<table>
<thead>
<tr>
<th>Terms to Know</th>
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<td><strong>Atonic</strong></td>
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<tr>
<td><strong>Atrophy</strong></td>
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<tr>
<td><strong>Bursa</strong></td>
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<tr>
<td><strong>Callus</strong></td>
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<tr>
<td><strong>Cancellous bone</strong></td>
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<td><strong>Cartilage</strong></td>
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<tr>
<td><strong>Clonus</strong></td>
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<tr>
<td><strong>Contracture</strong></td>
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<tr>
<td><strong>Cortical bone</strong></td>
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<tr>
<td><strong>Crepitus</strong></td>
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<tr>
<td><strong>Diaphysis</strong></td>
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<td><strong>Effusion</strong></td>
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<td><strong>Endosteum</strong></td>
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<td><strong>Epiphysis</strong></td>
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<td><strong>Fascia (epimysium)</strong></td>
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<td><strong>Fasciculation</strong></td>
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<td><strong>Flaccid</strong></td>
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<tr>
<td><strong>Hypertrophy</strong></td>
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<tr>
<td><strong>Isometric contraction</strong></td>
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<tr>
<td><strong>Isotonic contraction</strong></td>
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<tr>
<td><strong>Joint</strong></td>
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<td><strong>Joint capsule</strong></td>
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<td><strong>Kyphosis</strong></td>
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<td><strong>Lamellae</strong></td>
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<td><strong>Lordosis</strong></td>
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<td><strong>Osteoblast</strong></td>
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<td><strong>Osteoclast</strong></td>
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<td><strong>Osteocyte</strong></td>
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Introduction to Orthopedics

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Osteogenesis</td>
<td>Bone formation</td>
</tr>
<tr>
<td>Osteon</td>
<td>Microscopic functional bone unit</td>
</tr>
<tr>
<td>Parasthesia</td>
<td>Abnormal sensation (e.g. burning, tingling, numbness)</td>
</tr>
<tr>
<td>Periosteum</td>
<td>Fibrous connective tissue covering bone</td>
</tr>
<tr>
<td>Remodeling</td>
<td>Process that ensures bone maintenance through simultaneous bone resorption and formation</td>
</tr>
<tr>
<td>Resorption</td>
<td>removal/destruction of tissue, such as bone</td>
</tr>
<tr>
<td>Scoliosis</td>
<td>Lateral curving of the spine</td>
</tr>
<tr>
<td>Spastic</td>
<td>Having greater-than-normal muscle tone</td>
</tr>
<tr>
<td>Synovium</td>
<td>Membrane in joint that secretes lubricating fluid (synovial fluid)</td>
</tr>
<tr>
<td>Tendon</td>
<td>Cord of fibrous tissue connecting muscle to bone</td>
</tr>
<tr>
<td>Tone (tonus)</td>
<td>Normal tension (resistance to stretch) in resting muscle</td>
</tr>
<tr>
<td>Trabeculae</td>
<td>Lattice-like bone structure; cancellous bone; spongy bone</td>
</tr>
</tbody>
</table>

Anatomic & Physiologic Overview

Musculoskeletal system provides

- protection for vital organs
- a framework to support body structures
- allows for mobility
- muscles & tendons hold bones together
- muscles & tendons allow for movement
- muscles also produce heat for temperature maintenance
- serves as a reservoir for immature blood cells & essential minerals (calcium, phosphorus, magnesium & fluorine).

206 bones in human body divided into 4 categories

1. Long bones → example → femur → designed for weight bearing
2. Short bones → example → metacarpals
3. Flat bones → example → sternum → important site for hematopoiesis
4. Irregular → example → vertebrae → unique shape related to function

![Bone Diagram](image)
Introduction to Orthopedics

Bone is in a constant state of turnover
- During childhood bone grows via **modeling**
- Early adulthood bone forms via **remodeling**

The balance between bone resorption & formation is influenced by:

- **Physical activity**
  - particularly weight-bearing activities
  - bones subjected to weight bearing tend to be thick & strong

- **Dietary intake of nutrients** (especially calcium)
  - absorption of approximately 1000-1200mg of calcium is essential to maintaining adult bone mass
  - drinking 16 to 24 ounces of milk daily can achieve this

- **Hormones**
  - calcitriol (activated vitamin D)
    - increases the amount of calcium in the blood by promoting absorption of calcium from the GI tract
    - facilitates mineralization of osteoid tissue
    - vitamin D deficiency results in bone mineralization deficit, deformity, and fracture (GET SOME SUN PLEASE!)
Introduction to Orthopedics

- **parathyroid hormone (PTH)**
  - PTH & calcitonin are major hormonal regulators of calcium homeostasis
  - regulates the concentration of calcium in the blood by promoting movement of calcium from bone
  - low calcium levels in the blood trigger PTH release which in turns prompts the mobilization of calcium, the demineralization of bone and the formation of bone cysts

- **calcitonin**
  - PTH & calcitonin are major hormonal regulators of calcium homeostasis
  - secreted by the thyroid gland
  - released in response to elevated blood calcium levels, inhibits bone resorption and increases the deposit of calcium in bone

- **thyroid hormone**
  - excessive thyroid hormone production in adults (eg Graves' disease) can result in increased bone resorption and decreased bone formation

- **cortisol**
  - increased cortisol levels can result in increased bone resorption and decreased bone formation.

