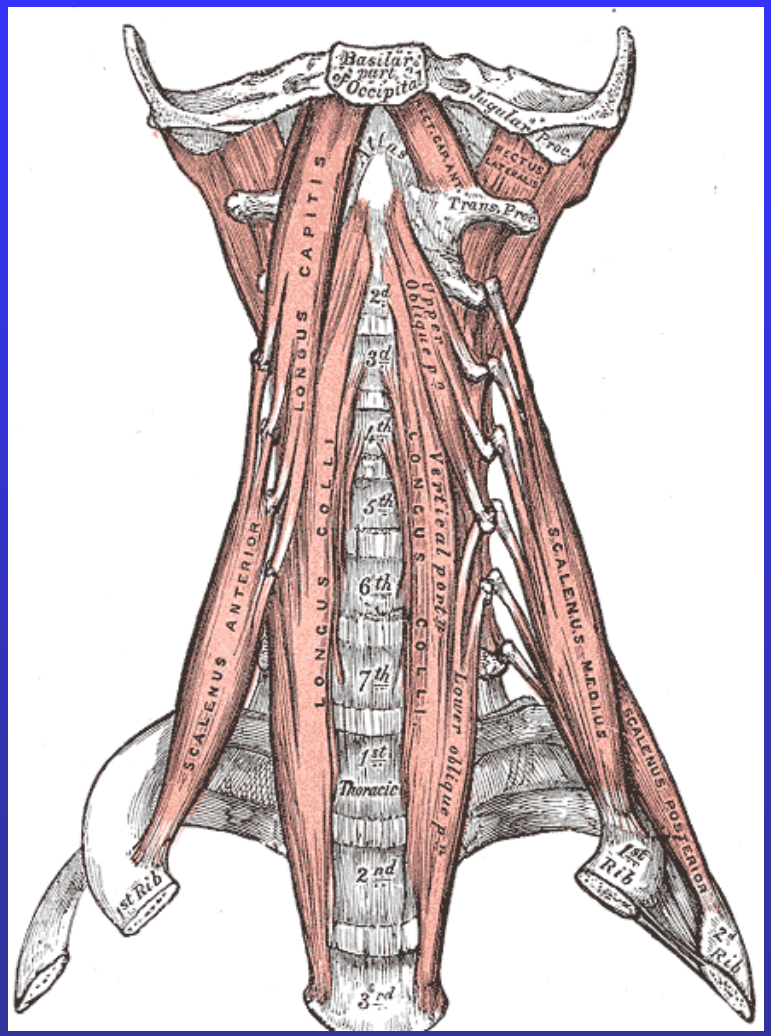
Spine and Spinal Cord Injuries

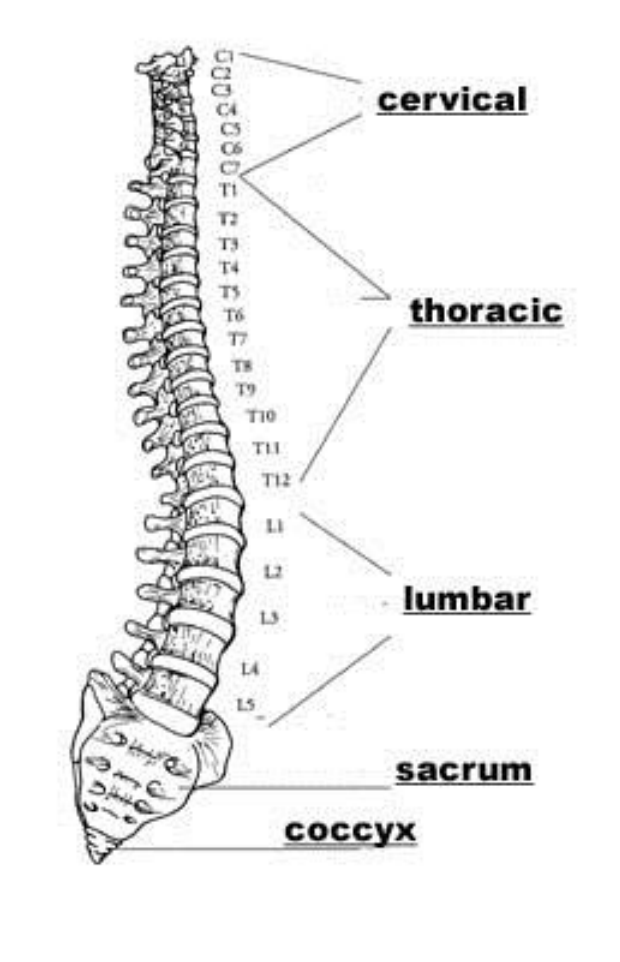
William Schecter, MD

Anatomy of the Spine



http://education.yahoo.com/reference/gray/fig/387.html

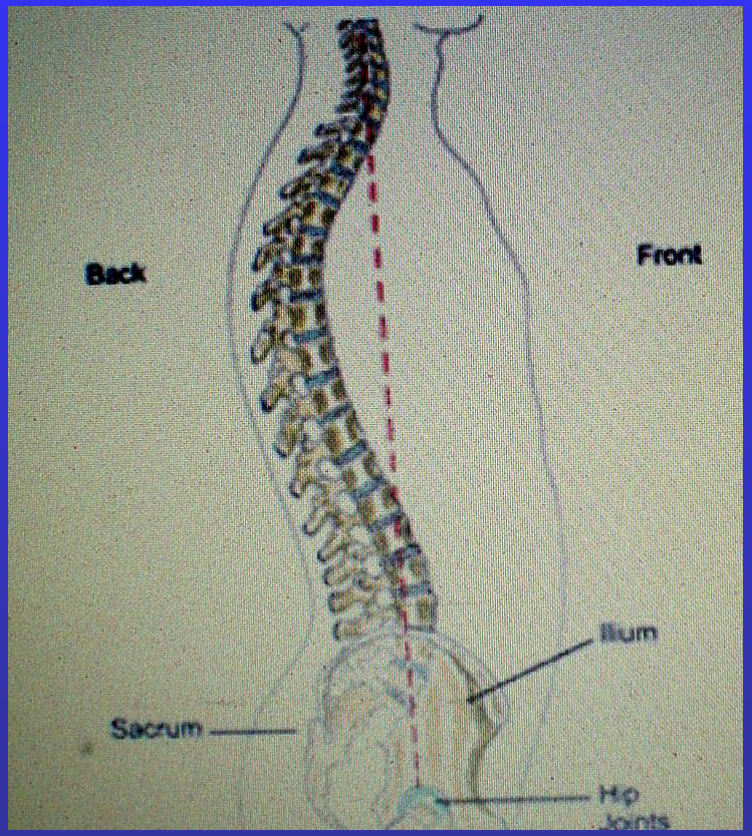
Anatomy of the spine



- 7 cervical vertebrae
- 12 thoracic vertebrae
- 5 lumbar vertebrae
- 5 fused sacral vertebrae
- 3-4 small bones comprising the coccyx

http://www.courses.vcu.edu/DANC291-003/unit_3.htm

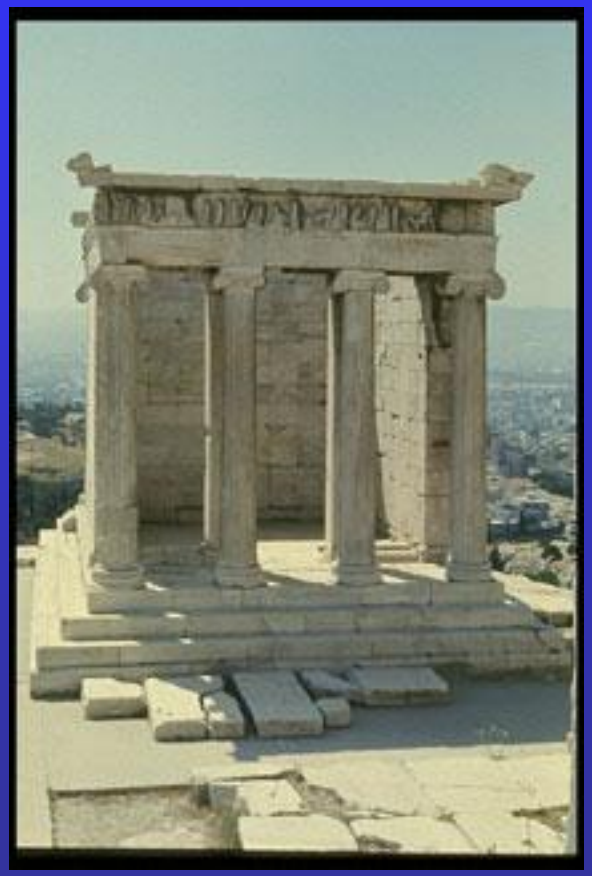
Anatomy of the Spine

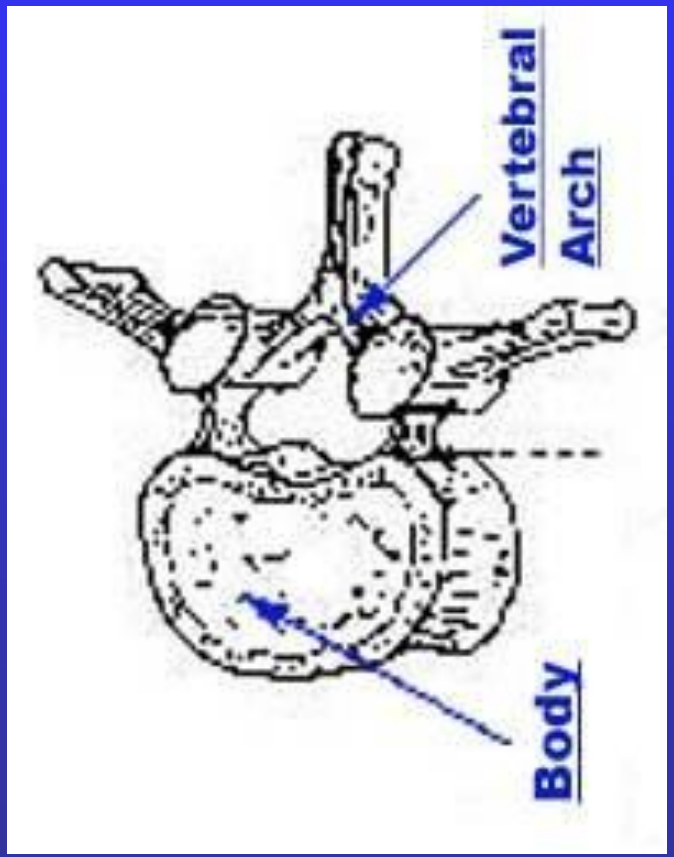


- Cervical lordosis
- Thoracic kyphosis
- Lumbar lordosis

http://www.orthospine.com/tutorial/frame_tutorial_anatomy.html

Structure of the Vertebra





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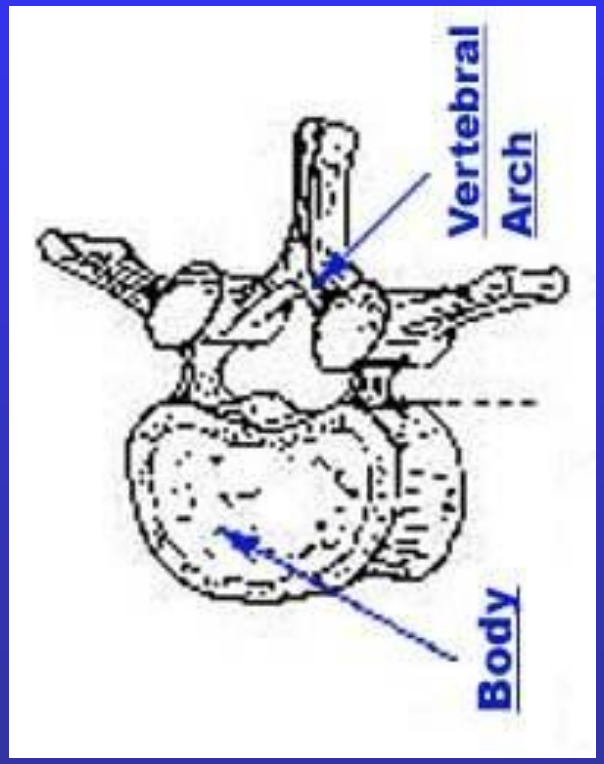

