Spinal Cord Injuries

Disclosure

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Lumbar Vertebra
Thoracic Vertebra
C1-2 Vertebra
Annulus fibrosis (fibrocartilage)
Nucleus pulposus
Disc or nucleus pulposus

Ligaments
- 3 columns or zones
  - Anterior: anterior longitudinal ligament - anterior 2/3 vertebral body, anterior annulus fibrosis
  - Middle: posterior 1/3 vertebral body - posterior longitudinal ligament
  - Posterior: dorsal from posterior longitudinal ligament, includes posterior skeletal & ligament complex

Spinal Cord
- Extends from junction of medulla to about L1 (conus medullaris)
Spinal Tracts
- Major ascending & descending pathways

Ascending – sensory
Descending – motor

Motor Pathways
- Upper motor neuron
  - Brain & spinal cord (central nervous system)
  - Muscle weakness, spasticity, hyperreflexia, Clonus

Lower motor neuron
- From brain & spinal cord (ventral root) to muscle (peripheral nerves)
  - Flaccidity, atrophy, decreased reflexes, fasciculations

Interesting facts ...
- 12,000 new cases annually
  - 1979: Average age was 28.7 y/o
  - 2000: Average age is 38 y/o
  - 2012: Average age 43 y/o
  - 81% are male
  - 2 years post injury 86% non-working
  - Average hospital stay is 11 days in acute care, 36 days in rehab and 87.1 % are eventually home

Etiology
- Motor vehicle crashes 36.5%
- Falls 28.5%
- Interpersonal violence 24.8 down to 13.7%
- Sports related 8% (decreased)
  - C-spine in diving accidents
  - Thoracolumbar in parachuting
- Other causes 2%
Cost
- Dependent of location of injury
  - A high complete tetraplegia approximately $1,044,195$ in 1st year
  - A low incomplete may be $340,787$ in 1st year

Mechanisms of Injury
- Hyperflexion
- Hyperextension
- Rotational
- Axial loading
- Penetrating
- Considered unstable if two of the three columns are disrupted

Hyperflexion
- Causes
  - Front end crashes, diving
  - Sudden deceleration causes:
    - Extreme flexion of the spine
    - Wedge compression of the anterior body
    - Disruption of the posterior longitudinal ligament
  - Unstable if integrity of ligaments and posterior elements exists

Hyperextension
- Causes
  - Rear end crashes, falls
  - Acceleration/external force to C-spine
    - Anterior longitudinal ligament tears
    - Injury to annulus fibrosus
    - Posterior elements of the column

Rotational
- Causes
  - Extreme lateral torsion or flexion
  - Contact sports, side impact crashes
  - Flexion and rotation
    - Disrupts posterior ligaments
    - Unstable

Axial Loading
- Causes
  - Objects falling from above
  - Person falls directly onto head
  - Vertical pressure
    - Wedging
    - Crushing
  - Bursting of vertebral body or C1 ring
Penetrating

• Causes
  - High velocity missiles, complete injury
  - Low velocity stab wounds, incomplete
• Injury to the cord
  - Depends on velocity, bone fragments and swelling

Soft Tissue Injury

• Supporting muscles/soft tissue
  - Pain is referred along the dermatome pathway to the head, neck and upper and lower extremities
• Most common complaints
  > 50% head, neck and shoulder pain
  > 25% low back, interscapular, upper limb paraesthesia and cognitive disturbances

Soft Tissue Injury

• Ligamentous
  - Instability of the spinal column
• Cord meninges
  - Hematomas may cause cord compression
  - Tear may have CSF leak

Vertebral Injury

• Simple fracture
  - Single column
  - Rarely involve neurologic compromise
• Compression fracture
  - Flattened vertebral body
  - May require surgery to remove bone fragments
  - Amenable to orthotic stabilization
• Teardrop
  - Anterior inferior edge body is chipped
  - Unstable

Vertebral Injury

• Atlas Fracture
  - Jefferson’s
  - Burst fracture of ring of C1
• Axis Fracture
  - Odontoid fracture
  - Extreme flexion, extension or rotation
  - Stability depends on where the fracture occurs

Vertebral Injury

• Hangman’s fracture
  - Anterior soft tissue swelling
  - Fracture separates body from posterior elements
  - Small anterior C2 chip
Fracture Dislocation
- Superior facets are usually displaced anteriorly over the facets of the vertebra below
- May injure the vertebral disc
- Usually unstable and require closed reduction and surgery