- **growth hormone**
  - stimulates the liver and to a lesser degree the bones to produce insulin-like growth factor 1 (IGF I), which accelerates bone modeling in children and adolescents.
  - Directly stimulates skeletal growth in children and adolescents

- **sex hormones (estrogen & testosterone)**
  - estrogen stimulates osteoblasts and inhibits osteoclasts, thereby enhancing bone formation & inhibiting bone resorption.
  - Testosterone directly causes skeletal growth in adolescence
  - increases muscle mass which results in greater weight bearing stress on bones, which in turn results in increased bone formation
  - in aging men testosterone converts to estrogen in adipose tissue

- **blood supply**
  - bone necrosis can occur when bone is deprived of blood

**Current research is focusing on developing medications that block the effects of RANKL**
- **RANKL is produced by osteoblasts** during bone remodeling and **T cells activated by the inflammatory response**.
- **RANKL** (activated nuclear factor-kappa B ligand) binds to the **RANK** (activated nuclear factor-kappa B) receptor on osteoclast precursors.
- This causes osteoclast formation which instigates bone resorption.
- **Osteoblasts may produce osteoprogerin (OPG)** as opposed to RANKL. This **inhibits the effect of RANKL and thereby turns off bone resorption**.
Bone Healing

- **Phase 1: Reactive Phase:**
  - the body's initial response is similar to that after injury elsewhere in the body
  - there is bleeding into injured tissue & a hematoma forms at the site of the fracture
  - cytokines are released that initiate the fracture healing processes by causing the proliferation of fibroblasts
  - release of fibroblasts cause angiogenesis to occur (the growth of new blood vessels)
  - granulation tissue begins to form within the clot & becomes dense

- **Phase 2: Reparative phase**
  - the granulation tissue is initially replaced with a callus precursor called a procallus.
  - fibroblasts invade the procallus and forms the callus which is made mostly of fibrocartilage
  - the fibrocartilage callus is replaced with denser bony callus in approximately 3-4 weeks post injury.
  - Lamellar bone then forms as the body callus calcifies in the months post injury

- **Phase 3: Remodeling phase**
  - the final phase of fracture healing results in remodeling the new bone into its former structural arrangement
  - remodeling can take months to years, depending on the extent of bone modification needed, the function of the bone and the functional stresses.

Joints

There are three basic kinds of joints

1. Synarthrosis → immovable joints, like the skull sutures
2. Amphiarthrosis → joints that allow limited motion, such as the vertebral joints & the symphysis pubis
3. Diarthrosis → joints that are freely movable, there are different types of diarthrosis joints
   - i. Ball-and-Socket → permit full freedom of movement,
   - ii. Hinge → permits bending in one direction only
   - iii. Saddle → permits movement in two planes at right angles to each other
   - iv. Pivot → permits rotation, thing of the articulation between the radius and the ulna. This type of joint allows us to turn a doorknob
   - v. Gliding → permits limited movement in all directions, the carpal bones of the wrist are a prime example

See pictures on next page for visual representation.
<table>
<thead>
<tr>
<th>Musculoskeletal System</th>
<th>Structural Changes</th>
<th>Functional Changes</th>
<th>History and Physical Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bones</td>
<td>Gradual, progressive loss of bone mass after age 30 yr, Vertebrae collapse</td>
<td>Bones fragile and prone to fracture: vertebrae, hip, wrist</td>
<td>Loss of height, posture changes, kyphosis, loss of flexibility, flexion of hips and knees, back pain, osteoporosis, fracture</td>
</tr>
<tr>
<td>Muscles</td>
<td>Increase in collage and resultant fibrosis, muscles diminish in size, tendons less elastic</td>
<td>Loss of strength and flexibility, weakness, fatigue, stumbling, falls</td>
<td>Loss of strength, diminished agility, decreased endurance, prolonged response time, diminished reaction time, diminished tone, broad base of support, history of falls</td>
</tr>
<tr>
<td>Joints</td>
<td>Cartilage – progressive deterioration, thinning of intervertebral disks</td>
<td>Stiffness, reduced flexibility and pain interfere with activities of daily living</td>
<td>Diminished range of motion, stiffness, loss of height</td>
</tr>
<tr>
<td>Ligaments</td>
<td>Lax ligaments (less than normal strength, weakness)</td>
<td>Postural joint abnormality, weakness</td>
<td>Joint pain on motion, which resolves with rest, crepitus, joint swelling and enlargement, osteoarthritis</td>
</tr>
</tbody>
</table>
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Assessment
- nursing assessment of the pt with musculoskeletal dysfunction includes an evaluation of the effects of the musculoskeletal disorder on the patient
- assess the effects of musculoskeletal problems on general health, accomplishment of daily living, and treatment program management
- encourage optimal nutrition
- individualize plan of care to achieve patient's maximum health

Common symptoms
- **Pain**
  - bone pain is typically described as a dull, deep ache that is “boring” in nature
  - muscular pain is typically described as soreness or aching; can be referred to as muscle cramps.
  - Fracture pain is sharp and piercing; can be relieved by immobilization
  - Sharp pain may also be a result of a bone infection with muscle spasms or pressure on a sensory nerve.
  - Radiating pain occurs in conditions in which pressure is exerted on a nerve root.
  - Pain that increases with activity may indicate
    - joint sprain
    - muscle sprain
    - compartment syndrome
  - Steadily increasing pain points to:
    - progression of an infectious process
    - a malignant tumor
    - neurovascular complications
- **Altered Sensations**
  - Paresthesias → sensory disturbances frequently associated with musculoskeletal problems. May be described as burning, tingling sensations or numbness
  - these sensations may be caused by pressure on nerves or by circulatory impairment
  - soft tissue swelling or direct trauma to these structures can impair the function
  - assessment of the neurovascular status of the involved musculoskeletal area will be enlightening.
  - Questions the nurse should ask regarding altered sensations:
    - is pt experiencing any abnormal sensations or numbness?
    - if yes and it involves an extremity, how does it compare to the unaffected extremity?
    - When did the condition begin? Is it getting worse?
    - Does the pt have pain in addition to altered sensations?
  - Assessments the nurse should make regarding altered sensations:
    - if the affected part is an extremity, how does its overall appearance compare to the unaffected extremity?
    - Can the pt move the affected part? If it is an extremity, does each toe/finger have normal sensation and motion, and is the skin warm or cool?
    - What is the color of the part distal to the affected area? Is it pale? Dusky Mottled?
Cyanotic?
- Does rapid capillary refill occur?
- Is a pulse distal to the affected area palpable? If it is an extremity, how do the bilateral pulses compare?
- Is edema present?
- Is any constrictive device or clothing causing nerve or vascular compression?
- Does elevating the affected part or modifying its position affect the symptoms?