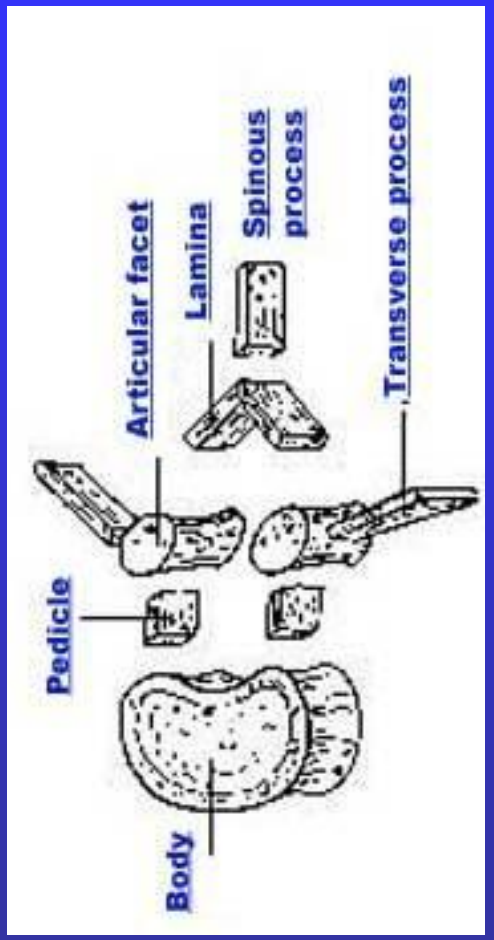

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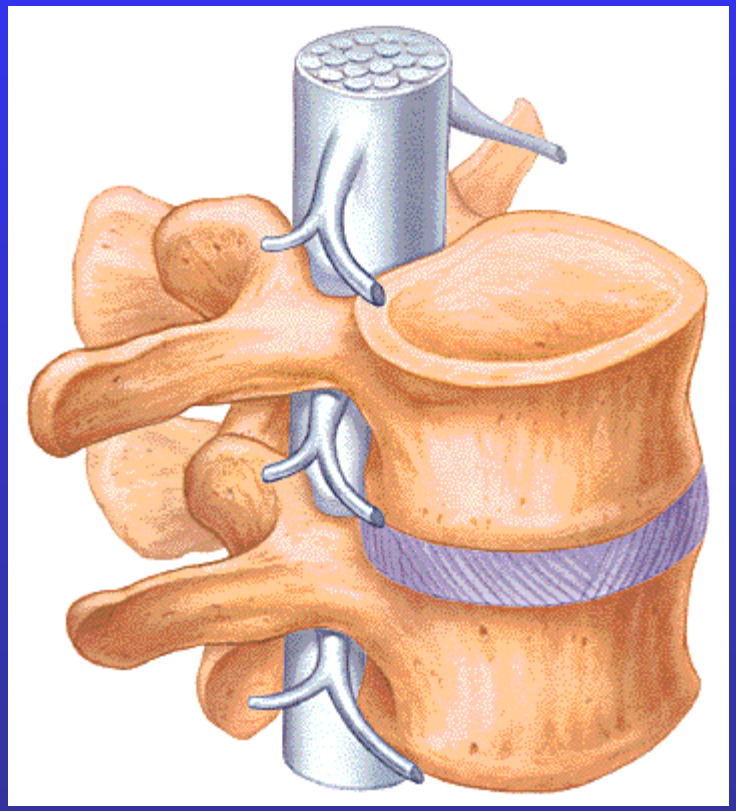
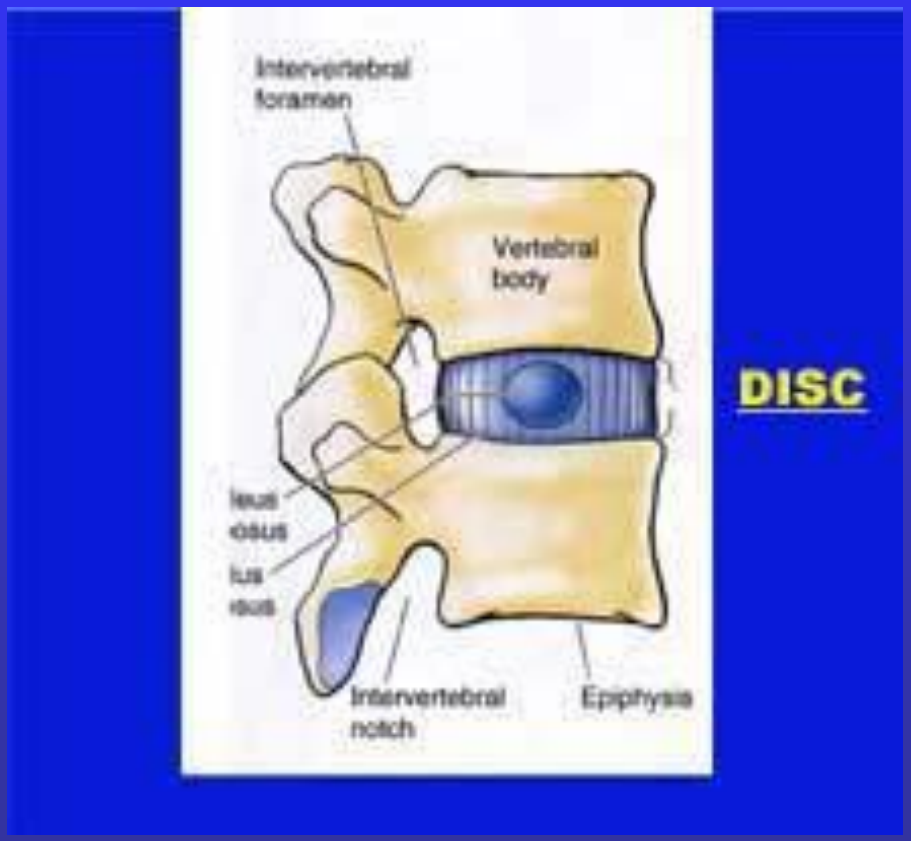
Spinal cord and Vertebrae



http://www.gotorna.com/pages/346343/index.htm

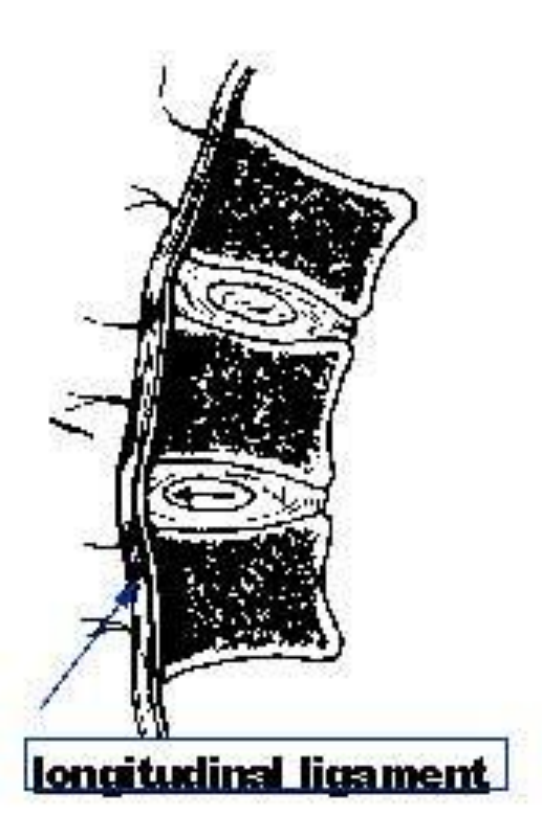
Spine Anatomy



- Disc is joint between both vertebral bodies
- Facet joints form intervertebral foramen through which pass the nerve roots

http://www.courses.vcu.edu/DANC291-003/unit_3.htm

Spine Anatomy



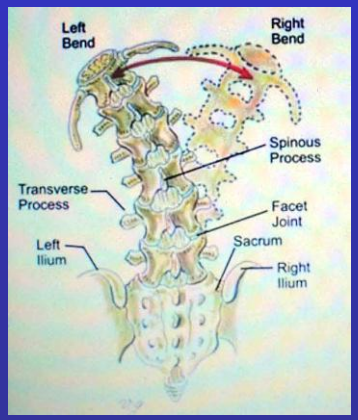
- Anterior and posterior longitudinal spinal ligaments
- Ligaments check the motion of the vertebrae and prevent the discs from slipping out of place

http://www.courses.vcu.edu/DANC291-003/unit_3.htm

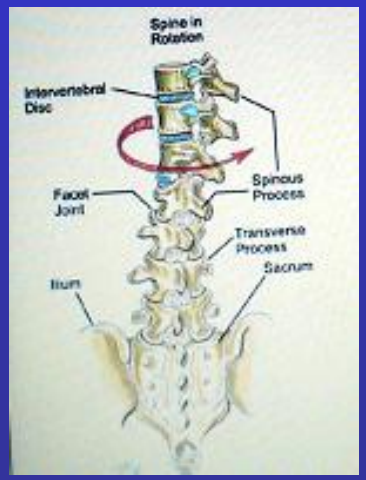
Spine Motions

Flexion

Extension



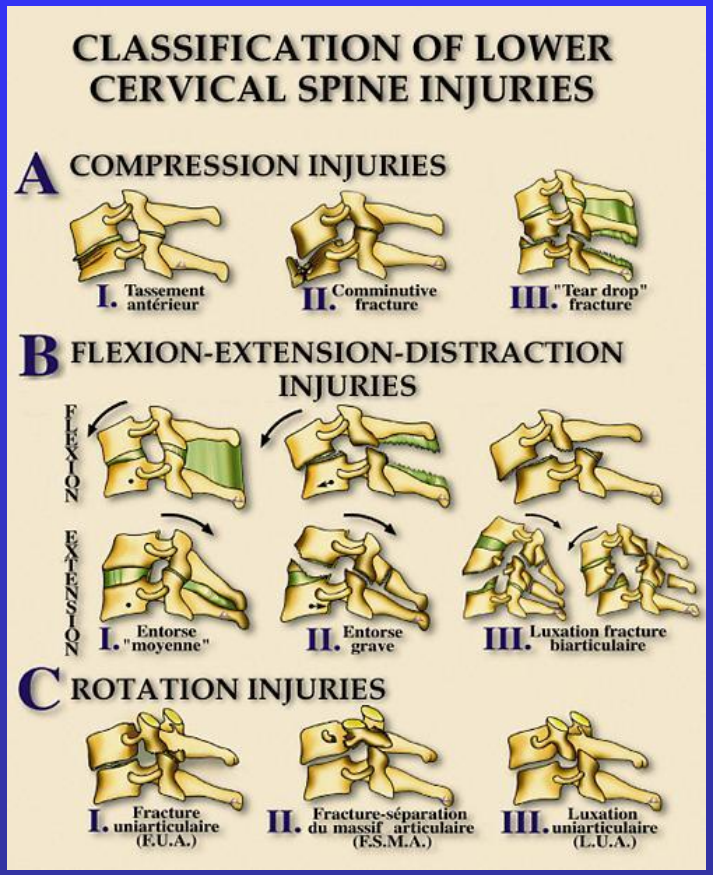
Side bend



Rotation

Mechanisms of Injury

- Compression
- Flexion Injury
- Extension Injury
- Rotation



http://www.maitrise-orthop.com/corpusmaitri/orthopaedic/mo61_spine_injury_class/spine_injury.shtml

