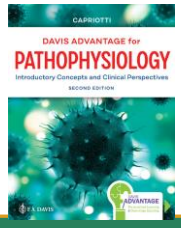


Chapter 37

Musculoskeletal Trauma

1

Basic Concepts

- Muscles, bones, cartilage, tendons, ligaments
- Bones: 206 in adult body
- Two forms
  - Cortical (dense)
  - Trabecular (spongy, cancellous)
    - Wrist, hip, and vertebrae have high percentage of trabecular bone, more susceptible to osteoporosis

2

Bone Development and Growth

- Osteogenesis: bone growth
- Skeleton continues to grow until about the age of 25 years
- Formation of diaphysis (shaft) and epiphyses (ends) of long bones

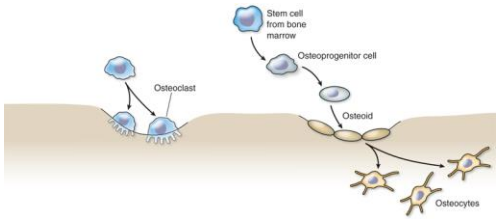
3

Types of Bone Cells

- Osteoblasts
  - Bone-forming cells
- Osteocytes
  - Mature osteoblasts, maintain bone matrix
- Osteoclasts
  - Bone resorption
- Osteoprogenitor cells
  - Differentiate into osteoblasts

4

Bone Physiology



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Bone Physiology (continued)

- Basic multicellular unit (BMU)
  - Bone remodeling
  - Osteoclasts and osteoblasts work together to reform bones
- Peak bone mass obtained at ages 30–35 years
- Adequate calcium and vitamin D essential for bone health
  - Calcitonin: released by C-cells of thyroid when serum calcium levels are elevated
  - PTH: released when serum calcium levels are reduced

6

Skeletal Muscle

- Composed of skeletal muscle fibers
- Myofilaments
  - Actin
  - Myosin
- Can undergo hypertrophy or atrophy

7

Tendons and Ligaments

- Tendons
  - Attach muscle to bone
  - Overuse injuries
    - Tendinopathies
- Ligaments
  - Attach bone to bone
  - Capsular
    - Part of joint capsule
  - Extracapsular
    - Provide stability
  - Can rupture
  - Less stability after injury and healing

8

Basic Concepts (continued)

- Sprain
  - Overstretch ligament with possible tear
  - 3 grades of sprain
- Strain
  - Overstretch of muscle or tendon
- Muscle contusion
- Bone fracture
- Neurovascular injury
- Soft tissue injury
  - Contractile
    - Tissues of contraction
  - Inert
    - Support role

Bone Fracture Healing

- Stage 1
  - Fracture and inflammatory phase
  - Bleeding between edges of fractured bone
- Stage 2
  - Granulation tissue formation
  - Fibroblasts are attracted to the area of injury, growth of vascular tissue

Bone Fracture Healing (continued)

- Stage 3
  - Callus formation consisting of osteoblasts and chondroblasts
  - Synthesis of extracellular organic matrix of woven bone and cartilage

Bone Healing

- Stage 4
  - Lamellar bone deposition
  - Strengthening phase, ossification occurring
- Stage 5
  - Remodeling
  - Final phase involves remodeling of the bone at the site of fracture
  - Adequate strength commonly occurs in 3 to 6 months

Common Types of Fracture

Type	Description
Closed (Complete)	A fracture in which bone fragments separate completely.
Open (Compound)	Fracture of bone that protrudes to the outside of the body.
Incomplete	A fracture in which the bone fragments are still partially joined.
Compression	A fracture that consists of the crushing of cancellous bone.
Transverse	A fracture where parts of the bone are separated but close to each other.
Comminuted	A fracture with more than one fracture line and more than two bone fragments, which may be shattered or crushed.

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Common Types of Fracture (continued)

Type	Description
Stress Fracture	A failure of one cortical surface of the bone, often caused by repetitive activity.
Avulsion	Separation of a small fragment of bone at the site of attachment of a ligament or tendon.
Greenstick	An incomplete break in the bone with the intact side of the cortex flexed (one side is broken and the other is bent). It is usually seen in children.
Impacted	One part of the fracture is compressed into an adjacent part of the fracture.

