

Spinal Cord Injury



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Incidence

- 10 - 15 per million
- 18 - 35 years
- Male - 3:1
- RTA 51% - cars
- Domestic 16%
- Industrial 11%
- Sports 16% - diving incidents
- Self harm 5%

Types

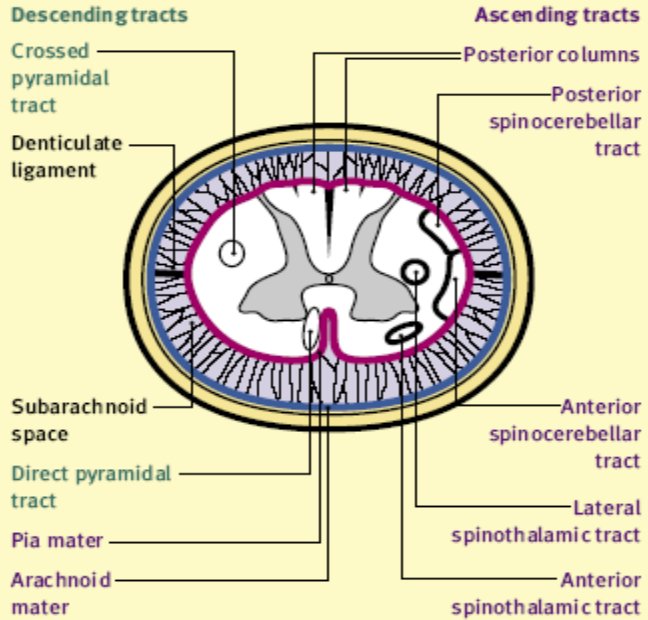
- Cervical 40%
- Thoracic 10%
- Lumbar 3%
- Dorso lumbar 35%
- Any 14%
- Injury – osseus/ligamentous
- SCIWORA Syndrome
(Spinal Cord Injury w/o Radiologic Abnormality)

Anatomy

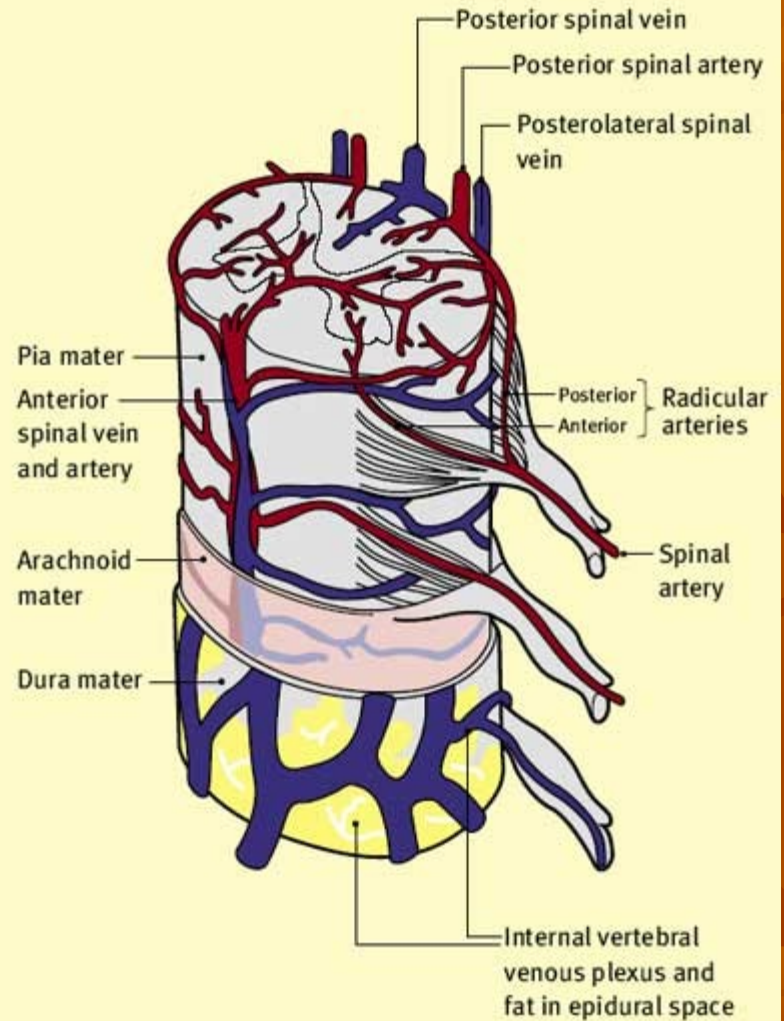
- Spinal cord ends below lower border of L1
- Cauda equina is below L1