Compression Injury

- Vertebral body fracture
- Disc herniation
- Epidural hematoma
- Displacement of posterior wall of the vertebral body

http://www.maitrise-orthop.com/corpusmaitri/orthopaedic/mo61_spine_injury_class/spine_injury.shtml

Flexion Injuries

- Tearing of interspinous ligaments
- Disruption of capsular ligaments around facet joints
- Fracture of posterior elements
- Disruption of posterior ligaments
- Often unstable fractures

http://www.maitrise-orthop.com/corpusmaitri/orthopaedic/mo61_spine_injury_class/spine_injury.shtml

Extension Injury

- Tearing of anterior longitudinal ligament
- Separation of vertebral bodies
- Rupture of Disc
- Avulsion of upper vertebral body from disc

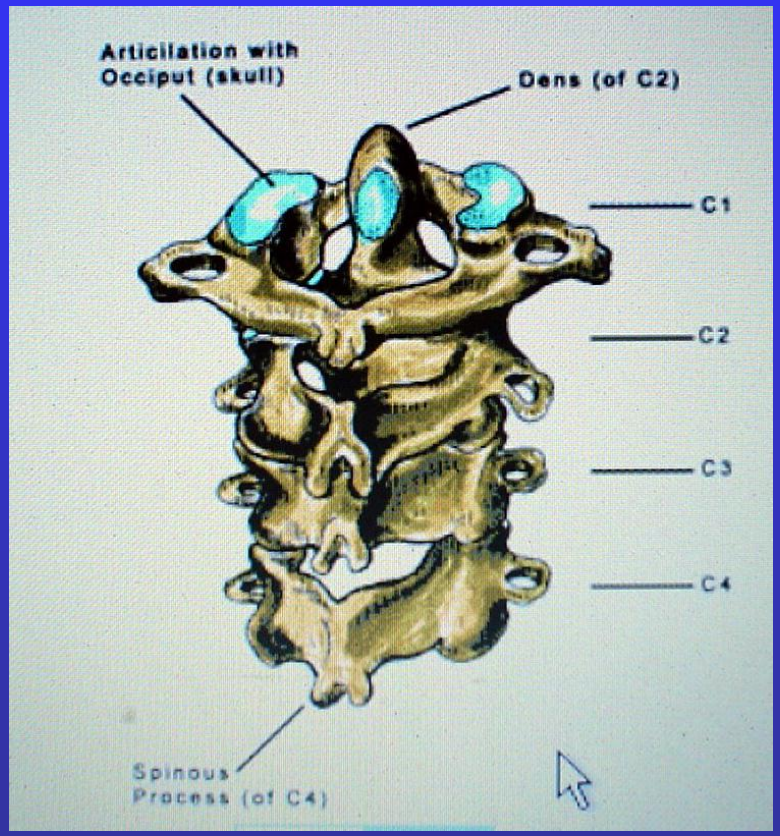
http://www.maitrise-orthop.com/corpusmaitri/orthopaedic/mo61_spine_injury_class/spine_injury.shtml

Rotational Injury

- Associated with unilateral facet dislocation

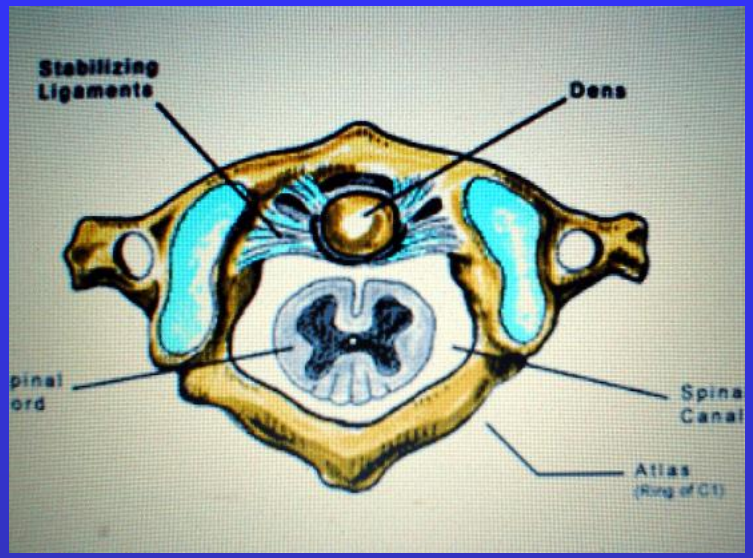
http://www.maitrise-orthop.com/corpusmaitri/orthopaedic/mo61_spine_injury_class/spine_injury.shtml

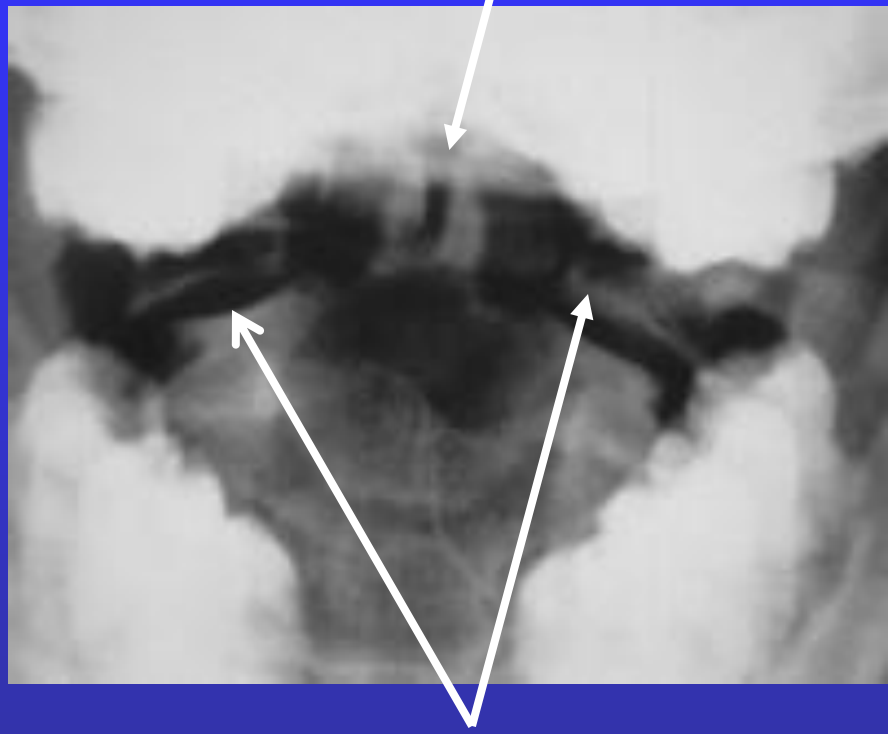
Cervical Spine



- 7 Cervical Vertebrae
- C1 (Atlas) is a ring which articulates with the occiput
  - C1 has no body
  - C1 has no spinous process
- C2 (Axis) so named because it is the pivot on which the Atlas turns to rotate the head
  - The Atlas has a vertical extension, the Dens, which articulates with C1
- Notice the canal for the vertebral arteries bilaterally

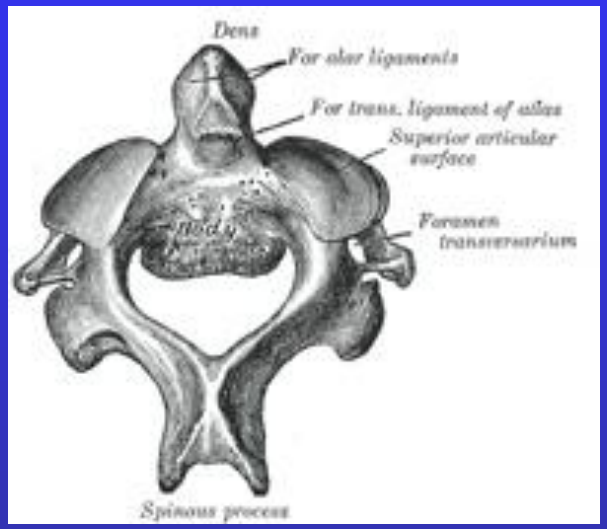
Jefferson Fracture

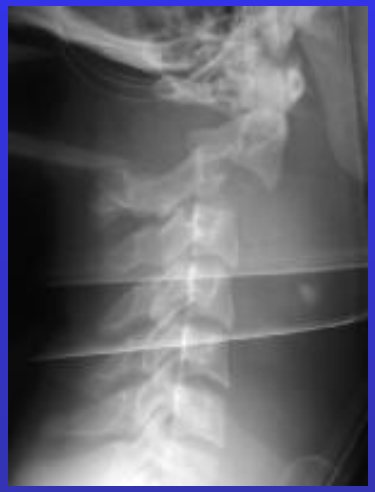




Compression of base of skull against C1
Results in cracking the ring of C1
Best seen on open mouth x-ray
Notice spreading of lateral masses of C1 away
From the Dens projecting up from C2 due to
Disruption of C1 ring

Atlantoaxial and Dens Fractures





http://education.yahoo.com/reference/gray/21.html#3

http://www.emedicine.com/sports/topic10.htm

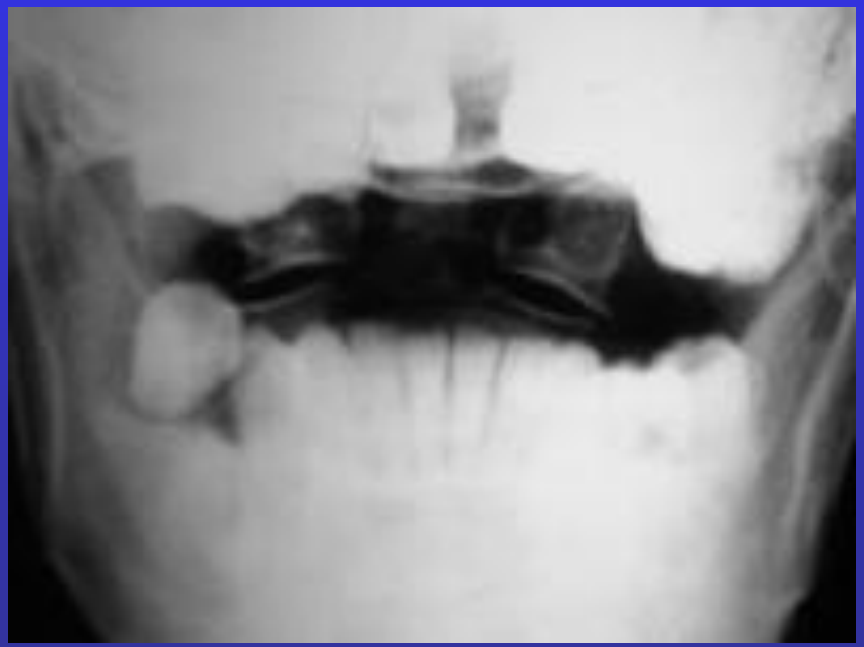
http://www.emedicine.com/sports/topic22.htm