Subluxation
- Rotary subluxation of C-spine
  - C1-2
  - Present with torticollis
- Subluxation
  - Locked, jumped, perched
  - Facets are misaligned
  - Ligament stretches, but no fracture

Vascular Injury
- Causes
  - Fracture of anterior body
  - Nucleus pulposus extrusion
  - Compression of anterior spinal artery
  - Cross clamping cuts supply to artery of Adamkiewicz
- Ischemia to the cord
- Hematoma causes pressure to the cord

Spinal Cord Injury
- Named for the level of injury
  - eg. C5-6
- Complete injury
  - Total loss of sensory and motor function below the level
  - Functional loss is very important because it will determine independence versus dependence

Spinal Cord Injury
- Concussion
  - Transient loss of function
- Contusion
  - Hemorrhage into the cord and associated swelling
- Laceration
  - Tearing or cut in the cord
  - Transection is complete severing of the cord, very unusual

Complete Cord Injury
- Tetraplegia
  - Loss of all voluntary motor and sensory function below the level of injury
  - Does not include injuries to peripheral nerves
  - Functionally C4-6 loss
Complete Cord Injury

- Paraplegia
  - Upper extremities are spared
  - Loss of voluntary motor and sensory function to thoracic, lumbar and sacral regions
  - Loss depends on the level

Spinal Cord Syndromes

Incomplete Cord Injury

- Central Cord
- Anterior Spinal
- Brown-Sequard
- Conus Medullaris
- Cauda Equina
- Horner’s

Central Cord Syndrome

- Hyperextension injury
- Elongated
- Cavitary cone injury
- Upper > lower loss
- Predisposition
  - disc disease
  - congenital stenosis
  - spondylosis

Brown-Sequard Syndrome

- Penetrating/crush injury
- Hemisection of cord and usually not clean cut
- Ipsilateral motor and position sense loss
- Contralateral loss of pain and temperature

Anterior Spinal Artery

- Injury to spinal artery
- Fracture dislocation
- Disc herniation
- Loss of anterior 2/3 of cord function
  - Motor, pain and temperature
  - Spares dorsal columns
  - Spares periphery/sacral

Conus Medullaris

- Compression of conus terminal L1,2
- Disc herniation, fracture
- Urinary retention, constipation
- Sexual dysfunction
- Saddle numbness
- Loss of anal & bulbocavernosus reflex
- Can have flaccid paralysis
Cauda Equina

- Injury below L1
- Usually related to tumors
- Mixed spinal cord and peripheral nerve
- Areflexive bowel and bladder
- Loss of Achilles reflex
- Variable weakness and sensory loss
- Sciatica

Spinal Shock

- Loss of neurological function below the level of injury in the acute phase
  - Decreased reflexes
  - Loss of sensation
  - Flaccid paralysis below injury
- Usually occurs within 30-60 minutes of injury
- Can last up to 4-6 weeks
- Poikilothermia
  - Loss of ability to sweat below injury
- Priapism
  - Bladder and Bowel paralysis

Autonomic Dysreflexia

- MEDICAL EMERGENCY
  - Severe hypertension, HA, flushing/diaphoresis, bradycardia, goose flesh, chills, nasal congestion, blurred vision, anxiety/apprehension, bronchospasms.
- Noxious stimuli below level of injury
  - Bladder distention, bowel distention, skin breakdown, positioning.
- Goal – treat stimuli without worsening.
- Patient education is essential in prevention.

Autonomic Dysreflexia

- Treatment
  - FIND THE CAUSE AND FIX IT
    - Check for bladder distention
    - Check for bowel distention, constipation
    - Check for skin breakdown, wrinkled sheets
    - Elevate HOB 90°
    - Place legs in a dependent position
    - Remove constricting clothing
    - Make sure patient is positioned in alignment
    - B/P > 140 Nitropaste B/P > 160 Labetelol

Initial Emergency Resuscitation

- Airway, breathing, circulation, deficits (ABCD)
- Complete neuro assessment
- Stabilization and rescue information
  - Collar and backboard in the field
  - Tongs, rotobed, halo in the hospital

Spinal Trauma

- Primary injury- what is done to the cord at the time of impact, no ability to change that damage
- Secondary injury- trauma causes swelling, bleeding, inflammatory cascade resulting in sodium-pump failure, influx of calcium, macrophages all resulting in additional injury to cord cells, hypoperfusion ischemia
Pharmacologic
Methylprednisolone is not indicated in the treatment of SCI. Multiple medications still in trial focus on the inflammatory process, sodium and calcium stabilizers, glutamate influence in secondary injury. Hypothermia still in clinical trial—unknown length of time, temp, complications.

