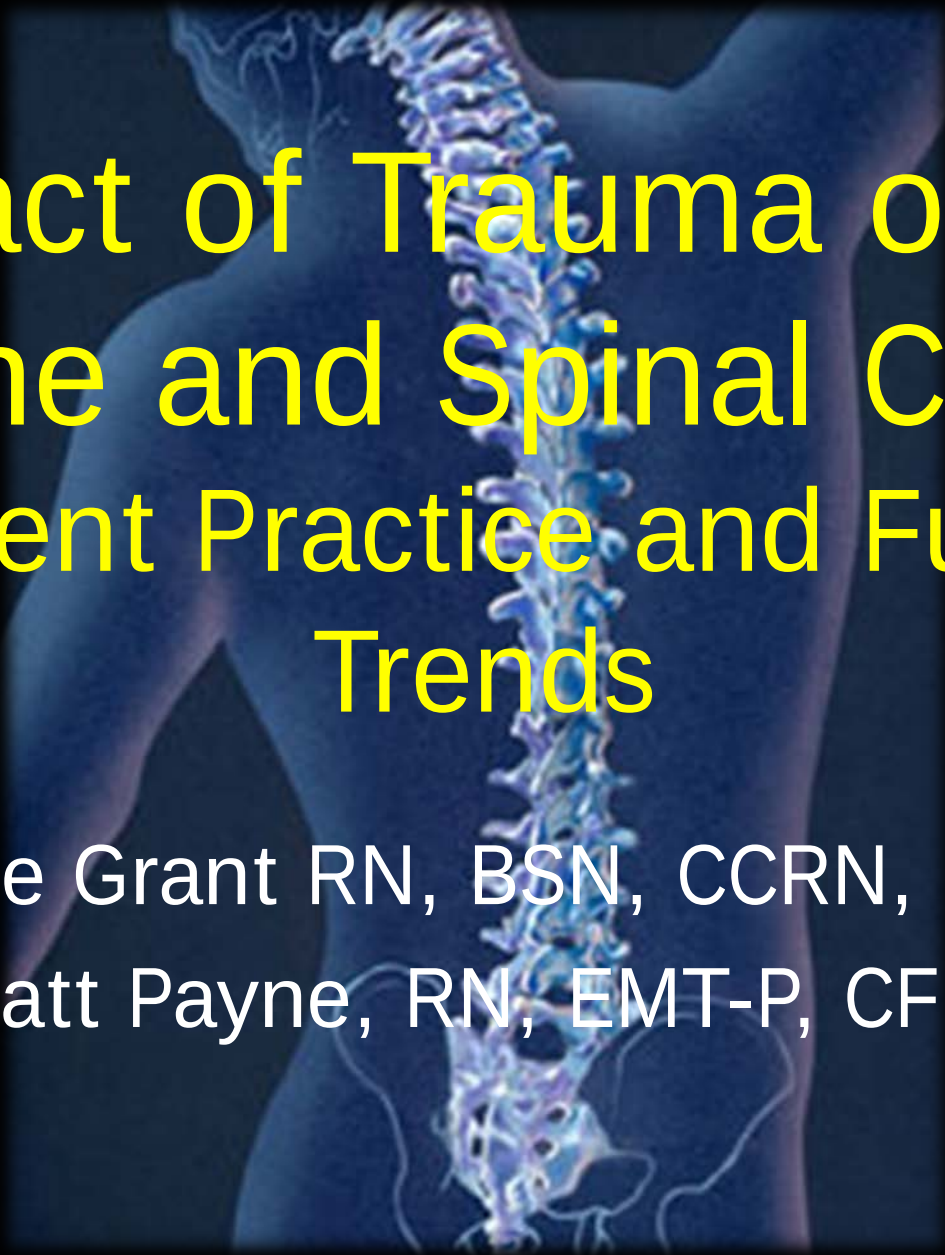




Impact of Trauma on the Spine and Spinal Cord: Current Practice and Future Trends

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U.S. News & World Report
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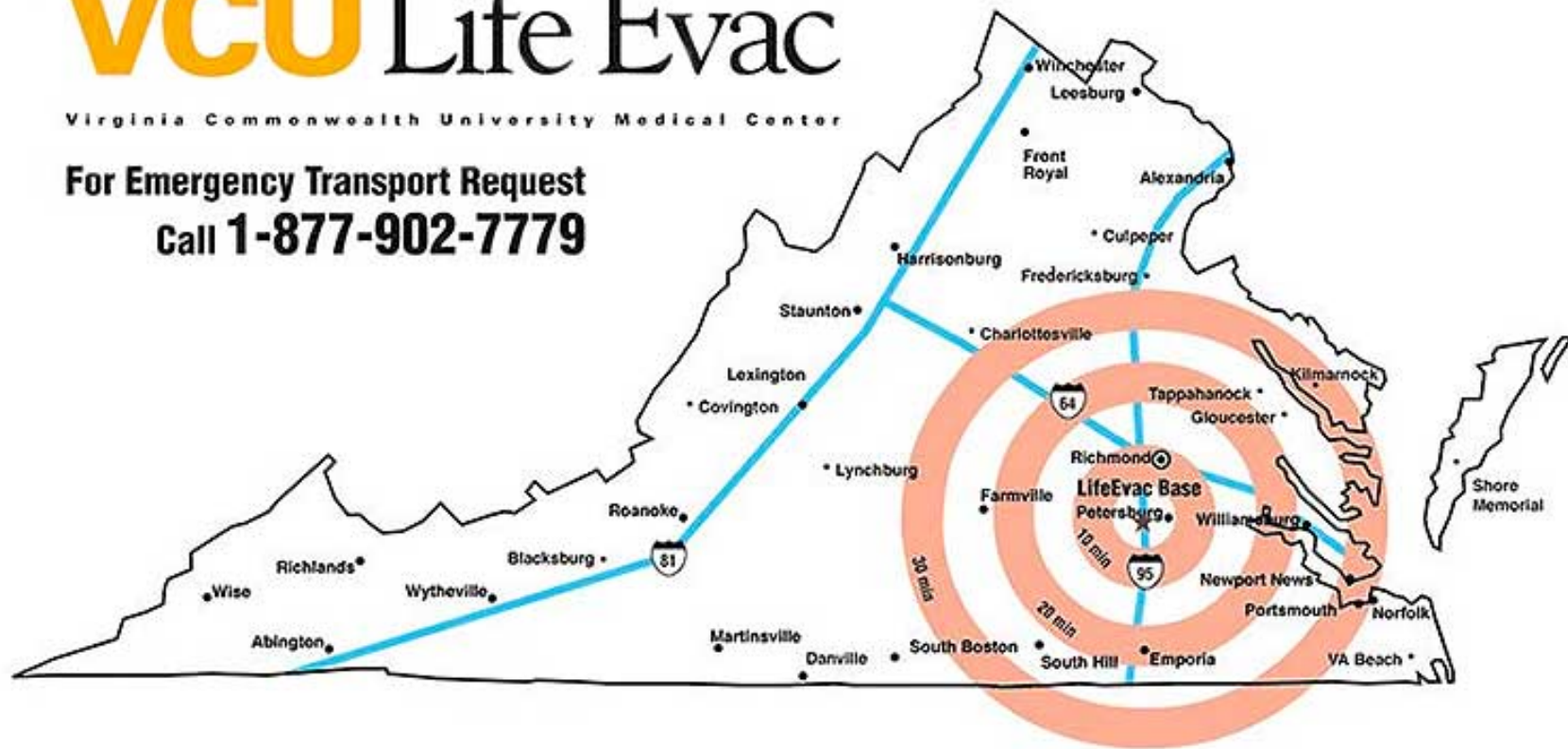




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Objectives

- Review basic anatomy and physiology of the spine and spinal cord.
- Review mechanisms of spinal injury.
- Discuss different types of injuries to the spinal cord.
- Discuss our goals as EMS providers in the care of the spinal trauma patient.
- Discuss future trends in spinal trauma management.