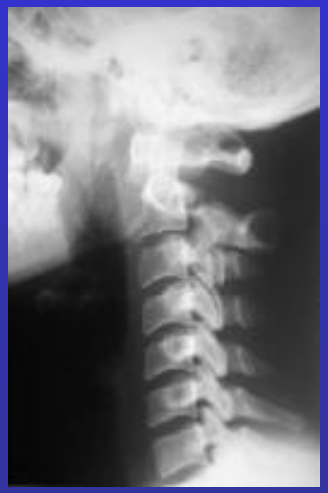
The result of hyperflexion or hyperextension injuries

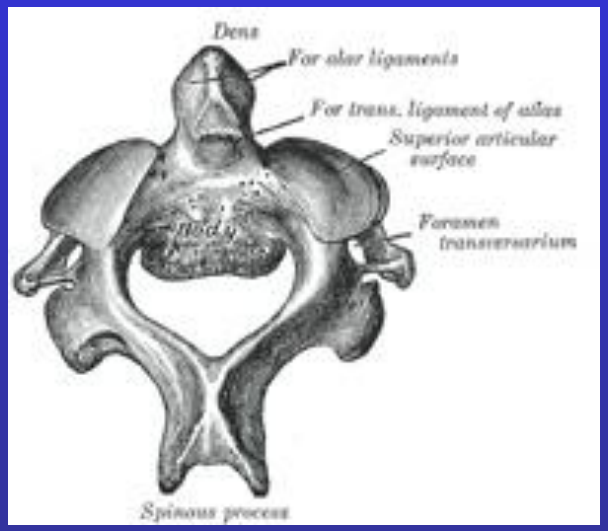
8% of Dens Fractures associated with C1 fractures

C2 Fractures

- Dens Fracture
  - Hyperflexion Injury
- Hangman Fracture
  - Hyperextension Injury
  - Bilateral Fracture of Pedicles of C2







http://www.emedicine.com/sports/topic22.htm

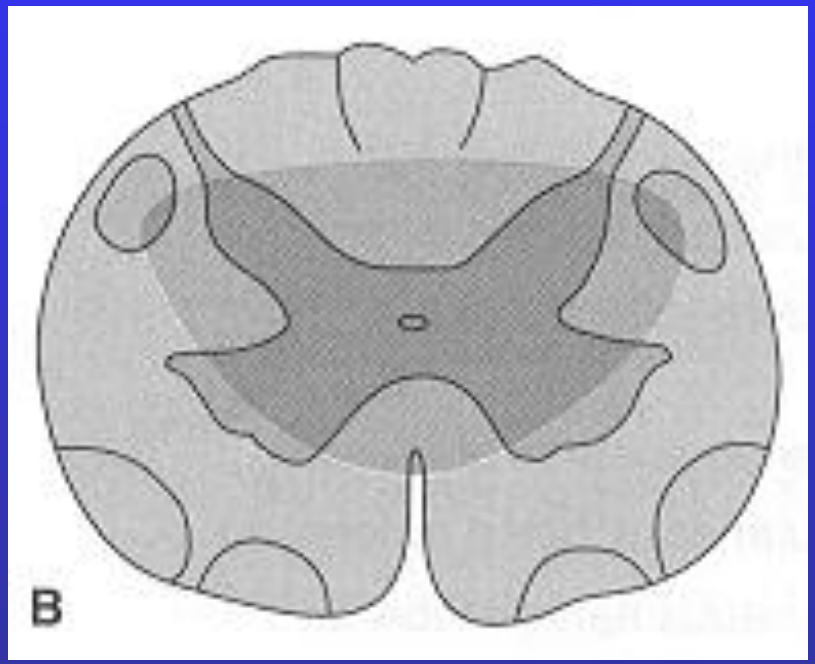
http://www.emedicine.com/sports/topic22.htm

http://education.yahoo.com/reference/gray/21.html#3

Fractures above C4

- Associated with Paralysis of muscles of respiration
- Diaphragm invervated by C3-5

Fractures in the Middle of the Cervical Spine



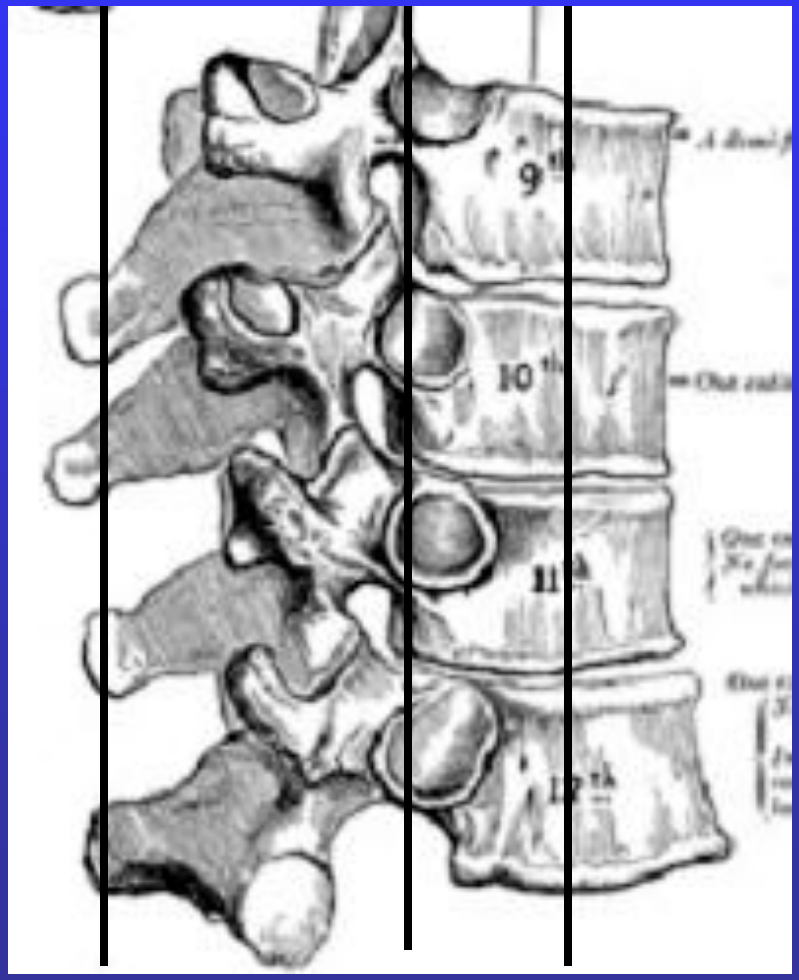
- Associated with dysfunction of upper extremities>lower extremities (Central Cord Syndrome)

Thoracolumbar Trauma

- Mechanism of injury
  - Compression
  - Distraction
  - Rotation

Assessing Stability: Denis Classification

III II I

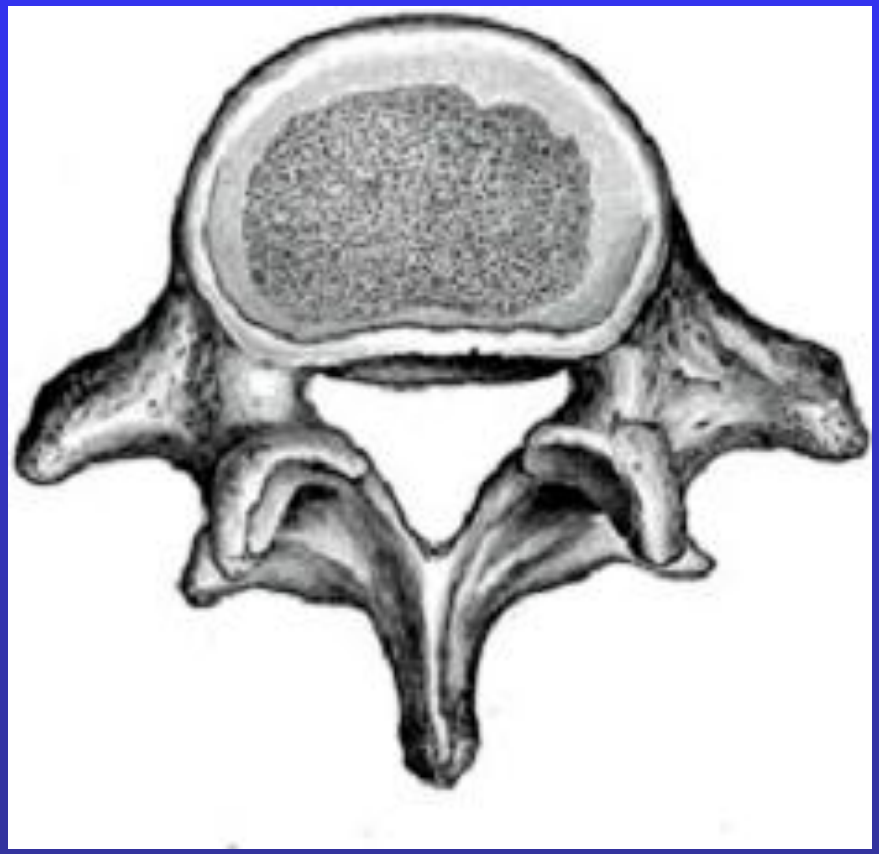


I Fracture involves The anterior 1/2 of Vertebral body—Stable—termed Anterior Column

II Fracture involves the Posterior ½ of Vertebral Body—Unstable—termed Middle Column

III Fracture involves The pedicles and lamina Of the vertebrae—Unstable—termed Posterior Column

Chance Fracture: Failure of all three columns due to flexion-distraction



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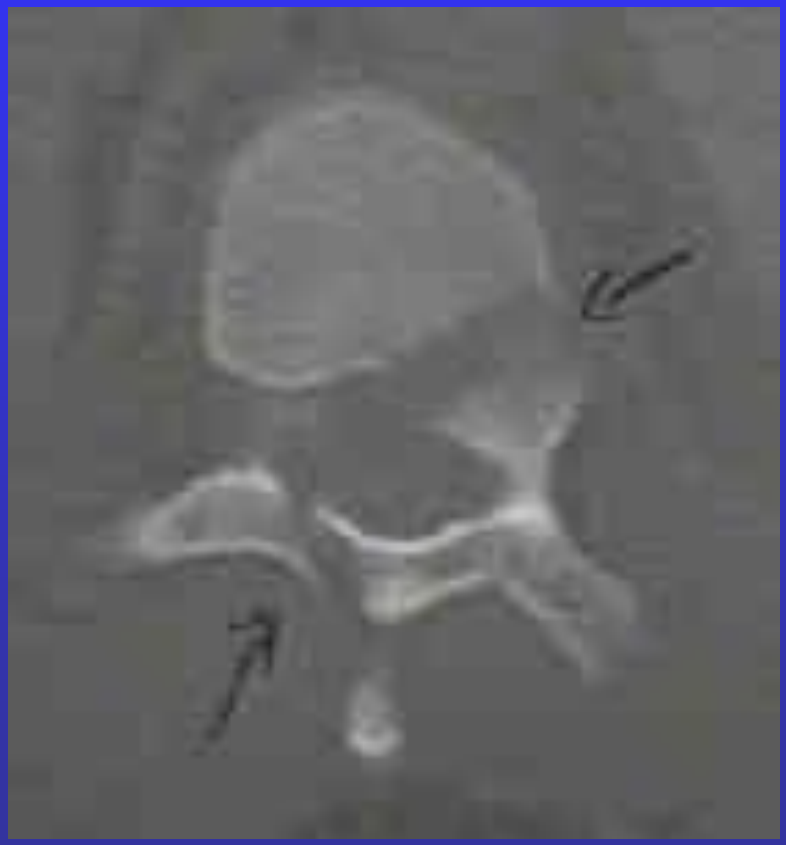


http://www.ortho-u.net/o11/198.htm

Compression vs Burst Fracture

- Compression Fracture
  - Stable
  - Failure of anterior column without injury to middle column
- Burst Fracture
  - UNSTABLE
  - Failure of both anterior and middle column
  - Often a boney fragment projecting into spinal canal

