Learning Objectives

● Identify the vertebral column, muscle groups, and ligaments of The Spine
● Examine the different major types of spinal injuries and diseases
● Learn about the different specific and general treatments available for spinal diseases
Anatomy

Vertebral Column

- 33 vertebrae in total:
  - 7 Cervical
  - 12 Thoracic
  - 5 Lumbar
  - 5 fused at Sacrum
  - 4 fused at Coccyx
Anatomy

Intervertebral discs

- Soft jelly-like structures that each forms a layer of cartilage
- Separate the vertebrae from each other and act as shock-absorbing pads
Muscle Anatomy

- **Extensor Muscles**
  - Attached to the back of the spine
  - Allow us to extend, stand and lift objects

- **Flexor Muscles**
  - In the front, and include abdominal muscles
  - Allow us to flex, lift objects and control the arch in the lower back
Ligaments of the Spine

Ligaments help prevent injury from hyperextension and hyperflexion

- ALL (Anterior Longitudinal Ligament)
- PLL (Posterior Longitudinal Ligament)
- Supraspinous
- Interspinous
- Ligamentum Flavum
Scoliosis

- Abnormal curvature of the spine in the frontal plane
- Single (C) or double (S) curve
- Two Types:
  - Degenerative Scoliosis
  - Idiopathic Scoliosis (Adolescent)
- Develops over time
  - 8x more girls than boys need treatment due to growth patterns in puberty
- Cause: unknown but appears to be inherited
Scoliosis Symptoms

- Uneven shoulders
- One shoulder blade is more prominent than the other
- Uneven waist
- One hip rests higher than the other
- Back pain
- Limited spine mobility in some cases
Scoliosis Exam: Adam’s Forward Bend Test

**normal**
Torso is symmetrical, head and pelvis are in a straight line, shoulders are even

**possible scoliosis**
Head is to one side of the natal cleft and not in a straight line with it; shoulders are uneven

**possible scoliosis**
Hump, usually in the right thoracic region; shoulder blades asymmetrical

**possible scoliosis**
Hump, usually in the left lumbar region, waist, asymmetry
Scoliosis Exam, Treatments

- For precise diagnosis X-rays are necessary
- Cobb angle measured between the most tilted vertebrae above and below the apex
- Larger angles lead to increasingly severe side effects
  - Curves less than 10 degrees are considered low risk spinal asymmetry
  - Curves between 20 and 30 degrees in growing children must be observed by an orthopaedic surgeon every four months
  - At around 25 degrees, backs are often braced to prevent further spinal deformation
  - Curves greater than 50 degrees can continue to degrade beyond maturity
  - If all else fails, surgery
Back Braces

- **TLSO (thoracolumbar sacral orthosis)**
  - Custom three point brace to be worn under clothing
  - Applies pressure to curvature to stop progression
  - Worn 23 hours/day, can be removed for sports

- **Charleston Bending Back Brace**
  - Higher pressure brace worn only at night
Surgery

- **Goal**
  - Reduce the Cobb angle by up to 50%
- **Vertebrae** are moved into alignment with screws
- **Bone** (harvested from patient’s hip or cadaver) then inserted to start spinal fusion.

- **Risks**
  - 1/1000 chance of Paraplegia
  - Excessive blood loss
  - Hardware failure
  - <1% Infection
  - Cerebrospinal fluid leak
  - Failure of spinal fusion (1-5%)
  - Continued spinal curve progression
We know all of these injuries and diseases can be a bit depressing, so here’s a puppy to cheer you up!
Degenerative Disc Disease (DDD)

- Also called degeneration of the intervertebral disc
- A condition in which a disc loses integrity, causing severe pain
- Major Factor = Age
Common Symptoms of DDD

- Pain that affects the lower back, buttocks, and thigh
- Pain that worsens when sitting, bending, lifting, or twisting
- Pain that lessens when walking and moving
- Neck or nerve pain
Causes of Lumbar Disc Disease

1. Inflammation → Occurs as proteins in the disc space start to irritate the surrounding nerves
2. Abnormal micromotion instability → The annulus fibrosus are worn down and can no longer absorb stress on the spine effectively

Causes of Cervical Disc Disease

1. One or more of the cushioning discs in the cervical spine start to break down due to wear and tear
2. Genetics
3. Injury
DDD Treatments