- Mechanical injury - early ischaemia, cord edema - cord necrosis

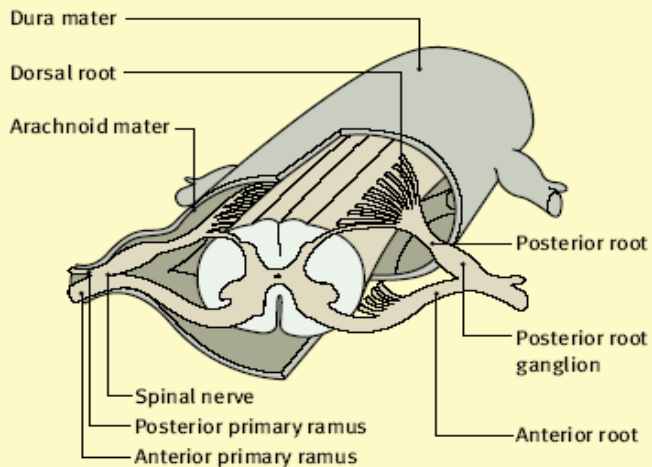
Cross-section of spinal cord showing meninges and denticulate ligaments and ascending and descending tracts



Arterial supply and venous drainage of the spinal cord



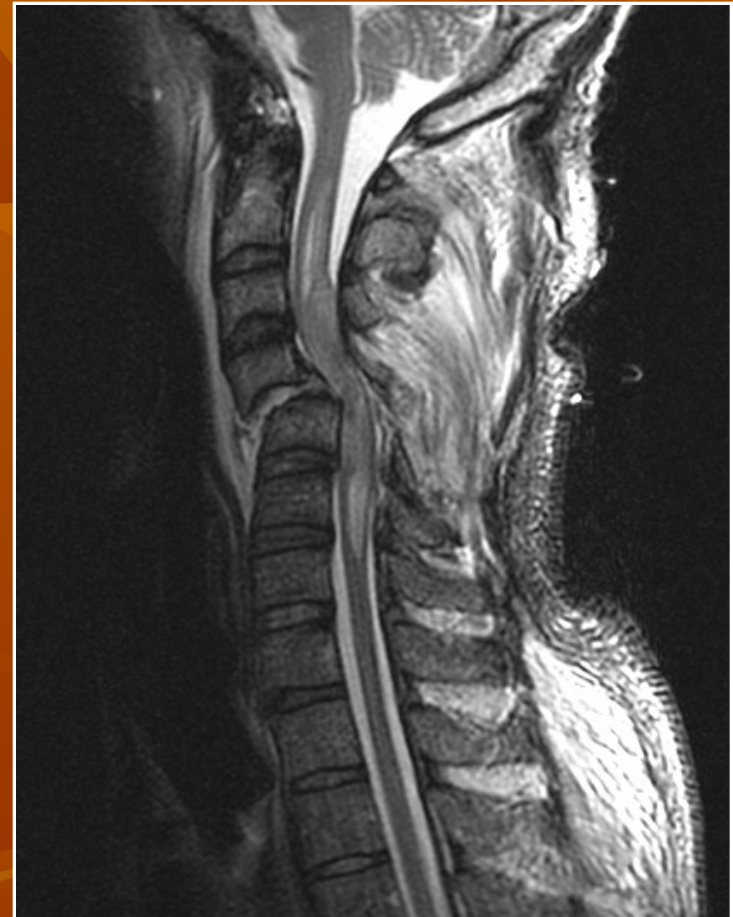
Spinal cord



Spinal Cord Injury pathophysiology

Primary injury

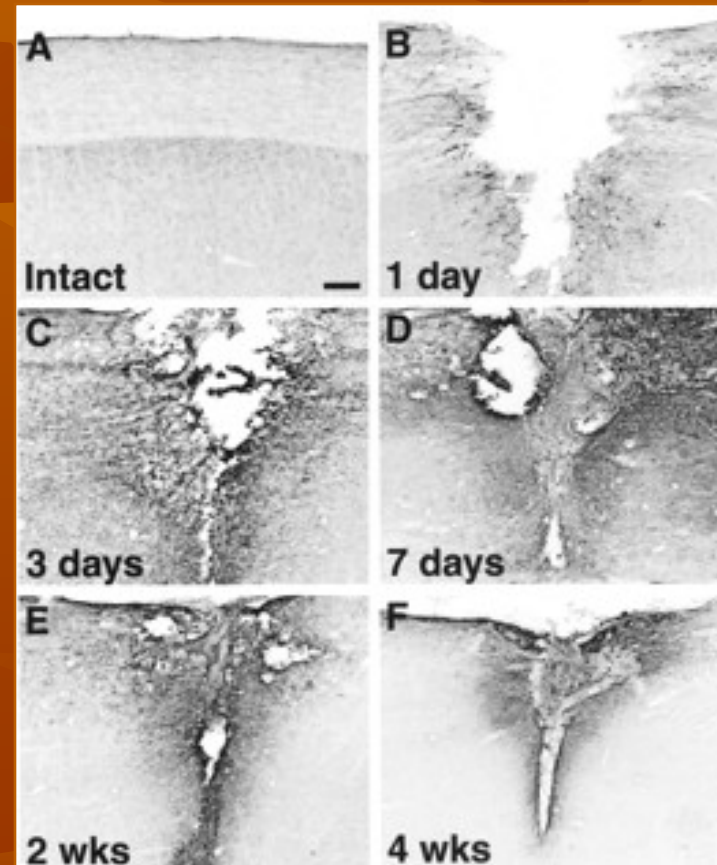
- Initial insult to cord
- Local deformation
- Energy transformation



Spinal Cord Injury *pathophysiology*

Secondary injury

- Biochemical cascade
- Cellular processes