Physical Assessment
An examination of musculoskeletal system ranges from a basic assessment of functional capability to sophisticated physical examination maneuvers that facilitates diagnosis of specific bone, muscle and joint disorders.

Assess:
- Posture – see pictures for abnormalities
- Gait
- Bone integrity (symmetry & crepitus)
- Joint function (ROM, deformity and effusion)
- Muscle strength, size & tone
- Skin
- Neurovascular (CMSTP)
Introduction to Orthopedics

Diagnostic Evaluation

X-ray
Bone X-rays can determine:
- bone density
- bone texture
- bone erosion
- changes in bone relationships
- reveals widening, narrowing and/or irregularities of the bone cortex

Joint X-rays can reveal:
- fluid
- irregularity
- spur formation
- narrowing
- changes in joint structure

- Multiple X-rays are needed for a full assessment.
- Serial X-rays will be ordered to determine the status of the healing process.
- Patient must remain still during x-ray procedure.

Computed Tomography [[CT Scan]]
- can be performed with or without contrast
- shows in detail, a specific plane of involved bone
- can reveal tumors of the soft tissue
- can reveal injuries to the ligaments and tendons
- typically used to identify the location and extent of fractures in areas that are difficult to evaluate (eg acetabulum)
- patient must remain still during the procedure

Magnetic Resonance Imaging [[MRI]]
- a noninvasive imaging technique that uses magnetic fields, radiowaves & computers to demonstrate abnormalities of soft tissues (eg muscle, tendon, cartilage, nerve and fat)
- because an electromagnet is used, patients with metal implants, clips or pacemakers are not candidates.
- Contrast agent may be used to enhance visualization
- patient must remain still during procedure

Arthrography
- useful in identifying acute or chronic tears of the joint capsule or supporting ligaments of the knee, shoulder, ankle, hip or wrist
- a radiopaque contrast agent or air is injected into the joint cavity to visualize irregular surfaces
- the joint is put through its range of motion to distribute the contrast agent while a series of x-rays is obtained
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- if a tear is present, the contrast agent leaks out of the joint and is evident on the x-ray image
- after an arthrogram, a compression elastic bandage is applied as prescribed and the joint is usually rested for 12 hours
- comfort measures (mild analgesia, ice) need to be provided after procedure is done
- it is normal to experience clicking or crackling in the joint for a day or two after the procedure

Bone Densitometry [[DEXA]]

- used to estimate bone mineral density (BMD)
- can be performed through the use of x-rays or ultrasound
- usual ways is dual energy x-ray absorptiometry (DXA or DEXA), quantitative computer tomography (QCT), and/or quantitative ultrasound (QUS)
- DXA BMD measures of the hip and spine are very accurate in estimating the extent of osteoporosis

Bone Scan

- performed to detect metastatic and primary bone tumors, osteomyelitis, some fractures and aseptic necrosis
- a bone-seeking radioisotope is injected via IV
- the scan is performed 2 to 3 hours after the injection
- the distribution and concentration of the isotope is measured. An increased uptake of the isotope is seen in primary skeletal disease (osteosarcoma), metastatic bone disease, inflammatory skeletal disease (osteomyelitis) and fractures that do not heal as expected.
- The bladder must be emptied prior to the scan

Arthoroscopy

- a procedure that allows direct visualization of a joint to diagnose joint disorders
- treatment of tears, defects and disease processes may be performed through the arthroscope
- it is a sterile procedure
- injection of a local anesthetic agent or anesthesia is used
- a large-bore needle is inserted into the joint, and then the joint is distended with saline
- the arthroscope is introduced and the joint structures, synovium and articular surfaces are visualized.
- After the procedure, the puncture wound is closed with adhesive strips or sutures and is covered with a sterile dressing.
- Complications can include infection, hemarthrosis, neurovascular compromise, thrombophlebitis, stiffness, effusion, adhesions and delayed wound healing.

Arthrocentesis

- aka joint aspiration
- carried out to obtain synovial fluid for purposes of examination and/or to relieve pain due to effusion
- compare to draining Water-on-the-Knee
- examination of synovial fluid is helpful in the diagnosis of septic arthritis and other inflammatory arthropathies
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- this can reveal the presence of hemarthrosis (bleeding into the joint cavity)
- normally synovial fluid is clear, pale, straw colored and is scanty in volume.
- Anti-inflammatory medications may be injected into the joint
- a sterile dressing is applied after aspiration
- there is a risk for infection after this procedure

Electromyography

- EMB provides information about the electrical potential of the muscles and the nerves
- the test is performed to evaluate muscle weakness, pain and disability
- needle electrodes are inserted into selected muscles & responses to electrical stimuli are recorded on an oscilloscope
- warm compresses may relieve residual discomfort

Biopsy

- may be performed to determine the structure and composition of bone marrow, bone, muscle or synovium to help diagnose specific diseases
- analgesic agents will be prescribed for comfort
- nurse needs to monitor the biopsy site for edema, bleeding, pain and infection
- ice is applied as prescribed