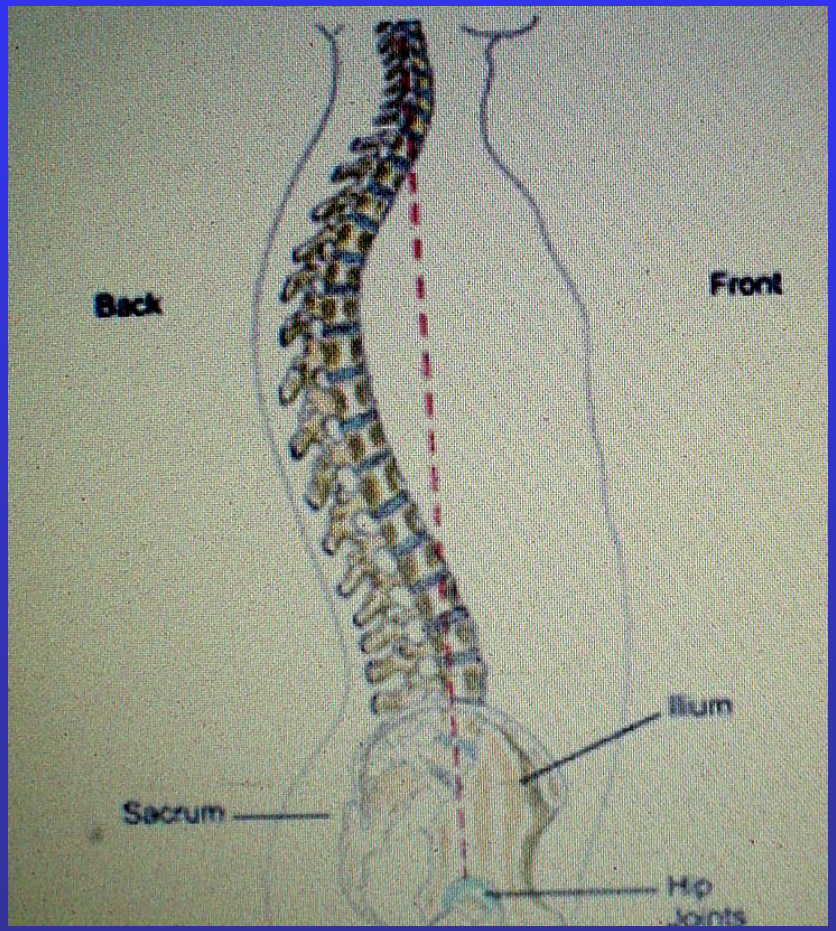
Indications for Spine Surgery

- Neurologic Deterioration
- Unstable fracture
- Epidural Hematoma
- Narrowing of spinal canal

