SPINE INJURIES

Dr. Waleed Dabbas
Consultant neurosurgeon
College of Medicine
Al Balqa University
Al Salt – Jordan

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Spinal injuries
WE WANNA SEE THIS WATCH OUT YOUR SPINE
Definition

- Injury to any of following
  - Bony elements
  - Soft tissues
  - Neurological structures

Concerns

- Instability of vertebral column
- Actual or potential neurological injury soon or later
- Development of chronic pain syndrome
- Further neurological decline in future
EPIDEMIOLOGY

- Most frequently a problem in the young males
  - 63% age 16-30
  - 4:1 male: female
  - 10:1 Adult to kids

- Mechanism
  - MVA 50%
  - Falls 21%
  - Sports-related 14%
  - “Acts of Violence” 15%
EPIDEMIOLOGY

- Multi trauma
  - Head injuries
  - Chest injuries
  - Abdominal injuries
  - Long bone fractures
- Association with Alcohol/Drugs
- 20% of patients with major spine injury will have a second spine injury
Pediatrics

- Only 5% of SCI occur in children
- C-spine is the most vulnerable segment 42%. Of these 67% of C-spine injuries occur in the upper segment
- 31% thoracic
- 27% lumbar
- Fatality rate is higher with pediatric spine injury than with adults. Opposite to head injuries
- Neural and soft tissue involvement are common
What happens when the spinal cord is injured?

local swelling at the site of injury which pinches off blood (hypoperfusion and ischemia)

- Excessive release of glutamate and excitotoxicity of neurons and oligodendrocytes at the site of injury
- Infiltration by immune cells (microglia, neutrophils)
- Free radical toxicity
- Apoptosis/necrosis
active cell death as well as passive necrosis may mediate damage after injury.

After spinal cord injury (SCI) in the rat, typical posttraumatic necrosis occurred, but in addition, apoptotic cells were found from 6 hours to 3 weeks after injury, mainly in the spinal white matter.

Apoptotic cells were positive for oligodendrocyte markers. After SCI in monkeys, apoptotic cells were found within remote degenerating fiber tracts. Both secondary degeneration at the site of SCI and the chronic demyelination of tracts away from the injury appear to be due in part to apoptosis.

As cytokines mediate oligodendrocyte death, it seems likely that chronic demyelination after CNS injury shares features with chronic degenerative disorders like multiple sclerosis.
biomechanics of spinal injury

- Traumatic forces
- **AXIAL**: elements pushed together
- **DISTRACTION**: elements are pulled apart
- **FLEXION**: severe forward bending
- **EXTENTION**: severe backward bending
- **SHEAR**: forces parallel to the surface on which it acts
- **ROTATIONAL**: torsional forces
Classification of fractures

- **Stable**: able to carry normal loads
- **Unstable**: unable to carry physical loads
- Simple, dislocation, sub laxation, wedge, burst.
- **3-COLUMN OF DENIS**
  - Anterior: ALL and anterior 2/3 of V. body and disc
  - Middle: posterior 1/3 and PLL
  - Posterior: pedicles, lamina, facets, ligaments
Patterns of neurological injury

Following syndromes need to be recognized:
- Central cord syndrome
- Anterior spinal artery syndrome
- Brown sequard syndrome
- Complete versus incomplete injuries
- Conus medullaries injury
- Cauda equina syndrome
Complete vs incomplete

- It is critical to look for any sign of preserved long tract function of the spinal cord for the purpose of treatment and prognostication.

Incomplete

Any residual motor or sensory function below the level of injury.

look for sacral sparing sensation, voluntary anal contraction, toe flexion, bulbocavernous reflex
Complete vs incomplete

- **Complete**
  - no preservation of any motor or sensory function

**Bad signs**

Priapism and abdominal breathing
Neurological level

- Motor or Sensory is defined as the lowest level that has completely normal motor or sensory function bilaterally.
- C 5 means C6 and below is involved
Spinal shock

- Transient physiological disruption which leads to hypotonic areflexic state
- Should not impair initial assessment.
- Less than an hour
- Different from Neurogenic shock

When SBP <90 mm hg. Caused by:
- Loss of muscle tone. Results in venous pooling
- Sympathetic interruption
Expected outcome

- Complete injury unlikely to walk again
- About 3% of patients with complete injuries on initial exam will develop some recovery
- Complete SCI beyond 24 h indicates no function will recover
- Incomplete may make complete or near normal recovery
NEUROLOGICAL STATUS

- 25% normal
- 20% complete lesion
- 55% incomplete lesion/radiculopathy
- DETAILED initial assessment imperative
  - American Spinal Injury Association (ASIA) sheet

Pain is the cardinal symptom in alerts
Deficits is the main sign in unconscious
# ASIA ASSESSMENT

## STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

### MOTOR

| Segment | C2 | C3 | C4 | C5 | C6 | C7 | C8 | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T10 | T11 | T12 |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|-----|-----|
| KEY MUSCLES | Elbow flexors | Wrist extensors | Elbow extensors | Finger flexors (distal phalanx of middle finger) | Finger abductors (little finger) |
| R | L | R | L | R | L | R | L | R | L | R | L | R | L | R | L | R | L |
| 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 |
| Voluntary anal contraction (Yes/No) |