Statistics

- 20,000 spinal cord injuries per year
- 20% die before hospital admission
- Male to female ratio is 4:1
- 50-70% are 15-35 years old



Causes of Spinal Trauma



42% - MVC's

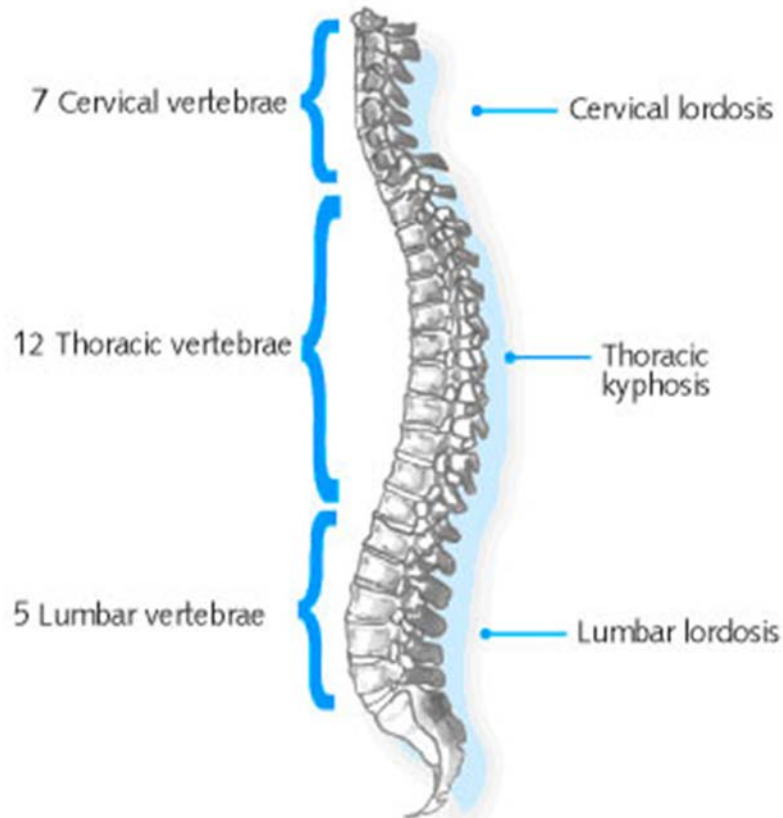
26% - Falls

15% - Violent Acts

13% - Sports

4% - Other

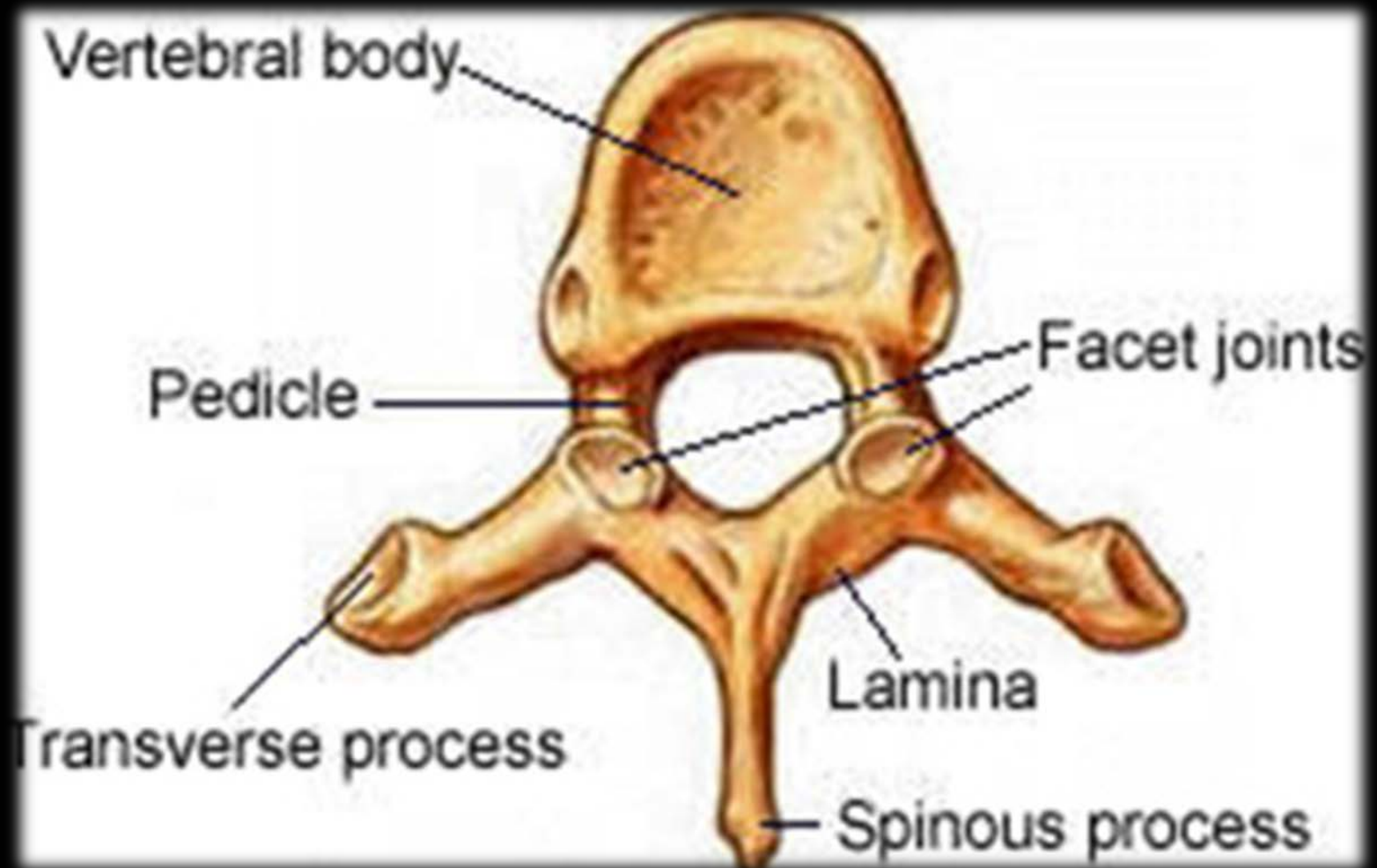
Spinal Anatomy



Vertebrae

- 7 cervical (neck)
- 12 thoracic (chest)
- 5 lumbar (back)
- 5 fused sacral
- 3 fused coccyx

Spinal Anatomy



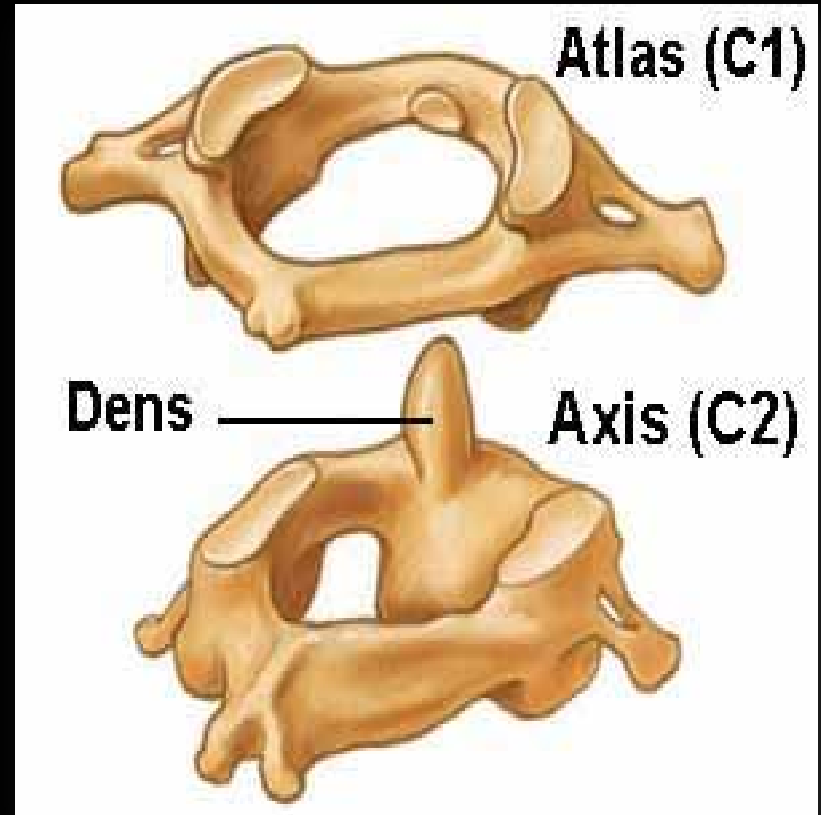
Cervical Spine

- Most vulnerable to injury because of mobility and exposure
- 55% of spinal injuries occur in the c-spine



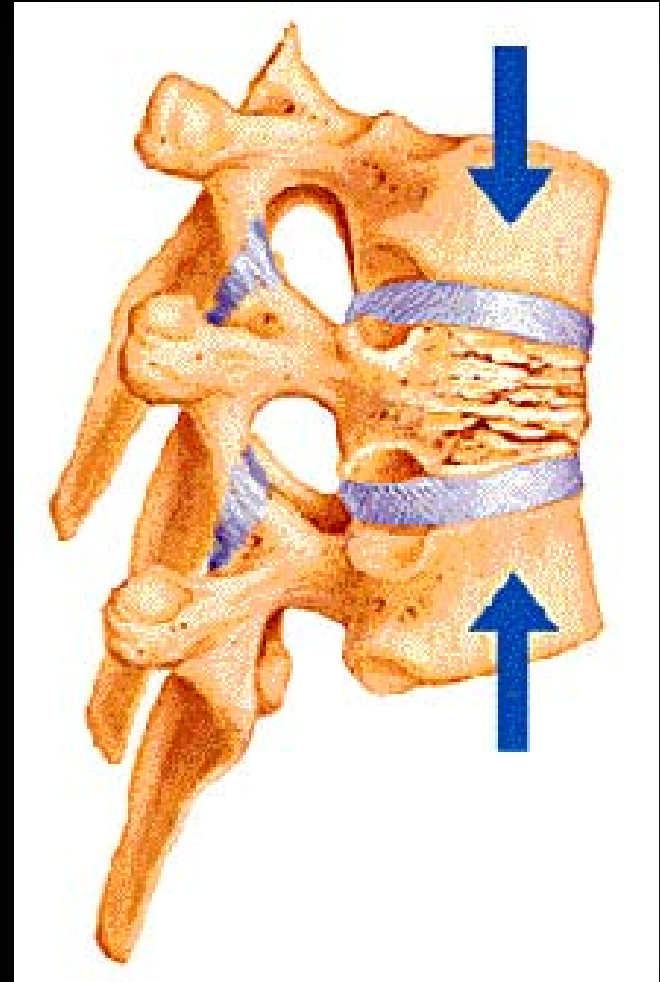
Cervical Vertebrae

- **Atlas**
 - 1st cervical vertebrae
 - Articulates with occipital bone superiorly and axis inferiorly
- **Axis**
 - 2nd cervical vertebrae
 - Articulates with atlas and allows for head rotation



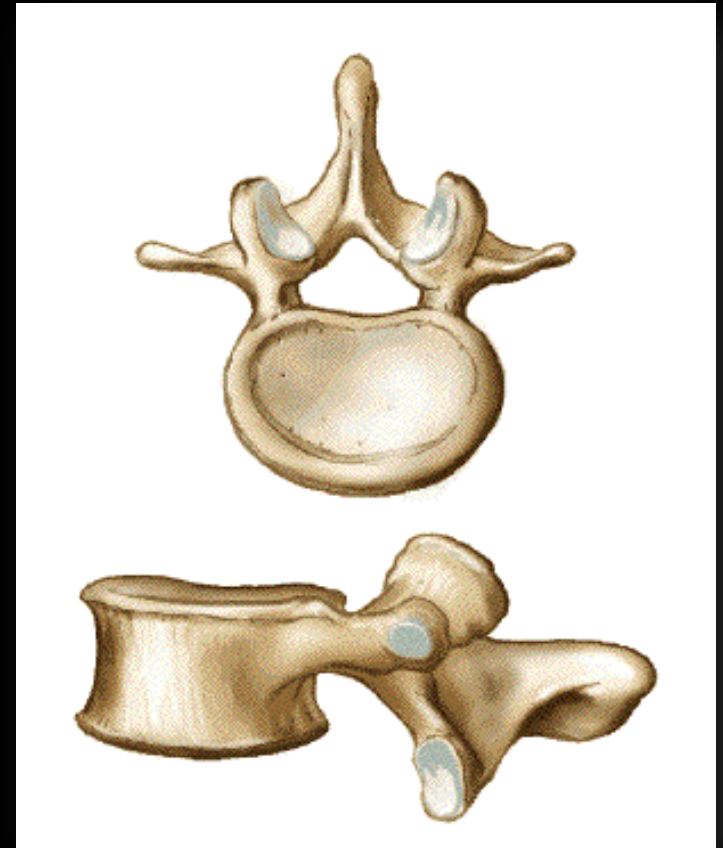
Thoracic Spine

- Larger & stronger than cervical
- Articulates with ribs
- Supports chest muscles
- Fractures/dislocations more often result in SCI



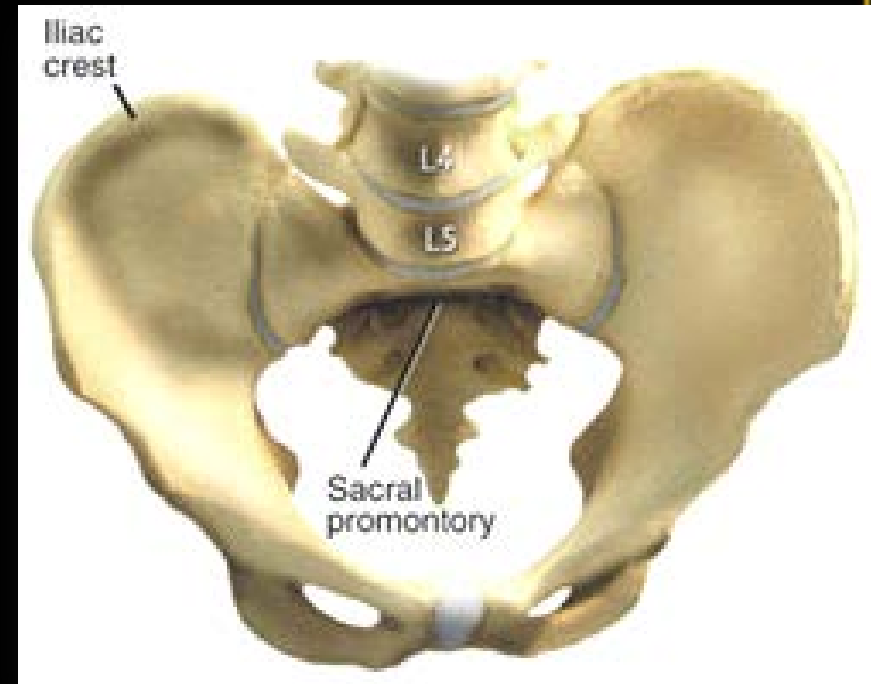
Lumbar Spine

- Largest & thickest
- Bending and lifting
- 15% of injuries here
- Herniated disc most common



Sacrum and Coccyx Spine

- **Sacrum**
 - Fused
 - Forms posterior plate of pelvis
 - Attaches pelvis and lower extremities to the axial skeleton
- **Coccyx**
 - 3 (5) rudimentary vertebrae



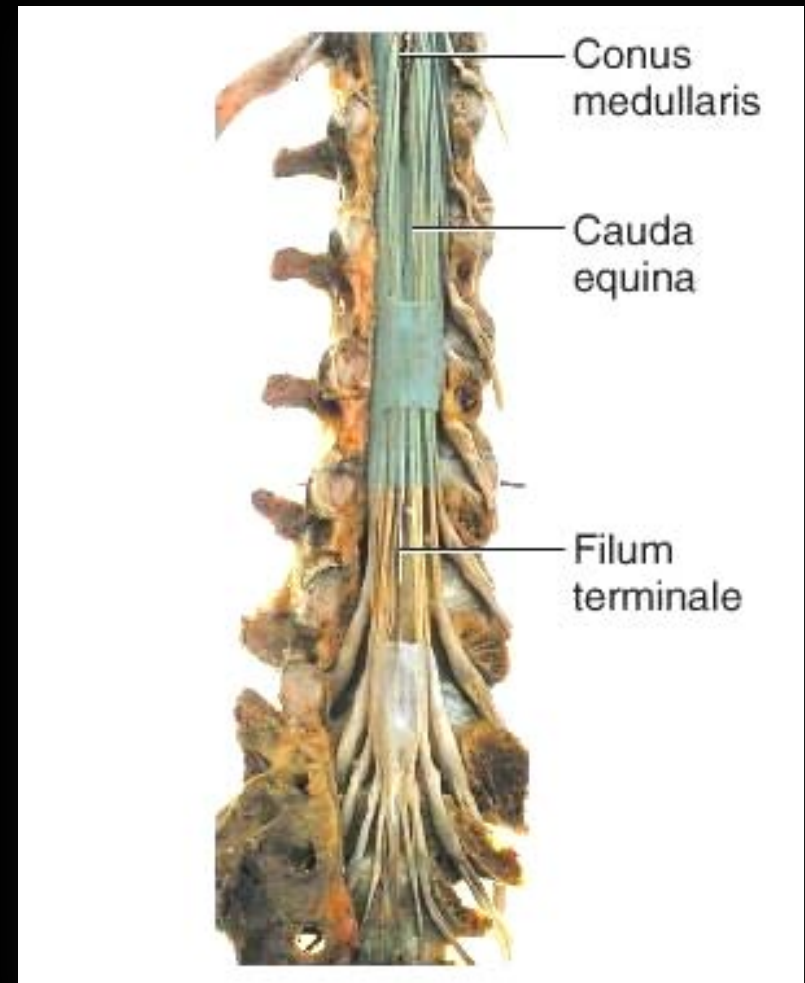
Spinal Cord

- Connects the brain & body
- Sends sensory information from the body to the brain
- Motor impulses from the brain to the muscles and organs



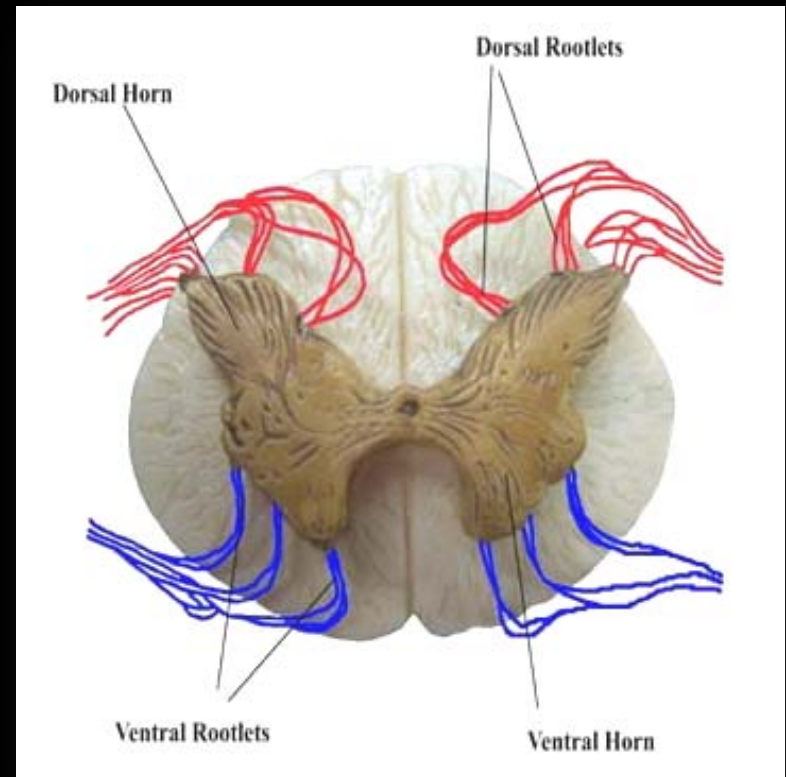
Spinal Cord

- Base of brain to L1-L2
- End of cord is called **conus medullaris**
- Spinal nerves continue to form the **cauda equina**



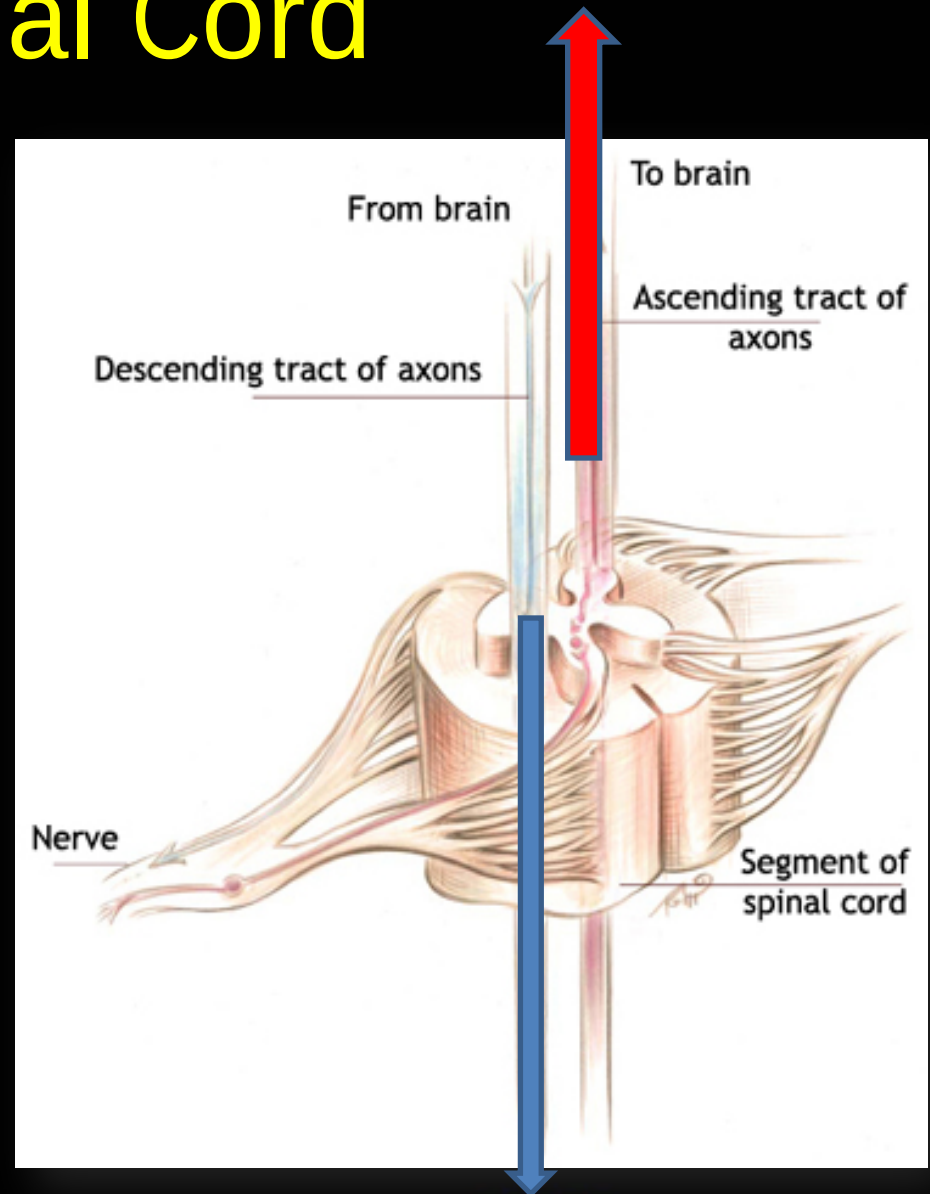
Spinal Cord

- **Gray Matter**
 - H-shaped mass of gray substance surrounded by white matter
 - **Anterior horn:** motor fibers
 - **Posterior horn:** sensory fibers



Spinal Cord

- **White Matter**
 - Surrounds the gray matter
 - Made up of **ascending** and **descending** pathways called spinal tracts



Spinal Tracts

- **Corticospinal tract**
 - Controls motor power on the same side of the body
- **Spinothalamic tract**
 - Transmits pain and temp sensation on the opposite side of the body
- **Posterior columns**
 - Carry position sense (proprioception), vibration sense, and some light-touch sensation from the same side of the body

Spinal Nerves

- **31** pairs of nerves that originate from the spinal cord
- **Plexus:** nerve roots that converge in a cluster of nerves



Spinal Nerves

- **Cervical Plexus**
 - Innervates the neck
 - Produces the phrenic nerve
 - “C3, 4, and 5 keep the diaphragm alive.”
- **Brachial Plexus**
 - C5-T1
 - Controls the upper extremities
- **Lumbar and Sacral Plexuses**
 - Innervate the lower extremities

Spinal Nerves

Autonomic Nervous System

- Maintains a “balance” among internal organs
- Mostly an involuntary system
- Separated into 2 nervous “systems”
 - Sympathetic
 - Parasympathetic

Sympathetic Nervous System

- Mobilizes energy stores in times of need
- “Fight or Flight” response
- Branches from nerves in the thoracic and lumbar region



Sympathetic Nervous System

- **Increases** heart rate
- **Increases** cardiac output
- **Increases** systemic vascular resistance
- **Decreases** organ and digestive system activity



