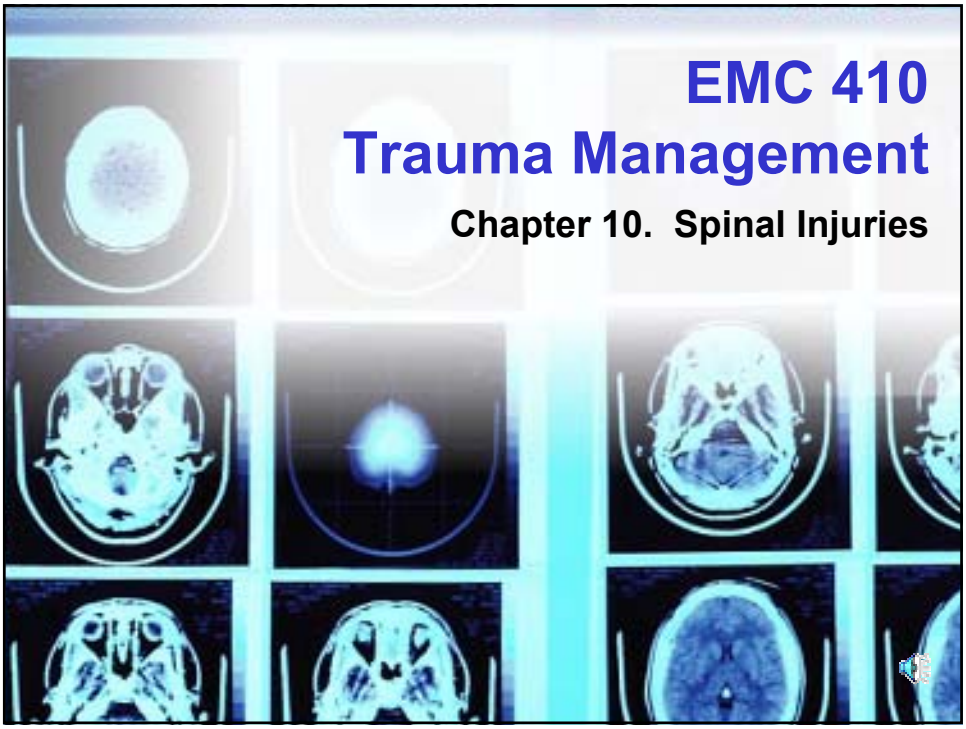


EMC 410
Trauma Management

Chapter 10. Spinal Injuries

Unit Objectives

- **Upon completion of this chapter, you should be able to:**
  - Describe the anatomy of the vertebrae from the cervical, thoracic, lumbar, sacral, and coccyx regions.
  - List the major functions of the spinal cord.
  - List the general functions of the ascending and descending tracts.
  - List the specific functions of the major ascending tracts.
  - List the specific functions of the major descending tracts.
  - Identify the components of the reflex arc.

Unit Objectives continued

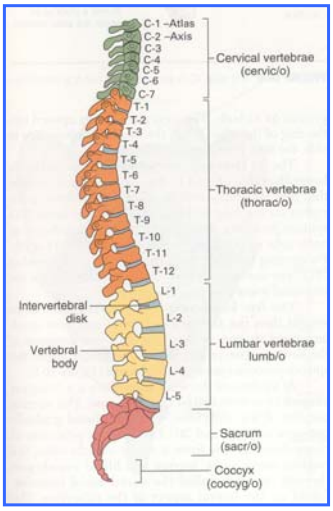
- Describe the function of the reflex arc.
- Identify the location of the spinal nerves.
- Describe the anatomy of a spinal nerve.
- Describe the function of the individual components of a spinal nerve.
- Identify the location and describe the function of the major spinal plexuses.
- Identify the 4 most common mechanisms of spinal injury.
- Describe the syndromes associated with partial cord lesions.
- Describe the clinical presentations of spinal cord transection.

Unit Objectives continued

- Describe the pathophysiology of neurogenic shock.
- Discuss the management of neurogenic shock.
- Discuss the role of anti-inflammatory agents used in the management of patients with suspected spinal cord injuries.

