



# Spine and Spinal Cord Trauma



# Objectives of Learning

- Describe the basic spinal anatomy and physiology
- Evaluate a patient with suspected spinal injury
- Identify the common types of spinal injuries and their X-ray features.
- Appropriately manage the spinal-injured patient during the first hour from injury.
- Determine the appropriate disposition of the patient with spine trauma.



# Introduction

- Vertebral column injury, with or without neurological deficits, must always be sought and excluded in a patient with
  - Multiple trauma.
  - Any injury above the clavicle
- Spine injury
  - Cervical spine 55%
  - Thoracic spine 15%
  - Thoracolumbar junction 15%
  - Lumbosacral spine 15%



**Beware**



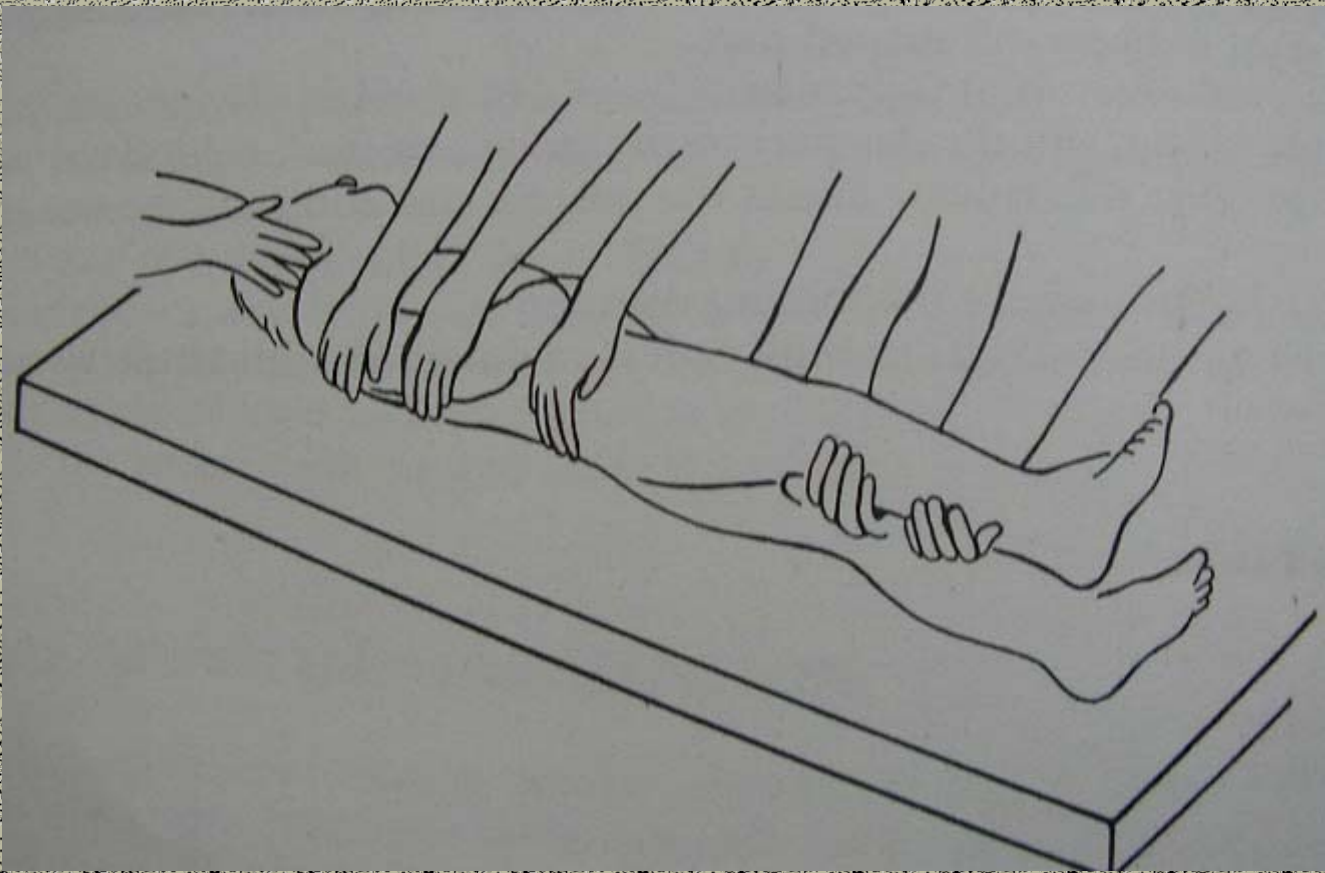
Excessive manipulation and inadequate immobilization of a patient with a spinal cord injury can cause additional neurological damage and worsen the patient's outcome



# Introduction

- As long as the patient's spine is protected, evaluation of the spine and exclusion of spine injury may be safely deferred, especially in the presence of systemic instability.
- Every patient with spine injury should be **log-rolled every 2 hours**, while maintaining the integrity of the spine, to reduce the risk of decubitus ulcer formation.