- Physical Therapy
- Medications → nonsteroidal anti-inflammatory drugs, pain relievers
- Surgery: Artificial disc replacement
- Spinal Mobilization
- Exercise and Rehabilitation
Cervical Artificial Disc Replacement

- Goal = maintain the intervertebral disc height while restoring the physiologic motion a person would have with a healthy disc
Are you ready for walkies? they ask...
"I was born ready for walkies".
Spina Bifida

- Birth defect where the backbone fails to surround the spinal cord
- Caused by failure of neural tube to properly develop into brain and spinal cord and the surrounding tissues
Spina Bifida

Signs & Symptoms:

1. **Spina bifida occulta**
   - No protrusion
   - Growth of hair or a dimple on the site
   - Many people asymptomatic

2. **Meningocele**
   - Spinal cord forced into the openings of the vertebral column
   - Back pain; extreme cases include paralysis

3. **Myelomeningocele**
   - Protrusion of spinal cord out into the open
   - Complete paralysis, bowel and bladder problems
   - Seizures, vulnerable to infections
   - Various orthopedic problems
Spina Bifida

**Causes**

Believed to be a mixture of genetic and environmental factors:

**Genetic:** Family history of neural defects

**Environmental:** Lack of folate in the diet, obesity, poorly controlled diabetes

**Diagnosis**

Prenatal screening tests:

- Blood test called MSAFP; Ultrasound
Spina Bifida

Treatments

- No known cure, but several treatments available to manage the pain and disease

Before Birth

- Fetal surgery while still in the womb (careful risk assessment needed)

After Birth

- **Occulta**: No treatment needed
- **Meningocele**: Surgery if complications like hydrocephalus
- **Myelomeningocele**: Surgery important: including for hydrocephalus and/or the spinal cord
- **Other treatments**:
  - Braces, crutches, or wheelchairs
  - Special physical therapy
Spina Bifida

Fetal Surgery: [https://www.youtube.com/watch?v=hNpjGh4YyA0](https://www.youtube.com/watch?v=hNpjGh4YyA0)

Hydrocephalus shunt: [https://www.youtube.com/watch?v=Qmym2iFVNw8](https://www.youtube.com/watch?v=Qmym2iFVNw8)
Cervical Stenosis

- Commonly called spinal cord compression
- One of the most common causes of neck/cervical pain in 55+ year old adults
- Symptoms
  - Slow onset
  - Coming and going spinal pain
  - Pain relief in any sitting, lying down, or flexed forward position
- Can lead to Cervical Spondylotic Myelopathy
Cervical Spondyloptic Myelopathy Symptoms

- Cervical: the spine in the neck
- Spondyloptic: spinal degeneration
- Myelopathy: damage to the spinal cord

- Numbness in the hands
- Clumsiness of the hand
- Arm / Hand weakness
- Leg stiffness
- Loss of balance
- Urinary urgency
- Neck pain
- Intermittent shooting pain in arms and legs
Stenosis Diagnosis

- **MRI**
  - For identifying soft tissue causes
    - Disc bulges
    - Disc herniations
    - Ligament hypertrophy

- **CT scan with Myelogram**
  - X-ray dye in spinal sac fluid
  - Better for identifying bony causes of stenosis

- **Selective nerve root block**
  - Injecting suspicious nerves with small quantities of local anesthetics
Stenosis Treatment

- Physical Therapy
- Activity modification
  - Altered posture (Use a walker, etc)
  - Bike instead of Walk
- Epidural cortisone injections
- Anti-inflammatory drugs
- Sometimes tricyclic antidepressants for pain management
- Surgical spinal decompression
Spondylolisthesis

- A condition in which one of the bones in the vertebra slips out of place to one side of the body.

- Pain is caused when the bone slips too much and presses on a nerve.
Congenital Spondylolisthesis

- The result of abnormal bone formation, which puts the vertebra at greater risk for slipping
- Condition is present at birth, but is rare
Isthmic Spondylolisthesis

- Occurs as a result of spondylolysis (a state that leads to small stress fractures in the vertebrae)

- These stress fractures can weaken the bone, causing it to eventually slip out of place
Degenerative Spondylolisthesis

- Occurs most often after the age of 40
- Causes by age → The discs between the vertebral bones lose water
- Loss of water decreases the spongy material of the discs, so it will no longer resist movement by the vertebrae
Symptoms and Diagnosis of Spondylolisthesis