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Bone Healing (continued)

- After fracture, a bone callus mineralizes and shows up on x-ray within 6 weeks
- Use of anti-inflammatory or immunosuppressive agents, such as steroids, can delay bone's healing process

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Skeletal Muscle Healing

- Regeneration heightened in response to injury
- Myocytes: muscle fibers
- Injury to surrounding nerves and blood vessels play a role in return to function
- Repaired muscle is not as strong as it was prior to injury

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Trauma

- With major trauma, the following life-saving measures are instituted first:
  - Airway with cervical spine protection
  - Breathing and ventilation
  - Circulation and hemorrhage control
  - Disability and neurological evaluation
  - Exposure and environmental control

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Musculoskeletal Assessment

- Pain
- Radiation of pain
- Tenderness
- Swelling
- Color
- Wound and wound drainage
- Deformity
- Sensation
- Muscle girth
- Paresthesia
- Pulse strength
- Muscle strength
  - 0/5 to 5/5
- Range of motion and limitations of movement
- Joint stiffness
- Joint clicking
  - Crepitus
- Joint instability
- Joint swelling

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Range of Motion (ROM)

- Passive
  - Muscle relaxed while examiner moves the joint
- Active
  - Patient uses his or her muscles for movement
- Active and passive ROM should be equal
- Crepitus
  - Clicking of joint

19

Diagnosis

- Diagnosis
  - X-ray, ultrasound, DEXA (bone mineral density)
  - CT, MRI, radionuclide bone scan
  - EMG

20

Diagnosis and Treatment

- Treatment
  - Most injuries are self-limiting
  - RICE therapy
  - Realign bones
    - Closed reduction
      - Devise worn outside
    - Open reduction
      - Surgical insertion of hardware
    - ORIF
      - Open reduction and internal fixation

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Treatment

- DVT and PE increased risk following orthopedic surgery
  - Anticoagulant therapy
- Other nonpharmacological therapies for musculoskeletal injuries
  - Physical therapy
  - Massage
  - Acupuncture
  - Transcutaneous electrical nerve stimulation (TENS)
  - Chiropractic care

22

Neurological and Vascular Injury

- Arterial injury a concern in some fractures
- To assess neurovascular status, check pulses and sensation distal to injury
- Patient will exhibit:
  - Pain, weakness, lack of sensation, decreased motor strength, absent or weak pulses
- If neurovascular compression is prolonged, severe atrophy of the muscle

23

Compartment Syndrome

- Tissue pressure exceeds perfusion pressure in closed anatomical space
- Patient complains of pain out of proportion of degree of injury
- Ischemia, necrosis, and functional impairment
- Weak distal pulses or pulselessness
- Immediate surgical evaluation

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Rhabdomyolysis

- Muscle breakdown
- May occur in compartment syndrome
- Myoglobin accumulates in bloodstream
  - Kidneys must filter myoglobin, which is toxic to nephrons in large amounts
  - Leads to acute renal injury
- Triad of symptoms
  - Myalgia, weakness, and myoglobinuria
- Elevated CK level

25

Infection

- Local infection in the form of cellulitis or osteomyelitis
- Systemic infection in the form of sepsis
- Fever, chills, nausea, vomiting
- Warmth, edema, and erythematous around injury are signs and symptoms
- Elevated WBC, ESR, and C-RP

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PE and DVT

- Virchow's triad
  - Injury to vessel wall, venous stasis, and hypercoagulability
  - Increased risk of clots
- Musculoskeletal injury and orthopedic surgery increase risk for clot formation
- Deep vein thrombosis travels to lungs
  - Pulmonary embolism

27

PE and DVT (continued)

- Area of DVT may be tender, edematous, and warm
- PE: dyspnea, cyanosis, cough
  - May show no symptoms

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Fat Embolism

- Associated with long-bone and pelvic fracture
- Fat embolism: fat globules from marrow of injured bone enter circulation
- Fat embolism syndrome may develop
  - May first present with pulmonary dysfunction
  - Hemodynamic stabilization is critical
- FES risk reduced when fixation of bone fracture occurs within 24 hours post-injury

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Avascular Necrosis (AVN)

- Deterioration of bone due to insufficient blood supply
  - Fractures of femoral head and neck, proximal humerus
- Motor weakness, abnormal gait if lower extremity is involved, and lack of rehabilitation progress
- Diagnosis
  - MRI or bone scintigraphy are used to detect AVN
- Treatment
  - Surgical removal of necrotic bone