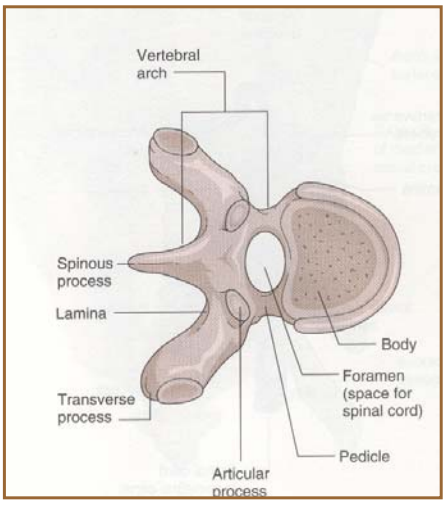
Anatomy

- **33 vertebrae**
- **Intervertebral discs**
- **Ligamentous support**
- **Five regions**
  - Cervical (C1-C7)
  - Thoracic (T1-T12)
  - Lumbar (L1-L5)
  - Sacrum (S1-S5 fused)



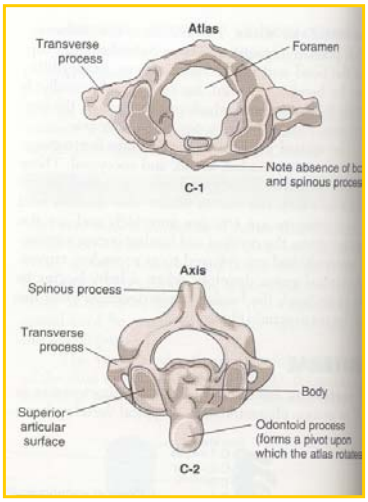
Anatomy continued

- Structure
  - Body
  - Pedicle
  - Transverse process
  - Spinous process



Anatomy Continued

- **Cervical vertebrae**
  - Atlas
  - Axis
  - Vertebral prominens
  - Minimal clearance

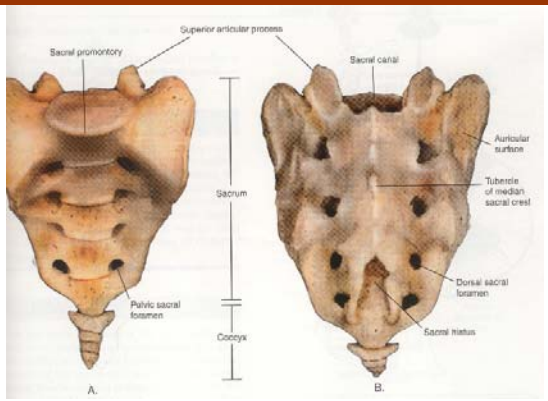


Anatomy continued

- **Thoracic vertebrae**
  - Larger than cervical
  - Progressively larger from T3
- **Lumbar vertebrae**
  - Much larger and stronger bodies
  - Horizontal transverse process
- **Sacral vertebrae**
  - Fused between 18 and 30 years of age
  - Body's weight transmitted to the legs through sacrum
  - Form posterior wall of pelvic cavity

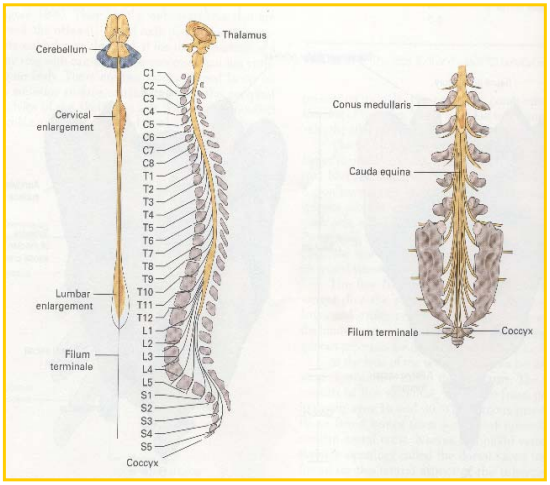
Anatomy continued

- Coccyx
  - 4 vertebrae fused by age 25



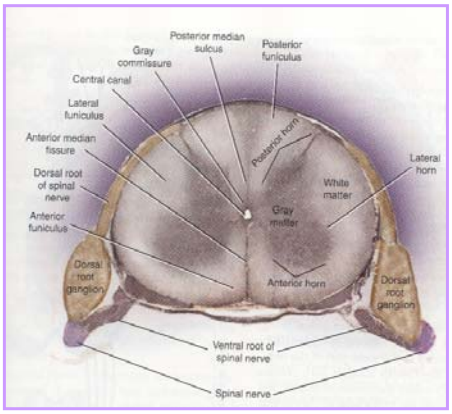
Anatomy continued

- Spinal cord
  - Extends from foramen magnum to the lower border of L1
  - 17 to 18 inches in length