# Log rolling





# Anatomy & Physiology

- The spinal column
  - The spinal column consists of 7 cervical, 12 thoracic, and 5 lumbar vertebrae as well as the sacrum and the coccyx.
  - For many reasons, the cervical spine is most vulnerable to injury
  - The thoracolumbar junction is a fulcrum between the inflexible thoracic region and the stronger lumbar levels. This makes it more vulnerable to injury, with 15% of all spinal injuries occurring in this region.



# Spinal Cord Anatomy

- Spinal cord ends at L1
- Three tracts can be readily assessed clinically.
  - The corticospinal tract
  - The spinothalamic Tract
  - The posterior columns
- If there is no demonstrable sensory or motor function below a certain level, this is referred to as a **complete spinal cord injury**.
- If any motor or sensory function remains, this is an **incomplete injury** and the prognosis for recovery is significantly better.
- Sparing of sensation in the perianal region (sacral sparing) may be the only sign of residual function.

# STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

## MOTOR

### KEY MUSCLES

	R	L
C2	<input type="checkbox"/>	<input type="checkbox"/>
C3	<input type="checkbox"/>	<input type="checkbox"/>
C4	<input type="checkbox"/>	<input type="checkbox"/>
C5	<input type="checkbox"/>	<input type="checkbox"/>
C6	<input type="checkbox"/>	<input type="checkbox"/>
C7	<input type="checkbox"/>	<input type="checkbox"/>
C8	<input type="checkbox"/>	<input type="checkbox"/>
T1	<input type="checkbox"/>	<input type="checkbox"/>
T2	<input type="checkbox"/>	<input type="checkbox"/>
T3	<input type="checkbox"/>	<input type="checkbox"/>
T4	<input type="checkbox"/>	<input type="checkbox"/>
T5	<input type="checkbox"/>	<input type="checkbox"/>
T6	<input type="checkbox"/>	<input type="checkbox"/>
T7	<input type="checkbox"/>	<input type="checkbox"/>
T8	<input type="checkbox"/>	<input type="checkbox"/>
T9	<input type="checkbox"/>	<input type="checkbox"/>
T10	<input type="checkbox"/>	<input type="checkbox"/>
T11	<input type="checkbox"/>	<input type="checkbox"/>
T12	<input type="checkbox"/>	<input type="checkbox"/>
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L3	<input type="checkbox"/>	<input type="checkbox"/>
L4	<input type="checkbox"/>	<input type="checkbox"/>
L5	<input type="checkbox"/>	<input type="checkbox"/>
S1	<input type="checkbox"/>	<input type="checkbox"/>
S2	<input type="checkbox"/>	<input type="checkbox"/>
S3	<input type="checkbox"/>	<input type="checkbox"/>
S4-5	<input type="checkbox"/>	<input type="checkbox"/>

- Elbow flexors
- Wrist extensors
- Elbow extensors
- Finger flexors (distal phalanx of middle finger)
- Finger abductors (little finger)

- 0 = total paralysis
- 1 = palpable or visible contraction
- 2 = active movement, gravity eliminated
- 3 = active movement, against gravity
- 4 = active movement, against some resistance
- 5 = active movement, against full resistance
- NT = not testable

Voluntary anal contraction (Yes/No)

TOTALS  +  =  **MOTOR SCORE**  
 (MAXIMUM) (50) (50) (100)

## LIGHT TOUCH

	R	L
C2	<input type="checkbox"/>	<input type="checkbox"/>
C3	<input type="checkbox"/>	<input type="checkbox"/>
C4	<input type="checkbox"/>	<input type="checkbox"/>
C5	<input type="checkbox"/>	<input type="checkbox"/>
C6	<input type="checkbox"/>	<input type="checkbox"/>
C7	<input type="checkbox"/>	<input type="checkbox"/>
C8	<input type="checkbox"/>	<input type="checkbox"/>
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L5	<input type="checkbox"/>	<input type="checkbox"/>
S1	<input type="checkbox"/>	<input type="checkbox"/>
S2	<input type="checkbox"/>	<input type="checkbox"/>
S3	<input type="checkbox"/>	<input type="checkbox"/>
S4-5	<input type="checkbox"/>	<input type="checkbox"/>