Laboratory Studies

- examination of the patient's blood and urine can provide information on a primary musculoskeletal problem, a developing complication, the baseline for instituting therapy, or the response to therapy.
- Before surgery coagulation studies should be performed to detect bleeding patterns.
- Serum calcium levels are altered in patients with osteomalacia, parathyroid dysfunction, Paget's disease, metastatic bone tumors, or prolonged immobilization
- serum phosphorus levels are inversely related to calcium levels and are diminished in osteomalacia associated with malabsorption syndrome.
- Acid phosphatase is elevated in Paget's disease and metastatic cancer
- alkaline phosphatase is elevated during early fracture healing & in diseases with increased osteoblastic activity (like metastatic bone tumors)
- bone metabolism may be evaluated through thyroid studies and determination of calcitonin, PTH and vitamin D levels
- serum enzyme levels of creatine kinase and aspartate aminotransferase become elevated with muscle damage
- serum osteocalcin indicates the rate of bone turnover
- urine calcium levels increase with bone destruction
Management of Patients with Musculoskeletal Trauma

<table>
<thead>
<tr>
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<th>Definition</th>
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<tbody>
<tr>
<td>Allograft</td>
<td>Tissue harvested from a donor for use in another person</td>
</tr>
<tr>
<td>Amputation</td>
<td>Removal of a body part, usually a limb or part of a limb</td>
</tr>
<tr>
<td>Arthroscope</td>
<td>Surgical scope injected into the joint to examine or repair</td>
</tr>
<tr>
<td>Autograft</td>
<td>Tissue harvested from one area of the body and used for transplantation to another area of the same body</td>
</tr>
<tr>
<td>Avascular necrosis</td>
<td>Death of tissue secondary to a decrease or lack of perfusion</td>
</tr>
<tr>
<td>Contusion</td>
<td>Blunt force injury to soft tissue</td>
</tr>
<tr>
<td>Crepitus</td>
<td>A grating sound or sensation by rubbing bony fragments together</td>
</tr>
<tr>
<td>Debridement</td>
<td>Surgical removal of contaminated and devitalized tissues and foreign material</td>
</tr>
<tr>
<td>Delayed union</td>
<td>Prolongation of expected healing time for a fracture</td>
</tr>
<tr>
<td>Disarticulation</td>
<td>Amputation through a joint</td>
</tr>
<tr>
<td>Dislocation</td>
<td>Complete separation of joint surfaces</td>
</tr>
<tr>
<td>Fracture</td>
<td>A break in the continuity of a bone</td>
</tr>
<tr>
<td>Fracture reduction</td>
<td>Restoration of fracture fragments into anatomic alignment</td>
</tr>
<tr>
<td>Malunion</td>
<td>Healing of a fractured bone in a misaligned position</td>
</tr>
<tr>
<td>Nonunion</td>
<td>Failure of fractured bones to heal together</td>
</tr>
<tr>
<td>Phantom limb pain</td>
<td>Pain perceived in an amputated section</td>
</tr>
<tr>
<td>RICE</td>
<td>Acronym for rest, ice, compression, elevation</td>
</tr>
<tr>
<td>Sprain</td>
<td>An injury to ligaments and muscles and other soft tissues at a joint.</td>
</tr>
<tr>
<td>Strain</td>
<td>A musculotendinous stress injury</td>
</tr>
<tr>
<td>Subluxation</td>
<td>Partial separation of joint structures.</td>
</tr>
</tbody>
</table>

Soft Tissue Injuries

**Contusions**
- a soft tissue injury produced by blunt force
- causes small blood vessels to rupture & bleed into surrounding soft tissue (ecchymosis or bruising)
- a hematoma develops from the bleeding at the site of impact
- local symptoms
  - pain
  - swelling
  - discoloration
- symptoms can be controlled with application of cold packs, compression and the elevation of the extremity above heart level.
- Most contusions resolve in 1 to 2 weeks
Introduction to Orthopedics

**Strains**

- aka “pulled muscle or tendon”
- an injury caused by overuse, overstretching or excessive stress
- typically is a developed injury, not a sudden onset injury
- strains are graded along a continuum based on post-injury symptoms:
  - A first-degree strain is mild stretching of the muscle or tendon. Signs and symptoms may include minor edema, tenderness, and mild muscle spasm. There is no noticeable loss of function.
  - A second-degree strain involves partial tearing of the muscle or tendon. Signs and symptoms include loss of load-bearing strength with accompanying edema, tenderness, muscle spasms, and ecchymosis.
  - A third-degree strain is severe muscle or tendon stretching with rupturing and tearing of the involved tissue. Signs and symptoms include significant pain, muscle spasm, ecchymosis, edema, and loss of function. An x-ray should be obtained to rule out bone injury, because an avulsion fracture may be associated with a third-degree strain. An MRI will reveal a third-degree strain, but x-rays do not reveal injuries to soft tissue, muscles, tendons or ligaments.

**Sprains**

- an injury to the ligaments and tendons that surround a joint
- caused by a twisting motion or hyperextension (forcible) of a joint
- causes joint instability
- blood vessels rupture and edema occurs
- the joint is tender and movement of the joint becomes painful
- the degree of disability and pain increases during the first 2 to 3 hours because of the associated swelling and bleeding, especially if treatment is delayed.
- Sprains are graded in a manner similar to the grading system used for strains
  - A first-degree sprain is caused by stretching the ligament, resulting in minimum damage. It's manifested by mild edema, local tenderness and pain that is elicited when the joint is moved.
  - A second-degree sprain involves partial tearing of the ligament. Results in increased edema, tenderness, pain with motion, joint instability and partial loss of normal joint function.
  - A third-degree sprain occurs when a ligament is completely torn or ruptured. A third-degree sprain may also cause an avulsion of the bone. Symptoms include severe pain, tenderness, edema, and abnormal joint motion.

