- **Management**
  - Life-threatening conditions managed 1st
  - Administer O₂
  - Splint injuries in preparation for transport or en route
  - Apply cold packs
  - Elevate splinted extremity

Musculoskeletal Injuries

- **Management**
  - **Splinting**
    - **Goals**
      - Reduce pain
      - Prevent further injury
      - Reduce blood loss

Musculoskeletal Injuries

- **Management**
  - **Splinting**
    - **Principles**
      - Should be adhered to regardless of specific technique used
      - Use long spine board to immobilize patients in critical condition
      - When in doubt, splint the injury
      - Splint before moving
Musculoskeletal Injuries

Management

Splinting

Principles

- Pad splints and remove clothing
- Immobilize joints/bones above and below injury
- Check and recheck nerve and vascular function

Splinting

- Straighten extremity in severe injuries
- Cover open wounds
- Treat protruding bones

Types of splints

- Rigid splints
- Pneumatic (air) splints
- Sling
- Swathe
Musculoskeletal Injuries

Management

- Splinting
  - Types of splints
    - Traction splints
    - Device used is less important than the principles of management
Musculoskeletal Injuries

Management

Splinting

Precautions

Learn how to apply splints properly and monitor effectiveness during patient transport
Never delay care for life-threatening injuries

Splinting techniques

- Be familiar and adept with various splinting techniques
- Long board splint
- Fracture of forearm/elbow
  - Use rigid splint extending from palm of the hand past the medial aspect of the elbow
  - Splint arm in extended position with rigid splint when found in straightened position
Musculoskeletal Injuries

Skill 23-1: Applying Rigid Splint to Lower Extremity

- Using PPE, apply manual stabilization
- Assess pulse, motor, sensory function

- If severe deformity, distal extremity cyanotic/lacks pulse, align with traction before splinting
- Measure splint
Skill 23-1: Applying Rigid Splint to Lower Extremity

- Apply splint, immobilizing bone & joint above/below injury
- Immobilize foot in position of function

Skill 23-1: Applying Rigid Splint to Lower Extremity

- Secure entire extremity
- Reassess pulse, motor & sensory function
- Record findings

Skill 23-2: Applying Rigid Splint to Forearm

- Maintain arm in alignment
- Check distal circulation, nerve function prior to splinting
Skill 23-2: Applying Rigid Splint to Forearm

- Place splint along medial surface from armpit to hand
- Place roller bandage between hand & splint to keep hand in position function

Skill 23-2: Applying Rigid Splint to Forearm

- Attach with cravats/bandage & secure to torso
- Assess distal circulation & nerve function

Musculoskeletal Injuries

- Management
  - Splinting techniques
    - Fingers
      - Splinted with flexible aluminum splint or a tongue blade
      - Attached with tape, do not constrict blood flow
      - Immobilize multiple finger fractures with rigid board splint or splint

Musculoskeletal Injuries

- Management
  - Splinting techniques
    - Joint injuries
      - Immobilized in straightened or angulated position
      - If extremity is cyanotic or lacks pulses, attempt to straighten

Musculoskeletal Injuries

- Management
  - Splinting techniques
    - Wrist and hand
      - Use rigid splint that extends from proximal joint of the phalanges to the midforearm
      - Place forearm in sling
      - If injury is proximal to the wrist, check radial & ulnar pulses
      - Use skin color & temperature and capillary refill time to gauge distal vascular function
Skill 23-3: Applying Rigid Splint to Forearm & Wrist

- Apply manual stabilization
- Assess pulse, motor & sensory function
- Reassess distal circulation, nerve function prior to splinting

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Skill 23-3: Applying Rigid Splint to Forearm & Wrist

- Align with gentle traction if distal extremity cyanotic/lacks pulses, no resistance
- Immobilize bone above & below site of injury

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Skill 23-3: Applying Rigid Splint to Forearm & Wrist

- Reassess pulse/circulation, motor & sensory function after application of splint
- Record findings
Musculoskeletal Injuries

- Management
  - Splinting techniques
    - Elbow
      - If angulated and locked because of a dislocation, immobilize in position found
      - Use rigid splint bridged from the humerus to the distal forearm

Skill 23-4:
Applying Rigid Splint to Elbow in Flexed Position

- Apply splint from armpit area to wrist
- Secure with cravat/bandage

Skill 23-4:
Applying Rigid Splint to Elbow in Flexed Position

- Use cravat bandage to form sling to support arm
Musculoskeletal Injuries

Management

- Splinting techniques
  - Sling and swathe combination
    - Do not apply excessive pressure over the axillary region on the opposite side
    - Sling supports weight of the arm and keeps forearm elevated
    - Place knot made in sling on side of patient's neck

Skill 23-5: Applying Sling & Swathe

- Place sling with long end over opposite shoulder, apex toward injured side
- Check distal circulation & nerve function before splinting
Skill 23-5: Applying Sling & Swathe

- Secure sling at side of neck to avoid pressure

Skill 23-5: Applying Sling & Swathe

- Secure end of sling with knot/twist

Skill 23-5: Applying Sling & Swathe

- Attach swathe
- Check distal circulation
Musculoskeletal Injuries

- Management
  - Splinting techniques
    - Traction splint
      - Used to immobilize isolated painful, swollen, deformed mid-thigh injuries
    - Hare traction splint
    - Sager traction splint

Skill 23-6: Applying Hare Traction Splint

- Cut away clothing

Skill 23-6: Applying Hare Traction Splint

- Assess pulse, motor & sensory function distal to injury
- Record findings
Skill 23-6: Applying Hare Traction Splint