TOTALS  +  =   
 (MAXIMUM) (56) (56)

## PIN PRICK

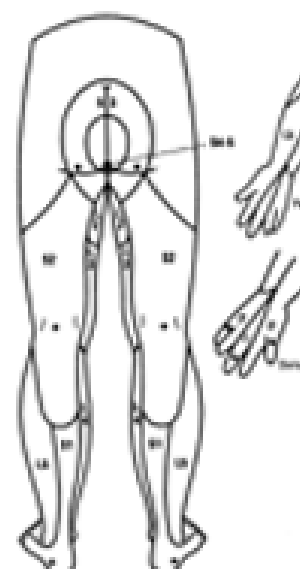
	R	L
C2	<input type="checkbox"/>	<input type="checkbox"/>
C3	<input type="checkbox"/>	<input type="checkbox"/>
C4	<input type="checkbox"/>	<input type="checkbox"/>
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L4	<input type="checkbox"/>	<input type="checkbox"/>
L5	<input type="checkbox"/>	<input type="checkbox"/>
S1	<input type="checkbox"/>	<input type="checkbox"/>
S2	<input type="checkbox"/>	<input type="checkbox"/>
S3	<input type="checkbox"/>	<input type="checkbox"/>
S4-5	<input type="checkbox"/>	<input type="checkbox"/>

-  =  **PIN PRICK SCORE** (max: 112)  
 +  =  **LIGHT TOUCH SCORE** (max: 112)

## SENSORY

### KEY SENSORY POINTS

- 0 = absent
- 1 = impaired
- 2 = normal
- NT = not testable



\* Key Sensory Points

Any anal sensation (Yes/No)

### NEUROLOGICAL LEVELS

The most caudal segment with normal function

	R	L
SENSORY	<input type="checkbox"/>	<input type="checkbox"/>
MOTOR	<input type="checkbox"/>	<input type="checkbox"/>

### COMPLETE OR INCOMPLETE?

Incomplete = Any sensory or motor function in S4-5

### ASIA IMPAIRMENT SCALE

### ZONE OF PARTIAL PRESERVATION

Partially innervated segments

	R	L
SENSORY	<input type="checkbox"/>	<input type="checkbox"/>
MOTOR	<input type="checkbox"/>	<input type="checkbox"/>



# Sensory Examination

- A **dermatome** is the area of skin innervated by the sensory axons within a particular segmental nerve root. They are important to determine level of injury
- The key sensory points are
  - C-5----Area over the deltoid
  - C-6----Thumb
  - C-7---- Middle finger
  - C-8---- Little finger
  - T-4---- Nipple
  - T-8---- Xiphisternum
  - T-10--- Umbilicus
  - T-12--- Symphysis
  - L-4----- Medial aspect of the leg
  - L-5----- Space between the first and second toes
  - S-1----- Lateral border of the foot
  - S-3----- Ischial tuberosity area
  - S-4 --5---- Perianal region



# Myotomes

For the sake of simplicity, certain muscles or muscle groups are identified as representing a single spinal nerve segment.

In addition to bilateral testing of these muscles, the external anal sphincter should be tested by digital examination.

- The important key muscle (s) are.
  - C-5-----Deltoid
  - C-6-----Wrist extensors
  - C-7-----Elbow extensors
  - C-8-----Finger flexors to the middle finger
  - T-1-----Small finger abductors
  - L-2----- Hip flexors
  - L-3-----Knee extensors
  - L-4----- Ankle dorsiflexors
  - L-5----- Long toe extensors
  - S-1-----Ankle plantar flexors



# Neurogenic Shock vs Spinal Shock

- **Neurogenic shock** results from impairment of the descending sympathetic pathways in the spinal cord resulting in loss of vasomotor tone and loss of sympathetic innervation to the heart

The result is

- Hypotension
- Bradycardic



# Management of Neurogenic Shock

- The blood pressure can often be restored by the judicious use of vasopressors, but adequate perfusion may be maintained without normalizing the blood pressure.
- Atropine may be used to counteract hemodynamically significant bradycardia.