Theories for secondary injuries

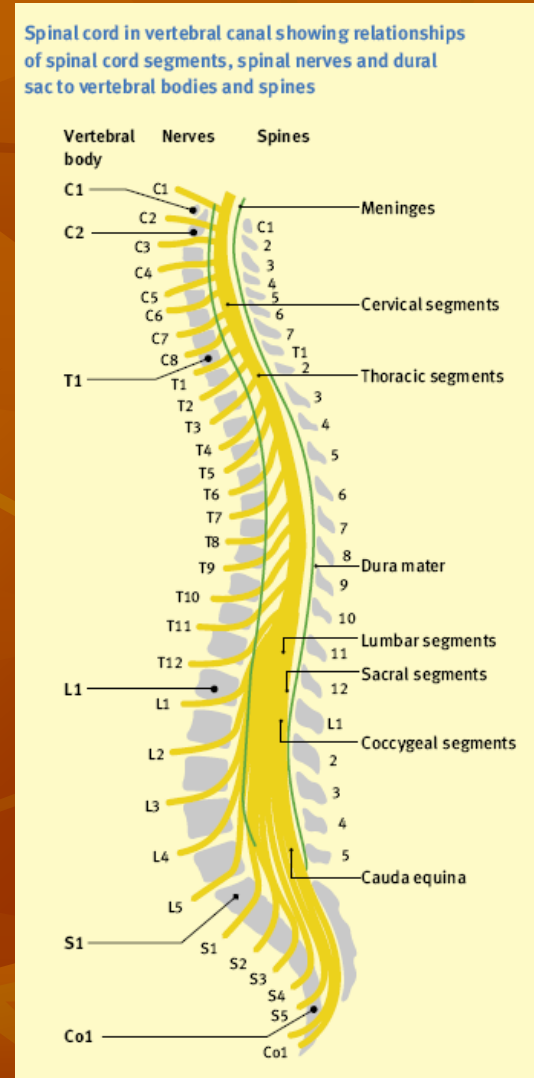
- *Lipid Peroxidation and Free Radicals*
- *Abnormal Electrolyte Fluxes and Excitotoxicity*
- *Abnormal Vascular Perfusion*
- *Abnormal Intracellular Sodium Concentration*
- *Associated Inflammatory and Immune Response*

Level of Spinal injury

- Neurological level is at the most lowest segment with normal motor & sensory function
- Difficult to determine :
 - as most muscle efferents receive fibres from more than one level
 - Closed cord lesions may extend over several cms.
 - Dermatomes have imprecise boundaries.

