Spinal Cord Trauma

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Objectives

- To discuss basic mechanism, anatomy and physiology of spinal cord injury
- To review assessment and diagnostic steps
- To identify maneuvers to help improve outcomes
- To not fall asleep
- 18 year old female dives into a shallow body of water
- Friends notice she hasn’t surfaced after an appropriate interval
- Cousin swims to her and finds her unable to move, face down in shallow water
Basic Anatomy
Basic Anatomy

Atlas (C1)

Dens

Axis (C2)
Basic Anatomy

- Figure 7-1: Dorsal view of the spinal cord and dorsal nerve roots in situ, after removal of the neural arches of the vertebrae.
- Figure 26-1: Relationship between spinal cord, nerve roots, and bony spine.
Terminology

- **Plegia** = complete lesion
- **Paresis** = some muscle strength is preserved
- **Tetraplegia** (or **quadriplegia**)
  - Injury of the cervical spinal cord
  - Patient can usually still move his arms using the segments above the injury (e.g., in a C7 injury, the patient can still flex his forearms, using the C5 segment)
- **Paraplegia**
  - Injury of the thoracic or lumbo-sacral cord, or cauda equina
- **Hemiplegia**
  - Paralysis of one half of the body
  - Usually in brain injuries (e.g., stroke)
Muscle or Sensory Loss?

Table 26-7  ASIA motor scoring system (EXTREMITIES)

<table>
<thead>
<tr>
<th>RIGHT grade</th>
<th>Segment</th>
<th>Muscle</th>
<th>Action to test</th>
<th>LEFT grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>C5</td>
<td>deltoid or biceps</td>
<td>shoulder abduction or elbow flexion</td>
<td>0-5</td>
</tr>
<tr>
<td>0-5</td>
<td>C6</td>
<td>wrist extensors</td>
<td>cock up wrist</td>
<td>0-5</td>
</tr>
<tr>
<td>0-5</td>
<td>C7</td>
<td>triceps</td>
<td>elbow extension</td>
<td>0-5</td>
</tr>
<tr>
<td>0-5</td>
<td>C8</td>
<td>flexor digitorum prof</td>
<td>squeeze hand</td>
<td>0-5</td>
</tr>
<tr>
<td>0-5</td>
<td>T1</td>
<td>hand intrinsics</td>
<td>abduct little finger</td>
<td>0-5</td>
</tr>
<tr>
<td>0-5</td>
<td>L2</td>
<td>iliopsoas</td>
<td>flex hip</td>
<td>0-5</td>
</tr>
<tr>
<td>0-5</td>
<td>L3</td>
<td>quadriceps</td>
<td>straighten knee</td>
<td>0-5</td>
</tr>
<tr>
<td>0-5</td>
<td>L4</td>
<td>tibialis anterior</td>
<td>dorsiflex foot</td>
<td>0-5</td>
</tr>
<tr>
<td>0-5</td>
<td>L5</td>
<td>EHL</td>
<td>dorsiflex big toe</td>
<td>0-5</td>
</tr>
<tr>
<td>0-5</td>
<td>S1</td>
<td>gastrocnemius</td>
<td>plantarflex foot</td>
<td>0-5</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>← TOTAL POSSIBLE POINTS →</td>
<td></td>
<td>50</td>
</tr>
</tbody>
</table>

GRAND TOTAL: 100

<table>
<thead>
<tr>
<th>Grade</th>
<th>Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>no contraction</td>
</tr>
<tr>
<td>1</td>
<td>flicker or trace contraction</td>
</tr>
<tr>
<td>2</td>
<td>movement with gravity eliminated</td>
</tr>
<tr>
<td>3</td>
<td>movement against gravity</td>
</tr>
<tr>
<td>4</td>
<td>movement against resistance 4-</td>
</tr>
<tr>
<td>5</td>
<td>normal strength 4+</td>
</tr>
</tbody>
</table>

4- slight resistance
4+ moderate resistance
4+ strong resistance
Muscle or Sensory Loss?

**Table 26-6 Key sensory landmarks**

<table>
<thead>
<tr>
<th>Level</th>
<th>Dermatome</th>
</tr>
</thead>
<tbody>
<tr>
<td>C4</td>
<td>shoulders</td>
</tr>
<tr>
<td>C6</td>
<td>thumb</td>
</tr>
<tr>
<td>C7</td>
<td>middle finger</td>
</tr>
<tr>
<td>C8</td>
<td>little finger</td>
</tr>
<tr>
<td>T4</td>
<td>nipples</td>
</tr>
<tr>
<td>T6</td>
<td>xiphoid</td>
</tr>
<tr>
<td>T10</td>
<td>umbilicus</td>
</tr>
<tr>
<td>L3</td>
<td>just above patella</td>
</tr>
<tr>
<td>L4</td>
<td>medial malleolus</td>
</tr>
<tr>
<td>L5</td>
<td>great toe</td>
</tr>
<tr>
<td>S1</td>
<td>lateral malleolus</td>
</tr>
<tr>
<td>S4-5</td>
<td>peri-anal</td>
</tr>
</tbody>
</table>

**SENSORY**

**KEY SENSORY POINTS**

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

Any anal sensation (Yes/No)  
PIN PRICK SCORE (max: 112)  
LIGHT TOUCH SCORE (max: 112)
Basic Anatomy

- Deep Tendon Reflexes
  - Arm
    - Bicipital: C5
    - Styloradial: C6
    - Tricipital: C7
  - Leg
    - Patellar: L3, some L4
    - Achilles: S1
What is and how do you determine the level of injury?