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Post-Traumatic Arthritis

- Common in intra-articular fractures, particularly in those fractures inadequately reduced
- Symptoms
  - Persistent pain, aching in involved joint, crepitus in the joint
- Diagnostic tests
  - X-ray, CT scan
- Treatment
  - Arthroscopic debridement, osteotomy, arthroplasty

31

Delayed Healing of Fracture

- Delayed union
  - Fracture healing taking longer than expected
- Nonunion
  - Fracture with no chance of healing
- Malunion
  - Healing of bone in an unacceptable position

32

Cervical Strain and Sprain

- Etiology
  - Whiplash or abnormal posture
- Initial pain may be minimal, but increases
  - Shoulder, scapular, and arm pain maybe present
  - Cervical nerve impingement may occur
- Diagnosis
  - MRI
- Treatment
  - Pain relief, muscle relaxants, cervical collar

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Lumbar Strain and Sprain

- Low back pain
- L4-5 and L5-S1
  - Sharp pain, tenderness
  - Spasm over the posterior lumbar area
  - Decreased, painful ROM
- Neurological problem due to herniated disc or spinal nerve root impingement
  - Straight-leg raising test can be used for assessment for herniated disk

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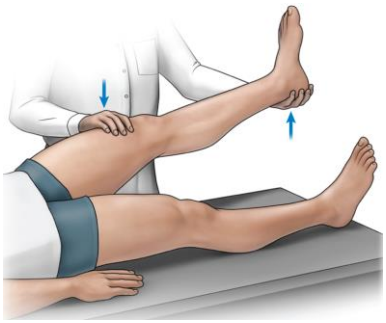
Straight-Leg Raising Test



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Lumbar Strain and Sprain (continued)

- Cold therapy initially for a short period up to 48 hours
- Low level of activity
- Lifting activities involving spine should be avoided
- Anti-inflammatory agents; muscle relaxants
- Weight loss (abdominal obesity can strain back)

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Ankle Sprain

- Lateral ankle complex most at risk for sprain
  - Most sprains are inversion
- Assessment
  - Exclude ankle fracture (bony point tenderness)
- Ottawa Ankle Rules help determine if x-ray is needed
- Diagnosis
  - Drawer and talar tilt to assess stability

37

Ankle Sprain (continued)

- Treatment
  - RICE
  - Supports (compression dressing, splint)

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Stress Fracture

- Repetitive stress on bone
- Second and third metatarsals, tibia, and fibula
- Extensive microdamage before bone adequately remodeled
- Risks
  - Genetics, female sex, low body weight, amenorrhea
- May not be apparent on x-ray initially

39

Carpal Tunnel Syndrome (CTS)

- Cumulative trauma disorder
- Increased pressure on the median nerve through carpal tunnel area
  - Symptoms affect at least two of the first through third fingers
  - Paresthesia with pain worse at night
- Diagnosis
  - Phalen signs with hyperflexion of wrist for 60 seconds
- Treatment
  - Rest, splinting, surgery

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Lateral Epicondylitis

- AKA “tennis elbow”
- Extensor carpi radialis brevis (ECRB) muscle
  - Scar tissue in origin of the ECRB
  - Inflammation of radial humeral bursa
- Diagnosis
  - Chair raise test
- Treatment
  - Rest, pain management, anti-inflammatories

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Bursitis

- Bursa
  - Fluid-filled, saclike structures
  - Act as cushions between bone, ligaments, and tendons
- Bursitis
  - Synovial lining produces excessive fluid, leading to localized swelling and pain
- Cause
  - Repetitive overuse
- Pain with motion, discomfort at rest

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Bursitis (continued)

- Diagnosis
  - X-ray
  - ESR
  - WBC count
- Treatment
  - Rest
  - Anti-inflammatories

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Temporal Mandibular Joint (TMJ) Disorder

- TMJ
  - Connects mandible to temporal bone
- TMJ disorder results from repetitive, cumulative trauma
- Mandibular branch of the trigeminal nerve becomes irritated
- TMJ pain aggravated by chewing
- Clicking sound may be heard with chewing

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Temporal Mandibular Joint (TMJ) Disorder (continued)

- Diagnosis
  - Dental exam
- Treatment
  - May resolve on own
  - Anti-inflammatory medications

45

Fractures

- Traumatic
- Pathological
  - Bone is weakened
  - Fracture occurs without significant trauma
  - Fragility fracture