Parasympathetic Nervous System



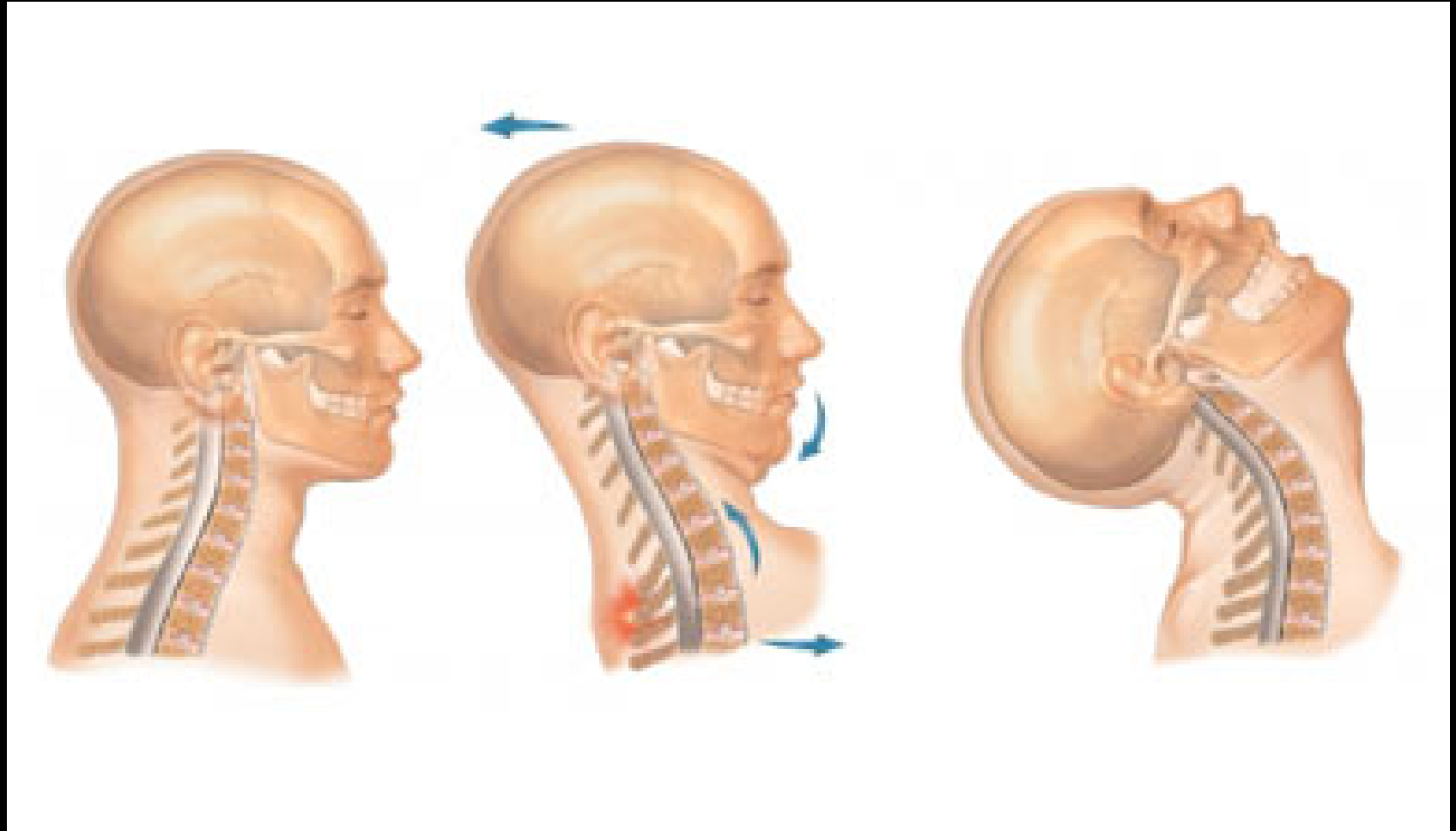
- Conserves and restores energy
- “Feed and breed”
- Functions:
 - Slows heart rate
 - Increases digestive activity
 - Plays role in sexual stimulation

Mechanisms of Spinal Injury

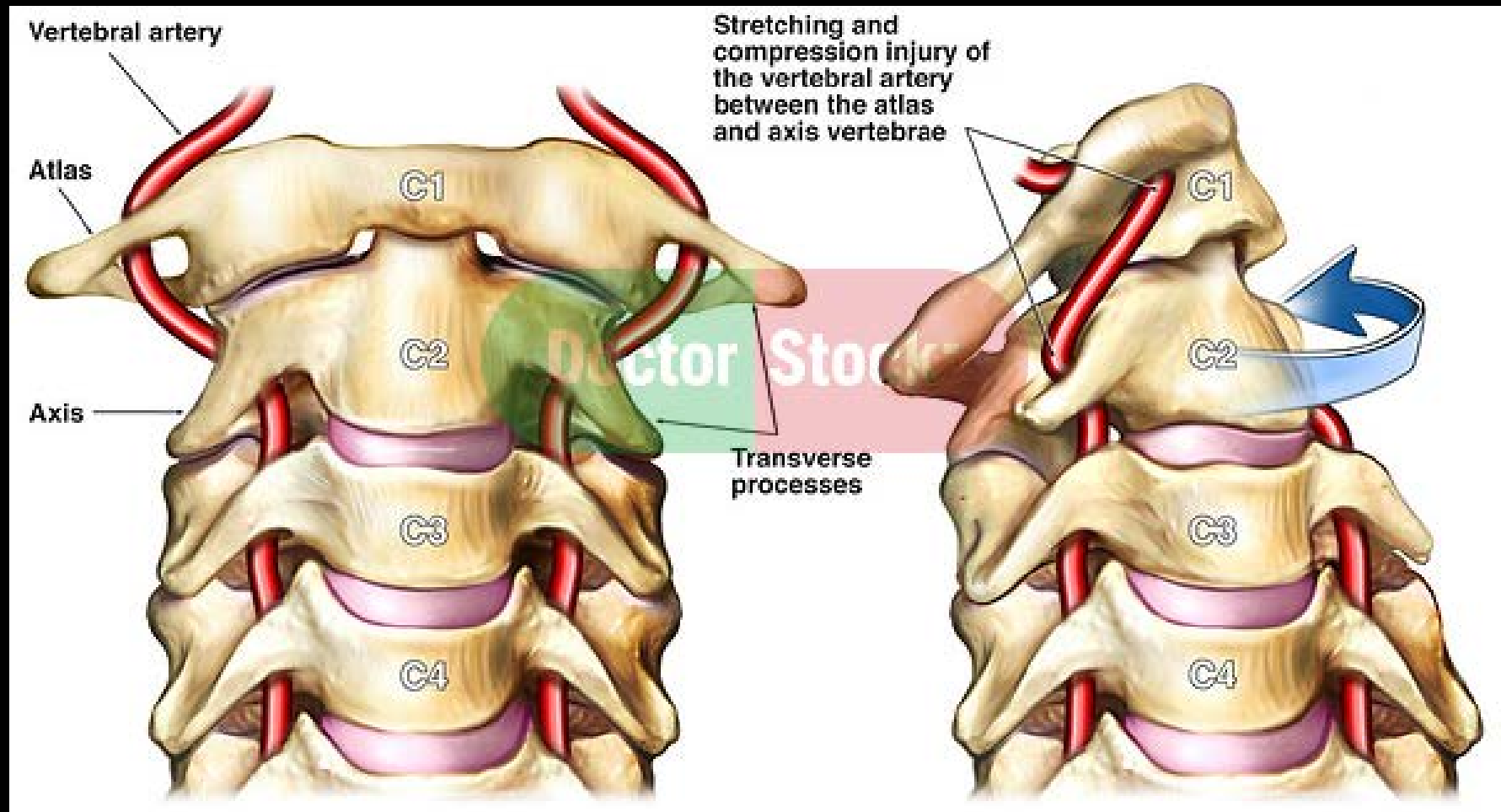
- Hyperextension
- Hyperflexion
- Vertical Compression
- Rotational Forces
- Penetrating Trauma