Cord level

- C2 – C7 = add +1 for cord level
- T1 – T6 = add +2
- T7 – T9 = add +3
- T10 = L1, L2 level
- T11 = L3, L4 level
- L1 = sacro coccygeal segments



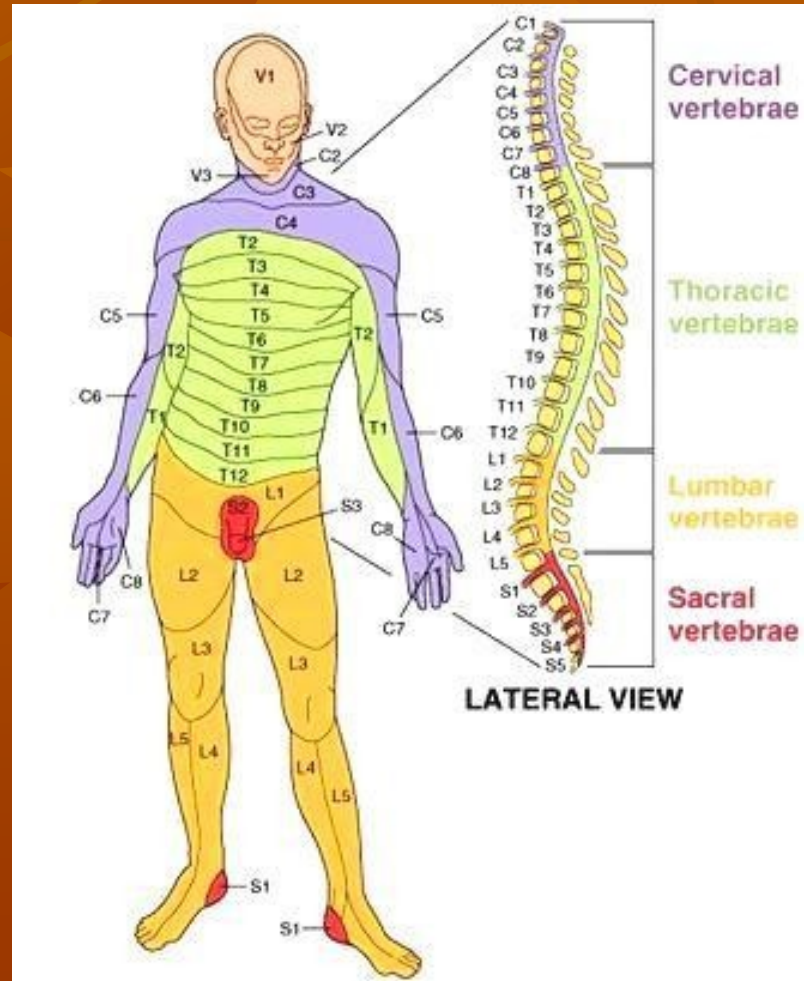
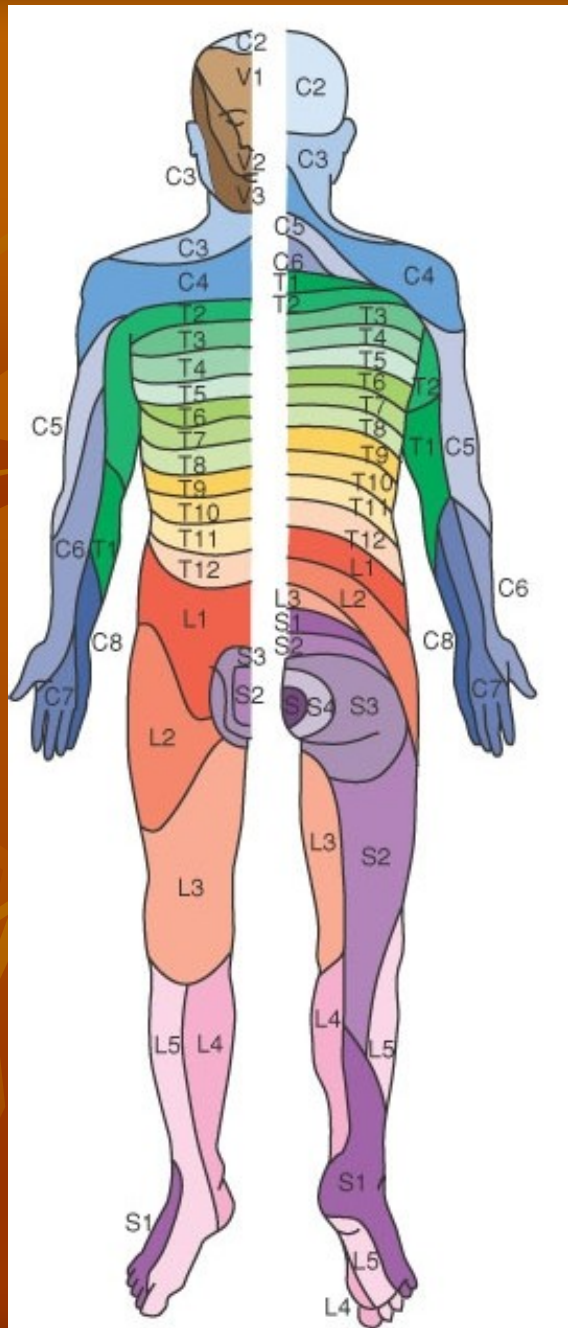