- Asymptomatic
- However, common symptoms include back pain and/or leg pain
- Aching in one or both legs
- Hamstring tightness
- Diagnosed based on medical images (X-ray, CT scan, MRI scan)
Spondylolisthesis Diagnosis

- The one-legged hyperextension maneuver → The patient stands on one leg in a position that hyperextends the lumbar spine
  - If this test produces pain, it can indicate active spondylolisthesis
Spondylolisthesis Treatment

Physical Therapy

- Stabilization Exercises to strengthen the abdominal muscles

Surgery

- Only necessary if the vertebra continues to slip or there is extreme pain that interferes with daily activities
Surgical Treatment for Spondylolisthesis

1. Decompressive Laminectomy → Removes the part of the bone that is pressing on the nerves and also reduces pain

2. Spinal Fusion → Provides stability
   a. A piece of bone is transplanted to the back of the spine
   b. As bone heals, it fuses with the spine and eventually keeps the spine from moving
Disc Herniation

- Bulging of the nucleus of an intervertebral disc pushes out of the annulus
- Touches and irritates spinal nerves
- Caused by weakening of annulus through repetitive motion and/or contact trauma
Disc Herniation

**Signs & Symptoms:**

- No symptoms if only disc is injured
- Otherwise, unrelenting pain in the affected area
- Pain, numbing and tingling (sciatica) in arm and/or legs
- Severe case can include bowel and bladder dysfunction
Disc Herniation

Causes:

- Disc degeneration (for old age)
- Common in young people performing manual labour or contact sport
  - Flexion of back is considered a sin if you want to avoid this injury
- Cause in the 21st century: **Sedentary lifestyle**

Prof. Currey’s father
Disc Herniation

Lumbar disc herniation in athletes
Disc Herniation

Treatment:

- Surgical treatment, called microdisectomy, is the last option
- Pain medications like NSAIDs and Epidural Corticosteroid

Most effective treatment:

Physical Therapy

- Improving body posture and exercises to strengthen back and core muscles
- Maintaining an active and healthy lifestyle
Disc Herniation

Physical Diagnosis
Spinal Fractures

- A fracture or dislocation of a vertebra
- Can cause bone fragments to pinch and damage the spinal nerves/cord
Symptoms, Causes and Diagnosis

- Can be caused by osteoporosis → weakened vertebrae become at high risk for fracture
- For vertebral compression, occurs when too much pressure is placed on a weakened vertebra causing the front to crack and lose height
- Causes back pain
- Doctor will examine the alignment of the spine and posture
1. Flexion Fracture

- Compression fracture
- Axial burst fracture
2. Extension Fracture

- The vertebra is pulled apart (distraction)
3. Rotation Fracture

- A vertebra moves off an adjacent vertebra (displacement)
Treatments

Surgery

A. Kyphoplasty → A needle is inserted into the fractured vertebra with the guidance of an x-ray
B. Vertebroplasty → Cement is injected directly into the narrowed vertebra
Paralysis

● Causes
  ○ Traumatic Injury
    ■ Motor vehicle accidents
    ■ Football
    ■ Falls
    ■ Gymnastics
    ■ Violence
    ■ Diving into shallow water
  ○ Non-Traumatic Injury/ Disease
    ■ Cancer Osteoporosis
    ■ Multiple sclerosis
    ■ Inflammation of the spinal cord
    ■ Arthritis
  ○ Interesting Statistics
    ■ 80% of injuries are in males
    ■ Top three causes are car accidents, falls, and gunshot wounds
Types of Paralysis

- **Tetraplegia**
  - Most severe
  - Requires 24-hour care
  - Only the head is fully functional

- **Paraplegia**
  - Some extra assistance with everyday activities can be required
  - Varying levels of mobility
Biomedical Devices (and the puppies that use them)
Hope for the Future

- Neural Implants
  - University of Melbourne
  - Stent based electrodes to transmit signals directly from the brain to muscles. ("Stentrode")
Managing back pain with our sedentary lifestyle

Figure 5.16 The effect of four postures on the intervertebral disc pressure between the 3rd and 4th lumbar vertebrae. The pressure measured when standing is taken as 100 per cent. According to Nachemson and Elfström (1970).
Why is the Spine important?

![Diagram of common postural problems]
The Future of the Spine

- Medical robotics has potential for improving precision and capabilities of neurosurgical, and therein spinal surgical procedures
- Spinal surgeons experience fatigue, hand tremor when working at the spinal cord and nerve roots
- Example → The SpineAssist®: