SPINAL CORD INJURY

Spinal Cord Injury: Outline

- Anatomy
- Facts
- Etiologies
- Mechanism of Injury
  - Primary
  - Secondary
- Injuries
- Spinal cord syndromes
- ASIA scale
- Spinal Shock
- Management:
  - medical
  - nursing
- Functional levels
Spine

- Vertebral Column
- 26 bones
- 4 major curves
- Weight Bearing
- Movement
- Protect Spinal Cord

Vertebrae:
- 7 cervical
- 12 thoracic
- 5 lumbar

Nerves:
- C1-C8
- T1-T12
- L1-5; S1-5

Spinal cord levels:
- Quadriplegia
- Paraplegia
- Cord level @ L1-2
- Cauda equina

Anatomy
Ligaments

- Anterior Longitudinal ligament
- Posterior longitudinal ligament
- Ligamentum Flavum

Anatomy

- C1
  - ring
- C2
  - odontoid

The first two cervical vertebrae are:
- atlas—the skull rests on the superior articular facet
- axis—articulates with the atlas and forms the axis of rotation of the skull
Spinal Cord

- extension of medulla oblongata
- white matter
  - ascending tracts
  - descending tracts
- gray matter
  - motor neurons (ant. horns)
  - sensory neurons (post. horns)

Blood Supply

- Anterior spinal artery (anterior 2/3 of cord)
- Two posterior spinal arteries (posterior 1/3 of cord)
- Radicular arteries (periphery of cord)
**Corticospinal Tract**
- Crosses in medulla
- Motor

**Sensory**

**Spinthalamic**
- Crosses in spinal cord
- Pain, Temperature & Crude Touch

**Posterior Columns**
- Crosses in medulla
- Position & Fine Touch

**Anatomy**

*Figure 4-6*: A cross-section of the spinal cord detailing major motor and sensory tracts and their functions.
Spinal Nerves

- 31 pairs
- from spinal cord to peripheral body parts
- dorsal (posterior) ascending, afferent-sensory
- ventral (anterior) descending, efferent - motor
**Dermatomes**

Levels:
- C4: clavicle
- T4: nipple
- T10: umbilicus
- L1: groin

**Spinal Reflexes**

- don’t require brain involvement
  - muscle stretch
  - cutaneous
  - Pathological

- **Above 12th thoracic vertebrae**: Upper motor neuron signs - spastic, hyperreflexia

- **Below 12th vertebrae**: Lower motor neuron - flaccid paralysis
Complex Reflex Arc

Spinal Cord Injury
Incidence Canada

- 1,035 Canadians/ year
- Males 4:1 more than females
- 78% 15-34 years
- 50 % of spinal cord injuries result in quadriplegia
- Incidents involving brain and spinal cord involve alcohol 1/3 of the time

Think First Foundation of Canada

Facts about SCI

- Location
  1. Cervical: 57%
  2. Thoracolumbar: 24%

- Secondary Injuries
  1. Closed Head Injury: 61%
  2. Systemic Injury: 60%
  3. Additional SCI: 20%
Spinal Cord Injury: Etiologies

- Motor vehicle collisions (41%)
- Recreational (23%)
  - Diving
  - Hockey
- Work-related (17%)
- Falls at home (10%)

Mechanism of Injury: Primary

- Impact alone
  - Hyperextension
- Impact + persistent compression
  - Burst fracture
  - Fracture/dislocation
  - Disc rupture
Mechanism of Injury: Primary

- Distraction
  - Hyperflexion

- Laceration/Transection
  - Burst fracture
  - Laminar fracture
  - Fracture/dislocation
  - Missile

Mechanism of Injury

1. Hyperflexion
   1. MVA
   2. trauma
2. Lateral
   1. MVA
   2. trauma
Mechanism of Injury

1. Axial loading
   1. MVA
   2. Trauma
   - Hyperextension
     - fall

Mechanism of Injury

1. Rotational
   1. MVA
   2. Trauma
Mechanism of Injury

1. Penetrating Injury
2. Burst Injury
   1. MVA
   2. trauma

Classification of Injury

- Concussion (jarring: 24-48 hours)
- Contusion (bruising of the cord)
- Laceration (tear, causing permanent injury)
- Transection (severing of cord)
- Hemorrhage (bleeding into or around cord, damaging delicate tissue)
**Mechanism of Injury: Secondary**

- **Systemic effects**
  - Decreased Cardiac output

- **Local vascular damage of the cord/microcirculation**
  - Disruption & hemorrhage
  - Loss of microcirculation (vasospasm/thrombosis)
  - Loss of autoregulation

- **Biochemical changes**
  - Excitotoxicity (glutamate)
  - Neurotransmitter accumulation (NA/dopamine)
  - Free radical production
  - Lipid peroxidation ..

- **Electrolyte shifts**
  - Increased intracellular Ca++ & Na+
  - Decreased extracellular K+

- **Edema**
TYPES of Injuries: cervical-thoracic-lumbar

- Vertebral bodies
  - Compression #
  - Wedge #
  - Burst #
  - Dislocation/Subluxation
- Posterior elements
  - Lamina
  - Spinous process
- Facets
  - “locked”
  - “jumped”
- Ligaments
  - Anterior/posterior/interspinous
- Spinal cord
  - Penetrating
  - Contusion

Incomplete Transection

1. Brown-Sequard
   - hemisection of SC affected
   - loss of sensation 1/2, loss of motor other 1/2
   - best prognosis; 90% independent with sphincter control

2. Central Cord
   - weakness of arms & hands> legs
   - recovery variable-will walk, usefulness of hands

3. Anterior Cord
   - loss of motor & sensory, sparing of position sense
   - poor recovery; 10-20% recover functional control
Types of SC Injuries

- **Brown-Sequard syndrome**
  - damage to the lateral half of the sc
  - loss of motor on the same side as the injury as well as vibration and proprioception
  - preservation of pain on same side
  - loss of pain and sensory deficits on opposite side of injury
  - penetrating wound or tumors on same side

Types of SC Injuries - Incomplete

- **Central cord syndrome**
  - lower cervical spine injury
  - involves central portion of spinal cord, injuring the gray matter and deep aspects of the white matter
  - distal arm and hand weakness with preservation of lower limb and proximal upper limb function;
  - older patients with sig cervical spondylosis &

FIGURE 5–13 ■ A cross-section of the spinal cord showing damage that causes a Brown-Séquard syndrome.

FIGURE 5–11 ■ A cross-section of the spinal cord depicting damage that causes a central cord syndrome.
Types of SC injuries

- **Anterior cord syndrome**
  - vascular deficit of anterior artery - acute trauma, peripheral vascular disease, and rarely during episodes of systemic hypotension
  - severe motor deficits and loss of pain and temperature below the affected level
  - vibration and proprioception is spared (posterior column)

- **Posterior cord syndrome**
  - very rare; loss of posterior columns - vibration and proprioception
  - sparing of motor function
  - intraspinal tumors; spinal stenosis

*The conus and cauda equina in relation to the thoracolumbar junction of the spine.*
**SYNDROMES**

Complete Transection

- loss of sensation below injury: use segmental level
- loss of voluntary motor function: initially flaccid, later spastic
- after 24 hrs. no distal function return is possible
- label as highest level of completely normal function

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**Injuries: spinal cord level**

- C2-3: fatal
- C4-5: phrenic nerve involvement; potentially ventilator dependent (diaphragmatic pacer)
- above T1: quadriplegia/quadriparesis
- below T1: paraplegia/paraparesis
**Classification systems - ASIA A**

- **A - complete** - No motor or sensory function is preserved in the sacral segments - S4 - S5
- **B - Incomplete** - sensory but not motor function is preserved below the neurological level & includes the sacral segments S4-S5
- **C - Incomplete**: - Motor function is preserved below the lesion and more than half of key muscles below the lesion have a muscle grade less than 3
- **D - Incomplete** - Motor function is preserved below the lesion and at least half of the key muscles below the level have a muscle grade of 3 or more
- **E - Normal** - Motor & sensory function is normal