Table 3. Cervical And Lumbosacral Dermatomes And Myotomes.

| <u>Spinal level</u> | <u>Key sensory area for dermatomal testing</u> | <u>Myotome</u> |
|---------------------|--|---|
| C5 | Radial antecubital fossa | Elbow flexors (biceps*, brachialis, and brachioradialis*) |
| C6 | Thumb | Wrist extensors (extensor carpi radialis longus and brevis) |
| C7 | Middle finger | Elbow extensors (triceps*) |
| C8 | Little finger | Finger flexors* (distal phalanx—flexor digitorum profundus) |
| T1 | Ulnar antecubital fossa | Hand intrinsic (interossei) |
| L2 | Mid-anterior thigh | Hip flexors (iliopsoas) |
| L3 | Medial femoral condyle | Knee extensors* (quadriceps) |
| L4 | Medial malleolus | Ankle dorsiflexors (tibialis anterior) |
| L5 | Dorsal second/third toe web space | Long toe extensors (extensor hallucis longus) |
| S1 | Lateral heel | Ankle plantar flexors* (gastrocnemius, soleus) |

* Commonly tested reflexes

ASIA Score

- Based on key muscle strength & key sensory points
- Useful for following improvement or deterioration

MOTOR

KEY MUSCLES

| | R | L |
|------|---|---|
| C2 | | |
| C3 | | |
| C4 | | |
| C5 | | |
| C6 | | |
| C7 | | |
| C8 | | |
| T1 | | |
| T2 | | |
| T3 | | |
| T4 | | |
| T5 | | |
| T6 | | |
| T7 | | |
| T8 | | |
| T9 | | |
| T10 | | |
| T11 | | |
| T12 | | |
| L1 | | |
| L2 | | |
| L3 | | |
| L4 | | |
| L5 | | |
| S1 | | |
| S2 | | |
| S3 | | |
| S4-5 | | |

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

Hip flexors
Knee extensors
Ankle dorsiflexors
Long toe extensors
Ankle plantar flexors

Voluntary anal contraction (Yes/No)

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

SENSORY

KEY SENSORY POINTS

| | LIGHT TOUCH | | PIN PRICK | |
|------|-------------|---|-----------|---|
| | R | L | R | L |
| C2 | | | | |
| C3 | | | | |
| C4 | | | | |
| C5 | | | | |
| C6 | | | | |
| C7 | | | | |
| C8 | | | | |
| T1 | | | | |
| T2 | | | | |
| T3 | | | | |
| T4 | | | | |
| T5 | | | | |
| T6 | | | | |
| T7 | | | | |
| T8 | | | | |
| T9 | | | | |
| T10 | | | | |
| T11 | | | | |
| T12 | | | | |
| L1 | | | | |
| L2 | | | | |
| L3 | | | | |
| L4 | | | | |
| L5 | | | | |
| S1 | | | | |
| S2 | | | | |
| S3 | | | | |
| S4-5 | | | | |

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

Any anal sensation (Yes/No)

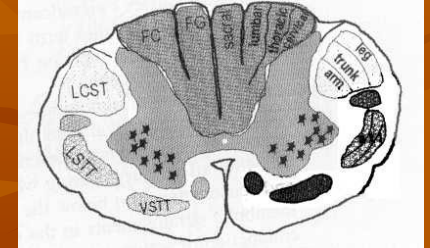
TOTALS + = **PINPRICK SCORE** (max: 112)
 + = **LIGHT TOUCH SCORE** (max: 112)
(MAXIMUM) (56) (56) (56) (56)

