Chapter 22
The Musculoskeletal System

Learning Objectives (1 of 2)
• Name common congenital abnormalities of the skeletal system
• Describe three major types of arthritis, pathogenesis, clinical manifestations, and treatment
• Describe causes and effects of osteoporosis, and methods of treatment
• Describe structure and functions of intervertebral disks; clinical manifestations of herniated disk

Learning Objectives (2 of 2)
• Describe pathogenesis, manifestations, and treatment of myasthenia gravis
• Describe manifestations, complications, and treatment of scoliosis
• Compare pathogenesis, common types, and clinical manifestations of muscular atrophy and dystrophy
Skeletal System (1 of 2)

- Skeleton: rigid supporting structure of the body
  - All bones have same basic structure
  - Cortex: outer layer of compact bone, the cortex
  - Trabeculae: inner spongy layer arranged in a loose meshed lattice of thin strands
  - Bone marrow: spaces between trabeculae consist of fat and blood-forming tissue
- Bone: specialized type of connective tissue
  - Composed of a dense connective tissue framework impregnated with calcium phosphate salts
  - Continually broken down and reformed

Skeletal System (2 of 2)

- Types of cells in bone
  - Osteoblasts
  - Osteocytes
  - Osteoclasts
- Strength and thickness of bones depend on activity
- Bones of skeleton are connected by joints
- Types of joints
  - Fibrous joint
  - Cartilaginous joint
  - Synovial joint

Bone Formation

- Intramembranous
  - Mesoderm transformed into osteoblasts that are converted into bone
- Endochondral
  - Cartilage model converted into bone
Congenital Malformations (1 of 2)

- Achondroplasia
  - Faulty endochondral bone formation
  - Impaired growth of extremities and formation of skull bones
  - Causes dwarfism with disproportionately short limbs
- Osteogenesis imperfecta
  - Thin and delicate bones easily broken
  - May be born with multiple fractures
  - Malformation of fingers and toes
  - Extra digits or polydactyly
  - Easily removed
  - Fused digits more difficult to correct

Congenital Malformations (2 of 2)

- Congenital clubfoot (talipes)
  - Multifactorial inheritance
  - Most common type: talipes equinovarus
  - Treatment: manipulation and casts
- Congenital dislocation of the hip
  - Multifactorial inheritance
  - More common in females
  - Shallow acetabulum causes femoral head to be displaced out of socket
  - Breech position favors development
  - Treatment: manipulation and casts

Severe form of osteogenesis imperfecta.
X-ray film of severe form of osteogenesis imperfecta.

Club Foot (Talipes)

Joint

- Capsule
- Joint space
- Synovium
- Articular cartilage
Rheumatoid Arthritis (RA)

- Systemic disease affecting connective tissues throughout the body, especially the joints
- Produces chronic inflammation and thickening of synovial membrane
- Classified as an autoimmune disease
- Rheumatoid factor: autoantibody in blood and synovial tissues; produced by B lymphocytes directed against individual’s own gamma globulin
- Encountered most frequently in young men and middle-aged women
- Usually affects small joints of hands and feet
- Dislocation from joint instability
Photomicrograph of rheumatoid arthritis illustrating destruction of articular cartilage by inflammatory reaction.

Photomicrograph of rheumatoid arthritis. Chronic inflammatory reaction in synovium.

Osteoarthritis

- Not a systemic disease
- "Wear and tear" degeneration of one or more weight-bearing joints
- Causes degeneration of articular cartilage
- Seen in older adults, considered a manifestation of normal aging process
- Treatment: drugs; joint replacement if severe
Knee joint, illustrating smooth articular surface of femoral condyles.

Advanced osteoarthritis

Osteoarthritis
Osteoporosis with a compression fracture of vertebral body.

Gout

- Disorder of purine metabolism
  - Uric acid: an insoluble end-product of purine metabolism
  - Acute episodes caused by precipitation of uric acid crystals in joint fluid
  - Uric acid stones also may form within kidney and lower urinary tract
- Urate nephropathy: urate deposits plug tubules and damage kidneys
  - Treatment: diet and drugs that lower uric acid
Gout
A. Mass of urate crystals with macrophages and fibrous tissue
B. Needle-like sodium urate crystals under polarized light

Radiograph of right hand of patient with gouty arthritis illustrating area of bone destruction (arrow) caused by masses of uric acid crystals.