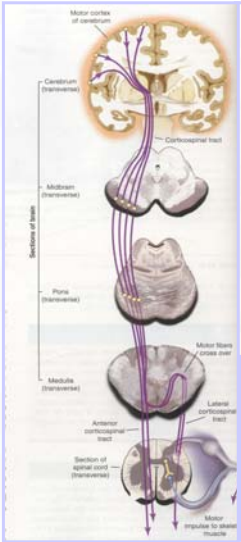


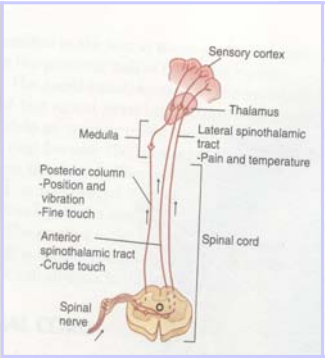
Anatomy continued

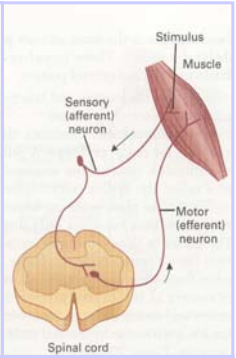
- Spinal cord continued
  - White matter on the outside
  - Gray matter forms the “H”
  - Central canal circulates CSF



Physiology



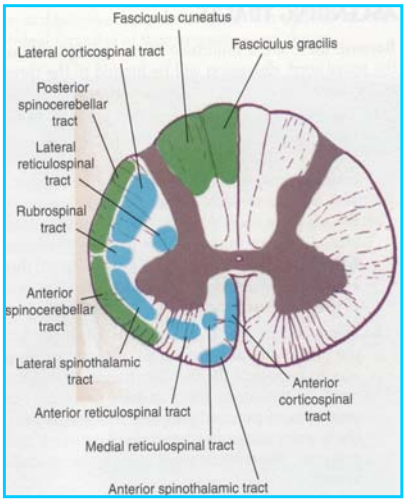




- **2 functions of the spinal cord**
  - Conduct nerve impulses
    - Ascending tracts
    - Descending tracts
  - Spinal reflexes

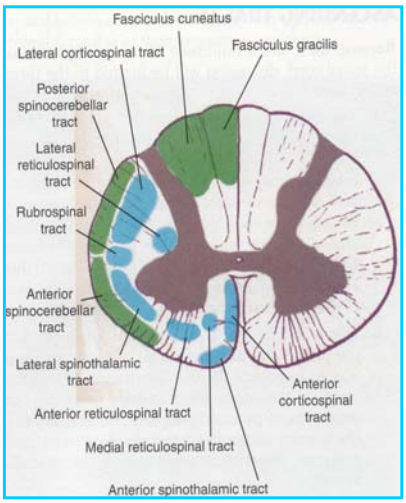
Physiology continued

- **Ascending tracts (sensory)**
  - Fasciculus gracilis and fasciculus cuneatus
    - Touch, pressure and movement
    - Crossover in the medulla
  - Spinothalamic
    - Pain and temperature (lateral tracts)
    - Touch and pressure (anterior tracts)
    - Crossover in the medulla



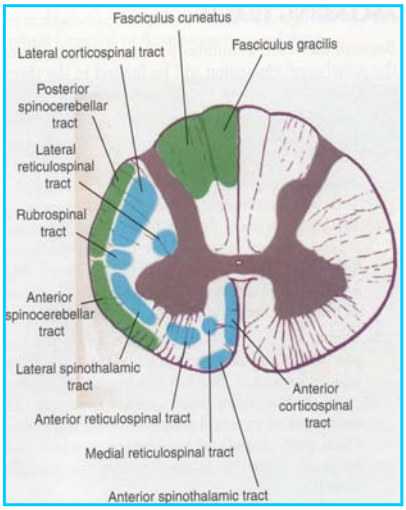
Physiology continued

- **Ascending tracts continued**
  - Spinocerebellar tracts
    - Coordination of muscle movement
    - Anterior tracts cross in medulla
    - Posterior tracts do not cross