**Joint Dislocations**

**Dislocation**

- a condition in which the articular surfaces of the distal and proximal bones that form the joint are no longer in anatomic alignment
- a subluxation is a partial dislocation and does not cause as much deformity
- in complete dislocation the bones are literally “out of joint”
- traumatic dislocations are orthopedic emergencies because the associative structures, blood supply, and nerves are displaced and may be entrapped due to extensive pressure. If the
dislocation or subluxation is not reduced immediately, avascular necrosis may develop.

- Signs & symptoms of traumatic dislocation include acute pain, change in position of the joint, shortening of the extremity, deformity, and decreased mobility.
- X-rays will confirm the diagnosis & reveal and associative fractures.
- Affected joints need to be immobilized at the scene and during transport to the hospital.
- Analgesia, muscle relaxants and possible anesthesia are used to facilitate closed reduction.
- The joint is immobilized by splints, casts, or traction & is maintained in a stabilized position.
- Neurovascular status is assessed at a minimum of every 15 minutes until stable.
- After reduction, if the joint is stable, gentle, progressive, active and passive movement is begun to preserve range of motion & restore strength.
- The joint is supported between exercise sessions.

**Injuries to the Tendons, Ligaments & Menisci**

**Rotator Cuff Tears**

- a tear in a tendon that connects one of the rotator muscles to the humeral head
- the rotator cuff stabilizes the humeral head & is composed of four muscles & their tendons (includes the supraspinatus, infraspinatus, teres minor, and subscapularis).
- May result from acute injury or from chronic joint stresses
- patients complain of pain, limited ROM, some joint dysfunction, and muscles weakness.
- Many times patients experience night pain and cannot sleep on the involved side.
- Patients cannot perform over-the-head activites
- the acromioclavicular join is tendernessx-rays are helpful in evaluating join
- arthrography, MRI or ultrasound tests are used tod etermine soft tissue pathology & the extent of the rotator cuff tear
- conservative management includes use of NSAIDS, rest, modification of activites, injection of a corticosteroid into shoulder join, progressive stretching, progressive ROM and lengthening exercises
- surgery may be necessary, including debridement, arthroscopic or open acromioplasty, and/or tendon repair. Postop, the should is immobilized for several days to 4 weeks.
- Physical therapy with shoulder exercises is begun as prescribed.
- Full recovery is 6 to 12 months.

**Epicondylitis**

- chronic, painful condition that is caused by excessive, repetitive extension, flexion, pronation and supination motions of the forearm
- the motions result in inflammation & minor tears in the tendons at the origin of the muscles on the lateral or medial epicondyles
- lateral epicondylitis (tennis elbow) occurs often in individuals who repeatedly extend the wrist or frequently pronates and supinates the forearm
- medial epicondylitis (golfers or pitchers elbow) is consistent with repetitive wrist flexion
- application of ice & administration of NSAIDS usually relieves pain
- sometimes the arm is immobilized in molded splints or casts
- local injection of corticosteroid is reserved for pts with severe pain who do not respond to NSAIDS
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- after pain subsides, rehab exercises include gentle and gradual increased stretching of the tendon

**Lateral & Medial Collateral Ligament Injury**
- lateral & medial collateral ligaments of the knee provide stability to the knee
- injury occurs when the foot is firmly planted and the knee is struck from the side
- the pt experiences an acute onset of pain, point tenderness, joint instability and inability to walk without assistance
- early management includes RICE
- the joint should be evaluated for fracture
- hemarthrosis (bleeding into the joint) can develop
- joint fluid may be aspirated to relieve pressure
- treatment depends on severity
- conservative management includes limited weight bearing & use of a protective brace
- as pain subsides, ROM exercise is encouraged
- pt's return to full activities, including sports, depends on return of motion, functional stability of joint & muscle strength.
- Surgical reconstruction may be needed immediately or it may be delayed
- if surgery is indicated, the leg is immobilized for approximately 6 to 8 weeks
- progressive rehab programs help restore the function & strength of the knee
- rehab occurs over months & the pt may need to wear a derotational brace while engaging in sports to prevent reinjury
- nurse needs to instruct the pt about proper use of ambulatory devices, the healing process & activity limitations
- education should address pain management, analgesic use, antibiotic use, brace use, wound care, signs & symptoms of possible complications, and self-care.

**Cruciate Ligament Injury**
- anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL) of the knee stabilize the motion of the tibia articulating with the femur.
- The ligaments cross each other in the center of the knee
- injury occurs when the foot is firmly planted and the leg sustains direct force, forward or backward.
- The injured person may report feeling & hearing a pop in the knee with this injury
- if the patient exhibits significant swelling of the joint within 2 hours after the injury the ACL or PCL may be torn
- a torn cruciate ligament produces pain, joint instability and pain with weight bearing
- immediate postinjury management includes RICE and stabilization
- the joint may need to be evaluated for fracture
- severe joint effusion & hemarthrosis may require joint aspiration & wrapping with an elastic compression dressing (ace bandage)
- treatment depends on severity of injury and effects on daily living
- early intervention includes application of a brace and physical therapy
- surgical reconstruction may be scheduled after near-normal joint ROM is achieved and can
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- include tendon repair with grafting
  - this surgery is typically rendered as ambulatory arthroscopic surgery
  - the best candidates for this surgery are patients who are young and physically active
  - older less active pt's tend to benefit from non-surgical therapy
  - after surgery the pt is taught to control pain w/ oral analgesics and cryotherapy
  - pt & family are taught about monitoring the neurovascular status of the leg, wound care, and signs of complications
  - exercises are encouraged during the early post operative period.
  - Pt must protect the graft by complying with exercise restrictions
  - a physical therapis supervises progressive ROM and weight bearing activities
  - continous passive motion may be helpful in restoring full ROM