- Manual stabilization of leg
- Apply distal securing device

Skill 23-6: Applying Hare Traction Splint

- Manual traction
- Prepare, adjust splint to proper length

Skill 23-6: Applying Hare Traction Splint

- Position splint under injured leg
- Apply proximal securing device
Skill 23-6: Applying Hare Traction Splint

- Apply mechanical traction
- Position, secure straps
- Place 2 straps below knee, 2 above knee

Skill 23-6: Applying Hare Traction Splint

- Reevaluate proximal, distal securing devices, pulse, motor & sensory function
- Secure torso & splint to long board

Skill 23-7: Applying Sager Traction Splint

- Remove, cut away clothing
Skill 23-7: Applying Sager Traction Splint

- Assess pulse, motor & sensory sensation distal to injury
- Record findings

Skill 23-7: Applying Sager Traction Splint

- Manual stabilization of injured leg

Skill 23-7: Applying Sager Traction Splint

- Prepare, adjust splint to proper length
Skill 23-7: Applying Sager Traction Splint

- Apply proximal securing device

- Apply distal securing device
- Apply mechanical traction
- Traction should not exceed 10% of patient body weight

- Position, secure support straps
- Reevaluate proximal, distal securing devices
Skill 23-7: Applying Sager Traction Splint

- Reassess pulse, motor & sensory function distal to injury after splinting
- Secure torso to long spine board; splint to long spine board

Musculoskeletal Injuries

- Management
  - Splinting techniques
    - Air splint available in:
      - Full arm
      - Leg partial arm
      - Leg lengths

Skill 23-8: Applying an Air Splint

- Provide manual stabilization
- Assess pulse, motor, & sensory function
- Apply splint, immobilizing bone & joint above, below injury
Skill 23-8: Applying an Air Splint

- Check pressure in splint, noting slight dent with finger pressure
- Reassess pulse, motor, & sensory function after splinting

Musculoskeletal Injuries

- Management
  - Splinting techniques
    - Dislocations of hip:
      - Often locked
      - Resist straightening
    - Place patient on long spine board, pillows between knees & board, legs tied together
    - Traction splints contraindicated

- Patients in shock or critically injured
  - Best immobilized with long spine board
  - PASG per local protocols
Musculoskeletal Injuries

- **Techniques**
  - Sling swathe combination
    - Air splint available in:
      - Full arm
      - Leg partial arm
      - Leg lengths

- **Dislocations of hip:**
  - Often locked
  - Resists straightening
  - Place patient on long spine board, pillows between knee, board, legs tied together
  - Patients in shock, best immobilized with long spine board

Summary

- **Fracture** - break in continuity of bone
- **Sprains** - injuries to ligaments
- **Strains** - injuries to muscles
- **Dislocation** - displacement of bones in joint
Summary

- Painful, swollen, deformed extremity treated as though significant bony/soft tissue injury exists
- Forces that cause fractures may be direct/indirect
- Direct forces applied to bone
  - Vehicle bumper striking tibia of pedestrian
  - Gunshot wound shattering bone
  - Falling person landing on both feet breaking heel bones
- Indirect forces transmitted along axis of bones
- Fractures classified as closed/open
- Closed fracture - no break in skin over fracture site
- Open fracture - exposed to external environment
- Pain - most common symptom of bone/joint injury
- Angulation of long bones, protuberance of bone end against soft tissues, overriding/separation of bone fragment by opposing muscles can result in visible, palpable deformities
- Fluid/blood loss at site of injury can result in swelling/discoloration of affected part
- Loss of function of skeletal part occurs with injury
Summary

- Never attempt to force movement
- *Crepitus* - grating sensation/sound indicating that bone fragments rubbing against one another
- Bone ends protruding through skin - obvious sign of open fracture

Summary

- Signs specific for dislocation include loss of movement, deformity at joint, joint locked in deformed position, pain, swelling over joint
- Common sites of dislocations include shoulder, elbow, fingers, hip, knee, ankle
- Vascular injuries result in loss of blood flow to distal tissues & blood loss at site

Summary

- Presence of vascular compromise determined by assessing:
  - Distal pulses
  - Skin color & temperature
  - Capillary refill time
  - Pain
  - Numbness, tingling, prickling
  - Sensory loss
  - Paralysis distal to injury
Summary

- Common sites where fractures/dislocation cause disruption of nerves include clavicle, shoulder, humerus, elbow, wrist, hip, femur, knee, spinal cord
- Signs/symptoms of nerve injury include pain, abnormal sensation, loss of motor ability

Summary

- General rules of splinting
  - Immobilize critical patients with spine board
  - When in doubt, splint injury
  - Splint before moving
  - Pad splints, remove clothing
  - Immobilize joint/bone above & below injury
  - Check, recheck neurovascular function
  - Cover open wounds

Summary

- Long board splints can be used to immobilize fractures of knee, tibia, fibula in straightened position
- Immobilize fractures of mid-forearm with rigid splint extending from palm of hand past medial aspect of elbow
- Suspected fractures of forearm/elbow can splint in extended position with rigid splint
Summary
- Fingers splinted with flexible aluminum splint/tongue blade
- Joint injuries can be immobilized in straightened/angulated position
- If extremity is cyanotic/lacks pulses, try to straighten extremity
- Wrist, hand region is immobilized by attachment of rigid splint that extends from proximal joint of phalanges to mid-forearm

Summary
- Angulated, locked elbow may be immobilized in position found
- Sling & swathe - primary immobilization technique for fractures of clavicle, scapula, shoulder, humerus

Summary
- Traction splints used to immobilize painful, swollen, deformed midthigh injuries with no joint/lower leg injury
- Contraindications for use of traction splint include:
  - Injury close to/at knee, hip, pelvis
  - Partial amputation/bone separation
  - Lower leg/ankle injuries
Questions?