### LIGHT TOUCH

| Segment | C2 | C3 | C4 | C5 | C6 | C7 | C8 | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T10 | T11 | T12 |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|-----|-----|
| KEY SENSORY POINTS | 0 = absent | 1 = impaired | 2 = normal |
| NT = not testable |

### PIN PRICK

| Segment | C2 | C3 | C4 | C5 | C6 | C7 | C8 | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T10 | T11 | T12 |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|-----|-----|
| SENSORY | Any anal sensation (Yes/No) |
| (max: 112) |

### MOTOR SCORE

- (MAXIMUM) (50)
- (100)

### ZONE OF PARTIAL PRESERVATION

- Partially innervated segments

### COMPLETE OR INCOMPLETE?

- Incomplete = presence of any sensory or motor function in lowest sacral segment

### NEUROLOGICAL LEVEL

- The most caudal segment with normal function

### SENSORY MOTOR

- R | L

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TREATMENT PRINCIPLES

- Any patient with significant trauma must be treated as having SCI.
- Stabilise
- Immobilisation

Spinal Cord Injury Surgical Principles

- Reduction
- Neural decompression
- Spinal Stability
- Rehabilitation
INITIAL ASSESSMENT

- Brief history
- Check vitals
- Check GCS
- Any spine tenderness is crucial
- IV access
- Bloods
- O2 mask
- Brief motor exam:
  ask patient to move arms, hands, legs, and toes
STABILISE

- Haemodynamic
  - Aim oxygen saturation >95%
  - Systolic BP >90 mm Hg and MAP >80 mm Hg

PREVENT SECONDARY INSULT TO CORD

- Treat other injuries
- NG tube / Ulcer prophylaxis
- Bladder care
- Temperature
- DVT prophylaxis
  - TEDS / SCD
  - Clexane
IMMOBILISATION

- Hard Collar
  - Change to Philadelphia / Aspen collar
- Traction: tongs, halo
- Straight line Spine
  - No head up (Reverse Trendelenburg)
  - Log roll patient to turn
  - Sandbags rigid
- Pressure Area Care
  - Off spinal board ASAP
  - Rolls
  - Mattress etc
SPINAL CORD INJURY

- Evaluation
  - Level of injury
  - Complete / Incomplete
  - Syndromes

- Methyl Prednisolone if within 8 hours of injury
  - NASCIS III guidelines
    - 30mg/kg bolus over 15 minutes
    - Wait 45 minutes
    - 5.4mg/kg/hr for 23 hours
    - Continue for additional 24 hours if 3-8 hours past

- Relieve Neurological Compression (incomplete)
  - Controversial
SPINAL STABILITY

- Assessment
- Immobilisation
  - Orthosis
  - Surgical
- Reassessment
- Treatment
REHABILITATION

- Mobilisation
- Bowel care
- Bladder care
- Pain management
- Pressure Area Care
- Psychology
- Placement
IMAGING

- Plain radiography
- Dynamic radiography in certain cases
- CT scanning for bony elements
- MRI most accurate

CT scan and MRI in case of:
- clinical suspicion
- or abnormal Xray
- Myelography?
PLAIN RADIOGRAPHY

- Routine in the ED
- AP
- Lateral 7 vertebra
- Open mouth
- (Obliques)
- Swimmer’s / Fletcher’s
  - Visualise Cervicothoracic junction
● Dorsal spine X ray: Not accurate
● Lumbar Spine Xray: 70% accuracy
PATTERNS OF INJURY

- Occipital injuries
  - Occipitoatlantal dislocation
  - Occipital condyle fractures
- Atlantoaxial (C1/C2) complex injuries
  - Jefferson’s fractures
  - Atlantoaxial instability
  - Rotatory subluxation
  - Odontoid fractures
  - Hangman’s fractures
- Subaxial Spine
INJURIES INVOLVING OCCIPUT

- Occipital-Atlantal dislocation
  - Rare - underestimated
  - Distraction under hyperflexion
  - Posterior fusion
    - Traction considered hazardous

- Occipital condyle fractures
  - Rare
  - Frequently associated with severe head injury
ATLANTOAXIAL ANATOMY
ATLANTOAXIAL INJURIES

- Jefferson’s fracture (C1 arch fracture)
  - Axial loading
  - Disruption of C1 ring in multiple sites
  - Halo immobilisation
  - May require surgical stabilisation if transverse ligament disrupted
Jefferson fracture
Atlanto-occipital dislocation (AOD) is a devastating condition that frequently results in prehospital cardiorespiratory arrest. Accounts for 1% of spinal trauma. AOD occurs 3 times more commonly in children than adults, hyperextension. Unstable.
ATLANTOAXIAL INJURIES