**SPINAL SHOCK**

😊 Immediate flaccid paralysis

😊 Loss of sensation, reflex activity & autonomic function below the level of injury
**SPINAL SHOCK: Effects**

- Loss of vascular tone (vasoconstrictors)
  - Low BP
- Loss of thermoregulation
- Intestinal peristalsis eg. Ileus
- Bladder sphincter contraction eg. Retention
- Bowel distension
- Reflex erection

**SPINAL SHOCK: Prognosis**

- Persists 1-6 weeks
- Progressive recovery 6-12 months (average 3 months)
- Return of reflexes and initiation of spasticity (UMN) signals spinal shock is lifting (BCR, anal wink/tone)
- Autonomic dysreflexia, changes in bowel/bladder may be necessary
Management: Medical

Initial immobilization
- Collar
- Sandbag
- Spinal board

Radiographic investigation
- Plain x-rays
  - C-spine series
  - “Swimmer’s view” (visualize C6,C7, T1)
  - Flexion-extension (final)
- CT C-spine
  - Bony anatomy
  - Reconstruction
- MRI spine
  - Spinal cord
  - Ligaments

Immobilization
Management: Medical

Medication:
METHYPREDNISOLONE
✓ Must be given within 8 hours of injury
✓ Give bolus (30 mg/kg) over 15 minutes
✓ Maintenance of 5.4 mg/kg/hr X 23 hours
✓ No longer “gold standard”

Management: Medical

Reduction: purpose
1/ to relieve compression
2/ to restore alignment
3/ to provide pain relief

➢ Non-operative
  ▪ Traction with weights (~5lbs per level)

➢ Operative
  ▪ Physically apply traction in operating room
Stabilization

The patient has had spinal fusion of the cervical spine. Screws and pins are stabilizing his cervical vertebrae.

Management: Medical

Stabilization: purpose
1/ to facilitate fusion
2/ to prevent kyphosis (abnormal curvature)

- Non-operative
  - Philadelphia (or other) collar
  - Halo vest
  - Duration: 3 months

- Operative
  - Fusion: use bony chips/acrylic/other
  - Instrumentation: hardware/rods/screws/wires
  - Post-operative neck immobilization: collar vs. halo
Halo Vest

Acute Management: Nursing

- Positioning
  - Maintain alignment
  - Log-roll with assistance
  - Ensure proper traction technique
    - Check weights/pulley system
    - Frequent spinal cord assessment when weights changed
Management: Nursing

- Respiratory
  - Monitor O2 saturation
    - Alert RT
  - Chest physiotherapy
    - “breath stacking”, assistive cough
  - Suctioning
  - PE/DVT prevention
    - TEDS/SCDs
    - Anticoagulation
    - Monitor for DVT
  - Monitor for PE
    - RR, HR, restlessness, hypoxia
    - BE READY FOR INTUBATION!

Acute Management: Nursing

- Cardiovascular
  - Monitor vitals
  - Watch for hypotension, bradycardia & arrhythmias
  - ?telemetry

- Gastrointestinal
  - Monitor for paralytic ileus
  - ?NG with low intermittent suction
  - Early initiation of bowel routine

- Genitourinary
  - Monitor in & output
  - Insert foley
**Functional Levels**

- **C4**  Dependent for all care; head controls for chair mobility
- **C5**  Self feed with universal cuff; hand controls for chair
- **C6**  Self feed(devices); UE ADLs; 1 assist with slider board transfer
- **C7/C8** Very independent with most aspects of care
Functional Levels

- Patients with thoracolumbar injuries have potential to be independent in all aspects of care
- With high thoracic injuries, decreased trunk control
- T12/L1 and below, usually lower motor neuron presentation
- Potential for brace walking with lower lumbar injuries