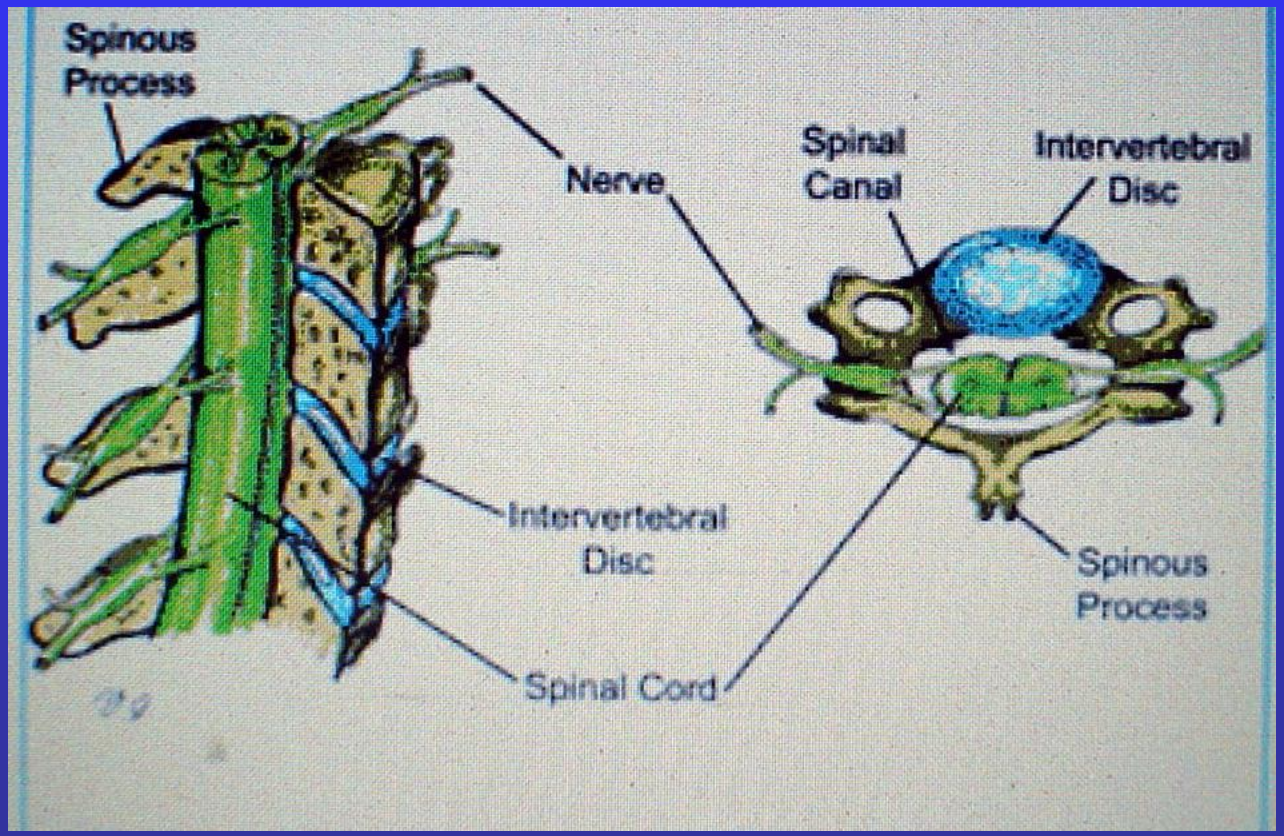
Goals of Spinal Surgery

- Decompression of Spinal Canal
- Stabilization of Spine

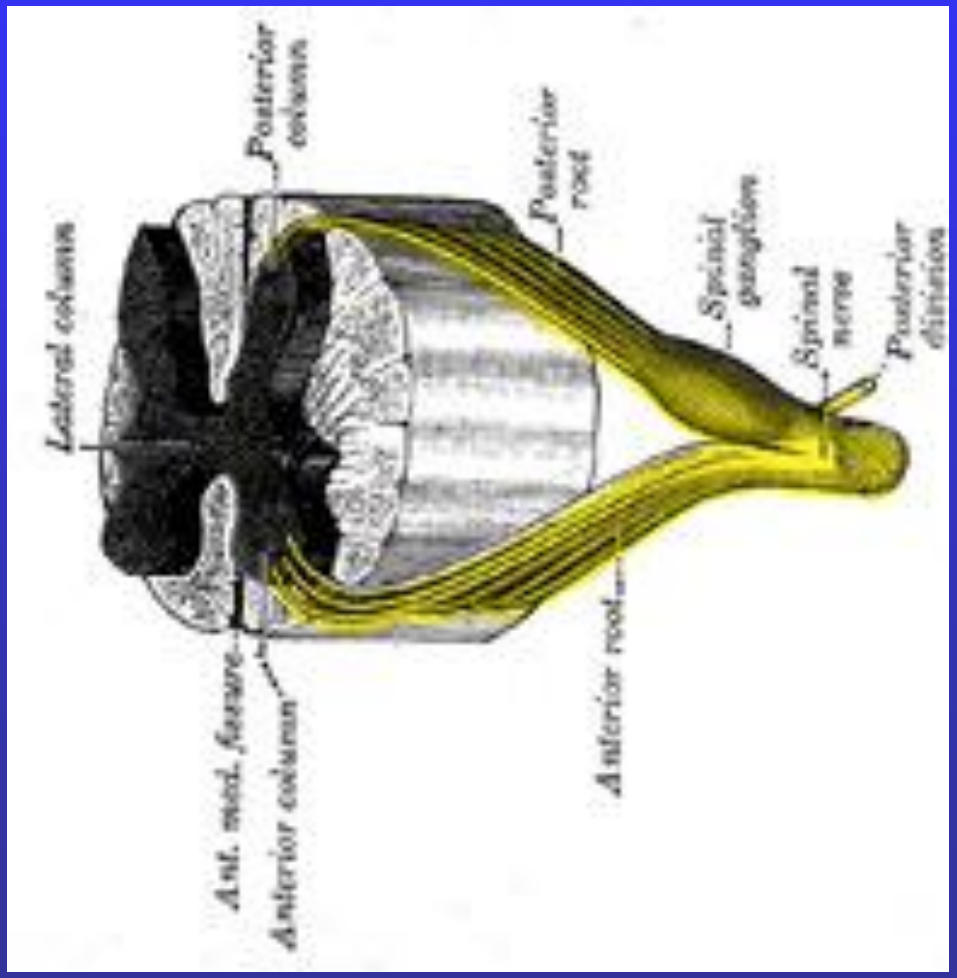
Spinal Cord Anatomy



Spinal Cord Anatomy



Spinal Cord Anatomy



Neurologic Exam: Dermatomes

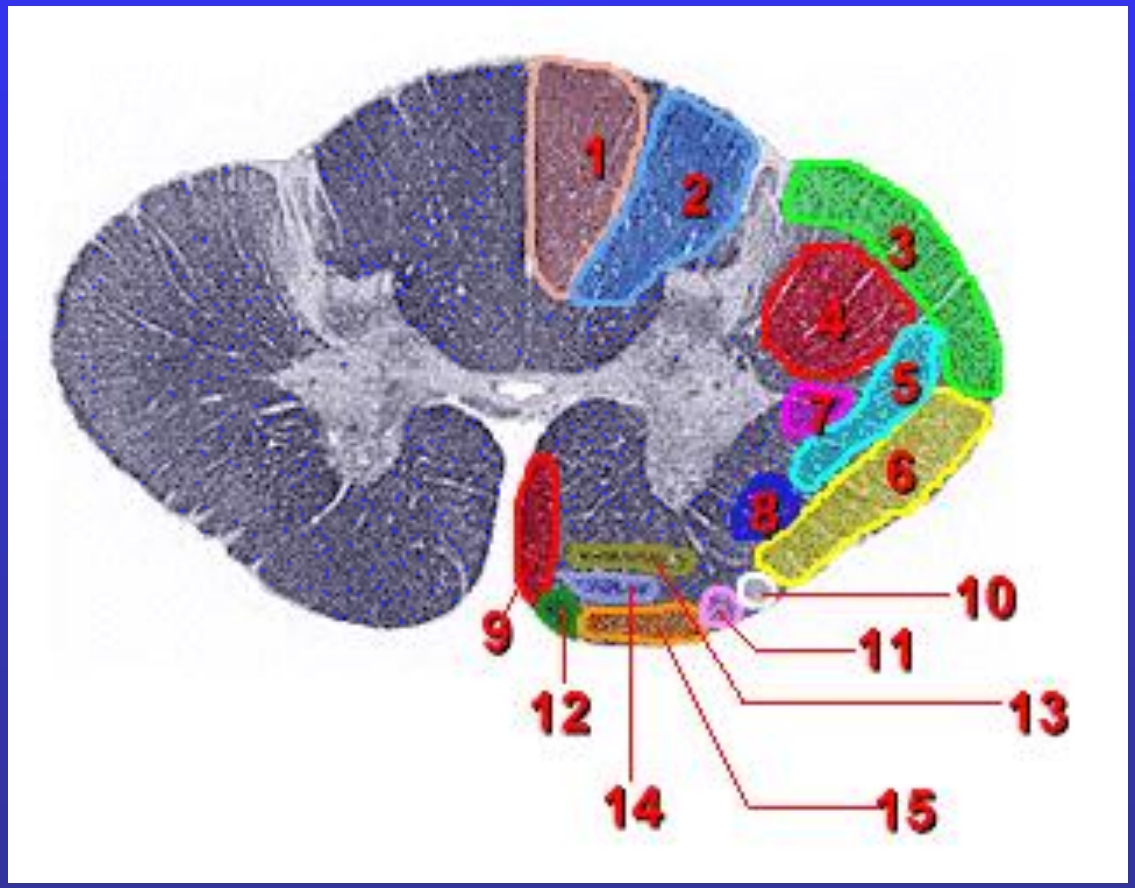
- C5- Deltoid
- C6 – Thumb
- C7 – Middle Finger
- C8 - Little Finger
- T4 – Nipple
- T8 – Xypoid
- T10 - Umbilicus
- T12 – Symphysis Pubis
- L4 – Medial aspect of leg
- L5 - Space between first and second toes
- S1 – Lateral border of the foot
- S3 – Ischial Tuberosity
- S4-5 – Perianal region

Neurologic Exam: Myotomes

- C5 – Deltoid
- C6 – Wrist Extensors
- C7 – Elbow Extensor
- C8 – Finger flexors
- T1 – Little finger abduction
- L2 - Hip flexion
- L3 - Knee Extension
- L4 - Ankle dorsiflexin
- L5 - Toe extension
- S1 – Plantar flexion

Spinal Cord Anatomy: A Brief Review

Posterior



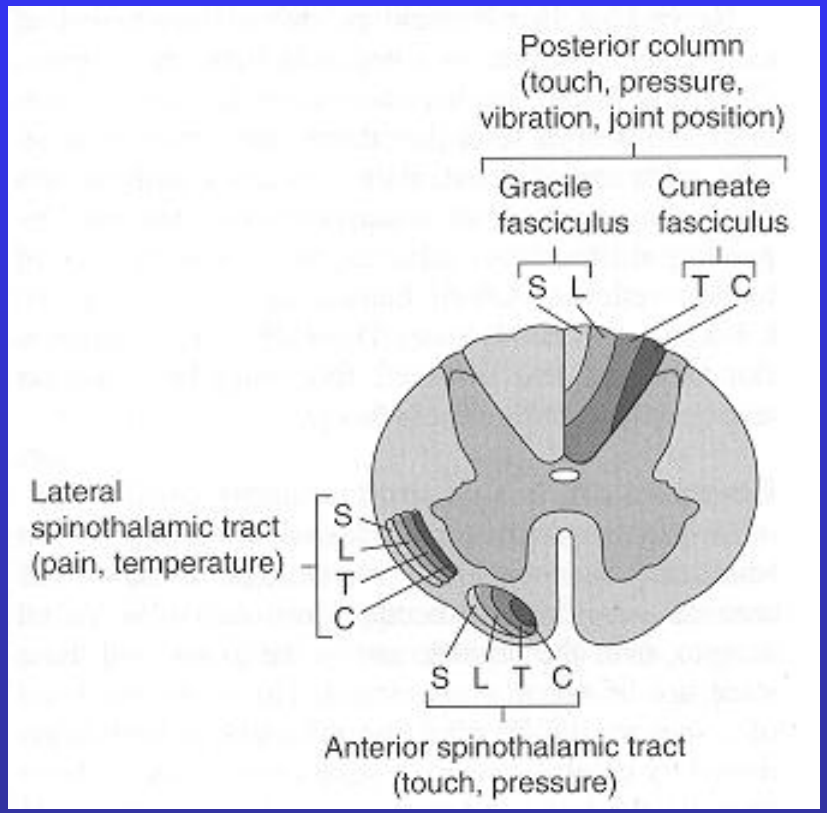
1&2 Posterior Columns: convey Ipsilateral information about two Point discrimination, proprioceptionAnd vibratory sense

5 Lateral Spinothalamic Tract: carries Pain and Temperature Information From contralateral extremity

4 Lateral Corticospinal Tract: Carries Motor Information from Contralateral Brain to Ipsilateral Extremity

http://academic.uofs.edu/student/mcnallye2/frames1.html

Afferent Sensory Tracts in the Spinal Cord

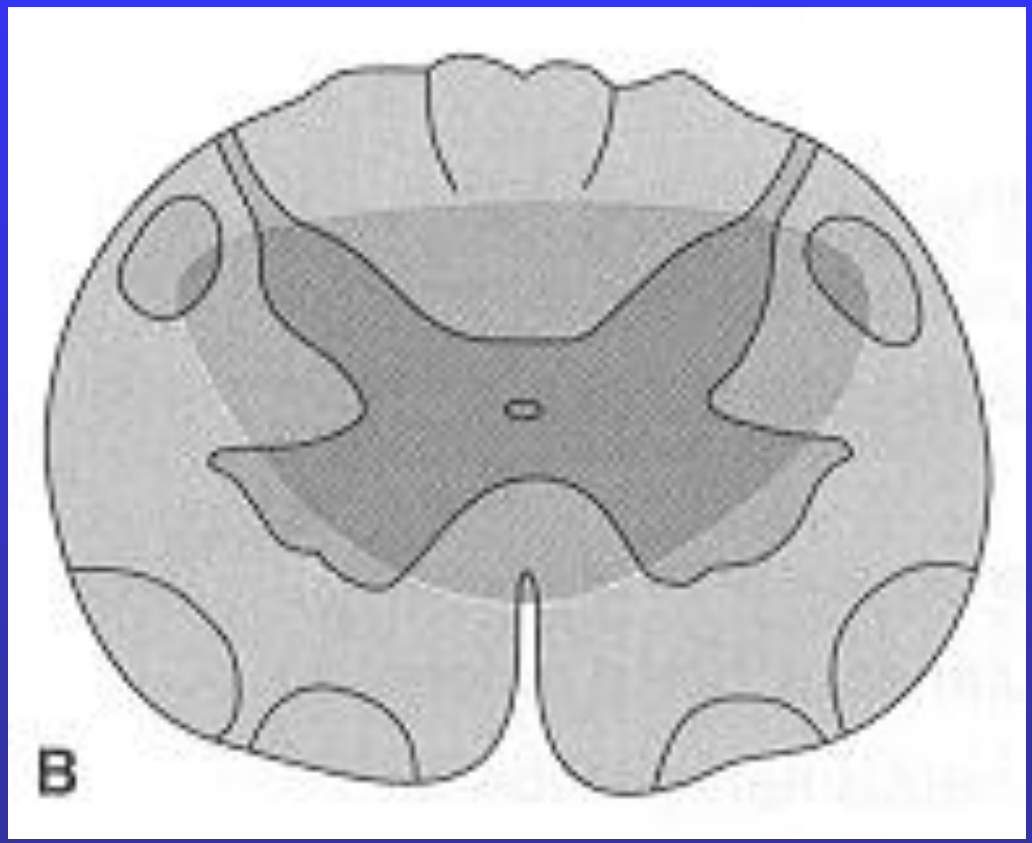


http://www.homestead.com/emguidemaps/files/spinalcord.html#Inferior%20cord%20syndrome%20(Conus%20medullaris%20syndrome)

Clinical Syndromes resulting from Incomplete Spinal Cord Injury

- Central Cord Syndrome
- Brown-Sequard Syndrome
- Anterior Cord Syndrome
- Conus Medullaris Syndrome
- Cauda Equina Syndrome

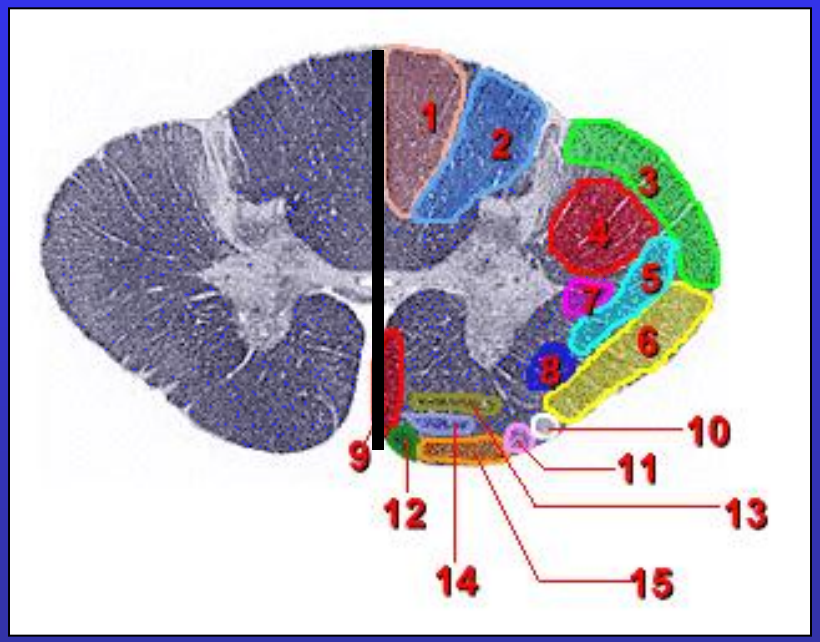
Central Cord Syndrome



- Motor>Sensory Loss
- Upper>Lower Extremity Loss
- Distal >Proximal Muscle Weakness
- Pneumonic: MUD
- Classically occurs with hyperextension injuries of the cervical spine

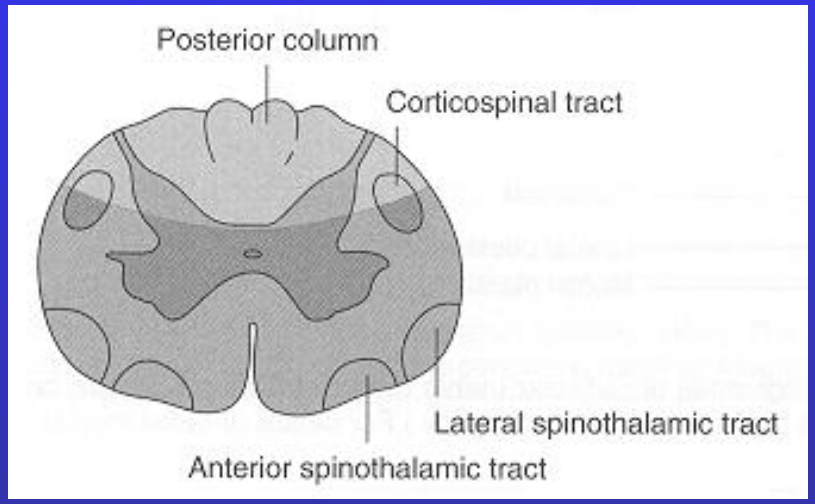
http://www.homestead.com/emguidemaps/files/spinalcord.html#Central%20cord%20syndrome

Brown-Sequard Lesion



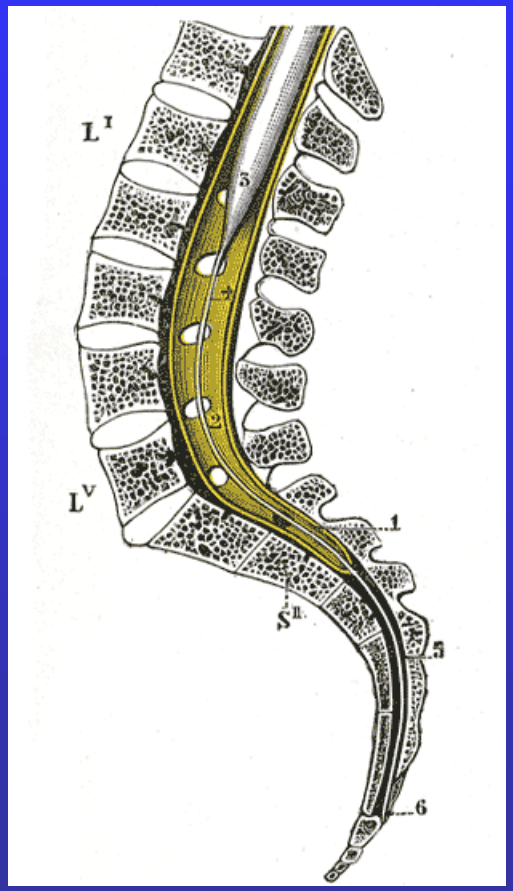
- Loss of Ipsilateral Proprioception, Light Touch and Motor Function
- Loss of Contralateral Pain and Temperature Sensation
- Due to hemisection of the cord due to penetrating injury
- Incomplete lesions most common

Anterior Cord Syndrome



- Loss of Motor function, Pain and Temperature Sensation
- Preservation of Light touch, Vibratory Sensation and Proprioception

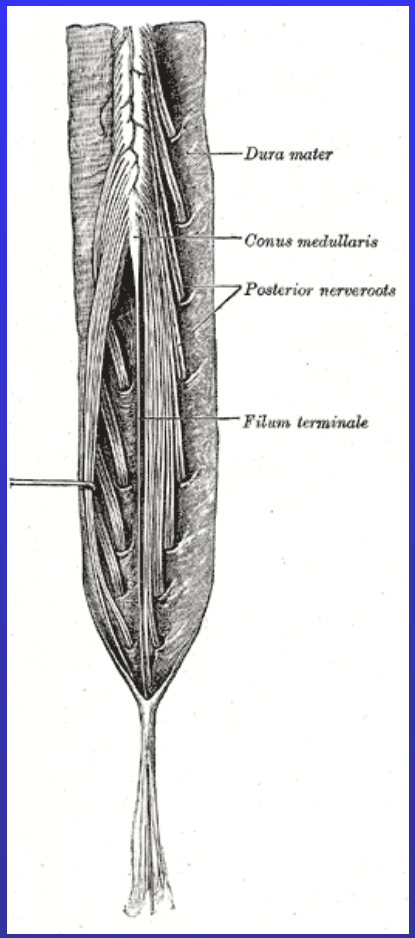
Conus Medullaris Syndrome



- Injury to sacral cord, lumbar nerve roots causing
  - Areflexic bladder
  - Loss of control of bowels
  - Knee jerk relexes preserved, ankle jerk absent
  - Signs similar to cauda equina syndrome except more likely to be bilateral

http://education.yahoo.com/reference/gray/fig/661.html

Cauda Equina Syndrome



- Injury to nerve roots and not spinal cord itself
- Muscle weakness and decreased sensation inaffected dermatomes
- Decreased bowel and bladder control

Treatment of Acute Spinal Cord Injury

- Methylprednisolone 30mg/kg as soon as possible (within the first 8 hours after injury) for proven NON-PENETRATING spinal cord injury
- 5.4 mg/kg/hr for the next 23 hours

Important Adjunct Measures

- Frequent turning
- Special bed to prevent pressure sores
- Splint extremities to prevent flexion contractures—splints MUST be well padded to protect skin
- Range of motion of joints
- Occupational and Physical Therapy
- Intermittent urinary catheterization if appropriate
- Skin Care
- Avoid succinylcholine b/o induced hyperkalemia
- Autonomic hypersensitivity
- Pulmonary Embolus Prophylaxsis

Principles of Initial Management

- Prevent further damage
- Assume a spine injury until proven otherwise

Primary Survey

- Airway
- Breathing
- Circulation
- Disability: Moves upper and lower extremities??
- Exposure

Secondary Survey

Careful Orthopedic and Neurologic Evaluation takes place in the Secondary Survey

History

- Pre-injury neurologic status
- Mechanism of injury
- Review Pre-hospital report
- Change in neurologic status?
- DOCUMENT FINDINGS

Cervical Spine Injury

- Cervical Spine poorly protected
- Suspect if:
  - Supraclavicular injury
  - Maxillofacial trauma
  - Head injury
  - High speed injury

Clinical Clearance of Cervical Spine only if:

- Patient awake and fully cooperative
- The neck is pain free without swelling, hematoma, pain to palpation or boney abnormalities
- No distracting injuries
- The patient has full pain free active range of motion
- DO NOT PASSIVELY MOVE THE PATIENT'S HEAD!!!!

Initial Treatment of Possible Cervical Spine Injury

- Immobilization
- Imaging studies
  - AP, lateral and open mouth spine films
  - Consider CT
  - MRI to view ligaments and spinal cord
- Search for occult injury in patient with a neurologic deficit
- DOCUMENT FINDINGS
- Early neurosurgical/orthopedic consultation

Neurological Examination

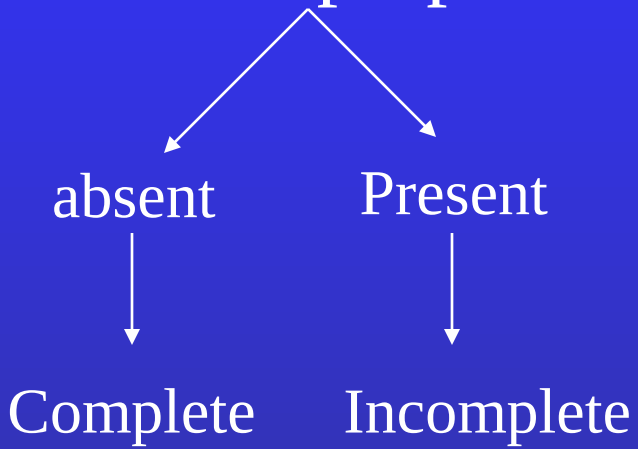
- Motor examination of upper and lower extremities
- Sensory Examination of upper and lower extremities
  - Examine perianal sensation to pinprick (S3,S4)
  - Distinguishes between a complete and incomplete spinal cord injury
- Reflexes
- DOCUMENT FINDINGS

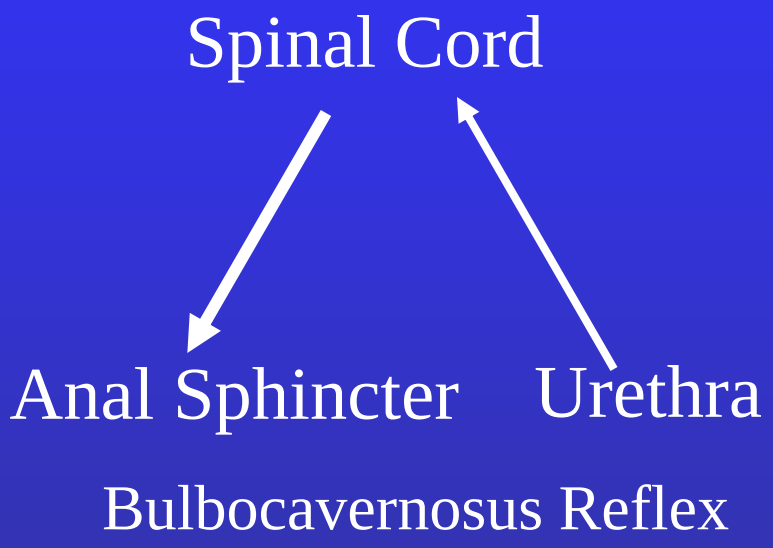
Clinical Signs of Cervical Spinal Cord Injury

- Areflexia
- Diaphragmatic Breathing
- Forearm flexion
- Response to pain above the clavicle
- Hypotension and bradycardia (sympathetic nervous system paralysis
- Priapism (paralysis of parasympathetics)

Complete vs Incomplete Spinal Cord Injury

- Perianal pinprick





Bulbocavernosus Reflex: Present -- Complete

Spinal Shock

- Temporary COMPLETE cessation of spinal cord function
- Occurs IMMEDIATELY after injury
- Complete loss of all reflexes– including the bulbocavernosus
- Flaccidity of all muscles

“Neurogenic” Shock

- Caused by high spinal cord injury
- Slow pulse
- Low blood Pressure
- Treatment
  - R/O Hemorrhage and other causes of hypotension
  - Fluids, Trendelenburg
  - Alpha adrenergic drugs
- Other problems
  - Inadequate ventilation
  - Change in clinical signs due to absent sensation

Frankel Classification of Spinal Cord Injury

- A. Complete: no motor or sensory function
- B. Sensory Only: Some sensation preserved, no motor function
- C. Motor Useless: Some sensory and motor function but motor function not useful
- D. Motor Useful: Sensory function preserved. Motor function weak but useful
- E. Intact: Normal Sensory and Motor function

American Spinal Injury Association (ASIA) Classification

- A. Complete: No sensory or motor function preserved in the sacral segments S4 & S5
- B. Incomplete: Sensory but not motor function preserved below neurological level including S4 and S5
- C. Incomplete: Sensory and motor function preserved below neurological level but more than half of the muscles have a grade of 3/5 or less

American Spinal Injury Association (ASIA) Classification

- D. Motor function preserved below neurological level and at least half of muscles have better than grade 3/5 function
- E. Normal motor and sensory function
- BUT ASIA Grade E does not describe pain, spasticity and dysesthesia that may result from spinal cord injury