- Atlantoaxial instability
  - Due to disruption of ligamentous structures, particularly transverse ligament
  - Also injury to anterior arch of C1, odontoid peg
- Tends to fail conservative treatment if ligamentous aetiology
- Posterior fixation
  - Transarticular screws
  - Wiring techniques
ATLANTOAXIAL INJURIES

- Rotatory subluxation
  - More common in children than adults
  - Graded I-IV based on integrity of transverse ligament
  - Often artefactual radiologically
ODONTOID PEG FRACTURES

- 7-17% of all cervical spine fractures
- Usually present with neck pain
- Neurological deficit rare
- Type I
  - Distal odontoid process
  - Lateral flexion and rotation
  - Rare usually treated in collar
- Type III
  - Fracture extends into C2 body
  - Usual heal with Halo / Minnerva
ODONTOID PEG FRACTURES

- Type II
  - Fracture through the synchondrosis of the process with body of C2
  - Common (90% of odontoid peg fractures)
  - Rate of nonunion due to disruption of blood supply
  - Frequently require surgical fixation
  - Integrity of transverse ligament important
ODONTOID PEG FRACTURES

(A)

(B)

(C)

Figure 265-13. A. Type I odontoid fracture. The rarest type. Low incidence of nonunion when treated in hard collar.
B. Type II odontoid fracture. The most common variety of axis fractures. The fracture line involves the synchondrosis where the dens fuses with the body of C2. Management of these fractures often requires surgery for fusion, especially if there is more than 4 mm of subluxation associated with the fracture.
C. Type III odontoid fracture. The fracture extends into the body of C2. These generally heal with an osseous union when treated with an external brace for 3 months.
SURGERY
TYPE II PEG FRACTURES

- Posterior C1/2 fusion
- Anterior screw fixation
  - Maintains rotation
  - Requires real time fluoroscopy
ODONTOID SCREW
ODONTOID SCREW
HANGMAN’S FRACTURE

- Traumatic spondylololisthesis of C2 as a result of bilateral fractures of the C2 pars interarticularis
- First reported in 1913 by Wood-Jones
- Hyperextension injury
- Majority heal in collar
HANGMAN’S FRACTURE

[Images of radiographs showing cervical spine fractures]
SUBAXIAL CERVICAL SPINE INJURIES

- Variety of mechanisms of injury
- Three column theory
  - Anterior column
    - Anterior longitudinal ligament
    - Anterior two thirds of body
  - Middle column
    - Posterior third body
    - Posterior longitudinal ligament
  - Posterior column
    - Pedicles, Laminae
    - Articular processes
    - Spinous processes
THREE COLUMNS

Anterior Longitudinal Ligament
Intervertebral disc
Supraspinous & Infraspinous Ligaments
Posterior Longitudinal Ligament

Anterior Column
Middle Column
Posterior Column
APPLICATION

- Few single column injuries require immobilisation / stabilisation
- Most two column injuries usually require immobilisation, some need stabilisation
- Almost all three column injuries require immobilisation AND stabilisation
MECHANISMS OF INJURY

- Compression – flexion
- Compression – extension
- Distraction – flexion
- Vertical compression
- Lateral flexion
- Distraction - extension
FACET DISLOCATION

- May be unilateral or bilateral
- Usually as a result of hyperflexion force
- May be reduced with traction (not always successful)
- Beware disc fragments in canal
- Most easily approached posteriorly
GENERAL PRINCIPLES

- Reduction
  - Traction
  - Intraoperative

- Decompression
  - Best approached from where majority of compression is from

- Stabilisation
CASE I

- 64 year old male
- Yoga
- “Piggy-backing”
- Fell back and struck head
- Brief period of tingling in arms – settled spontaneously
- Presented with neck pain
CASE I - Xray
CASE I - CT
CASE I - MRI
CASE I - Progress

- Traction applied via Gardner-Wells tongs
- Gradually increased
  - Repeat XR
  - Serial examination
- Reduction only partial
- OT
CASE I – POST OP
POSTERIOR CERVICAL INSTRUMENTED FUSION
CASE II
CASE II - Progress

- Anterior corpectomy
- Tricorticate graft from iliac crest
- Plate fixation
ANTERIOR FIXATION
CASE III

- 25 year old
- Dive into sand bank
- C4 complete
CASE III - CT
CASE III - MR
CASE III - PROGRESS

- Anterior corpectomy and cage, plate
- Posterior instrumented fusion
IMMOBILISATION

- Halo vest
- Minnerva jacket
  - Immobilise occipitocervical junction
  - Morbidity
- Hard Collars
  - Philadelphia
  - Miami Jackson
  - Aspen
- Soft collars for comfort only
“CLEARING” THE CERVICAL SPINE

- Precautions taken to prevent damage due to an occult cervical spinal lesion
- Particularly in “poor historians”
  - Head injured patient
  - Those with distracting injury
- Lateral C spine – 80%
- AP / open mouth – 99%
- CT
- Flexion/Extension views
- MRI – first 48 hours
Any hope ??

- Stem cell implantations
- still experimental and investigational