Meniscal Injuries

- there are two crescent-shaped cartilages in the knee, called the menisci
- the structures act as shock absorbers in the knee
- normally, little twisting movement is permitted in the knee joint
- twisting the knee or repetitive squatting and impact may result in either tearing or detachment of the cartilage from its place at the head of the tibia
- these injuries leave loose cartilage in the knee joint, which can interfere with full extension of the leg
- if it occurs during walking or running, the pt fees as though the leg “gives out”
- the pt may hear or feel a click in the knee when walking, especially when extending the leg that is bearing weight
- the cartilage can also “lock” the knee so that it neither flexes nor extends
- when a meniscus I torn, the synovial membrane secretes additional synovial fluid & the knee becomes very edematous
- initial conservative treatment includes immobilization of the knee, use of crutches, anti-inflammatory agents, analgesics and modification of activities to avoid those that cause the symptoms
- an MRI is used to detect a torn meniscus
- damaged cartilage is surgically removed (meniscectomy) arthroscopically
- after surgery a pressure dressing is applied
- most common complication is effusion into the knee joint, causing pain
- pt will be instructed to continue quadriceps-setting & ROM exercises

Rupture of the Achilles Tendon

- the Achilles tendon attaches the soleus and gastocnemius to the heel
- traumatic rupture of the Achilles tendon, generally within the tendon sheath, occurs during activities when there is a sudden contraction of the calf muscle with the foot firmly fixed to the floor or ground.
- The pt experiences sharp pain & cannot plantar flex the foot
- immediate surgical repair of complete Achilles tendon ruptures is usually necessary to obtain good results
- after surgery, a cast or brace is used to immobilize the joints
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- conservative management with a plantar flexed cast for 6-8 weeks may be used
- after immobilization, a heel lift is worn and progressive physical therapy is used to promote ankle ROM and strength

**Fractures**
A fracture is a complete or incomplete disruption in the continuity of bone structure. It is defined according to its type & extent.

Open Fractures are graded according to the following criteria:
- Grade I is a clean wound less than 1 cm long
- Grade II is a larger wound without extensive soft tissue damage
- Grade III is highly contaminated, has extensive soft tissue damage, and is the most severe.

**Clinical Manifestations of Fractures**

**Pain**
- pain is continuous and increases in severity until bone fragments are immobilized
- muscle spasms that accompany a fracture begin within 20 minutes after the injury and result in more intense pain
- the muscle spasms can minimize further movement of the fracture fragment OR can result in further fragmentation or misalignment.

**Loss of Function**
- after a fracture, the extremity cannot function properly
- pain contributes to loss of function
- false motion may be present.

**Deformity**
- displacement, angulation or rotation of fragments will cause deformity in an extremity
- easily detectable when the effected limb is compared to an uninjured limb

**Shortening**
- in fractures of long bones, there is actual shortening of the extremity
- sometimes muscle spasms can cause the distal and proximal site of the fracture to overlap

**Crepitus**
when injured extremity is gently palpated, a crumbling sensation can be felt is caused by the rubbing of bone fragments against each other

**Nursing alert**
Testing for crepitus can produce further tissue damage and should be minimized as much as possible

**Localized edema & Ecchymosis**
- localized edema & ecchymosis occurs after a fracture as a result of trauma
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- the signs may not develop for several hours after the injury
- rapidity of symptoms depends upon the severity of the fracture

**Not all signs/symptoms are present for every fracture.**

**Types of Fractures**

- Simple
- Compound or Open
- Comminuted
- Greenstick

- Oblique
- Spiral
- Impacted
- Transverse
Additional Types of Fractures

- Compression
- Avulsion
- Depressed

Open, Closed, Incomplete, Complete, Displaced, Comminuted
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Emergency Management of Fractures
• immediately after injury, if a fracture is suspected, it is important to immobilize the body part before pt is moved
• joints proximal and distal to fracture must be immobilized to prevent movement of racture fragments
• immobilization of the long bones of lower extremities may be accomplished by bandaging legs together
• immobilization of an upper extremity can be accomplished by bandaging the arm to the chest, or by placing a forearm in a sling.
• The neurovascular status distal to the injury should be assess before and after splinting to determine adequacy of peripheral tissue perfusion & nerve function.
• In an open fracture the wound is covered with a sterile dressing; do not attempt to reduce the fracture, even if a bone fragment is protruding from the wound

Assessment of a Fracture: The 5 P's
• Pain & point of tenderness
• Pulse [[distal tot he fracture site ]]
• Pallor
• Paresthesia [[sensation distal to the fracture site]]
• Paralysis [[movement distal to the fracture site]]

Medical Management of Fractures
• Fracture reduction
  ○ refers to restoration of the fracture fragments to anatomic alignment & positioning
  ○ closed or open reduction may be used to reduce a fracture
  ○ specific method selected will depend on the nature of the fracture
  ○ pt is prepped for procedure before reduction
  ○ consent is obtained & an analgesic is administered as prescribed
  ○ an anesthesia may be administered