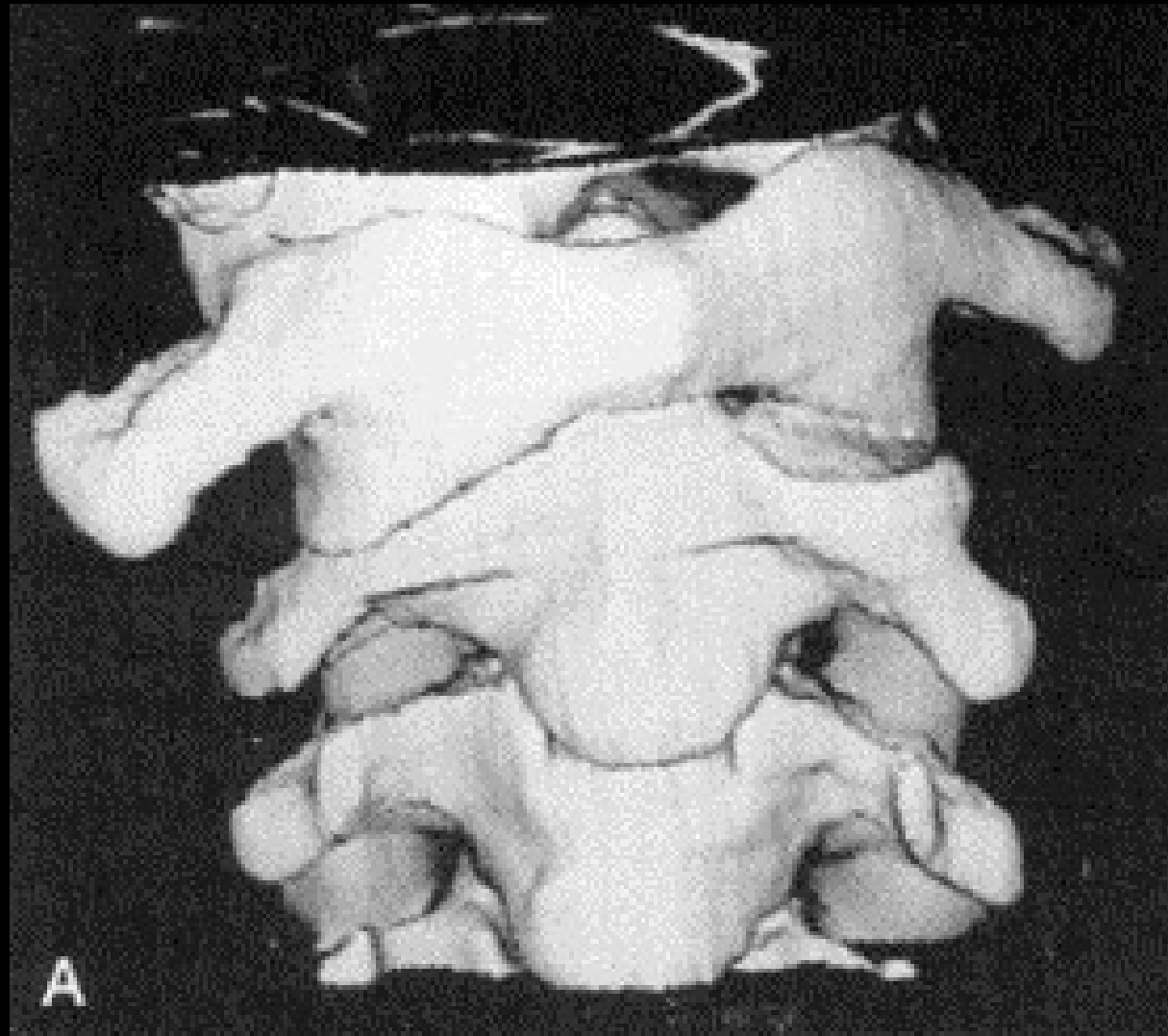
Hyperflexion and Hyperextension



Rotational Forces

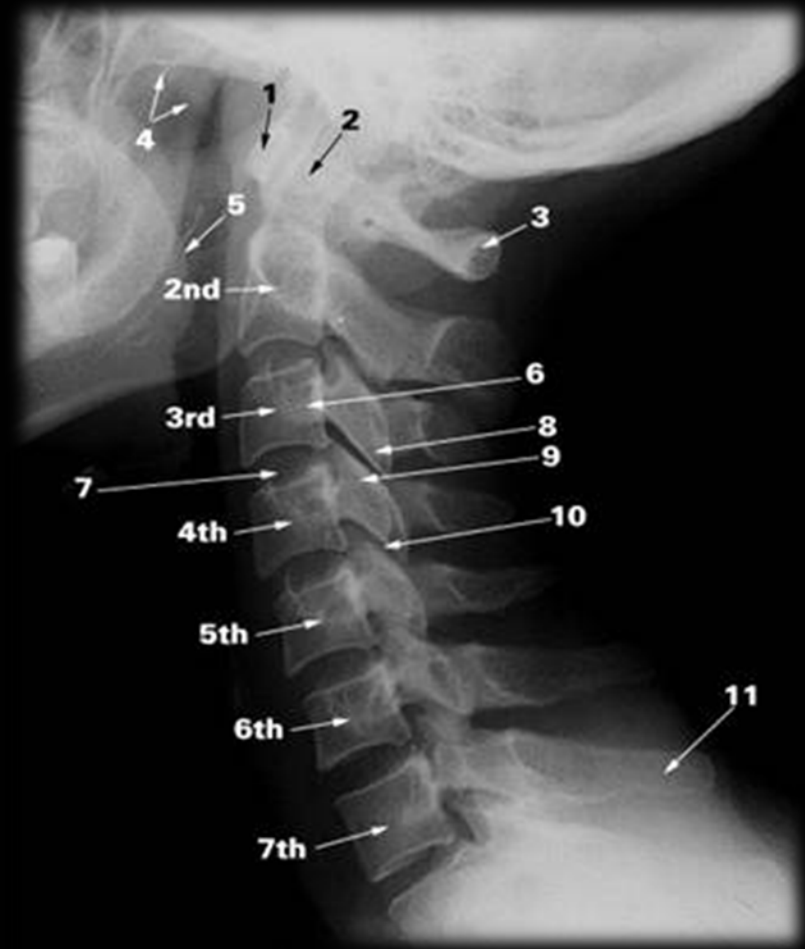


Facets & Rotational Injury



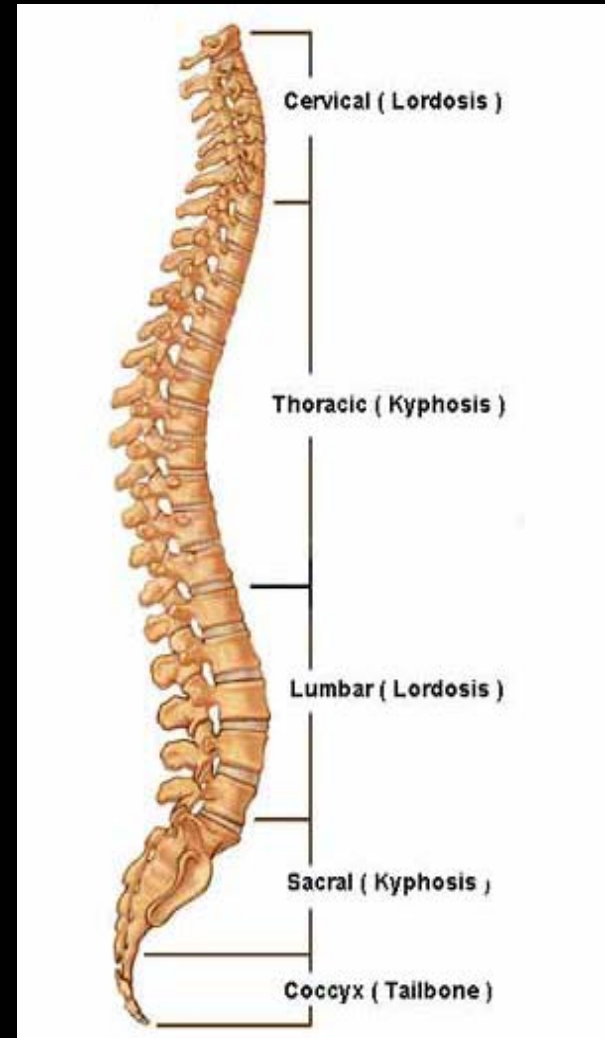
Vertical Compression

- Force from top of the cranium through vertebral bodies
- Results in shattering fractures



Vertical Compression

- Cervical & lumbar spine have natural **lordotic** curve
- Thoracic & sacral region have a natural **kyphotic** curve

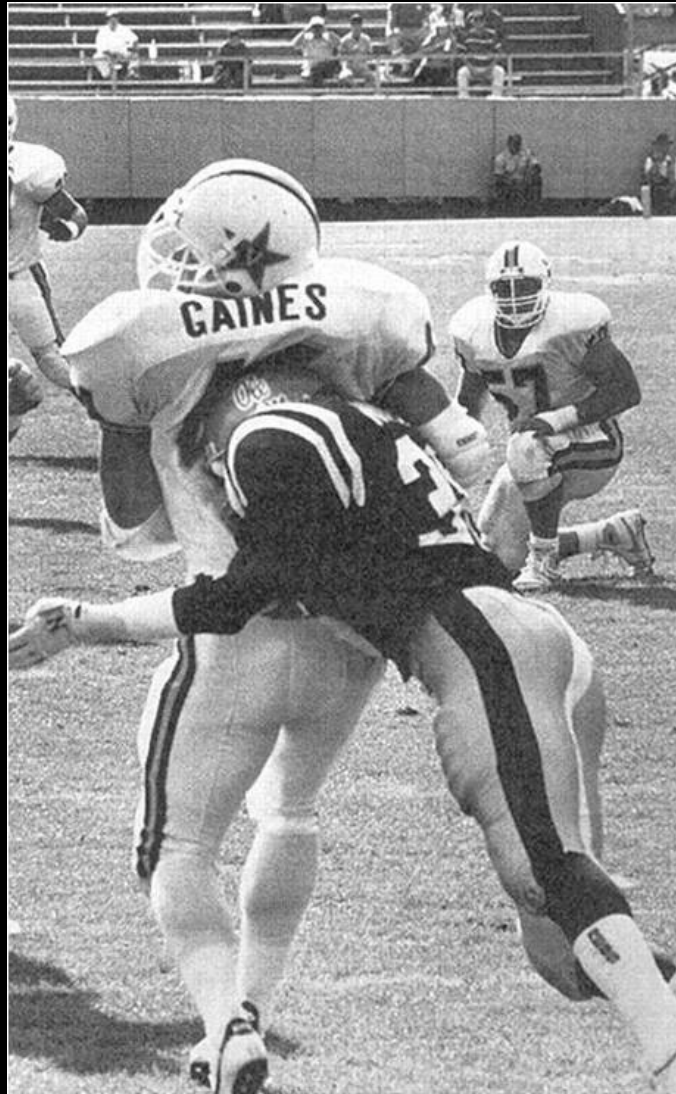


Vertical Compression



- Protective curve is lost when in head-down position
- The straight vertebral column loses absorbing capacities.