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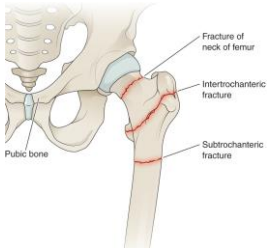
Hip Fracture

- Osteoporotic degeneration of the hip
- Instability of joint and inability to bear weight results in
- Femoral neck fractures most common with osteoporosis
- Femoral head fracture more common in young as result of trauma



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Assessing Hip Fracture

- Assess ROM
- If fracture exists, ROM will be painful
- Neurovascular examination distal to injury
- Intracapsular
  - Fractures of the femoral head and neck
  - Complicated healing
- Extracapsular
  - Trochanteric, intertrochanteric, and subtrochanteric

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Hip Fracture Complications

- Death after a fall
  - Caused by the complications that set in after hip fracture and immobility
- One out of five elderly hip fracture patients dies within a year of the injury because of complications

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Hip Fracture Diagnosis and Treatment

- Diagnosis
  - X-ray
- Treatment
  - Immobilize in the supine position
  - Assess for ABCDE's of trauma
  - Orthopedic, neurological, and cardiovascular consultations
  - IV for hydration, NPO status, pain management
  - Surgery
    - ORIF or hip replacement may be needed

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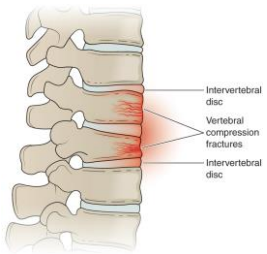
Vertebral Compression Fracture

- Pathognomonic of osteoporosis
- Weight of body exceeds load vertebrae can support
- Postural changes (kyphosis), loss of height, and pain



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Vertebral Compression Treatment

- Calcitonin can relieve the pain of vertebral compression
- Muscle relaxants, analgesics
- External support devices
- Calcium, vitamin D, bisphosphonates
- Surgical procedures
  - Vertebroplasty
  - Kyphoplasty

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Femur Shaft Fracture

- Significant force needed
  - Abundant blood supply: large amount of bleeding
  - Displacement of fracture: muscles surrounding fracture pull on bones
- Diagnosis
  - X-ray
- Treatment
  - Pain management, traction, and surgery

53

Femur Shaft Fracture (continued)

- Transverse
- Spiral
- Comminuted
- Open

54

Clavicle Fracture

- Most common of all childhood fractures
- Often greenstick fractures (splinter)
- Adjacent tissues
  - Lungs, subclavian artery
- Diagnosis
  - X-ray
- Treatment
  - Realignment of bone
  - Use of sling

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Distal Radius Fractures

- Common fracture
- Two main types
  - Smith fracture: radius displaced anteriorly
  - Colles fracture: radius displaced posteriorly
- Diagnosis
  - X-ray
- Treatment
  - Cast or splint for 6 weeks

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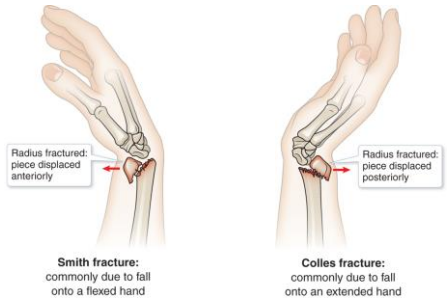
Distal Radius Fractures (continued)



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Tibia-Fibula Fracture

- Both bones often fractured together
- Tibia fractures may be open, as only thin layer of skin covers tibia
- Adjacent structures
  - Distal fibula
    - Common peroneal nerve
  - Tibia
    - Popliteal artery

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Tibia-Fibula Fracture (continued)

- Diagnosis
  - X-ray
- Treatment
  - Immobilization

59

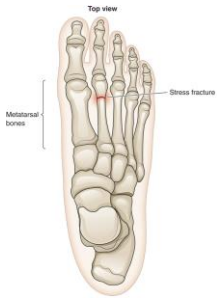
Foot Fractures

- 26 bones in foot
- Common fractures
  - 5th metatarsal fracture in ballet dancers
  - Jones fracture
    - Base of 5th metatarsal, blood supply may be disrupted
  - Lisfranc
    - Base of 2nd metatarsal
  - Metatarsal, tarsal, and navicular fractures are common sites for stress fractures

60

Foot Fractures (continued)

- If any of the following are present, an x-ray is required:
  - Point tenderness over the base of the fifth metatarsal
  - Point tenderness over the navicular bone
  - Inability to take four steps



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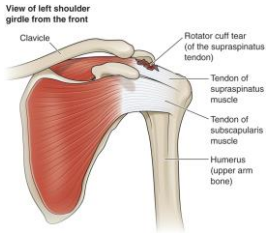
Rotator Cuff Injury

- Group of muscles that stabilize glenohumeral joint
- Muscles
  - Supraspinatus
  - Infraspinatus
  - Teres minor
  - Subscapularis
- Injuries
  - Tears of the tendons and muscles
  - Tendonitis



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Rotator Cuff Injury (continued_1)

- Pain, weakness, instability, and limited ROM
- Swelling, numbness in the arm, uneven rotation, or "popping" of the shoulder
- Pain exacerbated by overhead activities
- Night pain is a frequent symptom
- Adhesive capsulitis
  - "Frozen shoulder"
- Assess shoulder rotation and strength

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Rotator Cuff Injury (continued_2)

- Treatment
  - Physical therapy
  - Surgery

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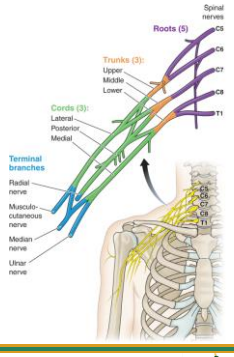
Shoulder Dislocation

- Most common dislocated joint
- Displacement of humerus from glenoid cavity
  - Inferior glenohumeral ligament is commonly injured, allowing for anterior displacement
- Patient complains of pain, shoulder "popping"
- Neurovascular examination needed before and after shoulder has been reduced
- Treatment
  - Reduction of the joint dislocation
  - Sling for 1 to 3 weeks

65

Brachial Plexus

- Motor and sensory nerves originating from the C5–T1 nerve roots
- Nerves within the plexus control the hand, wrist, elbow, and shoulder
- Most injuries of C7, C8, or T1



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Brachial Plexus (continued)

- Patient will complain:
  - Shock-like pain, numbness, and weakness of arm
  - Inability to move shoulder, arm, elbow, or fingers
- Shoulder may be swollen and diminished pulses in arm
- Sensory and motor function must be assessed

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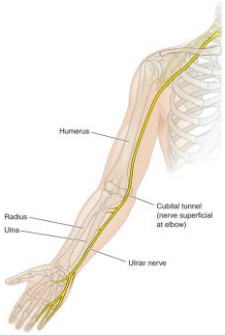
Ulnar Nerve Injury

- Ulnar nerve is superficial at the elbow's olecranon process
- Innervates the ring and small finger
- Paresthesia
- Assess for Froment sign
- Subject to entrapment and pressure injury
- Treatment may involve splinting, physical therapy



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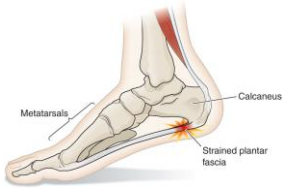
Plantar Fasciitis

- Inflammatory degenerative disorder of the connective tissue in the sole of the foot
- Plantar fascia originates at the calcaneus (heel bone) and attaches to deep ligaments of the metatarsal heads



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Plantar Fasciitis (continued)

- Develops secondary to repetitive microtrauma
  - Inflammatory process initiated
- Palpation of plantar fascia insertion elicits pain
- Tight Achilles tendon may contribute to condition
- Treatment
  - Rest
  - Orthotics

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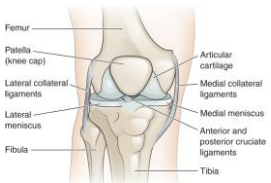
Ligament or Meniscus Injury of Knee

- 2 collateral ligaments and 2 cruciate ligaments
- MCL and ACL are the most frequently injured
- ACL
  - Primary knee stabilizer
  - Prevents forward displacement of the tibia on the femur
- ACL damage causes most joint instability



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Ligament or Meniscus Injury of Knee (continued)

- Valgus
  - Forces to lateral aspect
- Varus
  - Forces to medial aspect
- Diagnosis
  - Inspection, palpation, and neurovascular examination
- Test functionality of joint
- Treatment
  - Rest, ice, surgery if needed

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