- **Motor level** = the last level with at least 3/5 (against gravity) function
  - NB: this is the most important for clinical purposes
- **Sensory level** = the last level with preserved sensation
- **Radiographic level** = the level of fracture on plain X Rays / CT scan / MRI
Mechanism

- Penetrating Injury vs Blunt Injury
- Acceleration/Deceleration Patterns
- Always suspect in patients:
  - Neurologic deficit
  - Unconscious/Altered Mental Status
  - Mechanism
  - Spine Tenderness
  - When in doubt…assume they have one!
Case Presentation

- 25 y/o white male
- Fell off the roof (20 feet)
- Had to be intubated at the scene by EMS
- Consciousness regained shortly thereafter
- Could not move arms or legs
- Could close and open eyes to command
- Not able to breathe by himself—totally dependent on mechanical ventilation
High cervical injuries (C3 and above)

- Motor and sensory deficits involve the entire arms and legs
- Dependent on mechanical ventilation for breathing
  - (diaphragm is innervated by C3-C5 levels)
- Early tracheostomy, rehabilitation
- Most mortality after the first 48 hours due to pneumonia or pressure ulcers/other infections
Case Presentation

- 19 y/o white male
- Diving accident (shallow water)
- No loss of consciousness
- Could not understand why he could not move his legs, forearms and hands (he could shrug shoulders and elevate arms)
- BP 75/40, HR 54 bpm
- Had difficulties breathing and required intubation a few hours after the accident
Midcervical injuries (C3-C5)

- Varying degrees of diaphragm dysfunction
- Usually need ventilatory assistance in the acute phase
- Shock
What is the difference between spinal shock and neurogenic shock?

- Spinal shock is mainly a loss of reflexes (flaccid paralysis)
  - Usually not associated with cardiovascular symptoms
- Neurogenic shock is mainly hypotension and bradycardia due to loss of sympathetic tone
  - Decreased SVR
  - Ensure adequate fluid resuscitation prior to vasopressor use
Low cervical injuries (C6-T1)

- Usually able to breathe, although occasionally cord swelling can lead to temporary C3-C5 involvement (need mechanical ventilation)
- The level can be determined by physical exam
- Steroids are *occasionally* used at this level and *dependent on neurosurgeon and critical care team*
  - Have been associated with higher septic complications
  - Can spare one or two cervical levels in some cases
- **NOT** recommended by ATLS
So what do you expect with a cervical lesion?

- Quadriplegia or quadriparesis
- Bowel/bladder retention (spastic)
- Various degrees of breathing difficulties
- Neurogenic and/or spinal shock

Treatment Necessities

- Bowel/Bladder training
- Early Rehabilitation
- Prevent contractures and muscle spasticity
- Pulmonary toilet
Case scenario

- 22 y/o Hispanic female
- Motor vehicle accident (hit a pole at 60mph)
- + for ETOH and THC
- Short term loss of consciousness (10’)
- Not able to move or feel her legs
- DTRs 2+ in BUE, 0 in BLE
- No bladder / bowel control or sensation
- Sensory level at the umbilicus
Thoracic injuries (T2-L1)

- Paraparesis or paraplegia
- UMN (upper motor neuron) signs
Case scenario

- 22 y/o African-American female
- Motor vehicle accident
- Not able to move or feel her legs below the knee
- Could flex thighs against gravity
- DTRs 2+ in BUE, 0 in BLE
- No bladder / bowel control or sensation
- Sensory level above the knee on L, below the knee on R
Cauda equina injuries (L2 or below)

- Paraparesis or paraplegia
- LMN (lower motor neuron) signs
- Thigh flexion is almost always preserved to some degree
What is the central cord syndrome?

- Cervical spinal cord involvement with arms more affected than legs
- May occur with trauma, tumors, infections, etc
- Traumatic lesions tend to improve in 1-2 weeks
- Surgical decompression may be indicated if there is spinal stenosis
Initial Management

- **Immobilization**
  - Rigid collar
  - Sandbags and straps
  - Spine board
  - Log-roll to turn

- **Prevent hypotension**
  - Pressors: Dopamine, not Neosynephrine
  - Fluids to replace losses; do not overhydrate

- **Maintain oxygenation**
  - O2 per nasal canula
  - If intubation is needed, do NOT move the neck
Surgical Decompression and/or Surgical Decompression and/or
Fusion

- **Indications**
  - Decompression of the neural elements (spinal cord/nerves)
  - Stabilization of the bony elements (spine)

- **Timing**
  - Emergent
    - Incomplete lesions with progressive neurologic deficit
  - Elective
    - Complete lesions (3-7 days post injury)
    - Central cord syndrome (2-3 weeks post injury)
Soft and hard collars
Minerva vest and halo-vest
Long term care

- Rehab for maximizing motor function
- Bladder/bowel training
- Psychological and social support
- Ethical considerations
Original Case
Questions?