Vertical Compression



Penetrating Trauma



The Impact of Trauma on the Spinal Cord

- Concussion
- Contusion
- Compression
- Laceration
- Transection
- Hemorrhage



What is our Goal as EMS Providers for the Spinal Trauma Victim?





Our goal is to reduce neurological deficit and to prevent any additional loss of neurological function.

Recognize Mechanism of Injury



Assessment



Rapid Trauma Assessment

- Head to toe quick evaluation (multisystem trauma)
- Focused Assessment
 - Neck
 - Bilateral Extremities
 - Pulse, movement, sensation
- Vital Signs
- Ongoing Assessments



Indicators of Spinal Trauma

- Decreased LOC
- Pain in spine
- Pain in back of head, shoulders, arms, and legs
- Absent, altered sensation (numbness, parasthesias, loss of temperature, position)
- Paralysis or significant weakness
- Diaphragmatic breathing
- Shock with low heart rate and dry skin
- Incontinence
- Priapism

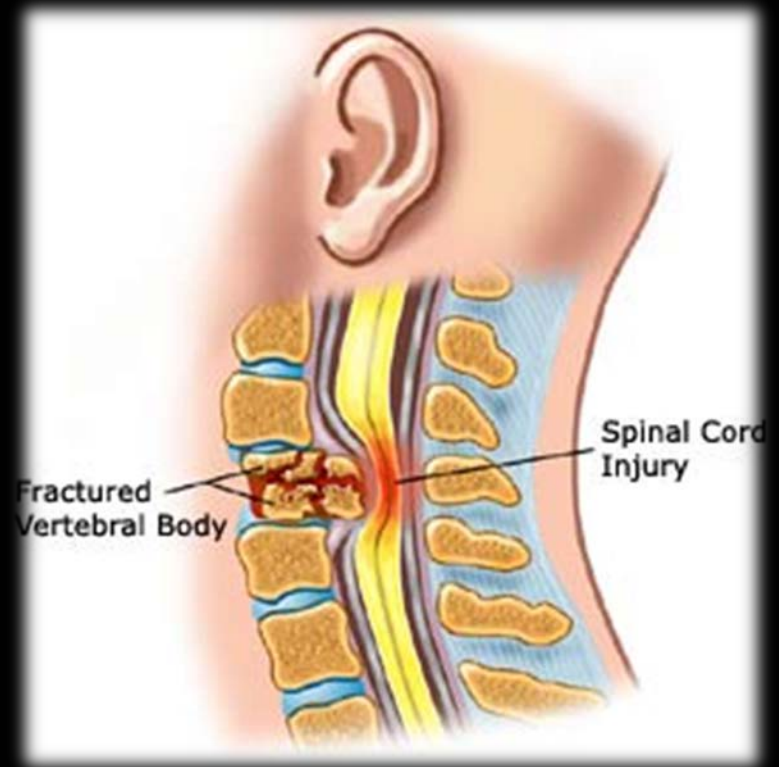
Immobilization



Currently, spinal immobilization is one of the most frequently performed procedures in the pre-hospital care of acute trauma patients in North America!!

Why do we immobilize?

To prevent motion of the spine that could lead to neurological deficit.



Why do we immobilize?

- 24 yo female, unrestrained driver of mid-size sedan involved in 2 car MVC with side impact
- Highway speeds
- Pt self-extricates, walking on scene on EMS arrival
- She reports her back “hurts a little bit”
- She **REFUSES TRANSPORT**

Why do we immobilize?



Immobilization

- Head injury
- Intoxicated
- Injuries above the shoulders
- Distracting injuries



Immobilization

- Rigid cervical collar
- Rigid backboard with straps
- Head blocks
- Do not force the spine into neutral position



Immobilization



KED
Kendrick
Extrication
Device
?

Pre-hospital Complications

Airway Compromise

- TBI
- Nausea/vomiting
- High risk for aspiration
- Face and neck trauma
- Neck mobility
- Pt Entrapment



Pre-hospital Complications

- Breathing
 - Aspiration risk
 - Impaired Intercostal Muscles
 - Impaired Diaphragmatic Function
 - Obesity
 - CHF/COPD
 - Chest Trauma



Be Prepared

- Vomit
 - Suction ready
 - Tip your backboard
 - Anti-emetics
- Airway Compromise or Inadequate Breathing
 - Loosen spider straps
 - Raise head of stretcher
 - Oral or Nasal Airways
 - BVM
 - Rescue Airway Devices
 - Intubation Equipment
 - RSI? Maximize first attempt



Intubation of the SCI Patient



- Can my patient protect his airway?
- Can my patient adequately ventilate and oxygenate?
- What is the anticipated clinical course of my patient?

Intubation of the SCI Patient

- C-collar off
- Bougie
- Back-up airway
- NC passive oxygenation



Engstrom, J. "Pharyngeal oxygen administration increases the time to serious desaturation at intubation in acute lung injury: an experimental study." Critical Care. 2010; 14(3): R93.

Neurogenic Shock

- Impairment of sympathetic pathways
- Loss of vasomotor tone
- Loss of innervation to the heart
 - Vasodilation
 - Hypotension
 - Bradycardia
 - no reflex tachycardia in times of shock



Be Prepared



- Fluids
- Vasopressors
- Atropine
- Blankets
- Rapid transport to trauma center
- No steroids

Your Goal

Reestablish blood
flow to the spinal
cord:

Systolic > 100

MAP > 80





Emerging Trends in Spinal Trauma Management

Emerging Trends

Airway Management



Emerging Trends

Airway Management



- 1998 study by Kaups et al in Journal of Trauma
- 16 out of 38 intubation attempts were unsuccessful in the field
- 14 of those unsuccessful attempts were on immobilized patients

Emerging Trends



Spinal Immobilization in Penetrating Trauma



Emerging Trends

“Spinal Immobilization in Penetrating Trauma:
More Harm Than Good?”

Journal of Trauma – Injury, Infection, and
Critical Care, Jan 2010

Haut et al

Emerging Trends

- 45, 824 penetrating trauma patients
- 4.3% spinal immobilization
- Overall mortality rate was 8.1%
- Spinal immobilization mortality rate was 14.7%
- Conclusion:
“Prehospital spinal immobilization is associated with higher mortality in penetrating trauma and should not be routinely used in every patient with penetrating trauma”
Haut et al

Emerging Trends

Thoracolumbar Immobilization for Trauma Patients with Torso Gunshot Wounds: Is It Necessary?

Cornwell et al, Arch Surg 2001

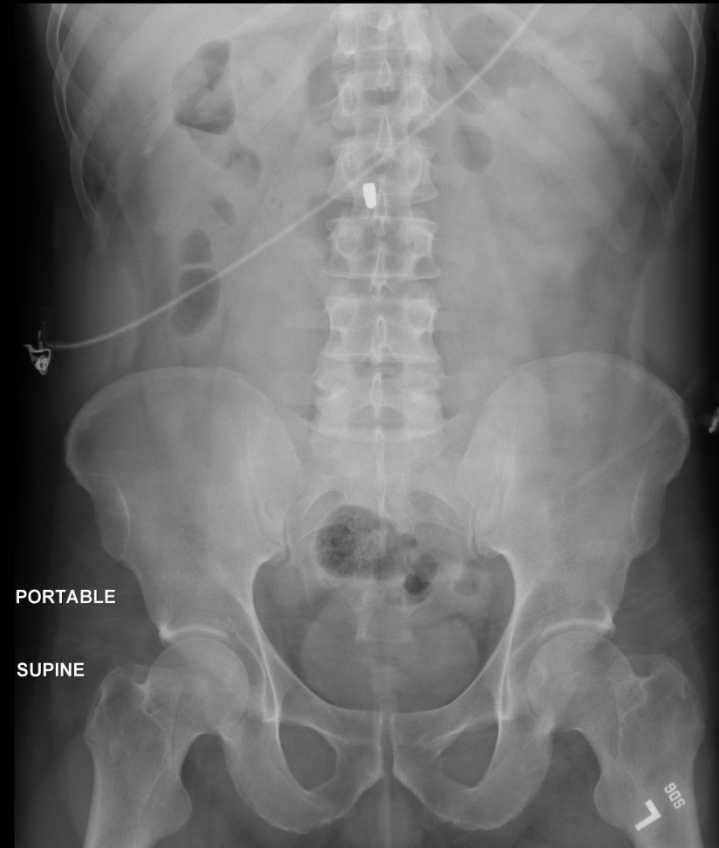
Emerging Trends

“This study suggests that thoracolumbar immobilization is almost never beneficial in patients with torso GSW, and that **a higher mortality rate** existed among those GSW patients **without vertebral column injury** versus those with such injuries. The role of formal thoracolumbar immobilization for patients with torso GSW should be reexamined.”