<table>
<thead>
<tr>
<th>Closed Reduction</th>
<th>Open Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Accomplished by bringing the bone fragments into anatomic alignment through manipulation and manual traction</td>
<td>• Through a surgical approach, fracture fragments are anatomically aligned</td>
</tr>
<tr>
<td>• extremity is held in position while physician applies a cast, splint or other device</td>
<td>• internal fixation devices may be used</td>
</tr>
<tr>
<td>• reduction under anesthesia with percutaneous pinning may also be used</td>
<td>○ metallic pins</td>
</tr>
<tr>
<td>• the immobilizing device maintains the reduction &amp; stabilizes the extremity for bone healing</td>
<td>○ wires</td>
</tr>
<tr>
<td>• x-rays will verify the bone fragments are correctly aligned</td>
<td>○ screws</td>
</tr>
<tr>
<td></td>
<td>○ plates</td>
</tr>
<tr>
<td></td>
<td>○ nails</td>
</tr>
<tr>
<td></td>
<td>○ rods</td>
</tr>
<tr>
<td></td>
<td>• devices may be attached to the sides of bones, inserted through bony fragments or directly into the medullary cavity of the bone</td>
</tr>
</tbody>
</table>
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- traction (skin or skeletal) may be used until pt is physiologically stable to undergo surgical fixation
- internal fixation devices ensure firm approximation & fixation of the bony fragments

- Immobilization
  - after a fracture has been reduced, the bone fragments must be immobilized in the proper position
  - can be accomplished by external or internal fixation
  - external fixation
    - bandages
    - casts
    - splints
    - continuous traction
    - external fixators

Open fractures will also require treatment to prevent infection:
- tetanus prophylaxis
- antibiotics
- cleaning & debridement of wound
- closure of the primary wound may be delayed to permit edema and allow for wound drainage, further assessment and debridement if necessary.

Complications of Fractures
- weeks to months are required for most fractures to heal
- in comminuted fractures the fragments must be properly aligned to attain the best healing possible
- adequate blood supply is essential to facilitate healing
- fractures of flat bones (pelvis, sternum & scapula) tend to heal rapidly
- a complex, comminutes fracture may heal slower
- fractures at ends of long bones, where bone is more vascular, heals more quickly than fractures in the mid shaft area (bone is dense & less vascular)
- weight bearing stimulates healing of stabilized fractures

<table>
<thead>
<tr>
<th>Factors that Enhance Fracture Healing</th>
<th>Factors that Inhibit Fracture Healing</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Immobilization of fracture fragments</td>
<td>• Extensive local trauma</td>
</tr>
<tr>
<td>• maximum bone fragment contact</td>
<td>• bone loss</td>
</tr>
<tr>
<td>• sufficient blood supply</td>
<td>• weight bearing prior to approval</td>
</tr>
<tr>
<td>• proper nutrition</td>
<td>• misalignment of the fracture fragments</td>
</tr>
<tr>
<td>• exercise: weight bearing for long bones</td>
<td>• inadequate immobilization</td>
</tr>
<tr>
<td>• hormones: growth hormone, thyroid, calcitonin, vitamin D, anabolic steroids</td>
<td>• space or tissue between bone fragments</td>
</tr>
<tr>
<td>• electric potential across fracture</td>
<td>• infection</td>
</tr>
<tr>
<td></td>
<td>• local malignancy</td>
</tr>
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<td></td>
<td>• metabolic bone disease</td>
</tr>
</tbody>
</table>
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| • irradiated bone (radiation necrosis) |
| • avascular necrosis |
| • intra-articular fracture (synovial fluid contains fibrolysins, which lyse the initial clot & retard clot formation) |
| • age (elderly persons heal slower) |
| • corticosteroids (inhibit the repair rate) |

Early Complications of Fractures

Shock

- hypovolemic shock results from hemorrhage
- more frequently noted in trauma pt's with pelvic fractures & pt's with displaced or open femoral fractures
- treatment consists of stabilizing fracture, restoring blood volume & circulation, reducing pain, providing proper immobilization and protection from other complications

Fat Embolism Syndrome

- after fracture of long bones, pelvic bones, or crush injuries, fat emboli can developing occurs most frequently in adults younger than 40 & in men
- more common in pt's w/ multiple fractures
- at time of fracture, fat globules may diffuse from marrow into the vascular compartment
- the emboli may occlude small blood vessels that supply blood to lungs, brain, kidneys & other organs.
- Onset of symptoms is rapid (within 12-48 hrs after injury)
- can still occur up to 10 days after injury
- manifestations:
  - presenting features
    - hypoxia
    - tachypnea
    - tachycardia
    - pyrexia
  - respiratory distress
    - tachypnea
    - dyspnea
    - crackles
    - wheezes
    - precordial chest pain
    - cough
    - large amounts of thick white sputus
    - tachycardia
  - occlusion of many small vessels can lead to a high blood pressure
  - edema & hemorrhages in alveoli impairs gas exchange & leads to hypoxia.
  - PaO2 drops to less than 60mmHg w/ early respiratory alkalosis and later respiratory acidosis
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- chest x-ray shows a “snowstorm” infiltrate
- w/o prompt treatment, acute pulmonary edema, acute respiratory distress syndrome, and heart failure may develop
- cerebral disturbances brought on by hypoxia & lodging of fat emboli in the brain are manifested by mental status changes varying from headache & mild agitation to delirium & coma.
- Systemic embolization makes pt appear pale
- pt develops a fever of greater than 103 degrees F (39.5 degrees C
- free fat may be found in the urine
- acute tubular necrosis & renal failure may develop

Compartment syndrome

- Thick layers of tissue called fascia separate groups of muscles in the arms and legs from each other
- Inside each layer of fascia is a confined space, called a compartment, that includes the muscle tissue, nerves, and blood vessels
- fascia does not expand, so when edema occurs within the compartment, pressure increases
- compartment syndrome develops when pressure within a compartment is greater than normal
- This leads to impaired blood flow and muscle and nerve damage
- If the pressure lasts long enough, the limb may die and need to be amputated.
- Management: elevate to the level of the heart, but not above!!!! and release restrictive devices
- if conservative management measures do not work within 1 hour, a vasciotomy must be completed by a physician
Venous thromboemboli (deep vein thrombosis) / Pulmonary embolism

- associated with reduced skeletal muscle contractions & bed rest
- pt w/ fractures of the lower extremities & pelvis are at high risk for these
- PE's may cause death several days to weeks after injury
- disseminated intravascular coagulation (DIC) is a systemic disorder that results in widespread hemorrhage and microthrombosis with ischemia
- causes are diverse and can include massive tissue trauma
- early manifestation of DIC include unexpected bleeding, bleeding from mucous membranes, bleeding from venipuncture sites, bleeding from the GI and GU tracts.

