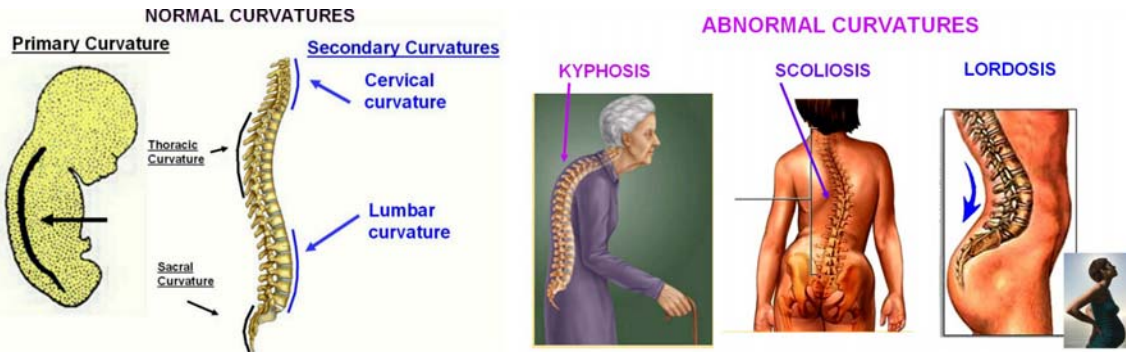


**REVIEW VERTEBRAE, SPINAL NERVES, REFLEXES**

**1) VERTEBRAE - NORMAL SPINAL CURVATURES:** Primary = Concave Anterior - (fetal curvature); preserved in adult Thorax, Sacrum  
Secondary = Concave Posterior (develop in childhood) - Cervical (support head), Lumbar (support body)

**ABNORMAL CURVATURES** - all can cause pain from compression of spinal nerves

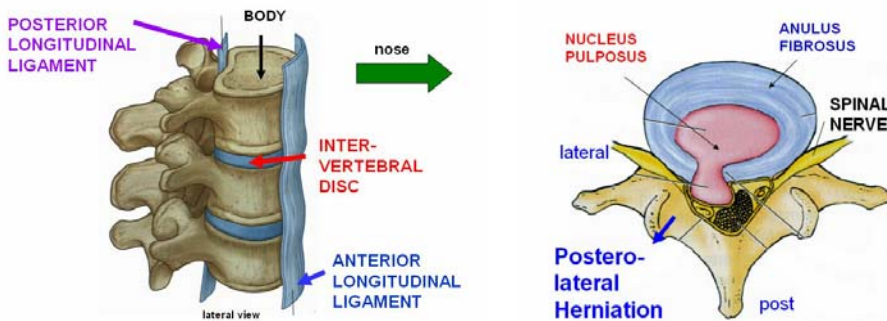
	Curvature	Location (Most common)	Cause
<b>Kyphosis</b>	Exaggerated Concave <b>Anterior</b>	Often in <b>Thoracic Region (Hump back)</b>	<b>Osteoporosis</b> , etc. - loss of bone in bodies of vertebrae
<b>Scoliosis</b>	Exaggerated <b>Lateral</b>	<b>Thoracic, Lumbar</b> most common	<b>Hemivertebra</b> (half of vertebral body does not form in development), etc.
<b>Lordosis</b>	Exaggerate Concave <b>Posterior</b>	<b>Lumbar</b> (normal in pregnancy)	<b>Obesity</b> , etc.



**SUMMARY OF LIGAMENTS OF VERTEBRAE AND DISC HERNIATION**

Ligament	Connects	Clinical
Anterior Longitudinal Ligament	Anterior side of bodies of vertebrae	Broad band; <b>Prevents disc herniation anteriorly</b>
Posterior Longitudinal Ligament	Posterior side of bodies of vertebrae (inside canal)	Narrow band; ( <b>intervertebral discs herniate in posterolateral direction, lateral to ligament</b> )
Ligamenta Flava	Elastic layer connecting Laminae of vertebrae	Last layer penetrated by needle in <b>Epidural anesthesia</b> ; (Note: <b>Dura is last</b> in <b>Lumbar Puncture</b> spinal tap)
Interspinous and Supraspinous ligaments	Spines of vertebrae	Thickened in neck to form <b>Ligamentum nuchae</b> (extends from Ext. Occipital Protuberance to C7)