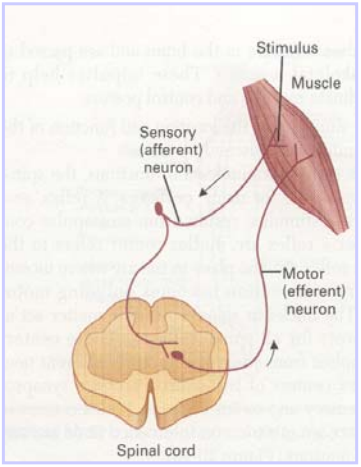
Physiology continued

- **Descending tracts (motor)**
  - Corticospinal tract
    - Control voluntary movement
    - Most fibers cross, some do not
  - Reticulospinal tract
    - Muscular control and sweat gland activity
    - Some cross, some do not
  - Rubrospinal tracts
    - Coordinate muscles and control posture



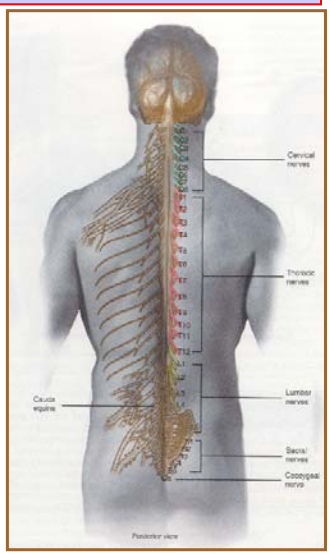
Physiology continued

- Reflex arc
  - Gray matter is reflex center for all spinal reflexes
  - Reflex arc is where sensory input becomes motor output



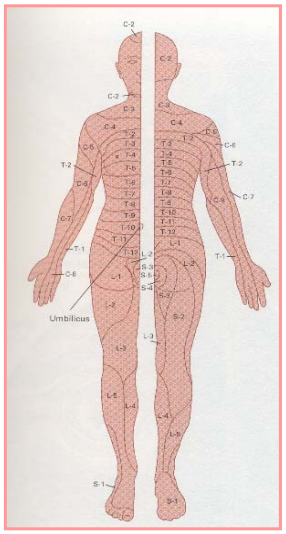
Physiology continued

- **Spinal nerves (31 pairs)**
  - 8 C, 12 T, 5 L, 5 S, 1 C
  - First cervical pair arises from above C1
  - All others exit through intervertebral foramina
  - Cauda equina is spinal nerves below L2
  - Spinal nerves emerge from two roots
    - Dorsal root of nerve is sensory
      - Determine dermatomes
    - Ventral root is motor



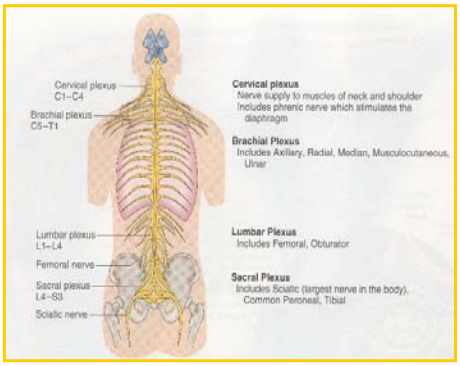
Physiology continued

- **Sensory dermatomes**



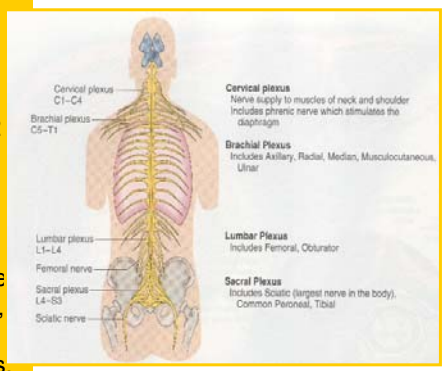
Physiology continued

- **Spinal plexuses**
  - Cervical plexuses are found on either side of the neck
    - Supply skin and muscles of neck
    - C3, C4 and C5 form phrenic nerves
  - Brachial plexus
    - Formed by C3-C7 and T1
    - Innervates chest muscles, shoulder and arm