ASIA Assessment of Motor Strength

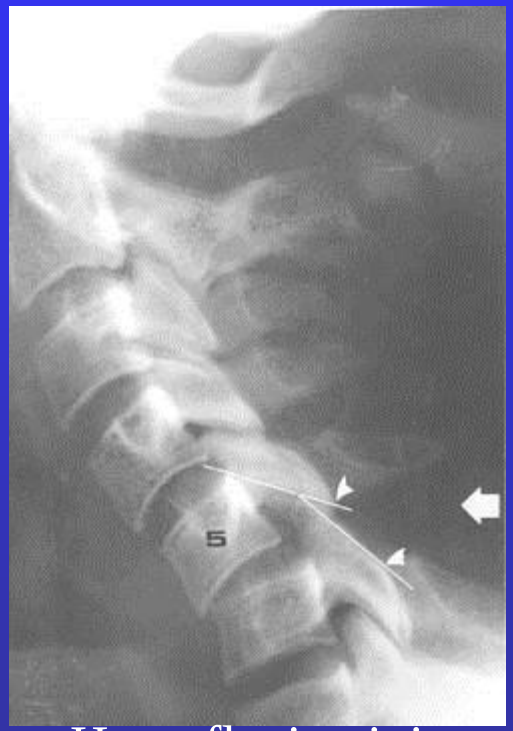
- 5 Normal Strength
- 4+ Submaximal movement against resistance
- 4 Moderate movement against resistance
- 4- Slight movement
- 3 Movement against gravity but not resistance
- 2 Movement when gravity eliminated
- 1 Flicker of Movement
- 0 No Movement

http://www.emedicine.com/pmr/topic182.htm

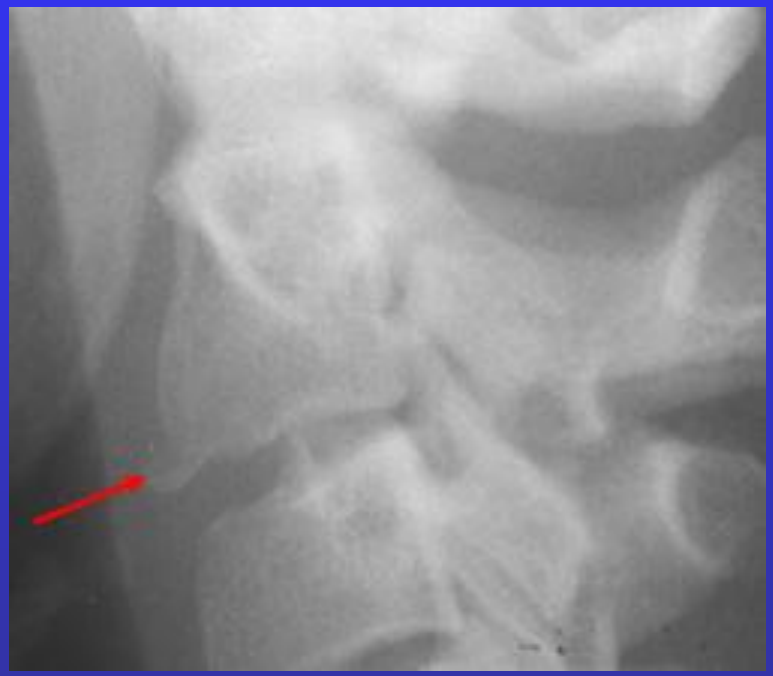
Radiologic Evaluation of Spine

- Cervical Spine
  - AP, Lateral and Open Mouth (to see the Odontoid) Views
  - Swimmer's View to see junction of C7 on T1
  - CT Scan outstanding exam to view bone anatomy and diagnose fractures
  - Flexion/Extension views: NOT BY NON-SPECIALIST
- REMEMBER: THE PATIENT CAN HAVE AN UNSTABLE CERVICAL SPINE WITHOUT A FRACTURE!!!!!

Ligamentous Injury



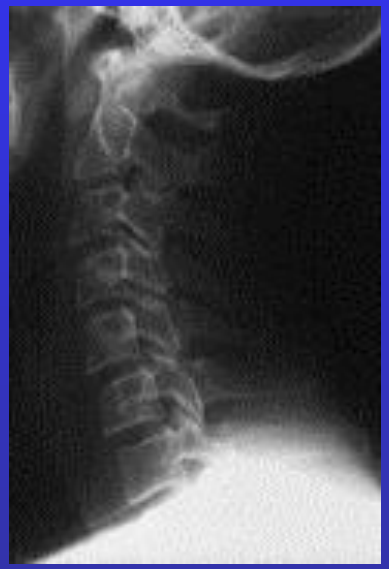
Hyperflexion injury
Disruption of posterior
Longitudinal ligament



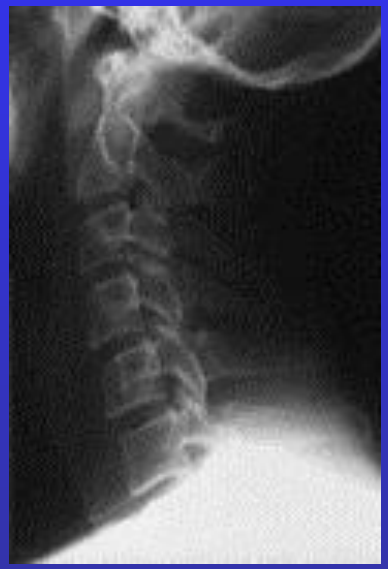
Hyperextension Injury

http://www.uth.tmc.edu/radiology/test/er_primer/spine/spfrm.html

CervicalSpine Film Evaluation



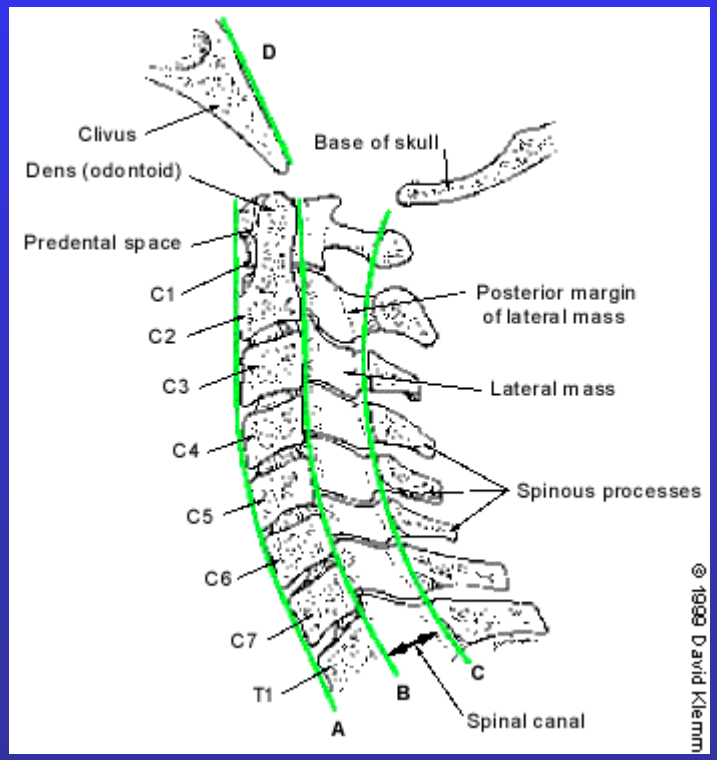
acceptable

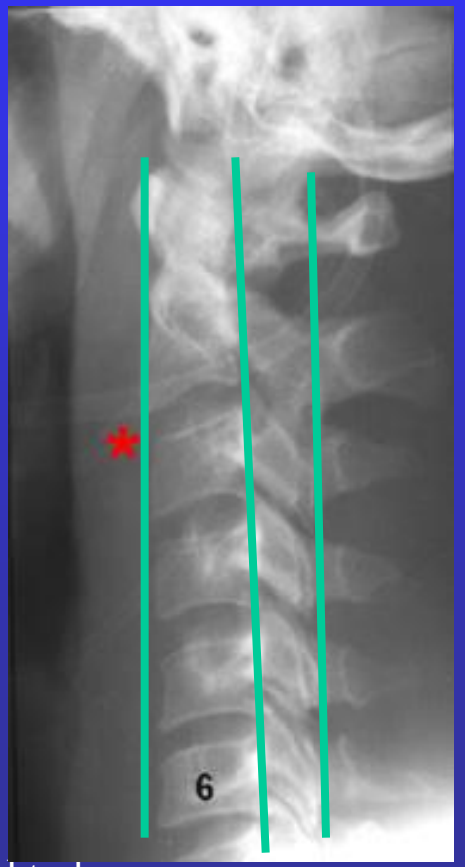


unacceptable

- See all 7 vertebrae including top of D1
- Check for soft tissue swelling
- Check for vertebral alignment

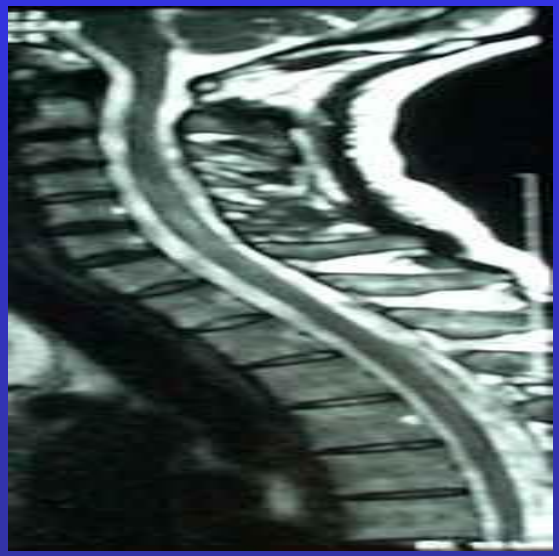
Evaluation of Lateral Cervical Spine Film



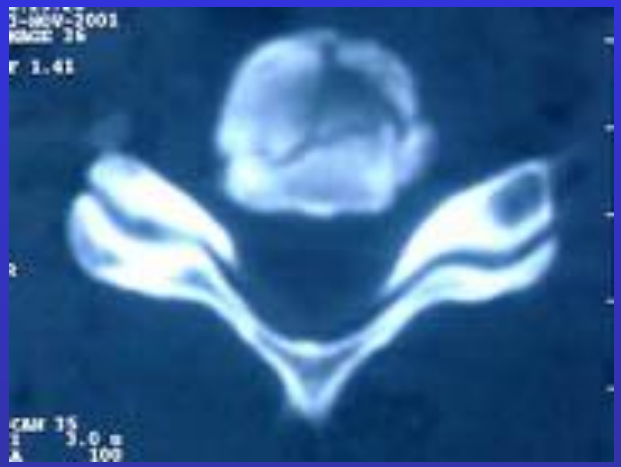


http://www.aafp.org/afp/990115ap/331.html

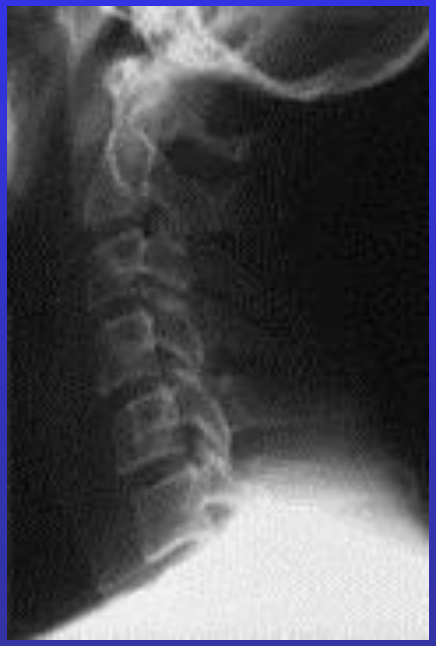
MRI is the definitive imaging technique



http://www.medi-fax.com/atlas/normalspine/case1.html



http://www.trauma.org/imagebank/imagebank.html



http://www.trauma.org/imagebank/imagebank.html

Summary

- Assume a spine injury until proven otherwise in blunt trauma
- X-ray the entire axial skeleton if: (1) appropriate mechanism of injury, (2) patient unable to cooperate with exam, a spine fracture is identified
- Careful DOCUMENTED neurologic, orthopedic, and radiologic evaluation of spine in secondary survey
- Timely orthopedic and neurosurgical consultation