Delay complications of Fractures

Delayed union

- occurs when healing does not occur within the expected time frame for location & type of fractures
- can be associated with:
  - distraction [[pulling apart of bone fractures]]
  - system or local infection
  - poor nutrition
  - comorbidities (diabetes mellitus)
  - autoimmune diseases
- the healing time is prolonged, but the fracture does heal

Malunion / Nonunion

- malunion → results from failure of the ends of the fractured bone to unite in normal alignment
- nonunion → results from failure of ends of a fractured bone to unite
- pt complaints of persistent discomfort & abnormal movement at fracture site can be symptomatic of these issues
- factors contributing to nonunion & malunion
  - infection at fracture site
  - interposition of tissue between bone ends
  - inadequate immobilization
  - manipulation that disrupts callus formation
  - excessive space between bone fragments
  - limited bone contact
  - impaired blood supply (resulting in AVN_)
- in nonunion, fibrocartilage or fibrous tissue exists between the bone fragments, but not bone salts have been deposited.
- a false joint (pseudarthrosis) often develops at the site of the fracture.

AVN of bone (necrosis)

- occurs when bone loses its blood supply & dies
- may occur after a fracture with disruption of the blood supply to a distal area
- can occur in dislocation, bone transplantation, prolonged high-dose corticosteroid therapy,
chronic renal disease, sickle cell anemia and other diseases

- the devitalized bone may collapse or reabsorb
- pt develops pain & experiences limited movement
- x-rays reveal loss of mineralized matrix & structural collapse
- treatment consists of attempts to revitalize the bone w/ bone grafts, prosthetic replacement or arthrodesis (joint fusion)

**Reaction to internal fixation devices**

- internal fixation devices may be removed after bony union has taken place
- in most pt's the device is not actually removed unless it produces symptoms
- pain & decreased function are the prime indicators of a problem
- problems can include:
  - material failure
  - faulty or damage device
  - corrosion of the device
  - local inflammation
  - allergica response to metallic alloy
  - ostoporotic remodeling adjacent to the fixation site
- if device is removed, bone needs to be protected from refracture related to osteoporosis, altered bone structure & trauma

**Complex regional pain syndrome (CRPS, formerly called reflex sympathetic dystrophy)**

- a painful sympathetic nervous system problem
- occurs infrequently, but when it does occur, it's usually in an upper extremity after trauma
- seen more frequently in women
- clinical manifestations of CRPS include:
  - severe burning pain
  - local edema
  - hyperesthesia
  - stiffness
  - discoloration
  - vasomotor skin changes (fluctuating warm, red, dry and cold, sweaty, cyanotic)
  - trophic changes that may include glossy, shiny skin & increased hair and nail growth
- syndrome is frequently chronic w/ extension of symptoms to adjacent areas of the body
- disuse muscle atrophy & bone deossification (osteoporosis) may occur w/ persisten CRPS
- might be prevented by elevating the extremity after injury/surgery
- might also be prevented by a selection of an immobilization device that allows for the greatest ROM & functional use of the rest of the extremity
- early effective pain relief is the focus of managemtn
- pain may need to be controlled with analgesics
- NSAIDS, corticosteroids & muscle relaxants may also be used
- nurse needs to avoid using the affected extremity for blood pressure measurements & venipuncture sites
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**Heterotopic ossification**
- aka myositis ossificans
- the abnormal formation of bone, near bones or in muscle, in response to soft tissue trauma or fracture after blunt trauma or total joint replacement
- the muscle is painful & normal muscular contract and movement are limited
- early mobilization may prevent its occurrence
- usually bone lesions reabsorbs over time
- abnormal bone eventually may need to be excised if symptoms persist.

**Amputation**

Amputation → the removal of a body part, often an extremity

**Reasons for Amputation**
- progressive peripheral vascular disease (often a sequela of diabetes mellitus)**
- fulminating gas gangrene
- trauma*
- congenital deformities
- chronic osteomyelitis
- malignant tumor*

*Upper extremity amputation is usually a result of these reasons
**Lower extremity amputation is usually a result of this reason

Amputation is used to
- relieve symptoms
- improve functional to save or improve the patient's quality of life

Site of amputation is always the most distal point that will heal successfully; determined by:
1. circulation in the part
2. functional usefulness (ie, meets the requirements for the use of a prosthesis

**Complications:**
- Hemorrhage
- Infection
- Skin Breakdown
- Joint contracture
- Phantom limb pain → The nerve endings at the site of the amputation continue to send pain signals to the brain that make the brain think the limb is still there

**Medical Management** [[achieve the healing of]]
- The amputation wound
- The residual stump
- Maintain healthy skin for prosthesis use
Rehabilitation
A multidisciplinary rehab team needed. In addition to physical therapy, a pt will need psychological support for:

- Body Image
- Long Term Rehabilitation
- Modification of life style