# Spinal Shock

- This refers to the flaccidity and loss of reflexes seen after spinal cord injury. The “Shock” to the injured cord may make it appear completely functionless, although all areas are not necessarily destroyed. The duration of this state is variable.



# Effect on other Organ Systems

- Hypoventilation due to the paralysis of,
  - Intercostal muscles
  - Diaphragm
- The inability to perceive pain may mask a potentially serious injury elsewhere in the body, such as the usual signs of an acute abdomen



# Classifications of Spinal cord Injuries

## ■ Level

- Determination of the level of injury on both sides is important.
- Injury above the T-1 level-----quadriplegia
- Injury Below the T-1 level----- paraplegia
- Apart from the initial management to stabilize the bony injury, all subsequent descriptions of the level of injury are based on the neurologic level.



# Severity of the Neurologic Deficit

- Incomplete paraplegia
- Complete paraplegia
- Incomplete quadriplegia
- Complete quadriplegia
- Signs of incomplete injury may include:
  - Any sensation ( including position sense) or voluntary movement in the lower extremities.
  - Sacral sparing



# Morphology

- Spinal injuries can be described as,
  - Fractures
  - Fracture dislocations
  - SCIWORA
  - Penetrating injuries
- All injuries can be stable or unstable
- All patients with x-ray evidence of injury and all those with neurologic deficits should be considered to have an unstable spinal injury.



# Specific Types of Spinal Injuries

- Cervical spine injuries can result from
  - Axial loading
  - Flexion
  - Extension
  - Rotation
  - Lateral bending
  - Distraction

# Specific Types of Spinal Injuries

- Atlanto-occipital Dislocation
- Atlas Fracture (C-1)
- C-1 Rotary Subluxation
- Axis (C-2) Fractures
  - Odontoid fractures
  - Posterior element fractures of C-2
- Fractures and Dislocation (C-3 through C-7)





# Specific Types of Spinal Injuries

- Thoracic Spine Fractured ( T-1 Through T-10)
- Thoracolumbar Junction Fractures ( T-11 through L-1)
- Lumbar Fractures
- Penetrating Injuries



# X-Ray evaluation

## ■ Cervical Spine

- A lateral cervical spine film should be obtained, when indicated, soon after life threatening problems are identified and controlled.
- Swimmer's view
- Open-mouth odontoid view / Oblique view of the odontoid process



# X-Ray evaluation

- Thoracic and lumbar spine
  - A.P films
  - CT Scanning



# General Management

- Immobilization

- Remember to immobilize until c – spine injury is excluded

- Intravenous fluids

- Patients with hypovolemia may not become tachycardiac (may be bradycardiac)

- Medications

- In North America methylprednisolone is given

- Transfer



## Guidelines for screening patients with suspected Injury

- The presence of paraplegia or quadriplegia is presumptive evidence of spinal instability
- Patients who are awake, alert, sober, and neurologically normal, and have no neck pain are extremely unlikely to have an acute c-spine fracture / subluxation.
- Patients who are awake and alert, are neurologically normal, but do have neck pain should undergo lateral, AP, and open-mouth x-rays of the c-spine.



## Guidelines for screening patients with suspected Injury

- Patients who are comatose, have an altered level of consciousness, or are too young to describe their symptoms should at least have a lateral and AP c-spine x-ray
- When in doubt, leave the collar on
- Backboards
- Never force the neck



# Guidelines for screening patients with suspected Injury

- Assess the c-spine film for
  - Bony deformity
  - Fracture of the vertebral body or processes
  - Loss of alignment of the posterior aspect of the vertebral bodies (anterior extent of the vertebral canal)
  - Increased distances between the spinous processes at one level
  - Narrowing of the vertebral canal
  - Increased prevertebral soft-tissue space



# Summary

- Attend to life-threatening injuries, minimizing any movement of the spinal column
- Establish and maintain **proper immobilization** of the patient until vertebral fractures or spinal cord injuries have been excluded
- Obtain a lateral c-spine x-ray, when indicated, as soon as life-threatening injuries are controlled
- Document the patient's history and physical examination so as to establish a baseline for any changes in the patient's neurologic status.



# Summary

- Obtain early consultation with a neurosurgeon and /or an orthopedic surgeon whenever a spinal injury is suspected or detected.
- Transfer patients with vertebral fractures or spinal cord injury to a definitive-care facility