Degrees of injury

- Complete - flaccid paralysis + total loss of sensory & motor functions
- Incomplete - mixed loss
 - Anterior sc syndrome
 - Posterior sc syndrome
 - Central cord syndrome
 - Brown sequard's syndrome
 - Cauda equina syndrome

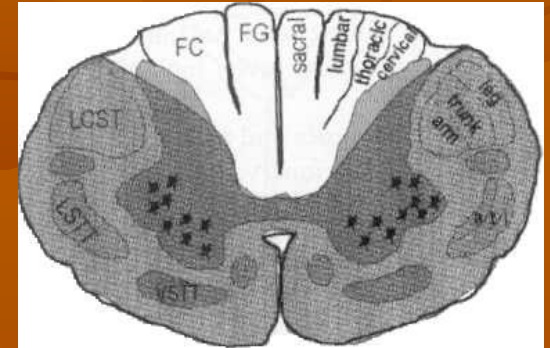
Anterior spinal cord syndrome

- Flexion rotational force to spine
- Due to compression fracture of vertebral body or anterior dislocation
- Anterior spinal artery compression
- Loss of power, reduced pain and temperature below the lesion.



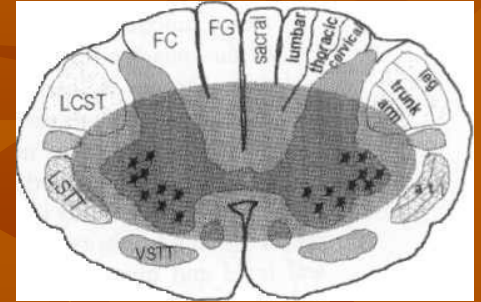
Posterior cord syndrome

- Hyperextension injuries
- Posterior vertebral body fracture
- Loss of proprioception and vibration sense
- Severe ataxia



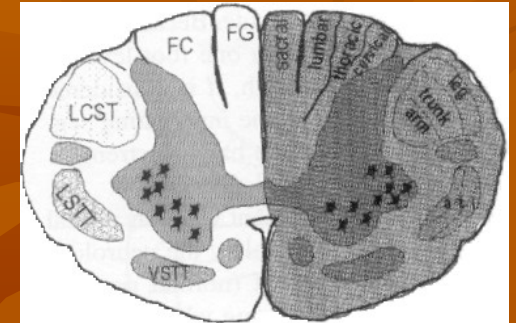
Central cord syndrome

- Older age with cervical spondylosis
- Hyperextension with minor trauma
- Cord is compressed by osteophytes from vertebral body against thick ligamentum flavum.
- Damages the central cervical tract



Brown sequards syndrome

- Hemisection of the cord
- Stab injury and lateral mass fractures
- Uninjured side has good power but absent pinprick and temperature
- Ipsilateral weakness and position sense loss
- Contralateral pain and temperature loss



Neurogenic shock

- Lesions above Th6
- Minutes – hours (fall of catecholamines may take 24 hrs)
- Disruption of sympathetic outflow from Th1 - L2
- Unopposed vagal tone
- Peripheral vasodilatation
- Hypotension, Bradycardia & Hypothermia
- BUT consider haemorrhagic shock if – injury below Th6, other major injuries, hypotension with spinal fracture alone without neurological injury.

Spinal shock

- Transient physiological reflex depression of cord function – **‘concussion of spinal cord’**
- Loss anal tone, reflexes, autonomic control within 24-72hr
- Flaccid paralysis bladder & bowel and sustained priapism
- Lasts even days till reflex neural arcs below the level recovers.

Assessment & Management

- Failure to suspect leads to failure to detect injuries
- ABCDE – Logroll and remove the spinal board
- Look for markers of spinal injury
- Secondary survey
- Adequate Xray's
- Emergency treatment
- Surgery
- Definitive care & rehab.

Clinical features

- Pain in the neck or back radiating due to nerve root irritation
- Sensory disturbance distal to neurological level
- Weakness or flaccid paralysis below the level

Signs in an Unconscious patients

- Diaphragmatic breathing
- Neurological shock (Low BP & HR)
- Spinal shock - Flaccid areflexia
- Flexed upper limbs (loss of extensor innervation below C5)
- Responds to pain above the clavicle only
- Priapism

Signs of spinal injury

- Forehead wounds – think of hyperextension injury
- Localized bruise
- Deformities of spine - Gibbus, feel a step & Priapism

Emergency Care

- Careful manual handling especially if unconscious
- Jaw thrust is safer
- Correct gross spinal deformities
- Call the anaesthetist if diaphragmatic paralysis or RR>35
- Use flexible fiberoptic scopes in unstable fractures
- Ryles tube if abdominal distension causes respiratory probl
- Cathetrize to avoid overstretching of detrusor
- IV fluids – paralytic ileus in first 48hrs.
- Passive movements to rule out fractures
- Small iv doses of opiates

Assessment

- Document the level of injury
- Rule out other injuries – CT/FAST in abdominal injuries as there is paralytic ileus and absent peritoneal irritation.
- Associated injuries in dorsal spine fracture are :
 - Renal injuries
 - Chest and Sternal injuries
 - Wide Mediastinum due to fracture haematoma.
 - Retroperitoneal injuries

Therapy

- *Pharmacologic Interventions*
- *Decompression*
- *Prospects of Spinal Cord Regeneration*

Emergency treatment

- ABCDE
- Keep warm
- Treat if BP < 80mmHg & HR < 50bpm
- H2 Antagonists & Heparin

The National Acute Spinal Cord Injury Study (NASCIS)

- Methylprednisolone 30mg/kg iv bolus over 15min immediately
- 45minutes after the bolus a 5.4mg/kg/h infusion over 23 hrs in first 3 hours after the injury.
- 5.4mg/kg/hr for 47hrs if 4 - 8hrs following the injury.

- *Steroids*
- Steroids mainly act by prevention of lipid peroxidation by free radicals and membrane stabilisation. They may help prevent apoptosis by checking calcium fluxes, improving vascular perfusion, and are thought to help reduce white matter oedema, and enhance Na/KATPase activity

- *Naloxone*
- Naloxone is an opiate receptor that was included in one treatment arm of the NASCIS studies
- Found to be effective in the subgroup of patients with incomplete spinal cord injuries

- *Gangliosides*
- These are glycosphingolipids at the outer cellular membranes of the central nervous system
- There is some evidence that gangliosides may have neuroprotective action, with more speedy recovery of motor and sensory function in partial cord injuries

- *Calcium Channel Blockers*
- Thought to work by improvement in blood flow via vessel dilatation

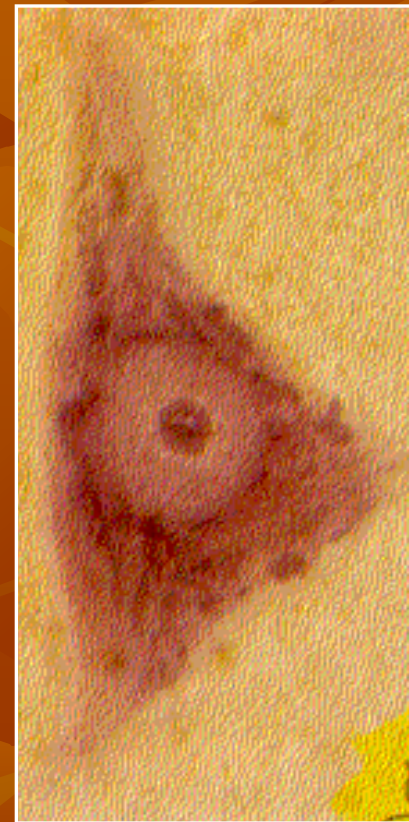
- *Antagonists of Glutamate Receptors*
- Works by prevention of excitotoxicity as a result of glutamate accumulation – helps to prevent abnormal sodium and calcium fluxes, which may prove lethal to cells

- *Others*
- Inhibition of cyclo-oxygenase
- Minocycline
- Sodium channel blockers
- Erythropoietin
- Cyclosporin

Augmentation of Regenerative Ability of CNS Neurons

Neurotrophic Factors

- **Epidermal growth factor**
- **Fibroblast growth factor 2**
- **BDGF: brain derived growth factor**
- **Cyclic AMP**



Whiplash injury

- Sudden hyperextension and flexion
- Increasing neck pain for the first 24hours
- Associated headache, pain radiating to both shoulders and paraesthesia in hands
- Reduced lateral flexion
- Anterior longitudinal ligaments are torn causes dysphagia
- Forward flexion against resistance is painful
- 90% are asymptomatic after 2years
- 10% still have pain
- Some still claim money hence the need for proper documentations.