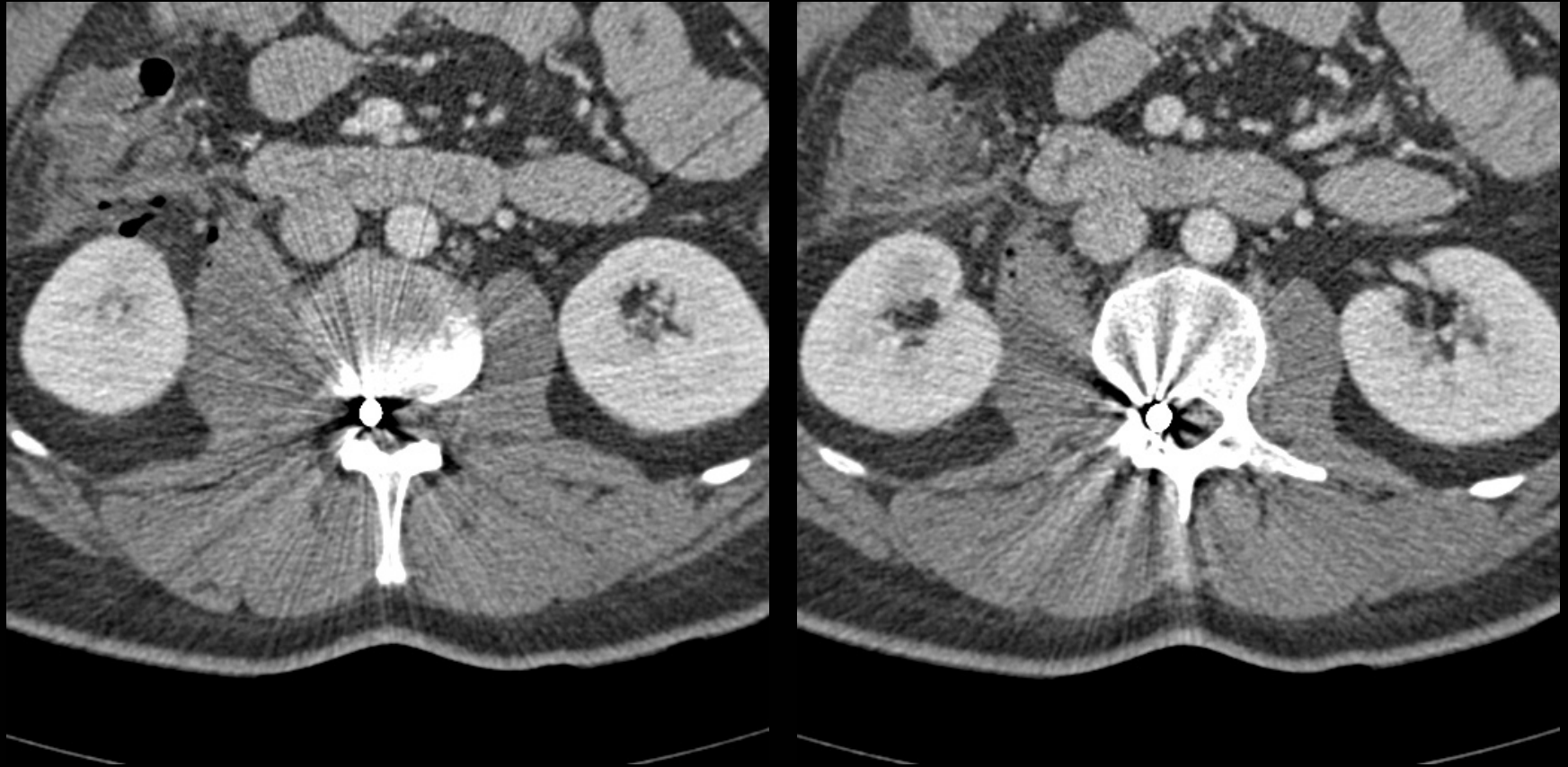
Cornwell et al

Emerging Trends

- 27 year old male
- GSW to the right mid-axillary region
- No exit wound
- No deficits



Emerging Trends





Emerging Trends

Cervical Spine Clearing
in the Field by EMS
providers?????

Emerging Trends

NEXUS Study

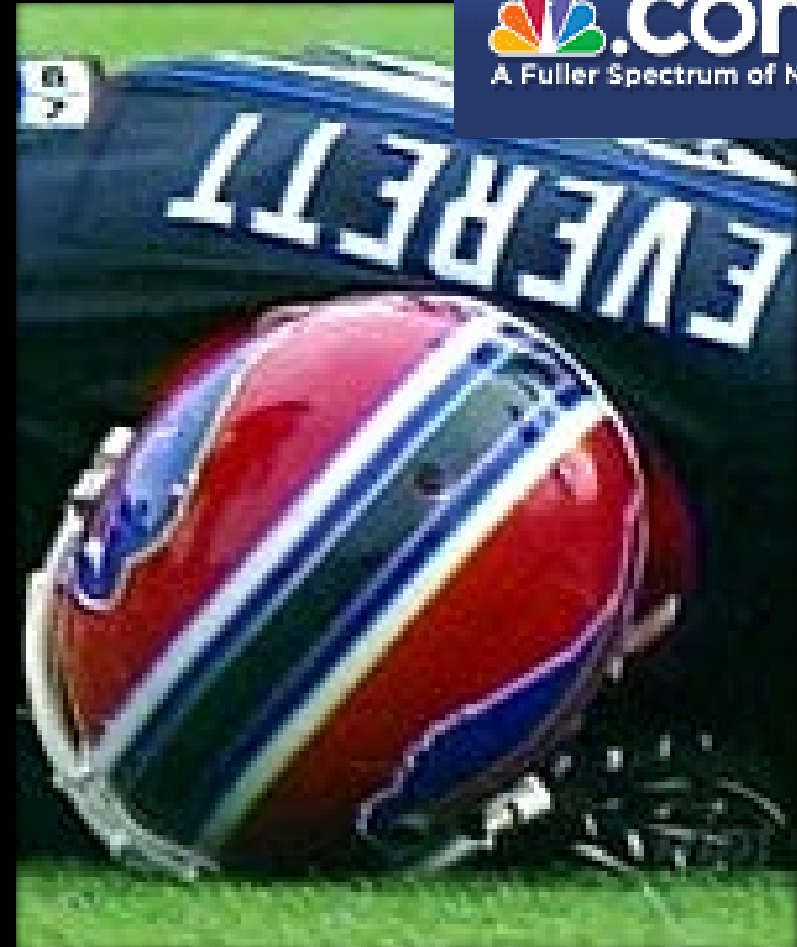
(National Emergency X-Radiography Utilization Study)

- Criteria:
 - Neuro deficit
 - Spinal Tenderness
 - Altered Mental Status
 - Intoxication
 - Distracting Injury

Future Trends in Spinal Trauma Management



Buffalo Bills player
Kevin Everett
treated with hypothermia



"I was trying to pull out all the stops to help this young man," Cappuccino said Wednesday at a news conference. He had heard of the therapy, called moderate hypothermia, at a conference attended by doctors from the Miami Project to Cure Paralysis who have been experimenting with it for more than a decade.

September 14, 2007

C3/C4 Paralysis, Experimental
Hypothermia with surgery

Therapeutic Hypothermia

- Yu, et al 2000 study:
 - Thoracic SCI
 - Systemic hypothermia (33°C)
 - Initiated 30 minutes after SCI, maintained x 4 hrs
 - Improved motor function
 - Gray/white matter damage significantly reduced.
 - Decreased swelling, preserved white matter
- Lo, et al 2009:
 - Cervical injury
 - Contusive SCI's
 - Cooling initiated 30 minutes after injury
 - Gradual slow cooling over several hours
 - Clinically significant improvement in hand, arm, upper limb motor function

Yu CG, Jimenez O, Marcillo AE, et al: Beneficial effects of modest systemic hypothermia on locomotor function and histopathological damage following contusion-induced spinal cord injury in rats. *Journal of Neurosurgery*. 2000; 93: 85-93.

Lo TP, Cho K-S, Garg MS, et al: Systemic hypothermia improves histological and functional outcome after cervical spinal cord contusion in rats. *Journal of Comparative Neurology* 2009; 514: 433-448.

Take Home Points

- Airway
- Breathing
- Circulation
- Early recognition of spinal cord injury
- Early intervention to reduce ischemia to spinal cord



THANK YOU



Any Questions?