Diagnostics & Assessment
- Lateral C-spine/CT/MRI
- Asymptomatic
  - No pain or tenderness
  - Awake and alert and not intoxicated
  - No radiographic assessment needed
- Symptomatic
  - 3 view spine series
  - Supplement with spine CT

Ongoing Management
- Optimize neurological function
  - Follow the ENLS guidelines (2013)
  - Prevent secondary injury
  - Perfusion and oxygenation
  - Ongoing thorough assessment and accurate charting

Surgery
- Goal is to allow adequate decompression of the neural elements, spinal stability to allow for mobilization and rehabilitation.

Respiratory Management
- Respiratory status and airway protection
- Serial assessment of parameters
- Establish and support ventilation
  - Noninvasive vs mechanical
- Aggressive pulmonary toilet
  - Suctioning
  - Physiotherapy
  - Assist cough (quad cough)
  - Incentive spirometer

Respiratory capacity
- High lesions of C1-2 vital capacity is only 5-10% of normal
- Lesions C3-6 vital capacity is 20% of normal, cough is weak
- High thoracic injury T2-4 vital capacity is 30-50% of normal, cough is weak
- With injuries at T11 respiratory dysfunction is minimal
Respiratory Management

- Positioning
  - Avoid positions that cause difficulty with breathing
  - Abdominal binders
  - Monitor and treat pneumonia
  - Prevent/recognize pulmonary embolus

Neurogenic Shock

Hemodynamic phenomenon
- Hypotension - due to massive vasodilation
  - Treat with vasopressors
- Bradycardia - due to unopposed parasympathetic stimulation
  - Atropine
  - Pacemaker
- Occurs
  - Within 30 min cord injury level T 5 or above. Last up to 6 weeks.

DVT

- Best to start with lovenox within 72 hours depending on injury of cord possibility of bleeding in the cord
- IVC filter placement if not a candidate for lovenox
- Compression stockings and device use, monitor for folds, skin breakdown with too tight compression

Temperature Regulation

- Poikilothermia
  - Loss of thermoregulation

Musculoskeletal/Integument

- Dependent edema
  - Skin integrity and breakdown areas
- Spasticity, contractures
- Heterotopic ossification
- Tedhose/compression devices
- Low molecular weight heparin
- Rotating beds

Pain Management

- Ongoing need for pain management to be addressed. Bone and muscular pain from trauma, burning pain due to nerves, spasticity development, limitations in mobility may benefit from baclofen/ pain pump, spinal stimulator or rhizotomy
- Botox injections for spasticity
Gastrointestinal/Genitourinary

- H2 blockers for stress ulcers
- Reflux silent aspiration
- Nutrition, begin feeding within 72 hours
- Ileus
- Bowel program
  - laxative, suppository
  - D/C foley and in and out catheterization early and on a schedule

Sexual Dysfunction

- Male
  - Difficulty with erections, emission, and ejaculation
  - Infertility
- Female
  - Amenorrhea occurs in most SCI for 4-9 months
  - Capable of conception and carrying baby to full term
  - SCI above T6 have epidural anesthesia during labor and delivery

Dermatomes

- Biceps C5/6
- Brachioradialis C5/6
- Triceps C7 (C6-8)
- Finger flexors C8 (C7-T1)
- Knee L3 (L2-L4)
- Ankle S1 (L5-S2)

Specific Findings Related to Level

- Above C7 dependent on others
- C2,3 Loss of breathing
- C4 Shrugs shoulders
  - Blow wheelchair
- C5 Biceps, bends elbow
  - Propel wheelchair; self feed with a splint
- C6 Triceps, extends elbow and wrist
  - Transfer with minimal assistance
- C7 Extensors, makes a fist
  - Independent transfer, toilet and dressing
- C8 Fingers straight
  - Independent curb up/down

Rhyming levels of injury

- C4 – Keeps you breathing more
- C5 – Keeps biceps and shoulders alive
- C6 – Extends elbows and wrists
- C7 – Makes a fist, thank heaven
- C8 – Keeps your fingers straight

Thank you!!

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