Physiology continued

- **Spinal plexuses continued**
  - Lumbosacral plexus
    - Formed by T12 and lumbar, sacral, and coccygeal nerves
    - Innervates lowe abdominal wall, genitalia, buttocks, thighs, legs and feet

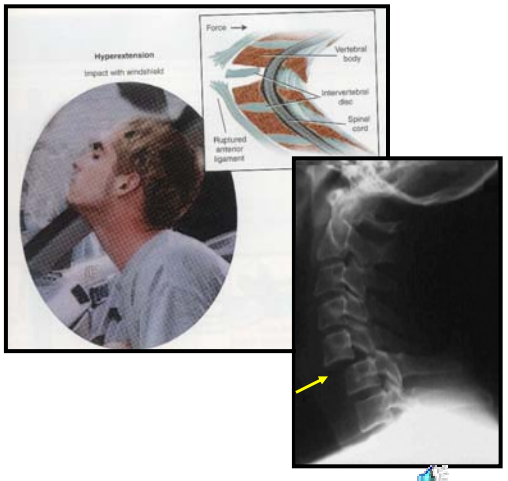


Mechanism of injury

- **Axial loading**
  - Falls, diving injuries, windshield strikes
  - Narrows intervertebral spaces
  - Shifts intervertebral disks
  - Fractures vertebral body or posterior process
  - Encroaches on nerve roots or blood vessels

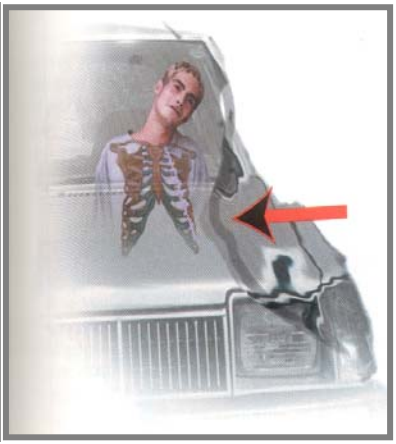
Mechanism of injury continued

- **Hyperflexion**
  - Diving injury
  - Windshield strike
- **Hyperextension**
  - Windshield strike
  - Diving injury
- **Hyper-rotation**
  - Boxing injury



Mechanism of injury continued

- **Lateral bending**
  - Results from very little force
  - Side impact MVC
  - Pedestrian
- **Distraction**
  - Laceration of ligaments
  - Fractures of vertebrae
  - Transection of cord
  - “Hangman’s fracture” (C2)



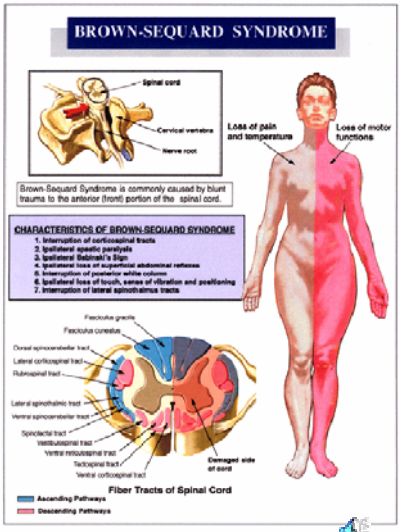
Specific injuries

- Cord transection

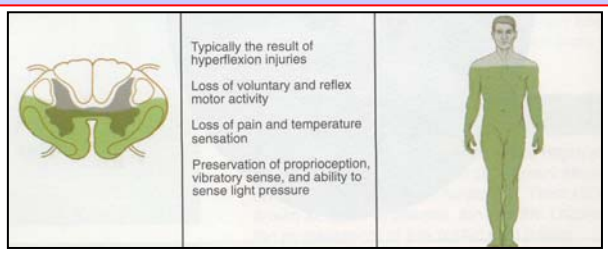
Level of Injury	Nerve Root	Motor Loss	Sensory Loss
C-1 to C-4	Cervical	Diaphragm weakness or paralysis Intercostal paralysis Total skeletal muscle paralysis below the neck	Neck and below
C-5 to C-8	Cervical	Intercostal paralysis Paralysis below shoulders and upper arms	Arms and hands, chest, abdomen, and legs
T1- to T6	Thoracic	Paralysis below midchest	Below midchest
T7 to T12	Thoracic	Paralysis below waist	Below the waist
L1 to L3	Lumbar	Paralysis in majority of leg muscles and pelvis	Lower abdomen and legs
L4 to L5	Lumbar	Paralysis in lower legs, ankles, and feet	Parts of lower legs and feet
S1 to S5	Sacral	Paralysis of bladder and rectum, feet and ankles	Posterior inner thigh, lateral foot, and perineum