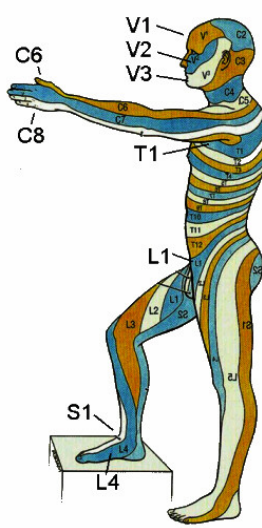
Note: **Herniation of Nucleus pulposus = 'Slipped Disc'** - Nucleus pulposus bulges out through Annulus fibrosus; usually in a **Posterolateral direction** (lateral to the Posterior Longitudinal Ligament); **Most common at levels L4-L5 or L5-S1**.  
 Note: **Cervical Intervertebral Disc Herniation** - Second most common region for disc herniation; **Lower cervical disc herniation** - Symptoms in Upper Extremity, if below C4 (Brachial Plexus C5-C8, T1)



**SUMMARY OF SOME FEATURES OF VERTEBRAE ON CT, LANDMARKS AND SOME CLINICAL SIGNS**

Vertebra	ID Features on CT	Clinical, Associated Structures on CT
Cervical (7)	<b>Foramina Tranversaria transmit Vertebral Artery (C1-C6)</b> <b>C1 = Atlas - no body</b> <b>C2 = Axis - dens</b> C7 = Vertebra prominens (long palpable spine)	1) <b>Damage to vertebral artery</b> - brainstem symptoms 2) <b>Upper cervical fracture</b> ( C1 or dens of C2) - <b>Quadriplegia</b> ; 3) <b>Disc Herniation in Lower Cervical Vertebrae</b> - symptoms in upper extremity (Brachial plexus)
Thoracic (12)	<b>Ribs abut bodies</b> (head of rib), <b>transverse processes</b> (tubercle of rib);	<b>Landmark: Thoracic aorta</b> anterolateral to bodies
Lumbar (5)	<b>Large bodies; No surrounding bones</b>	<b>Landmarks: Erector spinae</b> posterior; <b>Psoas major</b> lateral; <b>IVC</b> and <b>Abdominal aorta</b> anterior to bodies

**2) GROSS ANATOMY OF SPINAL CORD AND SPINAL NERVES**

Syndrome/ Procedure	Anatomy	Structures	Clinical, ID Features on CT
<b>Spinal Nerve Compression</b>	<b>Convention:</b> Cervical spinal nerves <b>C1-C7 exit Above</b> corresponding vertebrae; <b>C8 and All other spinal nerves exit Below</b> vertebrae	<b>Dermatomes</b> - area of distribution of single nerve root to skin; [V1 - Face (above eyes *) V2 - Face (below eyes*) V3- Face (below mouth)*] C5 - Shoulder C6 - Thumb C8 - Little finger T1 - Armpit T4 - Nipple T7 - Xiphoid T10 - Umbilicus L1 - Inguinal lig. L4 - Big toe S1 - Little toe [* Note: V - also Oral, Nasal Cav., Cranial Dura Mater - headache]	<b>Symptoms of compression of nerve root - Paresthesia, pain, sensory loss, hyporeflexia, muscle weakness</b>    <b>Note:</b> overlap of dermatomes in region of trunk: sensory loss in trunk only with Two Thoracic spinal roots
<b>Lumbar Puncture</b>	Inferior end of Spinal Cord = <b>Conus medullaris</b>	Conus medullaris at 1. In <b>Newborn</b> , vertebral level <b>L3</b> 2. In <b>Adult</b> , conus at vertebral level <b>L1</b>	<b>Lumbar Puncture</b> done below Conus Medullaris (region of Cauda Equina); Level: 1. <b>Children - L4-L5</b> 2. <b>Adult - L3-L4 or L4-L5</b>
<b>Metastasis to Vertebral Column</b>	<b>Epidural Space</b> (outside Dura) Dura is separated from inner side of vertebral canal; Note: in Skull, there is no epidural space	<b>Internal Vertebral Venous plexus</b> - inside vertebral canal in Epidural Space; drains to <b>External Venous plexus</b> (outside vertebrae) by Radicular and Intervertebral veins	<b>Disease processes (ex. cancer) can spread to vertebrae</b> and spinal cord via <b>anastomoses of Vertebral venous plexus and intervertebral veins with Lumbar veins</b> (ex. carcinoma of prostate can metastasize to vertebral column)