Fractures
- Simple fracture: bone broken in only two pieces
- Comminuted fracture: bone shattered into many pieces
- Compound fracture: overlying skin is broken with potential for infection
- Pathologic fracture: fracture through a diseased area in the bone
- Treatment
  - Closed reduction: plaster cast
  - Open reduction: internal fixation
Osteomyelitis (1 of 2)
• Infection of bone and adjacent marrow cavity as a result of bacteria
• Organisms gain access to bone via Hematogenous
  – Bacteria carried to bone from an infection in body; occurs at ends of bones
  – Spread of infection may strip periosteum from cortex and devitalize bone
  – Mostly in children
  – In adults: infection may spread into joints
  – Infection in drug abusers tends to localize in vertebral bodies

Osteomyelitis (2 of 2)
• Organisms gain access to bone via direct implantation of bacteria
  – From conditions that expose bone to direct infection
  – Following trauma or surgery
• Manifestation
  – Fever, local pain and tenderness
• Diagnosis and treatment
  – X-ray reveals changes in bone
  – Antibiotics, possible surgery

Tumors of the Bone
• Usually metastatic tumors from prostate, breasts, other organs
• Multiple myeloma: plasma cell neoplasm
• Benign cysts and tumors: encountered occasionally
• Primary malignant bone tumors: unusual
  – Chondrosarcoma: malignant tumor of cartilage
  – Osteosarcoma: malignant tumor of bone-forming cells
A. Chondrosarcoma of chest wall  
B. Metastatic carcinoma in humerus

Osteoporosis

- Generalized thinning and demineralization of entire skeletal system
  - “Porous bones”
  - Most common in postmenopausal women
  - Loss of estrogen accelerates rate of bone resorption
  - Also develops in elderly men
- Treatment: high-calcium diet, estrogen

Osteoporosis, with compression fracture of vertebral body
Avascular Necrosis

- Interference in blood supply to the epiphysis of bones
- Results in necrosis and degeneration at ends of bone
- Disturbance in blood supply probably from injury
- Local pain and disability
- Common sites
  - Femoral head, tibial tubercle, articular surface of femoral condyle

Spine

- Vertebral column forms the central axis of the body
  - Series of vertebrae joined by intervertebral disks and fibrous ligaments
  - Disks: fibrocartilaginous cushions interposed between adjacent vertebral bodies; function as shock absorbers
- 4 curves of vertebral column
  - Cervical and lumbar curves arch forward
  - Thoracic and sacral curves bend in opposite direction
Cross-section through the lumbar spine at the level of the intervertebral disk.

Intervertebral Disk Disease
- Intervertebral disks undergo progressive wear-and-tear degeneration of both nucleus and annulus
- Nucleus pulposus may be extruded through tear in annulus fibrosus
- Manifestation
  - Sudden onset of back pain radiating down the leg
- Diagnosis: CT scan or myelogram
- Treatment: surgery

Herniated nucleus pulposus (“slipped disk”). Schematic of anatomic structures and lesion as demonstrated on CT scan.
Herniated nucleus pulposus ("slipped disk"). X-ray examination obtained after radiopaque contrast material was instilled into dural sac.

Herniated nucleus pulposus ("slipped disk"). CT scan of lumbar region.

Scoliosis
- Abnormal lateral curvature of spine
- Occurs in 4% of the population
- Most cases are idiopathic, occurs in adolescence
- Can lead to asymmetry of trunk and decreased size of thoracic cavity
- One shoulder is higher than the other; pelvis is tilted
- Large curvatures cause pronounced disabilities
- Treatment: depends on extent of curvature
Scoliosis

Skeletal Muscle (1 of 3)

- Muscle contraction
  - Myofilaments slide together
  - Myoneural junction: communication between nerve and muscle
  - Nerve stimulation releases acetylcholine that interacts with receptors on surface of muscle fibers and initiates contraction
- Normal structural and functional integrity depends on
  - Intact nerve supply
  - Normal transmission of impulses across myoneural junction
  - Normal metabolic processes within muscle cell

Skeletal Muscle (2 of 3)

- Myositis: muscle inflammation
  - Localized
    - From injury or overexertion
  - Generalized
    - Systemic disease
Skeletal Muscle (3 of 3)

- Group of relatively rare diseases characterized by progressive atrophy or degeneration of skeletal muscle
- Categories
  - Progressive muscular atrophy
    - Secondary to motor nerve cell degeneration with secondary muscle atrophy
  - Muscular dystrophy
    - Primary muscle degeneration

Myasthenia Gravis

- Chronic disease characterized by abnormal fatigability of voluntary muscles due to abnormality at the myoneural junction
- Autoimmune disease; autoantibodies against acetylcholine receptors at myoneural junction
- Treatment: drugs that prolong action of acetylcholine

Discussion

- What is the difference between a simple fracture and a compound fracture? What are the complications of a compound fracture?
- What are the types of muscle cells?
- What is the difference between muscular atrophy and muscular dystrophy? What are the most common types of atrophic disease of the muscles? Of dystrophic disease?