Specific injuries continued

- **Partial cord lesions**
  - Brown-se'quard's syndrome
    - Result of penetrating trauma or vertebral fragments
    - Ipsilateral paralysis or paresis and loss of proprioception
    - Contralateral loss of pain and temperature sensation

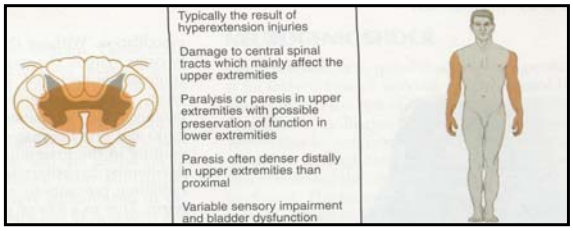


Specific injuries continued



- **Partial cord lesions continued**
  - Anterior cord syndrome
    - Result of hyperflexion injuries
    - Damage to anterior cord or anterior vertebral artery
    - Paralysis, loss of pain sensation and difficulty regulating temperature below the lesion
    - Sense of light touch and proprioception unaffected

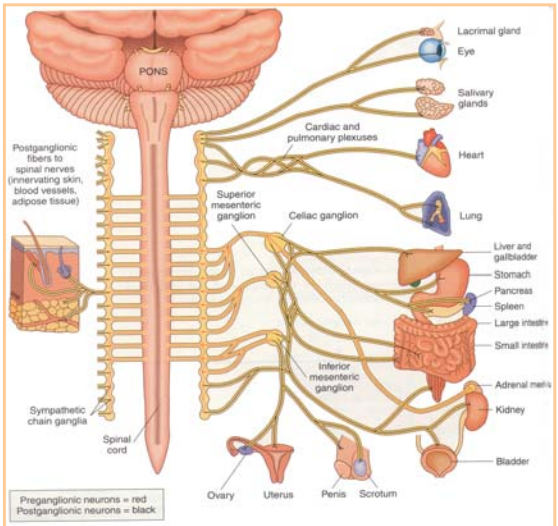
Specific injuries continued



- **Partial cord lesions continued**
  - Central cord syndrome
    - Result of contusion within the cord
    - Results from hyperextension or flexion
    - Results in swelling and ischemia of cord from inside out
    - Involves corticospinal tract, central portions of posterior columns, and lateral spinothalmic tracts
    - Loss of motor and sensation in upper extremities
    - Lower extremity involvement less pronounced or unaffected

Specific injuries continued

- **Neurogenic shock**
  - Loss of vasomotor tone below injury
  - Loss of sympathetic innervation and response
  - Hypothermia
  - Paralytic ileus

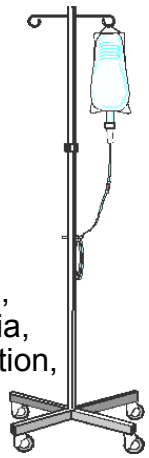


Specific injuries continued

- **Secondary injury**
  - Ischemia
  - Edema
  - Necrosis
  - Demyelination
  - Ultimately leads to permanent damage

Management and interventions

- Airway and spinal precautions
- Supplemental oxygen
- Volume resuscitation
- Methylprednisolone (solu-medrol)
  - 30 mg/kg over 15 minutes loading dose
  - 5.4 mg/kg/hour over next 23 hours
  - Side effects include increased infections, arrhythmias, hyperglycemia, hypokalemia, hypocalcemia, hyponatremia, fluid retention, edema



A Special Note Regarding Methylprednisolone

- Initial trials using methylprednisolone were very encouraging.
- Conducted by NIH
- Data recently called into question
- NIH refuses to release data for secondary analysis
- Future of methylprednisolone in the management of spinal cord injury is uncertain.