## LAYERS PENETRATED IN EPIDURAL ANESTHESIA/LUMBAR PUNCTURE (superficial to deep)

1. Skin, 2. Superficial Fascia, (3. Supraspinous ligament, 4. Interspinous ligament)
5. Ligamentum Flavum (sudden yield, first 'pop') - now inside vertebral canal in Epidural space
6. Epidural Space - STOP HERE FOR EPIDURAL ANESTHESIA
7. Dura Mater (sudden yield, second 'pop')
- (8. Arachnoid - adherent to inner side of dura mater)
9. Subarachnoid Space (Lumbar Cistern) - STOP HERE FOR LUMBAR PUNCTURE/SAMPLE CSF

## 3) SPINAL REFLEXES AND DIAGNOSIS OF UPPER AND LOWER MOTOR NEURON LESIONS

REFLEX	STIMULUS/SENSE ORGAN(S) EXCITED	RESPONSE	CLINICAL/ABNORMAL RESPONSES
Stretch (Myotatic, Deep Tendon) Reflex	Rapid Stretch of muscle (test: tap on muscle tendon) Excites Muscle Spindle Primary (Ia) and Secondary (II) sensory neurons (NOT Golgi Tendon Organ)	Stretched muscle contracts rapidly (monosynaptic connection); also excite synergist and Inhibit antagonist Note: Gamma motor neurons can enhance stretch reflexes (Gamma dynamic motor neurons specifically enhance Ia sensitivity; tell patient to relax before test)	<u>Hyporeflexia</u> - decrease in stretch reflexes occurs in Lower Motoneuron Diseases, Muscle atrophy etc. <u>Hyperreflexia</u> - (increase) - characteristic of Upper Motor Neuron lesions (ex. spinal cord injury, damage Corticospinal tract); note: <u>Clonus</u> = hyperreflexia with repetitive contractions to single stimulus
Autogenic Inhibition (Inverse Myotatic Reflex)	Large force on tendon excites Golgi Tendon Organ Ib (test: pull on muscle when resisted)	Muscle tension decreases; Also inhibit synergist muscles; excite antagonist muscles	<u>Clasped Knife Reflex</u> - occurs in Upper Motor Neuron lesions - forceful stretch of muscle is first resisted then collapses
Flexor Reflex	Sharp, painful stimulus, as in stepping on nail; Excites - Cutaneous and pain receptors	Limb is rapidly withdrawn from stimulus; protective reflex; also inhibit extensors of same limb and excite extensors of opposite limb (Crossed Extensor Reflex)	<u>Babinski sign</u> - toes extend (dorsiflex) to cutaneous stimulus of sole of foot (normally plantar flex); characteristic of Upper Motor Neuron lesion

## LOWER AND UPPER MOTOR NEURON LESIONS

Lesion	Structure Affected	Symptoms	Examples
Lower Motor Neuron Lesion (Flaccid Paralysis)	Lower Motor Neurons = Alpha Motor neurons with axons that innervate skeletal muscles	Muscle is effectively denervated: 1) Decrease Stretch (Deep Tendon) Reflexes 2) Decreased Muscle Tone 3) Muscle atrophy; Fasciculations (twitches) precede atrophy 4) No Babinski sign	1) Compression of spinal nerve 2) Poliomyelitis - viral infections affecting motor neurons
Upper Motor Neuron Lesion (Spastic Paralysis)	Upper Motor Neurons = All descending neurons that affect Lower Motor Neurons (ex. Corticospinal, Reticulospinal neurons)	Disrupt voluntary control and regulation of reflexes (remove inhibition): 1) Increase Stretch (Deep Tendon) Reflexes 2) Increased Muscle Tone 3) No Fasciculations 4) Babinski sign 5) Clasped Knife Reflex	1) Damage to Corticospinal (corticobulbar) tracts - can occur at all levels from cortex to spinal cord (including brainstem)

Note: Some diseases produce both Upper and Lower Motor Neuron Symptoms - (ex. ALS Amyotrophic Lateral Sclerosis)